Minutes of evidence and appendices. Vol. 2, Evidence received in 1902-3, together with appendices 16 to 32, and index (Being part 2 of the Final report of the Commission) / Royal Commission on Arsenical Poisoning arising from the consumption of beer and other articles of food or drink.

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.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

And to be purchased, either directly or through any Bookseller, from
EYRE AND SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C.; and
32, ABINGDON STREET, WESTMINSTER, S.W.; or
OLIVER AND BOYD, EDINBURGH; or
E. PONSONBY, 116, GRAFTON STREET, DUBLIN.

1903.

[Cd. 1869.]

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 1903-4,

Appendices 16 to 32, and

[illegible]

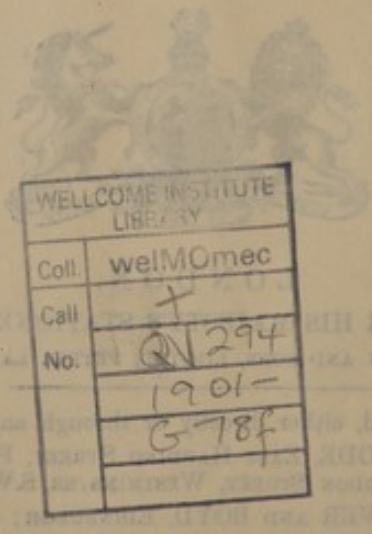


TABLE OF CONTENTS.

List of Witnesses, 1902-3 - - - - - - - - - - - - - iv

List of Appendices to Evidence, 1902-3 (Nos. 16 to 32) - - - - - vi

Minutes of Evidence, 1902-3 - - - - - - - - - - - - 1

Appendices to Evidence, 1902-3 (Nos. 16 to 32) - - - - - - - 181

Index - - - - - - - - - - - - - - - - - 363

Table of Equivalents (*Grains per lb. and Parts per million, &c.*) - - - - - 377

LIST OF WITNESSES, 1902–3.

Day.	Name.	Questions.	Pages.
19	Reynolds, Ernest S., M.D., F.R.C.P., Assistant Physician to the Manchester Royal Infirmary; Visiting Medical Officer to the Manchester Workhouse Infirmary. (*Recalled*)	8287–8462	1–8
19	Angell, Arthur, Consulting and Analytical Chemist; Public Analyst for the County of Hants, &c.	8463–8627	8–13
20	Smith, H. Hammond, M.R.C.S., L.R.C.P., Assistant Commissioner. (*In reference to Halifax Inquiries*)	8628–8847	14–29
21	Thompson, Geo. S., Manager to Messrs. Whitaker's Brewery, Halifax	8848–9089	32–37
21	Neech, James T., M.D., D.P.H., Medical Officer of Health of the Borough of Halifax	9090–9265	37–42
21	Buckley, F., Managing Director of Messrs. Webster and Sons' Brewery, Halifax	9266–9419	42–45
21	Worsick, A., Maltster, of Elland, Yorks - -	9420–9490	45–47
22	Woodyatt, John F., M.R.C.S., L.R.C.P., Medical Officer at the Halifax Union Poor Law Hospital	9491–9653	48–54
22	Thomson, William, Consulting and Analytical Chemist, Manchester; Public Analyst for Stockport	9654–9815	54–62
22	Fairley, Thomas, Consulting and Analytical Chemist and Public Analyst, Leeds	9816–9923	62–66
23	Moulton, J. Fletcher, K.C., M.P., F.R.S., Chairman of the Expert Committee of the Manchester Brewers' Association	9924–9963	67–70
23	Salamon, Alfred Gordon, Consulting and Analytical Chemist; Member of the Expert Committee of the Manchester Brewers' Association. (*Recalled*)	9964–10091	71–77
24	Hehner, Otto, Consulting and Analytical Chemist; Public Analyst for Nottinghamshire, West Sussex Derby, &c.; Chairman of the Joint Committee of the Societies of Public Analysts and Chemical Industry on Tests for Arsenic. (*Recalled*)	10092–10225	78–83
24	Chapman, Alfred C., F.C.S., Consulting Brewers' Chemist, &c.; Hon. Sec. of the Society of Public Analysts, Member of the Joint Committee of the Societies of Public Analysts and Chemical Industry on Tests for Arsenic.	10226–10372	83–89
24	Delépine, Sheridan, M.B., C.M., Professor of Pathology at the Owens College, Manchester. (*Recalled*)	10373–10439	89–98

LIST OF WITNESSES—*continued.*

Day.	Name.	Questions.	Pages.
25	Ling, Arthur R., Analytical and Consulting Chemist; Hon. Sec. of the London section of the Society of Chemical Industry; Editor of the Journal of the Federated Institutes of Brewing	10440–10708	98–109
25	Beaven, Edwin S., Maltster, of Warminster, Wilts.	10709–10910	109–116
26	Smith, H. Hammond, M.R.C.S., L.R.C.P., Assistant Commissioner. (*In reference to his Report on Arsenic in Foods, &c.*)	10911–11027	116–121
27	Lyle, Charles, Messrs. Abram Lyle and Co., Sugar Refiners, &c., London	11028–11160	122–126
27	Howell, Reginald; Messrs. Stevenson and Howell, Chemical Manufacturers and Merchants, London	11161–11259	126–129
27	Overbeck, Otto, Brewery Manager and Food Manufacturer, Grimsby	11260–11307	129–131
27	Walker, Norris, Manager Messrs. Castell and Brown, London	11308–11361	131–132
27	Pronk, E. Itterson, Messrs. Pronk, Davis and Co., Colour Manufacturers, London	11362–11455	132–135
2	Palmer, A. E., Messrs. Palmer Brothers, Cake and Biscuit Manufacturers, Bristol	11456–11496	135–136
28	Lithiby, John, LL.B., Assistant Secretary, Local Government Board	11497–11653	136–148
28	Thorpe, Thomas E., C.B., F.R.S., Principal of the Government Laboratory	11654–11737	148–151
28	Legge, Thomas M., M.D., H.M. Medical Inspector of Factories, Home Office	11738–11843	151–157
29	Primrose, Sir Henry W., K.C.B., C.S.I., Chairman of the Board of Inland Revenue. (*Recalled*)	11844–11967	158–166
29	Allen, Alfred Henry, Consulting and Analytical Chemist, Public Analyst for the West Riding of Yorkshire, the City of Sheffield, &c.	11968–12077	166–174
29	Voelcker, John A., M.A., B.Sc., Ph.D., Consulting Chemist to the Royal Agricultural Society of England	12078–12163	174–180

LIST OF APPENDICES TO EVIDENCE, 1902-3.

Appendix Number.	Subject of Appendix.	Pages.
16	Rat Experiments.	183–195
	Report on Experimental Investigations upon the action of Arsenical Beer and other Arsenical Solutions administered in large quantities to Rats. By Professor S. Delepine, M.B., C.M. *See* Q. 10,374, 10,378-10,424.	
17	Epidemic of 1900 and Birth Rate, 1901.	196–198
	Memorandum on the Apparent Relation between the Outbreak of Arsenical Poisoning in Manchester in the year 1900 and the Drop in the Birth Rate for 1901. By Mr. J. Niven, M.B.	
18	Malt Kilns in Relation to Arsenic.	199
	Memorandum in supplement to his evidence on June 20th, 1902. By Mr. E. S. Beaven. *See* Q. 10,713-34. 10,782-10,849.	
19	Final Report of Brewers' Expert Committee.	201–205
	Final Report of the Expert Committee appointed by the Manchester Brewers' Association; presented by Mr. J. Fletcher Moulton, K.C., M.P. *See* Q. 8,928-9,938, 10,025-10,035.	
20	Report of the Joint Committee on Tests for Arsenic.	206–207
	Report of the Joint Committee of the Societies of Public Analysts and Chemical Industry, on the Detection and approximate Estimation of minute quantities of Arsenic in Beer, Brewing Materials, Food-stuffs, and Fuels; presented by Mr. Otto Hehner, F.I.C., and Mr. A. C. Chapman, F.I.C. *See* Q. 10,094-10,145, 10,226-98, 10,371-2, 10,469, 11,976, &c.	
21	Report of the Inland Revenue Departmental Committee.	208–219
	Report of the Departmental Committee appointed by the Board 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; presented by Sir Henry Primrose, K.C.B., C.S.I. *See* Q. 11,654-11,737, 11,896-11,967.	
22	Report on Tests for Arsenic in Foods and other Substances.	220–226
	Report on the Methods employed in Testing for Arsenic various samples of Foods and other substances (not including Fuel) received from the Commission. By Mr. G. McGowan, Ph.D. and Mr. R. S. Finlow, B.Sc.	

Appendix Number.	Subject of Appendix.	Pages.
23	Report on Tests for Arsenic in Fuels.	227–229
	Report on experimental work done in connection with the Estimation of Arsenic in Fuel, and on methods employed in the Examination of Fuel Samples for the Commission; by Mr. G. McGowan, Ph.D., and Mr. R. B. Floris, A.I.C.	
24	Mr. Hammond Smith's Report.	230–259
	Report on Inquiries made for the Commission as to the Liability of Articles of Food and Drink (other than beer) to be contaminated by Arsenic; by Mr. H. Hammond Smith, M.R.C.S., L.R.C.P. *See* Q. 10,911-11,027.	
25	Reports on Examination for Arsenic of various substances submitted in connection with Mr. Hammond Smith's inquiry; by Mr. G. McGowan, Ph.D.	261–275
26	Letters from Mr. J. N. Beach, Secretary to the Maltine Company. *See* Q. 11,496.	276
27	Arsenic in Colouring Matters.	277
	Letter on the Arsenical Contamination of certain Foods through the use of Mineral and Other Colouring Matters; by Mr. Otto Hehner, F.I.C., &c. *See* Q. 7,931 (Vol. I.) and 10,210 (Vol. II.).	
28	Alleged Addition of Mineral Acid to Whisky and Gin.	278–279
	(1) Report on examination of samples of Whisky and Gin obtained from twelve public-houses in the East End of London; by Mr. G. McGowan, Ph.D.	
	(2) Information furnished by the London County Council on the result of Examination of Spirits for Mineral Acid and Arsenic by Analysts of London Borough Councils.	280
29	Arsenic in Enamel of Cooking Utensils.	
	(1) Account of the Inquiries instituted by the Commission, and their results.	281–285
	(2) and (3) Report on examination of certain Enamelled Cooking Utensils for Arsenic; by G. McGowan, Ph. D. *See* Q. 11,008-23.	
30	Reports on Malting Anthracite.	
	(1) Account of the Inquiries instituted by the Commission, and Summary of the Results obtained, with tables.	286–297
	(2) Notes on Inquiries as to Anthracite used by certain Maltsters; by Mr. H. Hammond Smith, M.R.C.S., L.R.C.P.	298
	(3) Notes on Visits made to certain South Wales Collieries supplying Malting Anthracite; by Mr. A. Strahan, F.R.S. (District Geologist) of H.M. Geological Survey.	299–307

Appendix Number.	Subject of Appendix.	Pages.
	Reports on Malting Anthracite—*continued.*	
	(4) Report on Collection of Samples from Anthracite Collieries in South Wales; by Mr. S. Warren Price, M. Inst., Min. Eng., F.G.S., &c.	308–310
	(5) 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 Mr. G. McGowan, Ph.D.	311–321
	(6) Account of two experiments at Newark Maltings.	322–325
31	Reports on Beri-beri in Relation to Arsenic.	
	(1) Account of the Inquiries instituted by the Commission and the results obtained.	326–33
	(2) Report on the Examination of Foods and other substances submitted in connection with the beri-beri inquiry; by Mr. G. McGowan, Ph.D.	335–344
32	Reports on Arsenic in Hair.	
	(1) Account of the Inquiries instituted by the Commission, and Summary of the results obtained with tables (1-2).	345–350
	(2) Report on the Methods adopted in testing for Arsenic specimens of Hair submitted by the Commission; by Mr. R. F. Wood Smith.	351
	(3) Detailed tabular statement of results (Tables A to F).	351–362

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. E. S. Reynolds.

7 Mar. 1902.

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.

Cessation of arsenical symptoms in Manchester since 1900.

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.

Less "alcoholic heart,"

herpes,

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.

and pigmentation.

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,

Dr. E. S. Reynolds.
7 Mar. 1902.

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 ·003 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.

Dr. E. S. Reynolds.
7 Mar. 1902.

Tuberculosis among epidemic cases.

8316. (*Dr. Whitelegge.*) Was consumption of recent origin in those 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.

Sites of pigmentation.

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.

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 those 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.

Dr. E. S. Reynolds.

7 Mar. 1902.

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.

Of 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.

Of 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.

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.

Rarity of neuritis caused by alcohol.

Alcoholic neuritis in Manchester and in other towns compared.

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 find 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

Dr. E. S. Reynolds
7 Mar. 1902.

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

Dr. E. S. Reynolds.
7 Mar. 1902.

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.

and in urine

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.

1/100 grain arsenic per gallon of beer would probably do no 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

Dr. E. S. Reynolds.

7 Mar. 1902

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.

Tolerance of arsenic.

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.

Beri-beri and arsenic.

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.

Dr. E. S. Reynolds.

7 Mar. 1902.

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.

Dr. E. S. Reynolds.

7 Mar. 1902.

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,

Symptoms.

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.

Dr. E. S. Reynolds.

7 Mar. 1902.

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

Dr. E. S. Reynolds.
Mar. 1902.

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.

berculosis cases of enical isoning.

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.

lifax tbreak.

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.

Dr. E. S. Reynolds.
7 Mar. 1902.

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 $As_2 O_3$ 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 comingj from nothing.

Dr. E. S. Reynolds.
7 Mar. 1902.

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.

Dr. E. S. Reynolds.
7 Mar. 1902.

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.

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.

Using arsenicated manure;

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

Mr. A. Angell. 7 Mar. 1902.

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. Hebner 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?

Type of Marsh mirror obtained depends upon acid used.

(*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 Hebner-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.

Preliminary treatment of plant substance.

8490. Does your use of the Hebner-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 sufficiency.

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.

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 plan 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 25:

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.

Mr. A. Angell.

7 Mar. 1902.

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.

Application of arsenicated manure.

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.

Weight of plant substance tested.

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.

No arsenic in ripened grains:

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

Mr. A. Angell. 7 Mar. 1902

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.

Such arsenic not necessarily assimilated.

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.

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.

Amount of arsenic in commercial superphosphates much less than in experimental manures.

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.

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.

Mr. A. Angell. 7 Mar. 1902

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.

Quantity of superphosphate usually applied to land.

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.

Distance of arsenicated manure from plants.

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.

Importance of ascertaining effect of destruction of organic matter;

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.

8628. (*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. 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.

Details of Infirmary cases.

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.

McNulty.

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.

Shearing.

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.

Whalan.

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).

Mr. H. H. Smith.
21 Mar. 1902.

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. 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.

Mr. H. H. Smith. 21 Mar. 1902.

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.

Mr. H. H. Smith. 21 Mar. 1902.

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"	Porters	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"		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

Arsenic in Halifax beers: Mr. Richardson's results.

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 166—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.

Mr. Allen's.

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:—

Date of Collection of Sample.	Number of Sample.	Public-house.	Brewer.	Result.
24 January 1902	183	"Duke of Leeds"	Bentley and Shore	$\frac{1}{150}$ grain per gallon, about.
24 „ „	184	"Prescott Arms"	Yorkshire Brewery Company	„ „ „ „ „
24 „ „	185	"London Tavern"	S. Webster and Son	$\frac{1}{70}$ „ „ „ „
24 „ „	186	"Mechanic's Arms"	Halifax Brewery Company	$\frac{1}{150}$ „ „ „ „
24 „ „	187	"Kimberley Arms"	Boardmans	Free from arsenic.
24 „ „	188	"Mitre Hotel"	Stocks's	No arsenic detected.
24 „ „	189	"Westgate Hotel"	Aspinall, Halifax	$\frac{1}{150}$ 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.	$\frac{1}{70}$ 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.

Mr. Ackroyd's.

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 yeer. 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 Berzelius test recommended by the Committee of the Societies of Chemical Industry and Public Analysts.

Excise officers sent samples from breweries after outbreak.

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.

Attitude of Halifax Brewers.

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.

Mr. H. H. Smith. 21 Mar. 1902.

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.

Mr. H. H. Smith. 21 Mar. 1902.

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. Similarily 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.

Mr. H. H. Smith.
21 Mar. 1902.

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 16th, 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.

Mr. H. H. Smith. 21 Mar. 1902.

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.

Mr. H. H. Smith. 21 Mar. 1902.

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 ¼th 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

Mr. H. Smith. Mar. 1902.

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.

H. H. Smith. 21 Mar. 1902.

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

Mr. H. H. Smith.
21 Mar. 1902.

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.

Mr. H. H. Smith.
21 Mar. 1902.

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.

1-30th grain arsenic per lb. in Mr. Firth's malt previously.

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.

Arsenical malt capable of explaining arsenic in implicated beer.

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.

Mr. H. Smith.
21 Mar. 1902.

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.

00-01 lts more enical an those 1901-02.

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.

00-01 alts used implicated ews.

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.

Mr. H. H. Smith.
21 Mar. 1902.

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.

Mr. H. H. Smith. 21 Mar. 1902.

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.

(*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.

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.

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.

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.

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.*)

Wood-'s opinion ase of Nulty.

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

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?

(*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.

May be little hand-picking of anthracite at maltster.

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.

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.

Maltsters who continue to use gas coke.

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

Mr. H. Smith. Mar. 1902.

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.

arantees ven with thracite ecify "free- m from senic."

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.

ture and lue of arantees tained by wers and ltsters.

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 Tharpe.*) 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.

Mr. H. H. Smith. 21 Mar. 1902.

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.

No samples of beer taken under F. and D. Acts in Halifax during 1901.

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.

Or at Huddersfield.

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.

Halifax Public Analyst uses test first recommended by Brewers' Expert Committee.

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.

No action to arsenic by local excise officers before outbreak.

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. H. Smith.

1 Mar. 1902.

epresenta-ions made o Coroner n behalf of rewer.

arge mount of rsenic in regs of asks.

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.

Mr. H. H. Smith.

21 Mar. 1902.

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

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.

Halifax outbreak, 1902.

Beers, &c., examined at the Government Laboratory.

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.

21 Mar. 1902.

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.

One sample was examined, and found to be free from arsenic.

21 Mar. 1902

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	–	–	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.

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.

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.

Halifax outbreak, 1902.

One sample of ground malt (marked No. 1), prepared by Firth and Blackman. This contains 1-200th grain of arsenious oxide per lb.

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.

Arsenic in urine of Halifax patients.

Samples of urine from patients in the Halifax Infirmary, sent by Dr. Smith:—

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 190

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.

8851. 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 *précis* 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.

Mr. G. S. Thompson.
11 April 1902.

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.

recent
nge in
ir
struction.

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.

shing of
lt.

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.

cent
cautions
inst
enic.

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.

lting fuels
d.

8902. Better fuel for malting?—Yes.

Mr. G. S. Thompson.
11 April 1902.

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.

Mr. G. S. Thompson.

11 April 1902.

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 of 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.

Mr. G. S. Thompson.

11 April 190

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.

Temperatu 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.

Mr. G. S. Thompson.

11 April 1902.

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.

Construction of malt 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.

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.

Necessity of cleansing girders, &c.

9017. From time to time unless those girders are looked to that dust will fall down?—Those girders are cleaned.

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.

Extent of analyses since 1901.

9023. You had a chemist you told us since 1901?—Yes.

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-

Mr. G. S. Thompson.
11 April 1902.

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.

Mr. G. S. Thompson.
11 April 190

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.

Mr. G. S. Thompson.

11 April 1902.

Brushing malt.

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.

Mr. J. T. Neech, M.D., D.P.H.

JAMES THOMAS NEECH, M.D., D.P.H., Medical Officer of Health, called; and Examined.

Halifax outbreak.

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.

Observations on Mr. H. Smith's report.

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.

Notes of five additional cases.

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.

Dangerous quantities of arsenic in beer.

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.

Mr. J. T. Neech, M.D., D.P.H. — 11 April 1902.

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.

Mr. J. T. Neech, M.D., D.P.H. — 11 April 1902.

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

Mr. J. T. Veech, M.D., D.P.H.

11 April 1902.

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.

McNulty's case.

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.

Dr. Woodyatt's evidence.

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."

Mr. J. T. Veech, M.D., D.P.H.

11 April 1902.

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.

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.

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.

Mr. Ackroyd's later report.

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.

M.O.H.'s inquiries outside borough.

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.

Given facilities by Halifax brewers.

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.

No powers to take malt under Food and Drugs Acts.

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. Whiteleggе.*) 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.

Samples taken by M.O.H. at breweries, &c.

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.

M.O.H's report to Town Council.

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.

M.O.H. no knowledge as to new kilns.

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.

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.

Power to take samples of malt.

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.

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.

Effect of sediment on analytical results.

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.

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.

Mr. J. T. Neech, M.D., D.P.H.

11 April 1902.

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.

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. Helmer, 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 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. F. Buckley.

11 April 1902.

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.

Kinds of fuel used.

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.

Advantage of anthracite.

9294. In what respect better?—We found the results better in our malts when we have examined them afterwards.

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.

Analyses differing.

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.

Mr. F. Buckley.

11 April 1902.

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 burned?—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.

Analyses differing.

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.*

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.

Mr. F. Buckley. 11 April 1902.

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.

Mr. F. Buckley. 11 April 1902.

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.

Mr. Buckley.

April 1902.

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.

ds of fuel d.

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.

s coke ndoned.

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.

rewery's emist is ublic alyst.

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.

Mr. F. Buckley.

11 April 1902.

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. If 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.

Halifax outbreak.

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.

Evidence in respect of Worsick's maltings.

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

Mr. A. Worsick. 11 April 1902.

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.

Mr. A. Worsick. 11 April 190

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.

Precaution have reduc 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 unsat factory.

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 26th, 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 ga coke use 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.

9480. Do you clear out the kilns?—Yes.

and their cleansing.

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.

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 ca

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

Mr. J. F. Woodyatt.

17 April 1902.

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.

Mr. J. F. Woodyatt.
17 April 1902.

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.

Mr. J. F. Woodyatt.
17 April 1902.

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 coroner as cause of L 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-

Mr. J. F. Woodyatt. 17 April 1902.

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.

Whalan. Reasons for considering he had pernicious anæmia"

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.

Mr. J. F. Woodyatt. 17 April 1902.

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

Mr. J. F. Woodyatt. 17 April 1902.

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.

Mr. J. F. Woodyatt. 17 April 1902.

Diagnosis of "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.

although evidence of arsenical poisoning.

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.

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,

Mr. J. F. Woodyatt. 17 April 1902.

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.

r. Mantle's inion of Whalan's se.

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.

ases not eported to M.O.H.

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.

Mr. J. F. Woodyatt. 17 April 1902.

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.

Mr. J. F. Woodyatt.

17 April 1902.

Whalan.

9651. And you only fill up one habitually?—I very often put a primary and secondary cause.

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.

Recent analyses arsenic beer, ma and brew ingredie

9665. And also as regards Yorkshire and other districts?—Yes.

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.

Mr. Thomson. 17 April 1902.

Mr. W. Thomson. 17 April 1902.

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.)

	$\frac{1}{10}$ inclusive to $\frac{2}{10}$ exclusive.	$\frac{2}{10}$ to $\frac{3}{10}$	$\frac{3}{10}$ to $\frac{4}{10}$	$\frac{4}{10}$ to $\frac{5}{10}$	$\frac{5}{10}$ to $\frac{6}{10}$	$\frac{6}{10}$ to $\frac{7}{10}$	$\frac{7}{10}$ to $\frac{8}{10}$	$\frac{8}{10}$ to $\frac{9}{10}$	$\frac{9}{10}$ to $\frac{10}{10}$	$\frac{10}{10}$ to $\frac{11}{10}$	Free (*i.e.* less than $\frac{1}{10}$).	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.

15 January 1902.

Mr. W. Thomson. 17 April 1902.

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;

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.

destruction of organic matter.

Mr. W. Thomson. 17 April 1902.

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

Mr. W. Thomson. 17 April 1902.

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).

Arsenical malts.

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.

Greater use of anthracite in Lancashire.

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.

Fumes of fuel should not pass through malt.

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.

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.

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.

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

Mr. Thomson. 17 April 1902.

Preparation of hydrochloric acid.

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.

Preparation of sulphuric acid free from arsenic.

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.

Object of destroying organic matter.

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.

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.

Improvement in beer and malt in 1902.

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:—

Mr. W. Thomson. 17 April 1902.

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.

Mr. W. Thomson. 17 April 1902.

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 1/150	1/150 to 1/200	Free (i.e. less than 1/200).	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 these 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?

Mr. Thomson.

April 1902.

periments brewer to lude es from lt.

et of shing bably ll.

know- ge of posal of enical r.

enic in hracite.

upling l.

enic in cory.

liquorice,

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 " "

Mr. W. Thomson.

17 April 1902.

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. 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

Mr. W. Thomson. 17 April 1902.

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 on 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.

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. W. Thomson. 17 April 190

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.

at outside 1-50th grai

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. — 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.

Mr. T. Fairley. — 17 April 1902.

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.

er samples. antities imated by rsh test.

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.

Mr. T. Fairley.
17 April 1902.

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 kiln

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.

Mr. Fairley. — April 1902.

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 knew?—That is all I knew.

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.*)

Mr. T. Fairley. — 17 April 1902.

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

Mr. T. Fairley.

17 April 1902.

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.

Mr. T. Fairley.

17 April 1902.

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.

Importance of cleansing 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 in Halifax bee

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., 1895, 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. Moulton, K.C., M.P.

Mr. F. Moulton, K.C., M.P.

9 May 1902.

Mr. FLETCHER MOULTON, K.C., M.P., called; and Examined.

9 May 1902.

nchester pert Com- tee and work.

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.

nergency ecautions eded at st.

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

Mr. F. Moulton, K.C., M.P. — 9 May 1902.

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 made 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.

Mr. F. Moulton, K.C., M.P. — 9 May 1902.

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 and the recommendations 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 danger now from brewing sugars.

Malt less certain

Advantage and limitations of "guarantee"

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 digs 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

Mr. F. Moulton, K.C., M.P.

9 May 1902.

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.

Need for official tests for ingredients which can be easily applied.

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.

Relation of such tests to official tests for beer.

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.

Mr. F. Moulton, K.C., M.P.

9 May 1902.

9944. (*Professor Thorpe.*) They come under the Act of 1899; anything which enters into the composition of food is *ipse 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.

The duty of manufacturers should be defined.

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.

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

Mr. F. Moulton, K.C., M.P.

9 May 1902.

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.

Mr. F. Moulton, K.C., M.P.

9 May 1902.

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 those 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.

Mr. A. G. Salamon. — Mr. Alfred Gordon Salamon, re-called; and Examined. — Mr. A. G. Salamon. 9 May 1902.

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.

wn to 1-50 in exclud- by Expert mmittee's t test.

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.

50th can e be ained by ewer.

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.

er now dom tains 100th.

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.

arsh test eferable skilled emists.

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.

nsuited for mall rewers.

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 maltster 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. — Reinsch test recommended for unskilled use.

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.

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. — Government Laboratory control over beer advocated.

Mr. A. G. Salamon.

9 May 1902.

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 limed.

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 malt

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 i systematic analysis of 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 n 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.

Governmen 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

Mr. A. G. Salamon.

9 May 1902.

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.

ests might e applied to ort.

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.

nprovement recent alts.

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,

Mr. A. G. Salamon.

9 May 1902.

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.

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.

Mr. A. G. Salamon.

9 May 1902.

Affinity of culms for arsenic.

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.

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. 9 May 1902.

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.

Mr. A. G. Salamon. 9 May 190

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.

Mr. A. G. Salamon.

9 May 1902.

Government Laboratory should control beer through local authorities.

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.

Prohibition of arsenical acid.

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.

Mr. A. G. Salamon.

9 May 1902.

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, 13th 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.

Mr. O. Hehner. 13 June 1902.

Question of electrolytic method of applying the 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.

Zinc.

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.

Mr. O. Hehner.
3 June 1902.

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.

Agreement that Marsh-Berzelius test should be used.

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.

Reinsch test.

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.

Advantages of Marsh-Berzelius.

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.

Purification of acid.

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.

Mr. O. Hehner.
13 June 1902.

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.

Objections to "blunt method."

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.

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.

Beer easily made with less than 1-100th grain per gallon.

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.

Absolute freedom not quite certainly obtainable.

10124. You think that absolute freedom cannot with certainty be obtained?—I think not; it could be often obtained, but not quite certainly.

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.

Objections to Reinsch test for beer and malt

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.

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

Mr. O. Hehner.

13 June 1902.

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.

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.

recommended 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.

Mr. O. Hehner. — 13 June 1902.

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.

fficial limit permissible arsenic cessary.

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

Mr. O. Hehner.

13 June 1902.

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.

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.

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.

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.

Objections to giving special report in such cases.

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.

New samples of beer now taken for public analysis.

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.

Arsenic in beet sugar;

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.

In mineral colours.

10211. In considerable amount?—Yes, 1-10th of a gramme gave a very dense mirror.

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.

Organic matter of stale beer should be destroyed.

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. 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.

Report of Arsenic Committee of Societies of Pub. Anal. and Chem. Ind.

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.

13 June 1902.

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.

Mr. A. C. Chapman.

13 June 1902.

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.

Addition of metallic salts may impair sensiveness.

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.

Mr. A. C. Chapman.

13 June 1902.

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.

Destroys organic matter both in beer and malt.

10262. What is your practice with regard to the destruction of organic matter?—I destroy the organic matter in all cases.

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.

Uses sulphuric acid.

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.

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.

As brewer's chemist, accepts Committee's test.

10272. As a brewer's chemist, you accept the committee's method as a good one?—Most certainly I do.

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.

Its delicacy.

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.

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

Mr. A. C. Chapman.

13 June 1902.

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.

Mr. A. C. Chapman.

13 June 1902.

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.

10297. And probably they have not been in the habit of testing those 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.

Destroys organic matter in testing worts.

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.

Advantage in applying official test to wort, not to finished beer.

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.

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

Mr. A. C. Chapman.
13 June 1902.

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.

Mr. A. C. Chapman.
13 June 1902.

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.

Mr. A. C. Chapman.

3 June 1902.

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-[illegible]th I should obviously have no hesitation.

Mr. A. C. Chapman.

13 June 1902.

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.

Professor Delepine.

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.

Quantity of arsenic which beer may get from 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.

Experimental brewing.

Quantitative use of Reinsch's test; further details.

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 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 3¼mm.. ¼ 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

Professor Delepine.
13 June 1902.

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.

Professor Delepine.
13 June 1902.

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.

Professor Delepine. — 13 June 1902. — of insoluble arsenical compound.

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:—

Professor Delepine. — 13 June 1902. — 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.

Professor Delepine. 13 June 1902.

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.

Professor Delepine. 13 June 1902.

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).

Professor Delepine.

13 June 1902.

I. *Wort inseminated with a few spores of* penicillium glaucum, *and kept at a temperature of* 25°C.

Professor Delepine.

13 June 1902

	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 - - - ?

Professor Delepine. 13 June 1902.

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 and 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.

Professor Delepine.

13 June 1902.

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.

eductions regards man subject.

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.

ffect of food.

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.

rsenic etter tolerated when beer than water.

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

Professor Delepine. 13 June 1902.

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.

Professor Delepine. 13 June 1902.

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 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.

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. Hehner 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

Professor Delepine. 13 June 1902.

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.

Professor Delepine. 13 June 1902.

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. ARTHUR R. LING, called; and Examined.

Mr. A. R. Ling. 20 June 1902.

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 invariably present.

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.

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.

Mr. A. R. Ling. 20 June 190

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.

Mr. R. Ling.

June 1902.

arsenic ained en fuel ited with e.

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.

enic lly esti- ted by enic com- tee's thod.

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.

Mr. A. R. Ling.

20 June 1902.

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.

Addition of lime to fuel on kiln.

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.

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.

Extraction of ignited residue.

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.

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.

Residue is now oxidised.

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.

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.

Mr. A. R. Ling. 29 June 1902.

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 *quâ* 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 $\frac{1}{4}$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 1$\frac{3}{4}$ grains per lb. of total arsenic were found in the slate.

Mr. A. R. Ling. 20 June 1902.

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 cannot always be judged by 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.

Mr. A. R. Ling. 20 June 1902.

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.

ormerly hought an dvantage or malting.

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 8d. 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.

ifficulty of electing nthracite by nalysis only.

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.

Mr. A. R. Ling. 20 June 1902.

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.

Less arsenic lately in malting anthracite.

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.

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.

Calculated amount of arsenic in anthracite which may reach malt.

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.

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.

Analysis of fuel.

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.

Mr. A. R. Ling. 20 June 1902.

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	1¼rd
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.

Mr. A. R. Ling. 20 June 1902.

V.—ARSENIC IN MALTS DRIED WITH LIMED COKE—AMOUNT OF ARSENIC IN THE COKE UNKNOWN. INSTRUCTIONS GIVEN, BUT NO PERSONAL SUPERVISION EXERCISED.

Mr. A. R. Ling 20 June 1902. 2

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.

Mr. A. R. Ling. 20 June 1902.

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 of 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 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.

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 in 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 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

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.

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 base.

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 base.

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 fuel and treatmen

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 limed coke, previously selected and analysed; in fact,

Mr. A. R. Ling.
20 June 1902.

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.

Arsenic in glucose.

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.

Organic matter of beer should be destroyed if sulphuric acid used.

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.

Sulphide of arsenic in Marsh apparatus.

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.

Mr. A. R. Ling.
20 June 1902.

Iron impairing Marsh estimations.

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 practicsily 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.

10557. You are aware that spent pyrites may be highly arsenical?—Yes.

10558. They may contain a large proportion of the arsenic?—Yes, they must.

10559. That is proof, of course, that the oxide of iron does act in that direction?—Yes, it is.*

Royalty on liming process.

10560. (*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.

Handpicking of anthracite.

10561. 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.

Mr. A. R. Ling. 20 June 1902

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.

Mr. A. R. Ling. 20 June 1902

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 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.

Mr. A. R. Ling. 20 June 1902.

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.

Formation of pyrites.

(*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.

(*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?

Mispickel.

(*Professor Thorpe.*) Mispickel is the mineralogical name given to this definite product.

(*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?

And marcasite.

(*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.

Mr. E. S. Beaven, called; and Examined.

Mr. E. S. Beaven.

10709. (*Chairman.*) You have been engaged in the management of maltings for 25 years, I think?—Yes.

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.

Arsenic in furnace gases mostly condensed before reaching malt.

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.

Mr. E. S. Beaven.

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.

Construction of kiln and velocity of gas important.

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 gas in which reaches the malt will be minute, according to my experience.

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

Mr. E. S. Beaven. 20 June 1902.

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.

Mr. E. S. Beaven. 20 June 1902.

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.

Mr. E. S. Beaven.
20 June 1902.

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 pyridine, 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.

Mr. E. S. Beaven.
20 June 1902.

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

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.

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.

Mr. E. S. Beaven. — June 1902.

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.

ndensed enic might be inter- ted,

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.

ough its division.

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.

e of lime.

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.

Mr. E. S. Beaven. — 20 June 1902.

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

Mr. E. S. Beaven.

20 June 1902.

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.

Mr. E. S. Beaven.

20 June 1902.

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.

Mr. E. S. Beaven.

20 June 1902.

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.

Mr. E. S. Beaven.

20 June 1902.

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.

Mr. E. S. Beaven.
20 June 1902.

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.

Mr. E. S Beaven.
20 June 1902.

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.
Sir WILLIAM CHURCH.
Professor THORPE.
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.

Mr. H. H. Sm
31 Oct. 19
or may no

B.P. requ
ments
uncertain
safeguard
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.

Pharmac
poeial su
stances
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

Mr. H. H. Smith.

31 Oct. 1902.

exception, because in that case a quantitative limit of arsenic is fixed by a special test in the British Pharmocopœia. 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.

Lanoline.

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.

Manufacturer often ignorant of risk from arsenic in ingredients.

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.

Mr. H. H. Smith.

31 Oct. 1902.

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.

Official safeguards against arsenic in ingredients.

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.

and in finished foods, insufficient.

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.

Possible inspection of food manufacturer.

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.

Imported foods.

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

Mr. H. H. Smith. 31 Oct. 1902.

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.

Mr. H. H. Smith. 31 Oct. 1902.

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 manufacture

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.

Analogy of margarine factory.

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.

Arsenic in coal tar colours.

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.

Ingredients requiring precautions against arsenic.

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.

Bostock's table syrup.

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.

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

Mr. H. H. Smith. 31 Oct. 1902.

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.

Mr. H. H. Smith. 31 Oct. 1902.

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.

Mr. H. H. Smith. 31 Oct. 1902.

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.

Arsenic in enamel of cooking pots.

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.

Mr. Albert Smith's results.

11009. You say he boiled some water in the enamelled pot with soda?—Yes.

11010. And he took arsenic out of the enamel?—Yes.

With Belgian ware.

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.

Not now used in British ware.

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.

Mr. H. H. Smith. 31 Oct. 1902.

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?—Those 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.

"Brewed temperance beverages."

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.

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.

Mr. C. Lyle. 21 Nov. 1902.

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.

11043. You think there is a distinction between the two?—I think that phosphoric acid is a little more apt to contain arsenic.

Mr. C. L. 21 Nov. 1

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.

Testsapp

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.

Questio for sulp acid us food.

11055. Do you think there would be any advantage in having a kind of fixed standard of purity as regards official 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

r. C. Lyle. — Nov. 1902.

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.

ringent cautions fore 1900.

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.

uestion of icial in- ection of factory.

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.

rsenic in est India gar,

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.

oidable.

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.

fficial limits arsenic in od gene lly,

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.

Mr. C. Lyle. — 21 Nov. 1902.

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.

Food might get arsenic from dust.

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.

Precautions before 1900.

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.

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.

Mr. C. Lyle.
21 Nov. 1902.

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.

Mr. C. Lyle.
21 Nov. 190

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.

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.

Does not 1 part arse in a millio of golden syrup.

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 offici limit shou 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.

Mr. C. Lyle. 1 Nov. 1902.

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.

Manufacturers safeguard is testing ingredients.

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.

Mr. C. Lyle. 21 Nov. 1902.

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.

Mr. C. Lyle. 21 Nov. 1902.

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.

Mr. R. Howell.

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.

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?—

Mr. R. Howell. 21 Nov. 1902.

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.

Limits of permissible arsenic in various substances.

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.

Mr. R. Howell. 21 Nov. 1902.

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.

Mr. R. Howell.

21 Nov. 1902.

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.

Mr. R. Howell.

21 Nov. 1902.

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.

Mr. R. Howell.

Nov. 1902.

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.

know-
lge of ar-
ic in Bole
menia.

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.

Mr. Overbeck.

11260. (*Chairman.*) I believe you come from Grimsby, do you not?—Yes.

11261. You invented a food called "Carnos"?—Yes.

rnos,

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.

de from
st and
lt culms.

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 scarce 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.

Samples called in on account of arsenic.

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.

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.

Arsenic in Carnos.

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

Mr. C. Overbeck. 21 Nov. 1902.

"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.

Would pass 1-25th grain per lb.

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.

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——

Mr. C. Overbeck. 21 Nov. 1902.

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.

No objection to samples being taken at factory.

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.

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

Mr. C. Oeerbeck.

21 Nov. 1902.

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.

Process for removing arsenic.

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 1080 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.

Mr N. Walker.

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.

Messrs Castell and Brown purchase golden syrup.

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.

do not test it.

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.*)

Guarantees shown.

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.

Mr N. Walker.

Glucose likewise

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.

No analysis considered necessary.

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

Mr. N. Walker.

21 Nov. 1902.

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.

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.

Mr. N. Walker.

21 Nov. 190

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.

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.

Mr. E. I. Pron

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 manufactu

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.

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.

Testing colours on purchase.

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.

Rejection of arsenical colours for food purposes.

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.

Arsenic in bole armenia.

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.

Tests made for firm.

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.

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.

Precautions are general.

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.

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.

Mineral colouring matters sold without knowledge of purity.

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.

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.

Objects to oxide of iron in food.

11406. Do you think it ought to be looked upon with suspicion?—Yes, I think it ought to be.

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.

Mr. E. I. Pronk.
21 Nov. 1902.

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.

Mr. E. I. Pronk.
21 Nov. 1902.

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.

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.

Mr. E. J. Pronk.
1 Nov. 1902.

No special precautions in selling for wall paper.

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.

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.

Mr. E. J. Pronk.
21 Nov. 1902.

Distribution of colours to butchers, &c.

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.

Cake manufacturer relies on guarantees for glycerine, and other ingredients.

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.

Occasional analyses by public analyst.

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.

Arsenic in Cream of Tartar substitute."

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.

Mr. A. E. Palmer.

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—1½lbs. 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.

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.

Should be standards available for manufacturer.

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.

Mr. A. E. Palmer. Nov. 1902.

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.

Mr. A. E. Palmer. 21 Nov. 1902.

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.
Sir William Church.
Professor Thorpe.
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

Mr. Lithiby.
Mar. 1903.

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 10,000 in excess of the number of samples analysed in 1899.

al
ples
en for
lic
lysis have
reased
ce 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.

Mr. J. Lithiby.
27 Mar. 1903.

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 and 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.

Mr. J. Lithiby.
27 Mar. 1903.

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:

Mr. J. Lithiby.
27 Mar. 190

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

Mr. J. Lithiby.

Mar. 1903.

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.

ndemna-
on of food
der Public
alth Acts.

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.

cal Acts.

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.

Mr. J. Lithiby.

27 Mar. 1903.

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

Mr. J. Lithiby.

27 Mar. 1903.

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:

Mr. J. Lithiby.

27 Mar. 1903.

"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.

Mr. J. Lithiby. 7 Mar. 1903.

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.

No authority with power to prohibit particular processes, &c., of food manufacture on ground of risk to health.

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.

No official memoranda or instructions to local authorities as to nature of samples to be taken.

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.

Mr. J. Lithiby. 27 Mar. 1903.

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.

Question of legislation to enable exercise of control over food manufacturer.

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

Mr. J. Lithiby. 27 Mar. 1903.

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.

Mr. J. Lithiby. 27 Mar. 1903.

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 commonsense 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

Mr. J. Lithiby
27 Mar. 1903.

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.

Court of Reference, if appointed, should advise an executive Government Department.

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.

No power of Medical Officer of Health or other officer of local authorities to enter food factory.

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.

Power of official entry for purposes of Factory Act.

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.

Mr. J. Lithiby.
27 Mar. 1903.

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

Mr. J. Lithiby. 27 Mar. 1903.

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.

Mr. J. Lithiby. 27 Mar. 1903.

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

Mr. J. Lithiby.

27 Mar. 1903.

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.

General increase in samples taken by local authorities under Sale of Food and Drugs Acts since 1899 largely represents milk and butter.

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.

Sale of Food and Drugs Acts principally a check against fraud.

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, 539 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.

Mr. J. Lithiby.

27 Mar. 1903.

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.

Mr. J. Lithiby.
27 Mar. 1903.

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.

Present powers of Medical Officer of Health and local authority as to arsenical food.

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.

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.

Mr. J. Lithiby.
27 Mar. 19

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 warrant 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

Mr. J. Lithiby. 27 Mar. 1903.

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.

Mr. J. Lithiby. 27 Mar. 1903.

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.

Mr. J. Lithiby. 27 Mar. 1903.

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.

Professor Thorpe.

27 Mar. 1903.

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.

Quantities of different materials prescribed for testing.

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.

Limit of delicacy according to quantity of substance taken.

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.

Electrolytic method now referred at Government laboratory.

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.

Professor Thorpe.

27 Mar. 1903.

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.

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

its relation to volatilisation on the kiln fire.

Professor Thorpe.

27 Mar. 1903.

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.

Professor Thorpe.

27 Mar. 1903.

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. Whiteleggc.*) 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

Professor Thorpe.
7 Mar. 1903.

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.

Professor Thorpe.
27 Mar. 1903.

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?—

Dr. Thomas M. Legge. 27 Mar. 1903.

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 haemoglobinuria.

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

Symptoms are of local irritation; neuritis rare.

They are local symptoms.

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.

Dr. Thomas M. Legge. 27 Mar. 1903.

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

Dr. Thomas M. Legge.

27 Mar. 1903.

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.

Number of men employed in making arsenical pigments.

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.

Report on arsenic workers in Cornwall;

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.

Dr. Thomas M. Legge.

27 Mar. 1903.

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.

Dr. Thomas M. Legge.

27 Mar. 1903.

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.

Facilities of entry given to officers of Government Departments.

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.

Dr. Thomas M. Legge.

27 Mar. 1903.

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 paperhanger 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 wallpaper, 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. 493-497.

Dr. Thomas M. Legge. Mar. 1903.

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. Gould†, 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.

Dr. Thomas M. Legge. 27 Mar. 1903.

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 anterior 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.

Dr. Thomas M. Legge.

27 Mar. 1903.

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.

Dr. Thomas M. Legge.

27 Mar. 1903.

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, ⅜" by ¼"	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, ⅛" by ¼"	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, ⅛" by ¼"	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.

F352-01 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

Sir H. Primrose.

April 1903.

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.)

Consequent instructions to Revenue officers.

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.

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.

Samples obtained from brewers using imported glucose if no warranty as to 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.

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.

Samples obtained from British manufacturers of glucose and invert.

(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 2/30 grain per lb. or 1/60 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	"	1-12th "
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 1903	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	8,641	Beer	1-80th "

Sir H. Primrose.
3 April 1903.

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.

Samples also taken of other brewing ingredients

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.

including malt.

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.

Prohibition of "malto-peptones"

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.

Sir H. Primrose.
3 April 1903.

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 your 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."

limited to particular specimens.

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.

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?

Sir H. Primrose.

3 April 1903.

(*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.

Sir H. Primrose.

3 April 190

in caramel;

11878. (*Chairman.*) It appears from Table 2 that the samples of caramel were largely arsenicated; they contain ¼ 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 ¼ 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

Sir H. Primrose.

3 April 1903.

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.

mount of senic in gredients a which tion might e taken.

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.

epart- ental Com- ittee on rsenic.

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.

Sir H. Primrose.

3 April 1903.

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

Sir H. Primrose. 3 April 1903.

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.

Sir H. Primrose. 3 April 1903.

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.

Sir H. Primrose. 3 April 1903.

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.

Departmental Committee's report and question of "standards."

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.

Prohibition by Treasury Order might be extended to arsenical malt.

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-

Sir H. Primrose. 3 April 1903.

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.

Sir H. Primrose. 3 April 1903.

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.

Mr. A. H. Allen.

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.

Mr. A. H. Allen.

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-

Mr. A. H. Allen.

3 April 1903.

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.

In fixing standard quantity a margin should be allowed for unavoidable differences in analysis.

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.

Form of public analysts' report on beer samples.

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.

Mr. A. H. Allen.

3 April 1903.

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

Mr. A. H. Allen.

3 April 1903.

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.

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.

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

Mr. A. H. Allen.

3 April 19

Reason of beer being seldom sen to public analyst before 190

Insufficie expert guidance local authoritie in collecti samples, under Sal of Food a Drugs Ac

More co-ordinatio work of public analysts desirable

Mr. A. H. Allen.

3 April 1903.

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.

Direction by Local Government Board insufficient.

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.

Quarterly reports of public analysts.

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.

Mr. A. H. Allen.

3 April 1903.

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

Mr. A. H. Allen.

3 April 1903.

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.

Mr. A. H. Allen.

3 April 190

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 frequentors 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.

Mr. A. H. Allen.

3 April 1903.

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.

No penalty for false descriptions.

Court of Reference.

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.

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.

Directions in which Sale of Food and Drugs Acts are unsatisfactory.

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.

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

Precautions against arsenic may become lax if no adequate official control.

Mr. A. H. Allen.

3 April 1903.

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.

Mr. A. H. Allen.

3 April 190

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 ove food manu facturer.

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 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, as

Mr. A. H. Allen.
3 April 1903.

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.

Court of Reference.

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.

Necessity for definitions.

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.

Mr. A. H. Allen.
3 April 1903.

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.

Beer should be well below 1-100th grain per gallon limit.

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.

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

Mr. A. H. Allen. 3 April 1903.

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?

Mr. A. H. Allen. 3 April 1903.

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.

Taking up of arsenic by farm crops. Experiments at Woburn.

12078. (*Chairman.*) I believe you have devoted yourself very much to the application of chemistry to agriculture?—I have.

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.

Dr. J. A. Voelcker.

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.

Dr. J. A. Voelcker. 3 April 1903.

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	"	—

Dr. J. A. Voelcker.

3 April 1903.

IV. Leaves of Swedes and Mangels, after cleaning and washing (to remove attaching soil, &c.). Crops under ordinary cultivation.

Dr. J. A. Voelcker.

3 April 1903.

	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 0·03 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 0·03 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 0·03 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 0·03 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

Dr. J. A. Voelcker.

3 April 1903.

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.

Difference as to arsenic between grain and green parts.

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.

Adherent soil.

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.

Pot culture experiments.

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.

Dr. J. A. Voelcker.

3 April 1903.

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 ·03 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;

Dr. J. A. Voelcker.

3 April 1903.

on plot 3, 3 cwt. of superphosphate per acre containing ·01 per cent. of arsenic; on plot 4, 5 cwt. of superphosphate per acre containing ·01 per cent. of arsenic; on plot 5, 3cwt. of superphosphate per acre, containing ·03 per cent. of arsenic; and on plot 6, 5cwt. of superphosphate per acre, containing ·03 per cent. of arsenic. I should make here a distinction which seems to me very necessary—in the case of the bulbs these were simply put in heaps, and they were scraped and cleaned, and topped and tailed, as the farmer ordinarily does, and then were brought down to the laboratory, where they were analysed—I have a laboratory at the farm itself. These bulbs were cleaned and washed just as I should clean and wash any other sample—for in fact this question of the mechanical attachment of the soil and other things had not been impressed upon me at that time, and it was only from my own results that this point subsequently came out so particularly. Similarly the leaves were allowed to lie on the ground, and the one sample of leaves that I got—this was from plot No. 3—had been lying on the ground, and they were simply brought in as they were, and they were just roughly brushed over and analysed. The result of these experiments was to show that in the case of the bulbs—whether no manure was used, or whether superphosphate made with pure acid was used, or whether varying quantities of superphosphate up to 5cwt. per acre containing ·03 per cent. of arsenic were used—in no case was there any perceptible amount of arsenic, any measurable quantity, in the bulbs, but, just as in the case of barley straw, the leaves did appear to retain a certain amount, for in the one sample of leaves that I examined I had as much as ·02—that is, 2-100ths of a grain per lb.

12121. Per lb. of the leaves?—Yes.

12122. Dried leaves?—Yes. That is an appreciable quantity. I regret now very much that this point about the apparent taking up of arsenic in the green parts of the leaf, and not in the fully matured parts, had not been impressed upon me before, and it was more accidentally than otherwise that I examined this one sample of leaves. I wish now that I had done the whole series; but that point did not then impress itself upon me, for the simple reason that a farmer practically ignores the leaves—they are left lying on the ground, and they are turned in as manure—they are not used as a regular food material. For the farmer's purpose really the only point he has to consider is whether the bulbs have got any quantity of arsenic in them or not. However, having got that one sample, and fortunately other crops being still in the land, I took the opportunity of going to other fields which were cultivated in the ordinary way, and where swedes and mangels were grown. I gathered the leaves of those crops, and took particular care to wash them well from all attached soil and other ingredients. My assistant wrote to me at the time and said that although to outward appearance the leaves, after a preliminary washing, looked quite clean, the quantity of dirt that was removed with careful scrubbing was astonishing. Examining the leaves then which were washed as well as one could ordinarily do it, I found that the quantity of arsenic in terms of grains per lb. in the dried leaves was enormously reduced from what I had previously obtained; in fact, it was about one-tenth only. The swede leaves from Great Hill had only ·002 grains of arsenic per lb. of dried leaves, whereas in the experiment already recorded they had ·02 or ten times as much. I confirmed this by taking the roots from another field. The swede leaves from Warren Field had ·004. I also took from that same field, Warren Field, which is heavy land, mangel leaves, and I found the quantity still less, namely, ·002. I think there is an explanation for this, namely, that the mangel leaf is a very much smoother leaf than is the swede, and it is possible to clean it very much more readily than the swede. I am afraid I have wearied you rather with details of these somewhat small matters; but agriculturally they have great importance, because they seem to me to show very clearly that where you have considerable quantities of arsenic recorded as being in the green plant, or in leaves, or in stems, I am convinced from these experiments that I have conducted that a great deal of it is owing to the mechanical attachment of materials, either soil or manure, which may contain the arsenic. The quantity actually taken up by the plant seems very small, even in the case of the green portions, and in the case of the matured portion, such as the barley grain, and the matured bulbs, it is practically negligible under the conditions of ordinary farming as practised in this country. In short, I should feel that no case whatever had been made out to lead one to think that the use of artificial manures, superphosphates in particular (that had been made by dissolving the raw materials with sulphuric acid, which might and does contain arsenic), would be in any way a source of danger as regards the subsequent products obtained from the farm.

Contamination by arsenic in adherent soil, &c.

Dr. J. A. Voelcker.

3 April 1903.

12123. Had the soil upon which your experiments were carried out been freely manured with superphosphates in previous years?—In the particular year in question no superphosphate had been used, but I should doubt whether there is any part of the farm that at some time or other has not had superphosphate upon it. In the ordinary course of farming there we should apply superphosphate once in four years—once in the rotation.

Previous manuring of experimental soil by superphosphates.

12124. Would a decoction of the soil be neutral or faintly alkaline?—It would depend entirely upon the soil and the treatment of it. I am, in fact, conducting experiments on that very question at the present time. The soil, I should say, of the lighter land is distinctly poor in lime; there is very little lime in it, and some of the land is distinctly acid—other parts of the land are neutral or alkaline.

12125. How do you account for some portions being slightly acid?—That is the particular experiment that I am working at now. I have for a number of years in succession been using ammoniacal salts in excess for the purpose of seeing at what rate the lime is removed from the soil, and I have got portions of the land to such a state that they will not bear a crop, because of the acid character of the soil.

12126. (*Dr. Whitelegge.*) I want to ask you whether the arsenical content of this soil is not unusually high; I am referring to the figure of ·02 grains per lb. which is given in your précis?—I have really no reliable materials to go upon to enable me to say whether that is the case or not; in fact, I should rather like to take this opportunity of saying that until we had the Hehner modification of the Marsh-Berzelius test I do not think that our results were sufficiently reliable to compare them. These tests have been made by Mr. Hehner himself. I have really no others that I could compare strictly with them.

12127. May I take it that the soil in question does not contain visible pyrites?—Certainly. One would say it was just an ordinary sand; it is a very light sand, and it is certainly not a soil that I expected to find any arsenic in. I was surprised when I did find it.

12128. Would you think that the probable explanation of that would be the former manuring with superphosphate?—No, I do not think that. I am not disposed to attribute the arsenic that exists in this soil to the previous manuring with superphosphate. I rather believe that you might examine any soil and find that amount of arsenic in it.

12129. Even in chalky soil?—Yes.

Amount of arsenic in commercial superphosphates.

12130. (*Chairman.*) Did you test commercial superphosphates for arsenic—are you satisfied that the ·03 per cent. of arsenic is the maximum likely to be found?—In commercial samples, I certainly believe that that is the maximum that would be found. I have made a calculation of that, for instance, and presuming superphosphate to have ·03 per cent.—the highest figure that I have given here—it would practically mean that an acid had been used which contained as much as 6·3 grains of arsenic per lb., which would be 880 parts per million. That is a tremendous amount. Of course, since this question was raised there have been numerous inquiries from the manufacturers of artificial manures as to the amount of arsenic which superphosphate, and every other manufactured manure, contains. The figures that I gave, and upon which I worked, are the ones that I have practically found to come forward. As you will see, in the other experiments I have supplemented the quantity by directly adding arsenic.

12131. When you added arsenic as arsenious oxide to the superphosphate did you first ascertain its solubility?—No. I added it to the superphosphate direct, except in the case that I mentioned to you, where I used the seed soaked in solution. There I took care to get the arsenic into solution by using soda, and then neutralising. So that I really have both sets.

12132. We have had some evidence of ordinary white arsenic getting into a porcellanous condition, and not being soluble?—I have heard of that.

12133. But you have not had experience of that?—No, I have not had special experience of that, except in so far that I avoided that occurring in the strong solutions where the seed was soaked.

12134. By using soda?—Yes.

Arsenic in superphosphates should be soluble.

12135. You do not think that in any manures made with superphosphate before it is applied to the soil, the white arsenic might get into an insoluble condition?—I have heard that stated, but I do not see what insoluble condition it would get into. I could understand that, when it was applied to the land, especially if the land contained a good deal of iron, you would get an insoluble iron—ferric-arseniate, for instance. That I can understand, but I do not think that in the superphosphate itself, with the acid present, and the acid in excess, as it generally is, you would find it in an insoluble condition; on the contrary, I have found it directly in a soluble condition. Excess of acid is always present in the superphosphate; there is sometimes an excess of sulphuric acid, but more generally there is an excess of free phosphoric acid. I cannot understand how the arsenic would then be in an insoluble condition. Though I have nothing directly to prove it, I should say that the arsenic in the superphosphate was in a soluble condition, and, at all events, I have been able to take it out in the soluble condition. When it goes on the land I can quite understand that just as the phosphate which was soluble passes into an insoluble or rather into a finely-divided and precipitated condition, so might the arsenic combine with the iron which is present in all soils, and forms an insoluble iron compound, and be, as it were, prevented from rising up into the plant, or at all events be a decidedly insoluble compound, and not easily assimilated.

Sampling grain.

12136. When you sampled the grain on the quarter-acre plots, was it all collected and mixed?—The whole of the crop was taken and put through the threshing machine and treated in just the same way that a farmer would treat it.

12137. So that the grain was all mixed?—You may take it that these samples that are represented as the produce of the quarter-acres, were not small picked samples, but represented the whole of the produce of the plot, and were samples taken from that. They were an average of the whole lot.

Delicacy of test

12138. What would be the delicacy of the test that you employed; for instance, you say that the bulbs contained "no arsenic"; what would that mean?—"None" would practically mean that there was less than a 1,000th of a grain per lb.; that there would be less than ·001. The figure that you have for the straw is practically ·005 grains per lb. That is a detectable quantity.

Organic matter destroyed before testing.

12139. You have mentioned small quantities, sometimes ·002; those were just about twice the amount that you regarded as not detectable?—Quite so. I should like, if I might, to add that in all these cases care was taken to destroy organic matter.

12140. I was going to ask that question; was the organic matter completely destroyed?—It was completely destroyed in all these cases.

12141. (*Sir William Church.*) I understood you to say, I think, in answer to Dr. Whitelegge, that you did not attribute any of the arsenic that you found in the soil to former dressings with superphosphate?—Perhaps I should not have put it so decidedly as that. I should not like to say that, but I could not discriminate.

Origin of arsenic in soil.

12142. What becomes of the arsenic in the soil?—I suppose that that land has perhaps in every four years had a dressing of superphosphate ever since superphosphate was introduced; and I do know also that in any soil which contains pyrites you may get arsenic.

12143. This soil, I understood you to say, was unusually free from iron?—It is not free from iron. It has not, to my knowledge, pyrites present, but at the same time there is an iron sandstone in it. When you have dug down a matter of 4ft., say, you will come to distinct ironstone.

12144. Your explanation would be that a good deal of the arsenic put upon the soil does not pass away in solution in the drainage?—I do not think it does.

12145. It enters into some combination with the iron?—Yes, I should think that. I do not know any way of discriminating between the arsenic that may be due to such a thing as pyrites in the soil and the arsenic that may be due to the accumulation of superphosphate. The difficulty is so enormous. If you take a sample of soil and you get a little pyrites in it, it may seem a tremendous quantity. The fact that I have taken samples over a number of my different fields and found ·02 or ·01, and not a larger quantity than that, would rather strengthen my belief that there is no pyrites in any quantity or else in particular samples I have obtained very abnormal results. Therefore, I should not like to say definitely that the arsenic here had not been the result of the accumulation of the superphosphate applied.

12146. Do any other of the chemical manures contain arsenic? Does nitrate of soda, for instance, contain any arsenic?—No. I have had to test those for manures. There is one that may possibly contain it, and that is sulphate of ammonia. I have had to test sulphate of ammonia; there you have the ammonia, the liquor from the gasworks, and that is neutralised with sulphuric acid.

12147. Does the sulphuric acid bring the arsenic in?—That is a possible, but I was going to say an improbable source. Freedom from arsenic in the finished product depends upon the perfection of the crystallisation. I do not know of any other ordinary manure that has to be considered as regards its liability to bring arsenic on to the land, except superphosphate, and when one says superphosphate one includes all artificial manures that are made by dissolving raw materials, bones——

12148. Dissolved guano, and so on?—Yes.

12149. Does kainit contain any arsenic?—I would not like to say.

12150. You see no chemical probability of it?—I do not see any chemical probability of it, but the more crystalline you get the substance, the less likelihood there would be.

12151. The outcome of your experiments is most clearly to demonstrate that the seed does not become contaminated with arsenic?—It does not become contaminated.

12152. Even though the plant may contain traces of arsenic?—Yes.

Access of arsenic to leaves.

12153. And it is the same with the roots?—That is so. My first belief with regard to the roots was that the arsenic passed up through the bulb and into the leaves. That, of course, was strengthened by some of the evidence that has been before this Commission already, and I am not prepared at present to say that that to some extent this is not so. I am, however, quite certain that some of the figures that have been before you as the results of the examination of whole plants have been very much due to the mechanical adherence of materials conveying the arsenic, and I think I have proved this by the difference between leaves grown, some in the ordinary way, and others carefully washed. I propose to continue those experiments, and if there is any particular line that this Commision would indicate as desirable I should be glad to follow it.

12154. In one of the experiments that has been brought before us the plants were grown artificially, and great care that none of the arsenicated water used should get on the leaves. In that case there were traces of arsenic found in the green leaves—it was corn that was being tested—but not when they were ripe; that was difficult to understand?—Were those Mr. Angell's experiments?

Comparison with Mr. Angell's results.

12155. Yes?—I have read those with a considerable amount of interest, and I may perhaps be allowed to say that in the main they fall into line with my own results. At the same time they do not seem to me thoroughly consistent among themselves. In some cases there were whole plants examined, and no arsenic at all found. In others arsenic was found in the green parts only.

12156. I think that was with regard to peas or beans?—Then the question was whether the pods were included or not.

12157. He took the pods and the seeds together?—That was in No. 15 experiment, I think you will find.

12158. He gave it (Q. 8557) as his opinion that he thought arsenic might be excreted, but it seemed to me a very unlikely thing that arsenic should be excreted?—I do not think that would be the case, and I do not follow Mr. Angell in the theory put forward to account for it. What seemed to me much more likely was that these experiments were not under his eye all the time. They were conducted by someone else, and we have not direct information regarding them. It is a very large series of experiments, and the general conclusion, as I say, very much agrees with mine, though I do not quite fall into line with him as regards all the details; for instance, I cannot at all see why, if oats do not have any arsenic, barley should. That is comparing

Dr. J. A. Voelcker.

3 April 1903.

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 190

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.

Objects of the experiments.

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.

Reasons why rats were selected.

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.

Relative susceptibility of man and rat to the action of arsenic.

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.

Determination of suitable doses for experiments upon rats.

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 $As_2 O_3$ 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 $As_2 O_3$ 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.

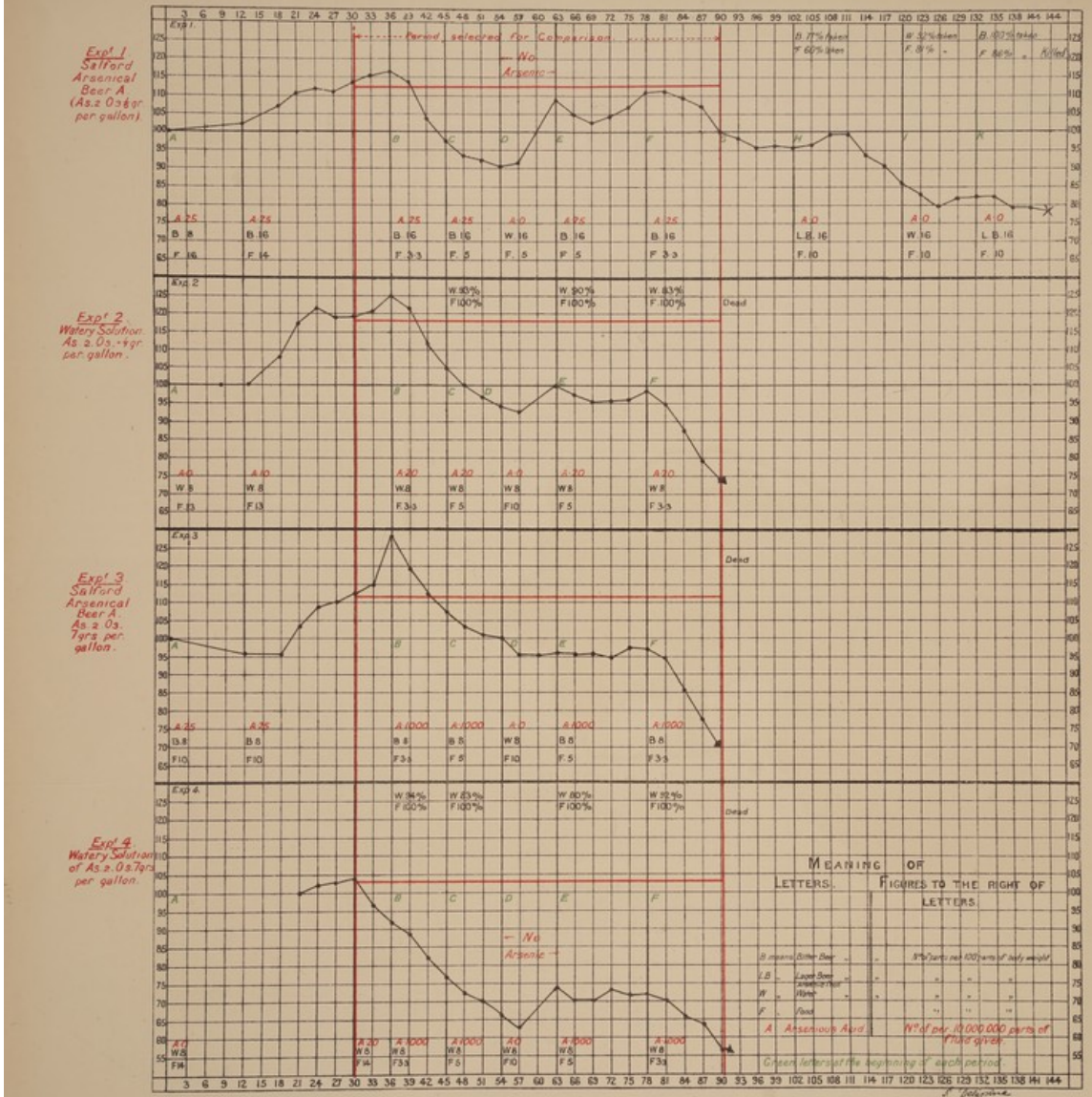
Second Set of Experiments.—Three rats were given the following fluids in daily quantities, uniformly equivalent to 8 per cent. of their body weight (corresponding to over 1 gallon for a man 140lbs. in weight).

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.*

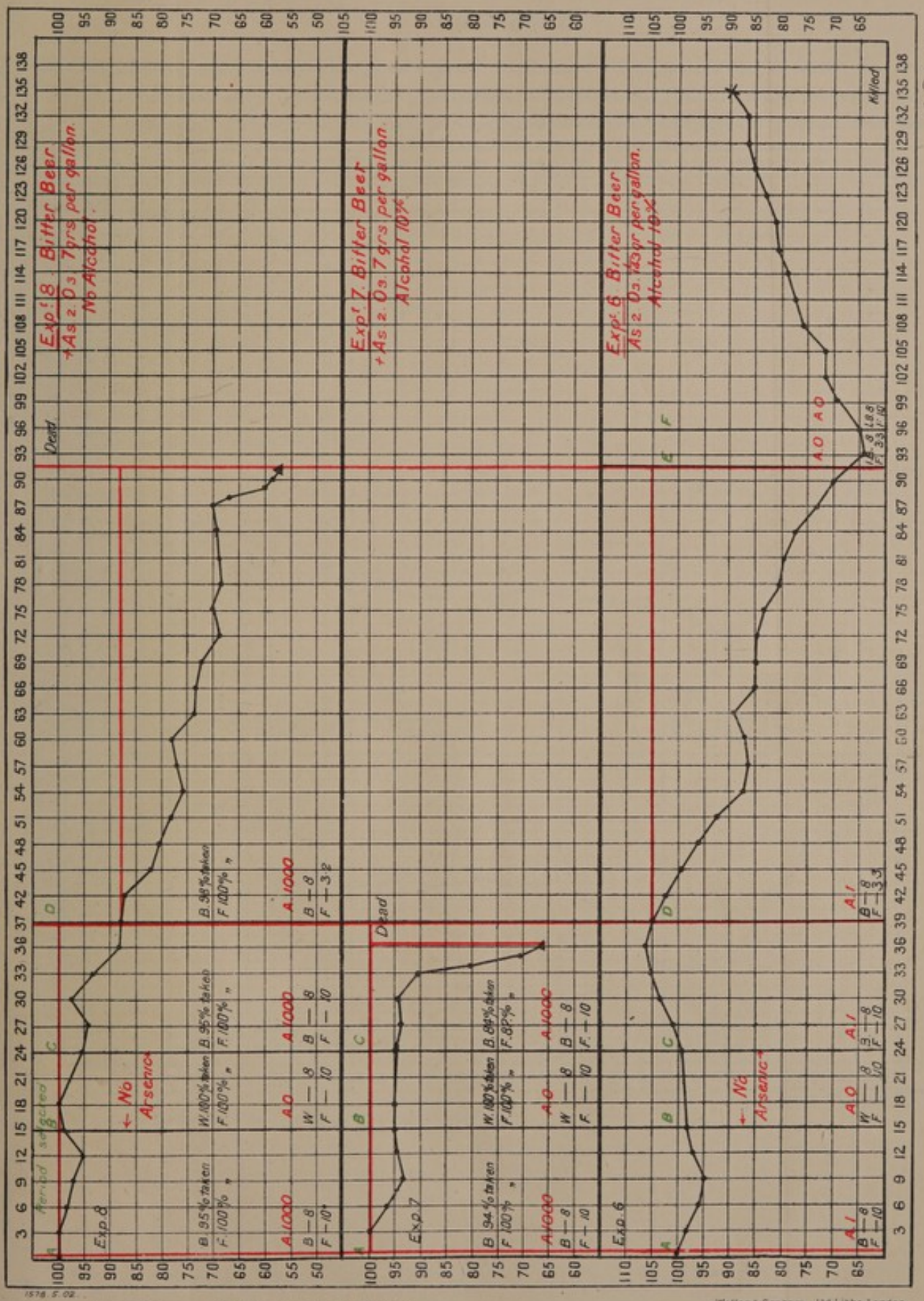


The original weight of each animal is reduced to 100 and the subsequent weights are given in proportion to an original weight of 100 grammes.
The black Vertical lines indicate the beginning of each period of the experiment, each one of such periods is characterised by the amount of food and sometimes 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.

1898. 6. 02.

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.



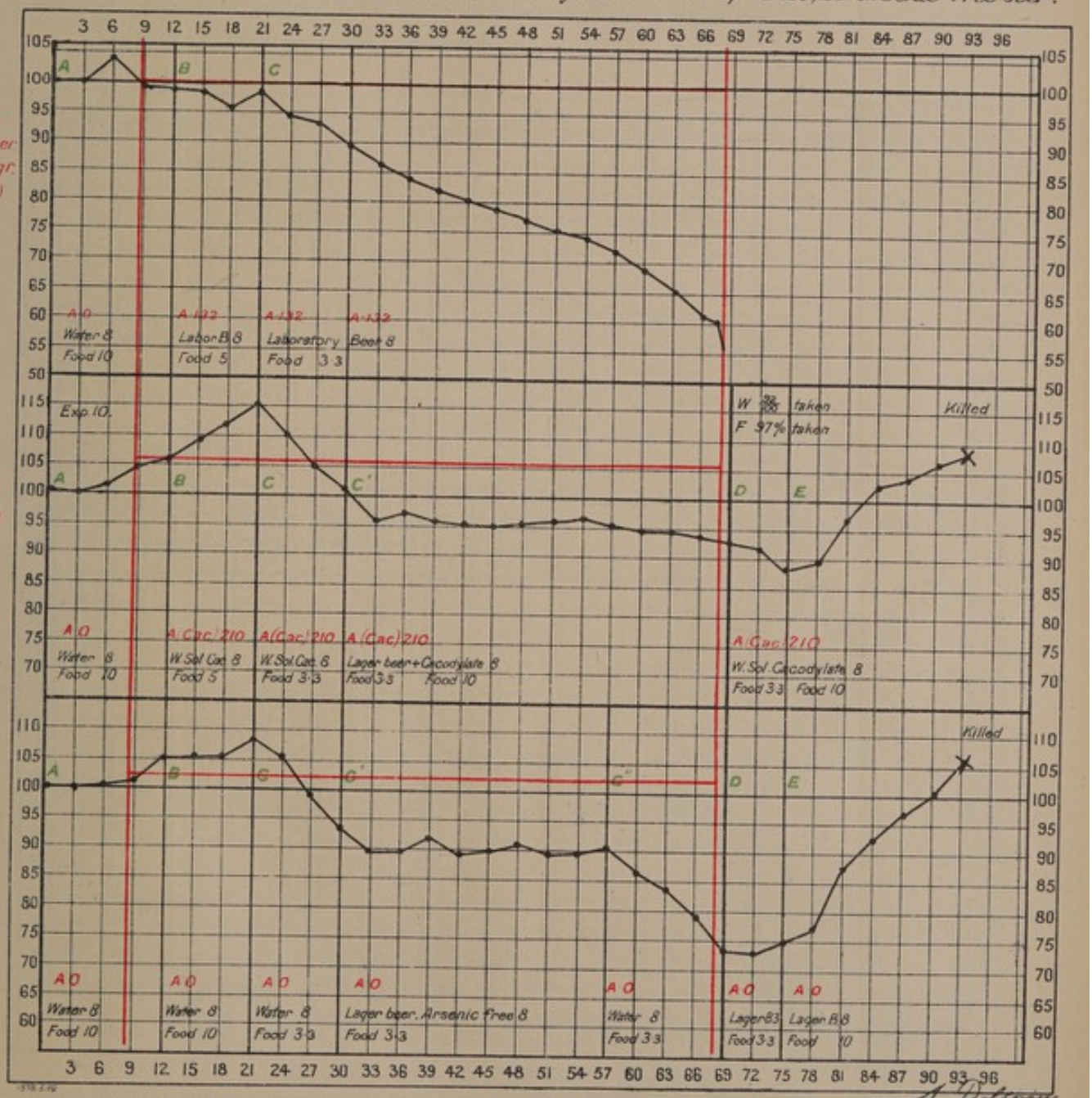
For explanation see 1st diagram and text.

1578. 5. 02.

Weller & Graham Ltd Litho. London.

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.*

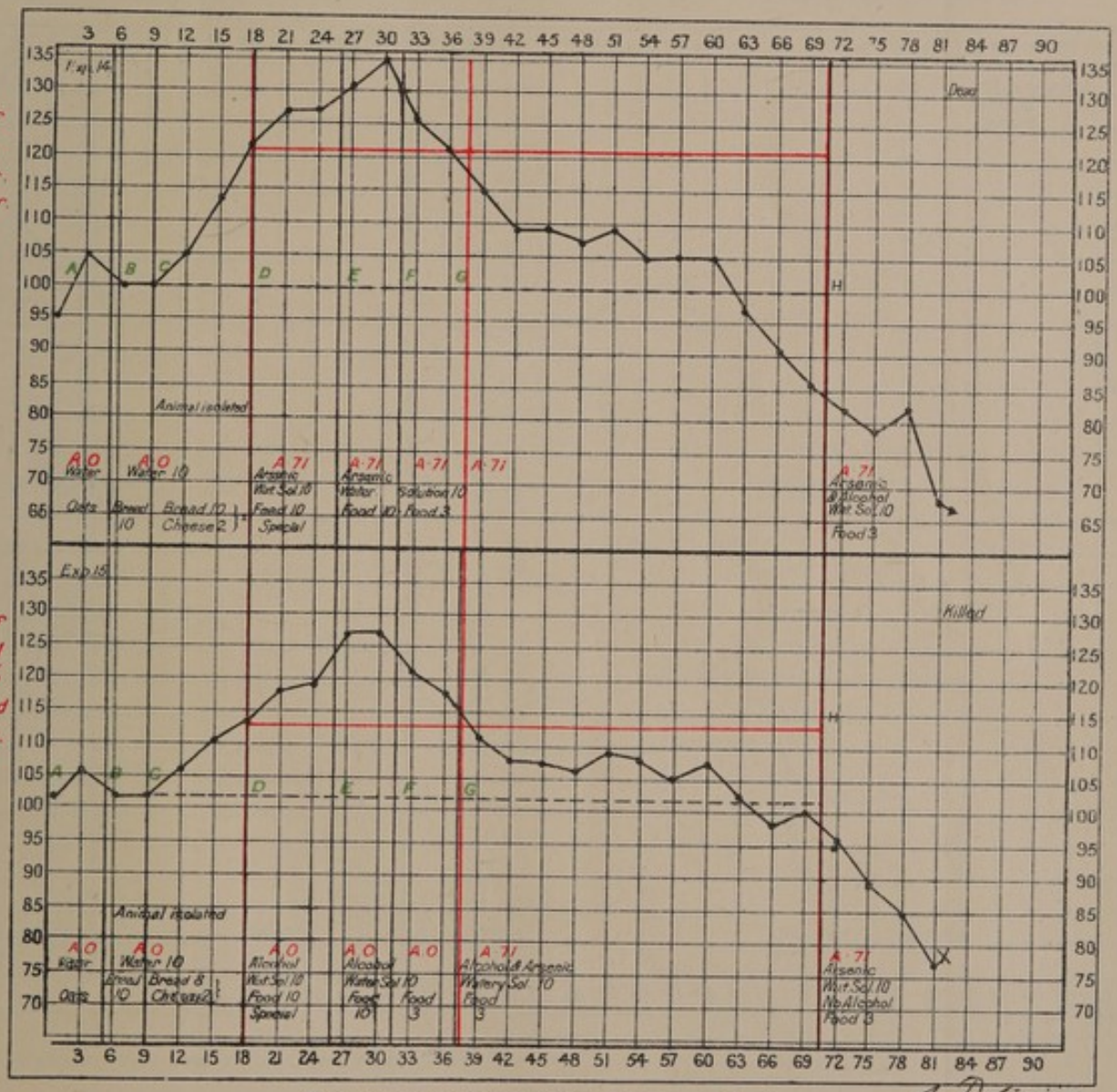


For explanations, see 1st diagram and text.

Weller & Graham 3rd Litho. London.

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.

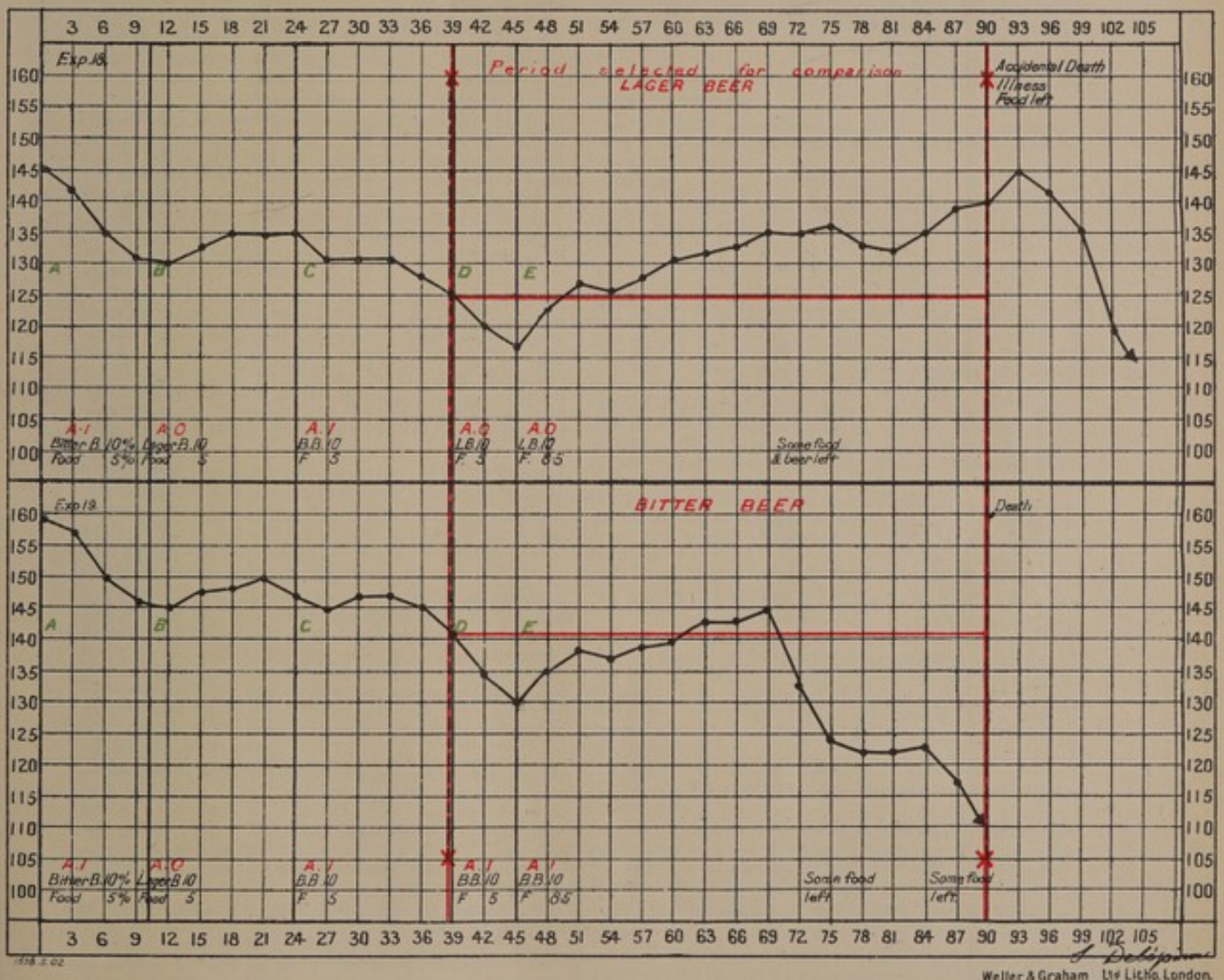
J. DeLépine

1878. E.02

Weller & Graham Ltd Litho. London.

DIAGRAM 5.

SET VI. Action of Arsenic-free beer and of beer containing a trace of Arsenic compared.



Weller & Graham Ltd Litho. London.

For explanation see 1st diagram and text.

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.

General results of the second set of experiments. Provisional conclusions.

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.

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).

Third set of experiments.

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 ($As_2 O_3$ = 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 26 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.

Appendix 16.

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 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 1-143rd 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.

mmary of ults of the th set of periments.

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.

venth set.

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

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.

rts amined. ethods.

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.

Appendix 16.

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 $As_2 O_3$.	Amount of Arsenic taken Daily per cent. of body weight. As $As_2 O_3$.	Apparent Total Amount of Arsenic* found P.M. in the body, Estimated in $As_2 O_3$.	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).

Appendix 16.

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.

anges- served in an.

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, 7 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 Lebahn, 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 ($\frac{1}{2}$ 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 $\frac{1}{2}$ 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. DELEPINE.

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 0·0065 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 $As_2 O_3$.	Total Amount of Alcohol taken during experiment per cent. of body weight
					Per 10,000,000, as $As_2 O_3$.	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	$\frac{1}{5}$	7·5	0·0000000	0
	3. (1116)	190	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	0·0176000	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 Bostock's arsenical glucose, alcohol about 6 per cent.	8	132	$\frac{13}{14}$	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	·0031950	26·5
V.	16. (1179)	141	Solution of arsenious acid in water -	6	10,000	70	5·	0·0120000	0·
	17. (1178)	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 ?	2·04
					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	+ 0·08	Killed	Whole body	2·5 ?	260·
51	93	105·4	+ 0·05	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
2	4	90·7	— 2·32	Acute poisoning	Body without liver, stomach, or intestines.	over 68	73·
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 63,364 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 $\frac{1}{14}$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 *given* 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	$\frac{1}{5}$	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	$\frac{1}{2}$	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.

Appendix

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	78	— 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 conside ed sufficient. Appendi 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	28·9	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	33·09	32·38	28·72	– 4·37	– 3·66
Manchester Township	35·51	33·84	29·08	– 6·43	– 5·46
Northern Districts	32·06	32·37	29·17	– 2·39	– 2·70
Southern Districts	32·39	31·57	27·86	– 4·51	– 3·71
Ancoats	37·98	36·88	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	26·99	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 $\frac{3}{4}$ 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.

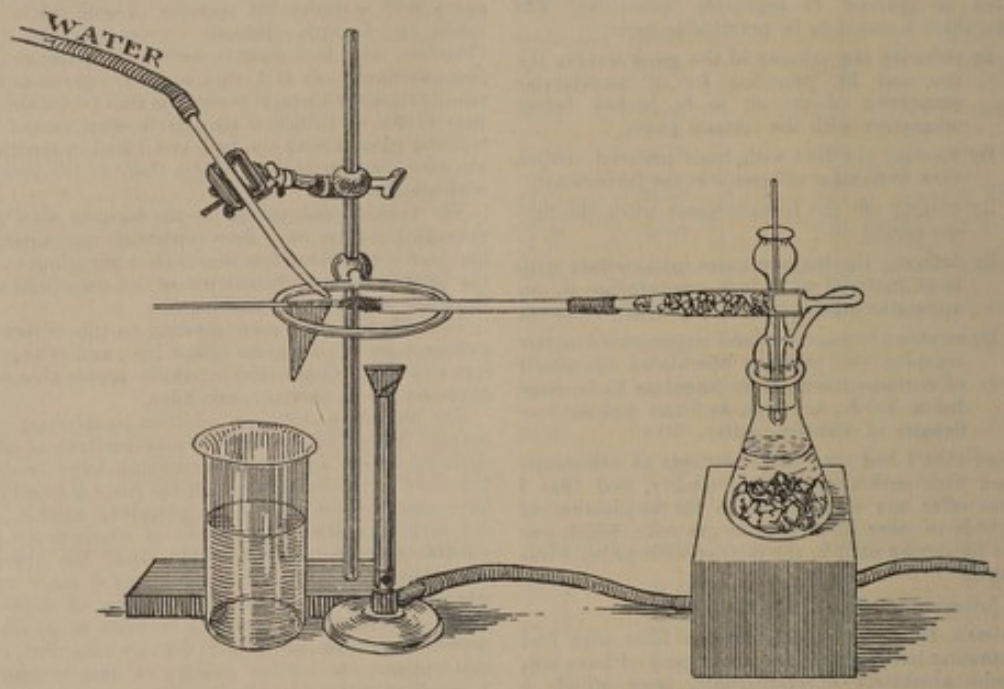
Samples corresponding to the above experiments are at the disposal of the Commission.

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 ¼th 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.

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 300 c.c. separator funnel furnished with a stopcock; 50 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 30 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 $\frac{1}{1000}$ grain per pound with liquids $\frac{1}{100}$ 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 grains Malt.		25 c.c. of Wort, Beer, or other Liquid.	5 grains of Hops, Sugar, Caramel, Yeast, or other substance.	1 gram of Chemicals.	10 grains 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	1/720	1/309	1/180	1/360	1/72	·15
·004	1/360	1/154	1/90	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.

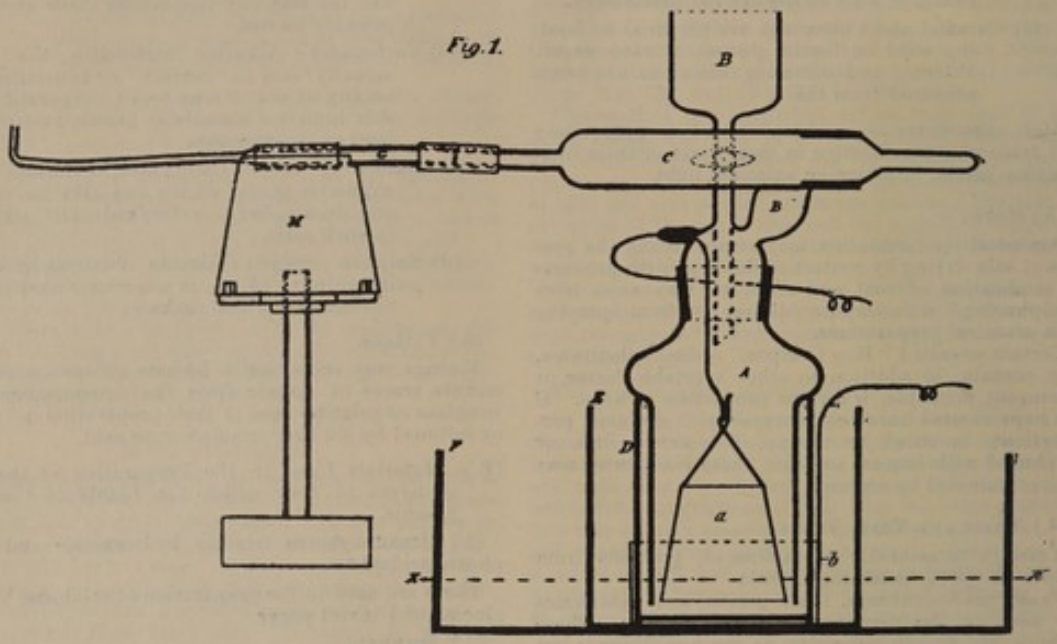
(2.) Sulphur.

(3.) Fuel.

Appendix 21.

APPENDIX, No. 21.

APPARATUS FOR THE ELECTROLYTIC PROCESS



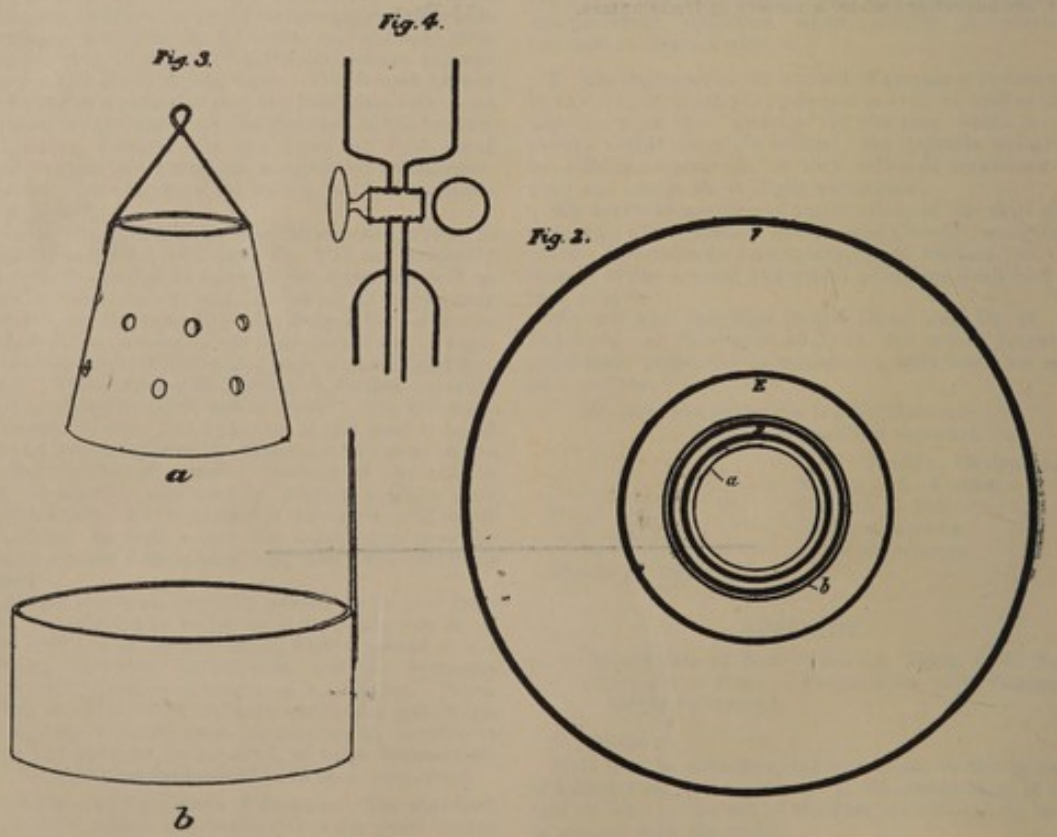


FIGURE 1 (Scale $\frac{3}{4}$ths).
Side Elevation.

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.

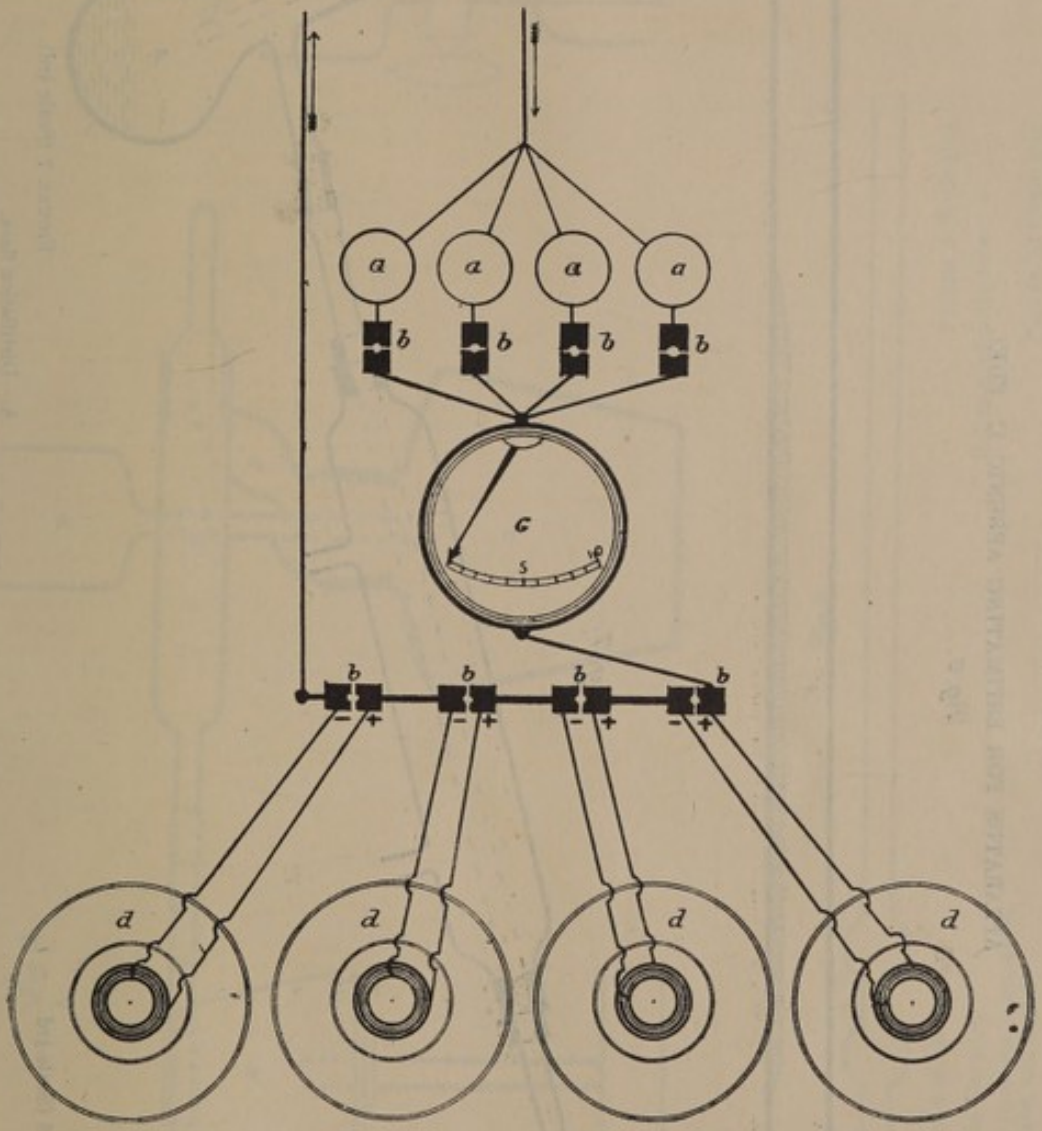


FIGURE 5. (Scale ¼th.)

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.

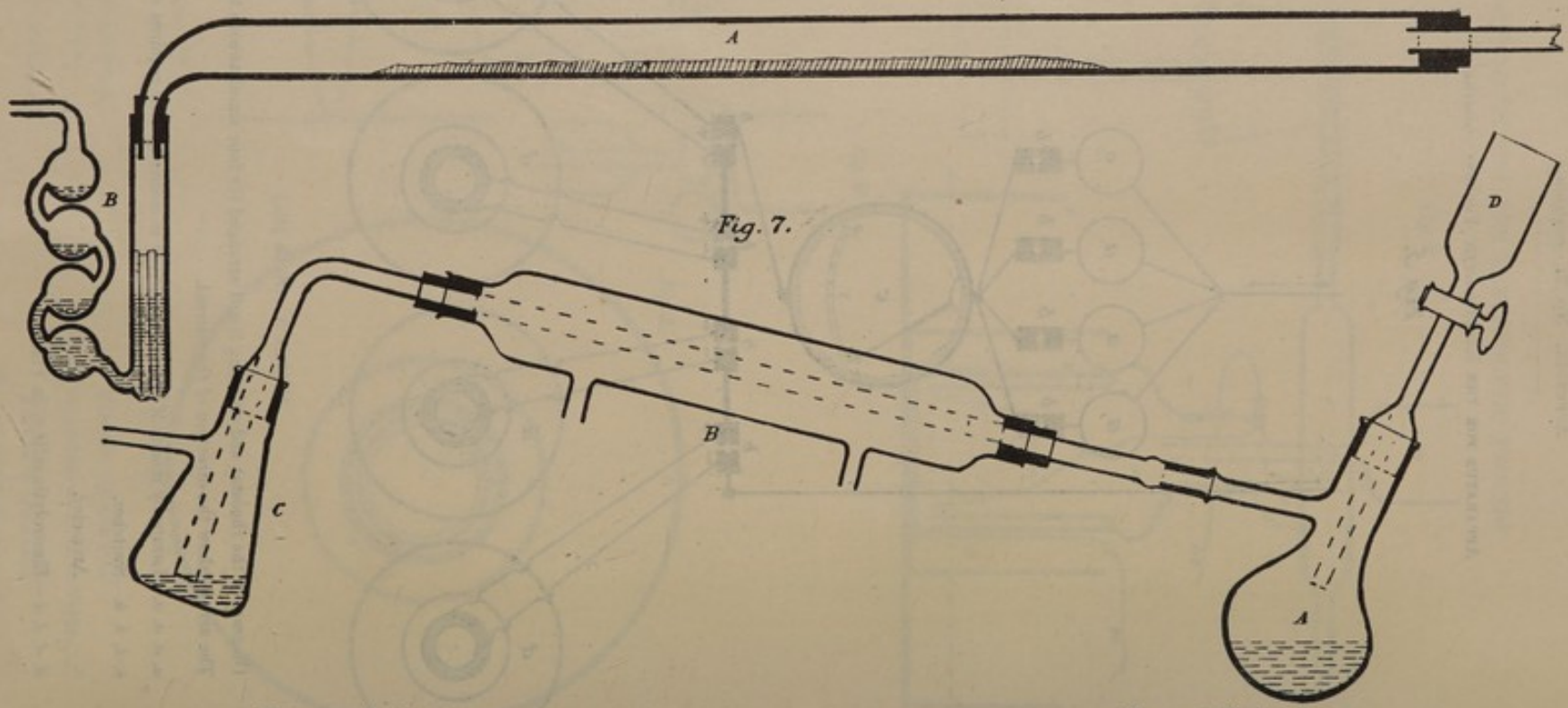


FIGURE 6 (Scale ⅓rd

A.—Hard glass tube.
B.—Absorption tube.

Fig. 7.

FIGURE 7 (Scale ⅓rd).

A.—Distillation flask.
B.—Condenser.
C.—Flask for receiving distillate
D.—Funnel.

APPARATUS FOR THE ZINC AND ACID PROCESS.

Fig. 8.

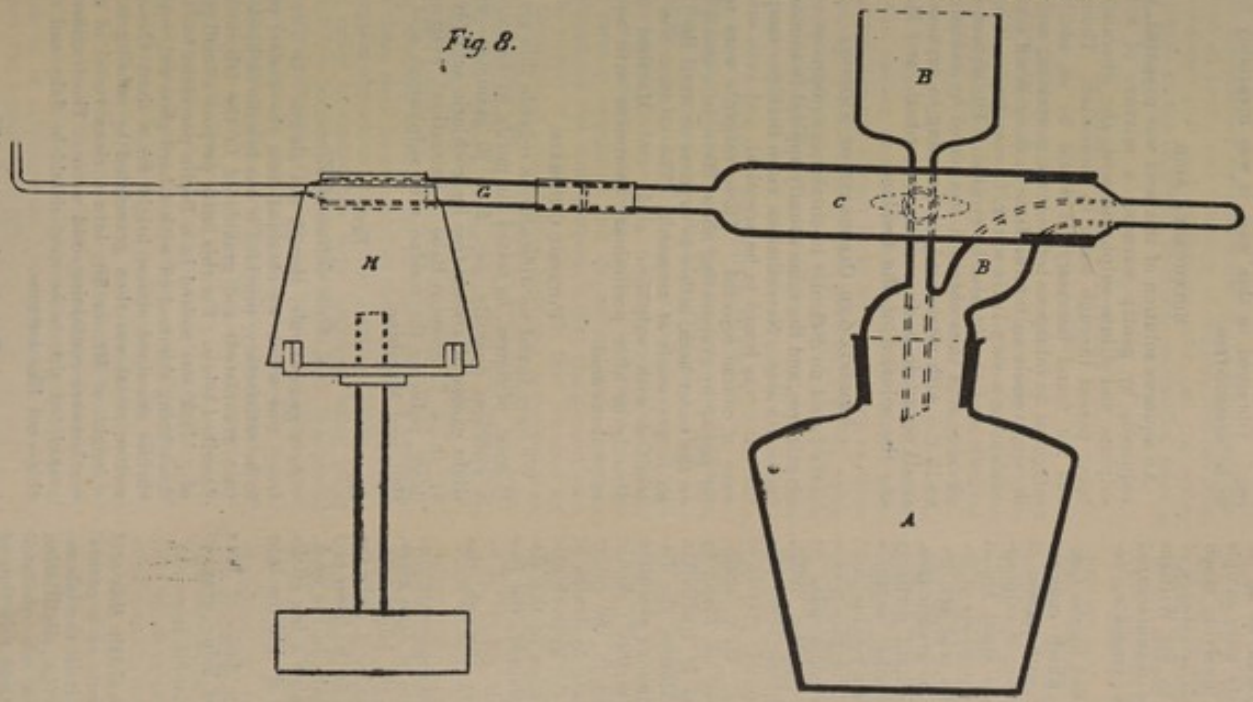


Fig. 10.

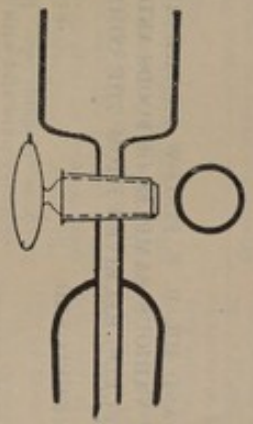


Fig. 9.

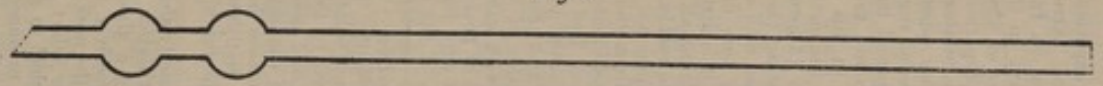


FIGURE 8 (Scale $\frac{4}{5}$ths).

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 $\frac{4}{5}$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. $As_4 O_6$. 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.	$As_4 O_6$
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 *Neulands* 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.

---

(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

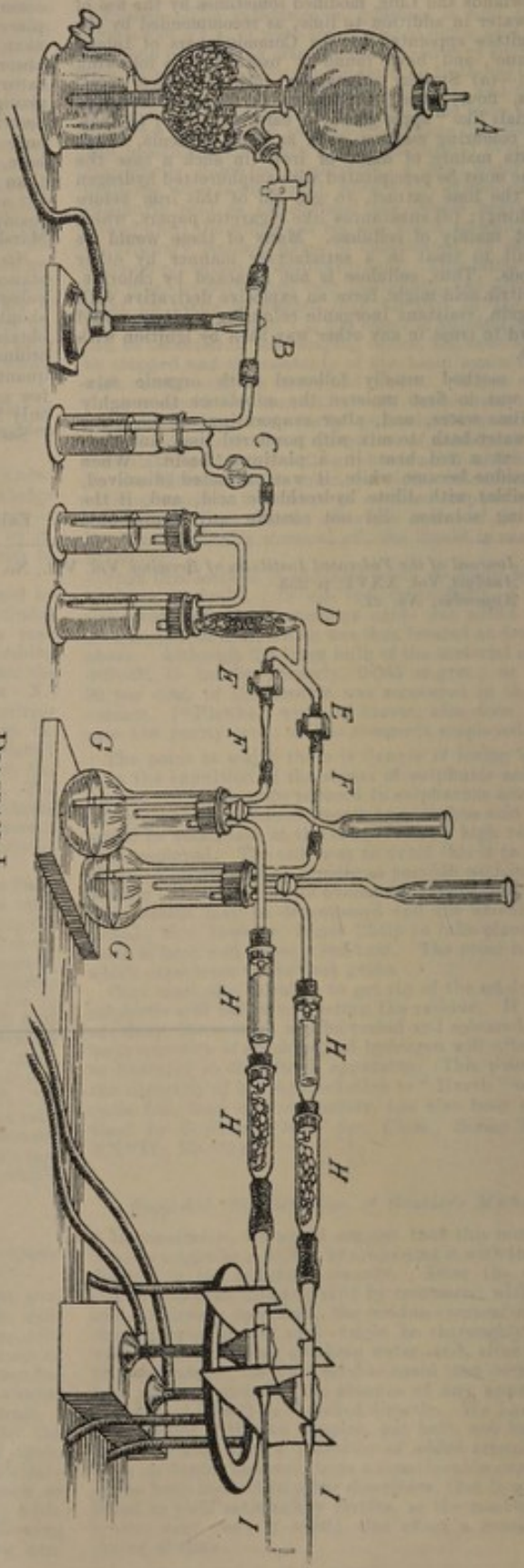


DIAGRAM I.

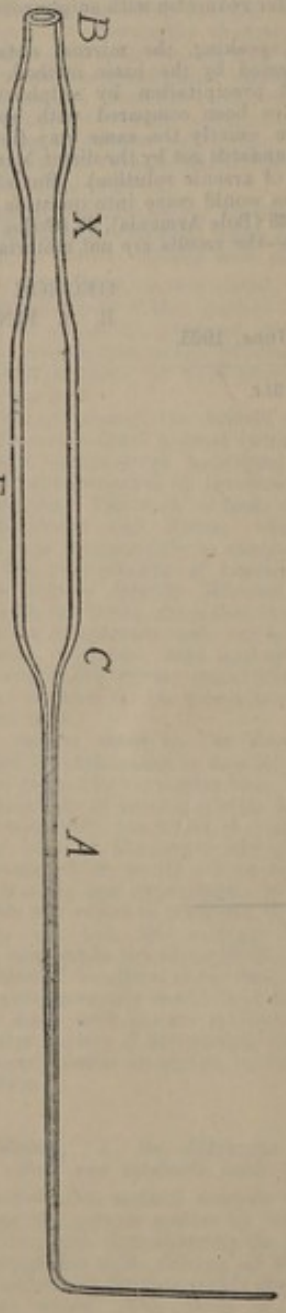


DIAGRAM II.

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	65

† 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 read 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 aërated 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.

Appendix 24.

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, 8¾ 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 1351bs. of sulphuric acid are used to produce 1001bs. 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.

Appendix 24.

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.

* 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 (3341), 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.

Appendix 24

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.

Appendix 24.

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 24.

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 2300th 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.

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 6 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

Appendix 24. 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 at 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:—

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 specifically 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.

* 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 - -	·0045 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 24.

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 18th, 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.

---

* 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.

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.

Appendix 24.

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	+2	+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	2⅄ grains in 108 days	16	22	+4	+8	+4	+7	+4	+5	+7	+6	+13	+4	+1	+6	+6	+4	+9	+2	+4	+0	106
4. (Pullet)	29 Aug. to 1 Dec. ⅄ grain 2 Dec. to 16 Dec. ⅄ grain	2⅄ 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	2½ 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	3½ 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 1-13th 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.

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 $AsO_3(C_3H_5)$, 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 I.	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 „	·032	·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, 1905.

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):							
38a	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	—	½½ths of solution Marshed. This must merely be regarded as qualitative.
38b	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.
38c	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	$\frac{5}{7}$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).

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	Carnation 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.)	26 Mar. 1903 -	36·0 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.	⅓ 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).	0·003	- 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 soup. But even in that case the quantity of arsenic comes out very small.

59*b*	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.*a*) From bottom layer of coke-room.							
60*a*	Flesh	9 April 1902	102·2 grms.	ditto	0·043	$\frac{1}{350}$	0·4	The whole of the extract Marshed.
60*b*	Skin	9 April 1902	56·5 grms.	ditto	0·005	$\frac{1}{1100}$, *i.e.*, trace	0·1	Two-thirds of extract Marshed.
	(I.*b*) From top layer of coke-room, *i.e.*, furthest from fire.							
61*a*	Flesh	8 April 1902	131·6 grms.	ditto	0·012	$\frac{1}{1600}$, *i.e.*, trace	0·1	Whole extract Marshed.
61*b*	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.*a*) From bottom layer of coke-room (*i.e.*, nearest to coke fire).							
62	Skin	15 May 1902	74·3 grms.	ditto	0·033	$\frac{1}{200}$	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	$\frac{1}{220}$	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.*a*) 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	$\frac{1}{430}$	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_4O_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_4O_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.)	$\frac{1}{10}$ of the original 5 c.c. were Marshed, *i.e.*, $\frac{1}{10}$ 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.
	(*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.
Tips. Uncovered Paper. Lengths (cms.) 1·25 5·7 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.
	(*b*) Tips (including the paper under the metal).	21 May 1903	0·5 grm.	Chlorate method	0·029	4	570·0	One-tenth of the extract was Marshed.
Tips. Uncovered Paper. Lengths (cms.) 1·25 5·75 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.
	(*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.
Tips. Uncovered Paper. Lengths (cms.) 0·9 6·3 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, $\frac{1}{25000}$; Series B, $\frac{1}{10000}$; Series E, $\frac{1}{20000}$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.,
6th November, 1902.

Dear Sir,

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.

---

24 and 25, Hart Street,
Bloomsbury, W.C.,
10th November, 1902.

Dear Sir,

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.
12th November, 1902.

Dear Sir,

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 add 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.

---

24 and 25, Hart Street,
Bloomsbury, W.C.,
19th November, 1902.

Dear Sir,

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.

---

24 and 25 Hart Street,
Bloomsbury, W.C.,
24th December, 1902.

Dear Sir,

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.	(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 $As_4 O_6$.	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	$\frac{1}{215}$	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	$\frac{1}{36}$	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	$\frac{1}{375}$	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.)	$\frac{1}{95}$	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	$\frac{1}{333}$	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_2, A_3, 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 $AS_4 O_6$.	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		Trace	None	Trace	Whole extract Marshed.
Small Saucepan	III.	750 „	23 February	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		Mere trace	None	Mere trace	Whole extract Marshed.
Small Saucepan	V.	350 „	16 February	ditto		Mere trace	None	Mere trace	Whole extract Marshed.
Frying-pan	V.	500 „	20 March	ditto		0·0018	None	Merest trace	Whole extract Marshed.
Small Saucepan	VI.	750 „	23 February	ditto		None	Small	None	Whole extract Marshed.
Pie-dish	VII.	1,250 „	27 May	ditto		None	None	None	Whole extract Marshed.
Small Saucepan	VIII.	500 „	18 February	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		0·0013	None	Merest trace	Whole extract Marshed.
Coffee-pot	X.	1,000 „	14 February	ditto		None	Slight	None	⅛ths of extract Marshed.
Jug	X.	1,600 „	20 February	ditto		0·002	None	Merest trace	Whole extract Marshed.
Mug	X.	500 „	27 February	ditto		None	None	None	Whole extract Marshed. Enamelling faulty.
Bowl	X.	500 „	27 February	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 - 4½ 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.

Appendix 30.

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.

Appendix 30.

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

Appendix 30.

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	19
						5–10 „	-	12	
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	12
						5–10 „	-	6	
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	17
						5–10 „	-	9	
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	*0*	*5*
						5–10 „	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	2	*0*	*2*
						5–10 „	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

Appendix 30. 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. Appendix 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 - -	LOWER PUMP QUART	From railway waggons at colliery.	6·00	4·75	1·25
	Green Vein.					
	Gras Uchaf.					
	Lower Pump Quart.					
COLLIERY B -	Big Vein - -	BIG VEIN - - -	From railway waggons at railway station near colliery.	4·67	3·14	1·53
	Green Vein -	GREEN VEIN.				
	Stanllyd - -	STANLLYD.				
	Gras Uchaf -	GRAS UCHAF.				
COLLIERY C -	Lower Pump Quart.	LOWER PUMP QUART	From railway waggons at colliery.	3·12	1·60	1·52
	Trequart.					
COLLIERY D -	Stanllyd - -	STANLLYD - -	From railway waggons at colliery.	8·00	4·00	4·00
	Upper Pump Quart.					
COLLIERY E -	Deep Stanllyd -	DEEP STANLLYD -	From railway waggons at colliery.	7·67	5·43	2·24
	Gras Isaf.					
COLLIERY F -	Big Vein - -	BIG VEIN - - -	From railway waggons at colliery.	3·04	1·58	1·46
	Peacock.					
	Tregloin.					
COLLIERY G -	Big Vein - -	BIG VEIN -	From railway waggons at colliery.	2·43	1·86	0·57
	Peacock.					
COLLIERY H -	(Big Vein) - -	BRASS VEIN	From screen, as no waggons available. Portions showing black band excluded.	5·43	4·86	0·57
	Brass Vein.					
COLLIERY J -	Upper Four Foot	BIG VEIN - - -	At colliery :—			
			(*a*) Provisional sample, 1902.	8·89	4·57	4·32
	Big Vein.					
	Brass Vein.		(*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 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.* Appendix 30.

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.:—

c dix 29.

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 6 ins. 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 ft. 2 in. 0 / Parting of dirt 0 0½ / Middle coal 3 6 / Bottom coal 3 6	0	9	0½
Measures, 20 yards to	23	0	0
Brass Vein { Top coal 0 3 / Parting 0 2 / Bottom coal 2 6	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 39.

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	5·59	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	—	3·55	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 lower 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

Appendix 30

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.

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 n 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	32	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	0·61	10·1	
3·20	2·71	0·49	15·3	
5·60	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.*

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, 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.		
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	58	- 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	3·20	0·60	15·8	

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.
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	

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 Farp 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 ¼-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. Appendix 30.

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. 10693.)

(*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 those 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.

---

* 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. Appendix 31.

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 40. 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" (Norwegiah 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 23th 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.	Handel Just.	H. C. Richards.	Victor.	TOTAL.
Dried fish	$\frac{1}{80}$	$\frac{1}{80}$ (Bombay duck).	$\frac{1}{180}$	$\frac{1}{500}$	$\frac{1}{75}$	$\frac{1}{200}$	$\frac{1}{440}$	—	$\frac{1}{150}$	—		—	—	$\frac{1}{170}$	10
Tinned fish	—	—	—	—	trace	—	—	trace	—	—	0	—	—	—	3
Tinned meat and vegetables	—	—	—	—	—	$\frac{1}{25}$	—	trace	—	Tomatoes, 0 Cabbage, trace.	—	—	—	—	4
Tinned milk	—	—	—	—	—	—	—	0	—	—	—	—	—	—	1
Fish balls	0	—	—	—	—	—	—	—	—	—	—	—	trace	—	2
Dried potatoes	$\frac{1}{90}$	—	—	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	$\frac{1}{500}$	trace	$\frac{1}{700}$	—	0	0	9
Sugar	—	—	—	—	—	—	—	—	—	—	—	0	—	—	1
															45

Trace in each column = below $\frac{1}{1500}$ 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 Christinia, 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. Nielson, 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 4½ 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 1-80th 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 boiling 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 Risor	19 Oct. 1901	50 grms.	Chlorate method	0·023	$\frac{1}{50}$	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 $\frac{1}{1}\frac{1}{0}$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	$\frac{1}{50}$	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	$\frac{1}{200}$	0·5	Whole extract Marshed.
8	"Pegu"	Sanusu (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	$\frac{1}{1000}$	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	$\frac{1}{45}$	1·9	One-fifth of extract Marshed.
12	"Cimbria"	Dried cod-fish from Norway.	9 Dec. 1902	39·7 grms.	Chlorate method	0·016	$\frac{1}{1250}$	0·8	Half of the extract Marshed.
13	"Argo"	Dried cod-fish	29 Jan. 1903	30 grms.	Chlorate method	0·029	$\frac{1}{35}$	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_4O_6) 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	$\frac{1}{80}$	0·6	Whole extract Marshed. Sample covered with small crystals.
19	"Ben More" -	Tinned mutton - -	12 Dec. 1902 -	100 grms.	Chlorate method - - -	0·0225	$\frac{1}{60}$	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	$\frac{1}{45}$	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	$\frac{1}{300}$	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	$\frac{1}{1000}$	1·0	Whole extract Marshed.
30	'Somali" - -	Rice - - - -	20 March 1903	50 grms.	Extracted with 100 c.c. of aqueous hydrochloric acid at 50° C. for 15 minutes.	0·0025	$\frac{1}{2000}$	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 $\frac{1}{10000}$).	—	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	$\frac{1}{5000}$	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	$\frac{1}{176}$	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	$\frac{1}{6}$	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	$\frac{1}{10}$	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.	8 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	$\frac{1}{10}$	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	$\frac{1}{8}$	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.	$\frac{1}{1\,8\,8\,5}$	0·07	$\frac{1}{5\,1\,7\,0}$	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.	$\frac{1}{5\,5\,9}$	0·26	—	$\frac{3}{4}$ 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	$\frac{1}{1\,2\,1\,5}$ 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.	On the dry hair. $\frac{1}{1\,0}$	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.	On the wet nails. $\frac{1}{5\,7}$	5·4	—	$\frac{3}{4}$ 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.	$\frac{1}{58}$	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	$\frac{1}{75}$	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	$\frac{1}{75}$	0·2		Two-thirds of extract Marshed.
60	Brain	10 June 1902	126·5 grms.	Chlorate method	0·009 Not a very good reading.	$\frac{1}{1350}$	0·11	—	Two-thirds of extract Marshed.
61	Hair	17 Sept. 1902	12·5 grms.	Nitric and sulphuric acids.	0·014	$\frac{1}{715}$	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	$\frac{1}{80}$	1·7	Whole extract Marshed.
64	Jon Jansen, Barque "Argo," aged 47.	17 March 1903	1·5 grms.	Chlorate method	0·0085	$\frac{1}{34}$	·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	$\frac{1}{170}$	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.	$\frac{1}{74}$	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.	$\frac{1}{78}$	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	$\frac{1}{93}$	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	$\frac{1}{93}$	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	$\frac{1}{93}$	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 $\frac{1}{570}$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 $\frac{1}{161}$rd grain of arsenic per lb. (6·12 parts per million). The second portion of No. 44a thus contained altogether $\frac{1}{128}$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.).	$\frac{1}{250}$ — (*0·57*)	$\frac{1}{100}$ — (*1·4*)	$\frac{1}{50}$ — (*2·8*)	$\frac{1}{25}$ — (*5·7*)	$\frac{1}{15}$ — (*9·5*)	$\frac{1}{8}$ — (*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.

ARSENIC IN HAIR—*continued.*

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.)	$\frac{1}{250}$ – (0·57)	$\frac{1}{100}$. – (1·4)	$\frac{1}{50}$. – (2·8)	$\frac{1}{25}$. – (5·7)	$\frac{1}{15}$. – (9·5)	$\frac{1}{8}$. – (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	—	—	—	—	—	—	—	—	—
Longer than 5 weeks before collection of sample—Roots	1	—	—	—	—	—	—	46	—	—
Longer than 5 weeks before collection of sample—Tips	1	—	—	—	—	—	—	63	—	—
						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.

June, 1903.

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

Bacteriological and Chemical Laboratory,
89, Bartholomew Close.

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	
73*a*	N. H.	40	$\frac{1}{150}$	Paddington	
74*a*	J. D.	19	Trace	Paddington	
75*a*	J. A.	26	Trace	Tooting	
76*a*	J. T.	34	Free	Tooting	
77*a*	H. S.	26	$\frac{1}{50}$	Tooting	*See note*, Table C.
78*a*	F. S.	37	$\frac{1}{150}$	Tooting	
79*a*	F. R.	30	Trace	Tooting	
80*a*	A. P.	16	Trace	Tooting	
81*a*	T. N.	31	Trace	Tooting	
82*a*	W. N.	31	Free	Tooting	
83*a*	W. K.	42	Free	Tooting	
93*a*	R. H. C.	50	$\frac{1}{25}$	St. George's Infirmary.	*See note*, Table E.
94*a*	F. A.	42	Free	St. George's Infirmary.	
95*a*	G. H.	49	Trace	St. George's Infirmary.	
96*a*	A. H.	46	Free	St. George's Infirmary.	
97*a*	J. B.	41	$\frac{1}{100}$	St. George's Infirmary.	
100*a*	J. S.	36	Free	St. George's Infirmary.	
101*a*	H. L.	51	Trace	St. George's Infirmary.	
102*a*	W. D.	47	Free	St. George's Infirmary.	
103*a*	J. S.	29	Free	St. George's Infirmary.	
106*a*	F. H.	45	Trace	St. George's Infirmary.	
107*a*	J. O.	61	Trace	St. George's Infirmary.	
108*a*	C. B.	36	Free	St. George's Infirmary.	

APPENDIX, No. 32—*continued.*

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	$\frac{1}{10}$	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	$\frac{1}{50}$†	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.*

TABLE C.—MALE CASES OVER 15 YEARS OF AGE TAKING OR HAVING LATELY DISCONTINUED TAKING LIQUOR ARSENICALIS. **C**

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 $\frac{3}{4}$ 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 leukaemia	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 (= 3¾ 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.
73*b*	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.
74*b*	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.
75*b*	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	$\frac{1}{80}$	$\frac{1}{120}$	–	—	Divided into (*a*) about 1½ in. from scalp end, (*b*) rest.
27	Middlesex	M. G.	35	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).	$\frac{1}{120}$	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	$\frac{1}{150}$	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.	$\frac{1}{10}$	Free.	(Middle) $\frac{1}{100}$	—	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.	–	–	$\frac{1}{10}$	—	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	$\frac{1}{40}$	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	Tubercular 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.
69*b*	Paddington	E. H.	43	Eczema	9 min. daily for 55 days, from 9 Dec. 1902 to 2 Feb. 1903.	9 min., 2 months	–	–	$\frac{1}{8}$	Free	Hair taken from same spot as control: length 1¾ ins.
71*b*	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.*
72*b*	Paddington	E. D.	41	Right hemiphlegia	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, $\frac{1}{15}$th; next 1½ inches, $\frac{1}{50}$th; next 2 inches, $\frac{1}{75}$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_2O_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.	$\frac{1}{80}$	—	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).	$\frac{1}{25}$	—	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 $\frac{1}{150}$ 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).	$\frac{1}{30}$	—	——
23	St. Bartholomew's.	C. E.	11	Chorea	9 mins. daily for 3 weeks	9 min., 3 weeks	$\frac{1}{150}$	—	——
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	$\frac{1}{2}$	—	——
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	$\frac{1}{2}$	—	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	$\frac{1}{100}$	—	——

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	$\frac{1}{10}$	" "
89*a*	Paddington Infirmary	A. D.	44	F.	20 days	3 months	Entirely beer	$\frac{1}{100}$	2 ins. from roots.
89*b*	" "	"	"	"	"	"	"	$\frac{1}{50}$	The next 2½ ins.
89*c*	" "	"	"	"	"	"	"	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.

INDEX TO
MINUTES OF EVIDENCE, &c., IN THIS VOLUME,
AND MEMORANDA.

INDEX TO MINUTES OF EVIDENCE IN THIS VOLUME.

ACETIC ACID:

Liability of, to contain arsenic (Appendix 24), p. 233.

ADDISON'S DISEASE:

Pigmentation in (Reynolds), 8318-20.

ALCOHOL:

Toxic effect of alcohol when taken along with arsenic (Reynolds), 8338; (Delépine), 10388-424; (Appendix 16), pp. 183-195.

ALCOHOLIC NEURITIS:

Alcoholic neuritis in relation to arsenic (Reynolds), 8322-38; none observed in beer drinkers since 1900 epidemic, 8332; exceptionally common among beer drinkers in Manchester before 1900, 8339-44; difference due to previous presence of arsenic in Manchester beer, 8402, which was largely attributable to malt, 8357-8, and to exclusion of arsenic from beer since epidemic, 8343.

Rarity of neuritis caused by alcohol without arsenic (Reynolds), 8338.

See also HALIFAX, NEURITIS.

ALL-MALT BEER:

Arsenic in (Expert Committee), Appendix 19, p. 201; at "Cross Keys," Halifax (H. Smith), 8628, p. 20; 8653-64.

ANALYSTS:

PUBLIC ANALYSTS:

Total number in England and Wales (Lithiby), 11505.

Relation with local authorities (Allen), 11987, 12008; often not consulted or asked to advise, 12005; (Hehner), 10203.

Quarterly report to local authority (Lithiby), 11629; (Allen), 12009-11. Four quarterly reports sent annually to Local Government Board (Lithiby), 11630-1. Extracts from, in Board's annual reports (Lithiby), 11513; (Allen), 12008. Terms of report (Lithiby), 11506, 11632-3; do not show what adulterations or impurities looked for, 11634-40.

Terms of report in individual cases (Hehner), 10197-205; (Allen), 11983-7. Significance of "genuine" (Lithiby), 11637-40; (Allen), 12007.

Work by, needs greater co-ordination (Allen), 12008, 12038-9.

PUBLIC ANALYSTS, SOCIETY OF:

Opinions of members on report of Joint Committee on Arsenic (Chapman), 10228, 10260-1, 10293-8.

WORK BY, FOR BREWERS AND OTHER MANUFACTURERS, in relation to arsenic:

Extent of analysis at Halifax breweries (H. Smith), 8628, 8706, 8784-8826; (Thompson), 8909-32, 8973-85, 9023-35; (Buckley), 9268-75, 9300-46, 9389-96.

Analysis of various brewers' samples (Thomson), 9654-9783; (Fairley), 9863-73; (Salamon), 9994-5; (Chapman), 10272-88, 10325-67. Extent of information, etc., received by analyst (Thomson), 9708-12; (Fairley), 9858, 9865-8.

Analysis of various substances used in food preparation; extent to which practised by different manufacturers (Appendix 24), pp. 230-254; (Lyle), 11028-59, 11077-11140, 11159-60; (Howell), 11181-4, 11215, 11259; (Overbeck), 11291-6; (Walker), 11327, 11341; (Pronk), 11378, 11387-8; (Palmer), 11465; (Appendix 27), p. 277.

ANILINE DYES:

Arsenic in. *See* COLOURING MATTERS.

ANTHRACITE. (*See* FUELS.)

ARSENIC:

One-hundredth grain daily may be considered a harmless quantity (Reynolds), 8373, 8443-7; might be injurious in certain cases (Neech), 9100, (Delépine), 10400-16. Small medicinal dose producing paralysis (Neech), 9264-5.

ARSENIC ACID AND ARSENATES:

"Marsh" estimations in the case of solutions containing arsenic as arsenic acid (Angell), 8507-13; (McGowan and Floris), Appendix 23, p. 227.

ARSENIURETTED HYDROGEN:

Poisoning by (Legge), 11747-52, 11792-5, 11819-20.

BARLEY:

Arsenic in kiln-dried barley, and also in barley not kiln dried (Expert Committee), Appendix 19, p. 202; latter attributed to use of superphosphates (Salamon), 9999-10006.

Negative evidence: no arsenic detected in barley and other cereals grown on soil manured under various experimental conditions. *See* VEGETABLES.

No arsenic in barley used for Newark experiment, Appendix 30, p. 322.

BEER:

MANUFACTURE OF:

Use of malt adjuncts in beer at Halifax (H. Smith), 8628, p. 18; action of Board of Inland Revenue as to arsenic in beer ingredients, preservatives, "regenerators," etc. (Primrose), 11844-967.

BEER, ARSENIC IN:

Will apparently diminish on keeping if the organic matter of the beer is not destroyed before testing (Hehner), 19212-5; more arsenic in sediment of beer than in liquid (H. Smith), 8844-7. Suspended matter may influence results of analysis (Neech), 9104-6, 9257-60.

Presence of arsenic in various beers. *See* QUANTITIES. Improvement in beers since the 1900 epidemic (Reynolds), 8367-72; (Thomson), 9758; (Fairley), 9846-52; (Salamon), 9967. Less than one-hundredth grain of arsenic per gallon now easily attainable (Salamon), 9966; (Hehner), 10123, 10169-78; (Chapman), 10277-9; (Primrose), 11847; (Allen), 11973.

Possible combination of arsenic with organic matter of beer. *See* ORGANIC MATTER.

BEER FREE FROM ARSENIC:

No arsenic found by delicate tests in some recent beers (Thomson), 9686-7; (Fairley), 9851-2; (Chapman), 10277; (Primrose), 11847. All arsenic should eventually be excluded from beer (Thomson), 9684-5. Absolute freedom from arsenic cannot be secured (Hehner), 10160.

BERI-BERI:

Possible relation to arsenical poisoning (Reynolds), 8381; Liverpool case, inquired into with Major R. Ross, 8381-97; Cardiff cases, 8381; relation of tropical beri-beri and arsenic requires investigation (Reynolds), 8381-6, 8398-401.

BERI-BERI—*continued.*

REPORTS ON BERI-BERI IN APPENDIX 31:

Section I.—General account of inquiries made for the Commission; collection of information and samples from ships arriving at home ports with cases of beri-beri, account of ships, cases, samples, and analyses, pp. 326-333.

Conclusions as to inquiries relating to ship-borne beri-beri, p. 334; inquiries reported from Malay States, p. 334.

Section II.—Report by Dr. McGowan on examination for arsenic of various substances in connection with beri-beri inquiry, pp. 335-344.

BIRTH RATE,

DIMINUTION FOLLOWING THE 1900 EPIDEMIC:

APPENDIX 17.—Dr. Niven's observations on the apparent relation between the 1900 epidemic in Manchester and the drop in the birth rate in 1901, with statistics, annual and quarterly, for Manchester and other towns affected by or free from arsenical poisoning in 1900 (Appendix 17), pp. 196-8.

"BOARD OF REFERENCE":

Question of establishing an authority to prescribe "standards" for foods and food ingredients (Moulton), 9945; (Lithiby), 11516-7, 11542, 11650-3; (Allen), 12033, 12056-61. If established, should be advisory not executive (Lithiby), 11543-6.

"BOLE ARMENIA":

Arsenic in (Pronk), 11444; (Appendix 24), p. 234; (Appendix 25), p. 268; (Appendix 22), p. 225; no arsenic found in (Howell), 11250-5.

Use of, to add to sausages, etc. (Appendix 24), p. 247.

BORAX AND BORIC ACID:

Arsenic in, manufacture, and prices (Appendix 24), p. 233; foods liable to arsenical contamination by their use, p. 248; absence of guarantees or tests as regards preservatives obtained commercially, p. 248; purchased on guarantee and analysis (Howell), 11224; arsenic in "Frigiline" (Appendix 25), p. 265.

Boron preservatives still used in milk, notwithstanding report of Preservatives Committee (H. Smith), 10984; (Appendix 24), p. 248.

BOSTOCK AND CO.:

Disposal of Bostock's contaminated glucose, invert sugar, and table syrup (Secretary), 10982.

Action by, against Nicholson and Sons (Secretary), 10983.

BOSTOCK'S TABLE SYRUPS:

Manufacture commenced in 1900; scarcely any sale to public; 14 tons on Bostock's premises in May, 1901; Nicholson's acid used in their preparation; dangerously contaminated (H. Smith), 10971-82. Result of analyses (McGowan), Appendix 25, p. 265.

BREWED BEVERAGES (OTHER THAN BEER):

Use of glucose and invert sugar in preparation of (Appendix 24), p. 242.

BREWERS:

Precautions regarding arsenic taken by brewers since 1900 epidemic. *See* BEER, EXPERT COMMITTEE, HALIFAX, MALT.

Nature of precautions taken or desirable (H. Smith), 8628, 8671-8700; (Hehner), 10162-6; (Chapman), 10325-32; (Thomson), 9708-20; (Fairley), 9846-75; (Salamon), 10025-47; precautions will be relaxed unless some official control (Ling), 10576-82; 10596-7; (Thomson), 9782-3; (Allen), 12037.

No drawback claimed by brewers in consequence of destruction of arsenical beer since 1901 (Primrose), 11961.

BREWING SUGARS (OTHER THAN BOSTOCK'S):

Result of testing for arsenic (Thorpe), 8847; (Thomson), 9669; (Ling), 10574-7; (Primrose), 11847; (Appendix 19), p. 201.

See also GLUCOSE, INVERT SUGAR, CARAMEL.

CACODYL:

No evidence that compounds of cacodyl or its homologues are present in arsenical beer; experiments on this question; tests under (Delépine), 10381-3.

Experiments on action of yeasts and moulds on cacodylates (Delépine), 10384.

Toxicity of (Delépine), p. 190, note. Effect of cacodylate of soda on experimental rats (Appendix 16), pp. 186, 190.

CARAMEL:

Recent analyses of samples from breweries (Thorpe), 8847; (Thomson), 9669, 9689; (Primrose), 11847 (Table I.); arsenical samples, 11847 (Table II.); 11878. Arsenic in various samples: may be due to caustic soda (Appendix 24), p. 236; foods in which caramel is used (Appendix 24), pp. 246, 248. Should be tested for arsenic (Appendix 19), p. 204; (Appendix 21), p. 215.

"CARNOS":

Nature and mode of preparation from yeast and malt culms (Appendix 24), p. 244; (Overbeck), 11261-2. Arsenic in (Appendix 24), p. 244; (Appendix 25), p. 262; (Overbeck), 11270-4.

Samples called in by manufacturer on account of arsenic (Overbeck), 11271. Subsequent process to exclude arsenic, 11272, 11291-307; amount of arsenic not excluded by process, 11274-6. Company now in liquidation (Overbeck), 11274.

CARPETS, CLOTH, ETC.:

Examined for arsenic on account of prohibitions of Swedish and Norwegian Governments (Thomson), 9797-800.

CASKS:

Shavings from casks which had held arsenical beer, showed no arsenic (Expert Committee), Appendix 19, p. 203.

CHEMICAL SUBSTANCES:

USED IN FOOD PREPARATION.

Sulphuric, hydrochloric, phosphoric, citric, tartaric, and acetic acids, sulphites, glycerine, etc., in relation to arsenic (Appendix 24), Sections I. and II., pp. 230-248. Food manufacturer sometimes ignorant of risk of arsenic from use of certain of these substances (H. Smith), 10923-8; recent demand for arsenic-free chemicals (Howell), 11166; purity ultimately depends on sulphuric acid, which should be obtained free from arsenic (Howell), 11229.

Chemical substances liable to be arsenical sold to food manufacturers under misleading names (Howell), 11201-2.

Demand by manufacturers for "standards" as to arsenic in (H. Smith), Appendix 24, page 254, 10939-49; (Howell), 11190; (Palmer), 11478. Pharmacopœial standards of uncertain value (H. Smith), 10912-8; (Howell), 11190; (Appendix 24), pp. 255-6.

Chemical substances which may introduce arsenic into beer (Appendix 21), p. 215; (Primrose), 11847, 11869-73.

USED IN TESTING FOR ARSENIC:

See TESTS.

CHLORIDE OF TIN:

Used in manufacture of West India sugar; may be a source of arsenic in the sugar (Appendix 24), p. 239; (Appendix 25), p. 268; (Lyle), 11064-5.

CHICORY:

Chicory drying in relation to arsenic; exposure of chicory roots to fumes of coke; additional drying for English market; analyses of, for arsenic (Appendix 24), p. 250; (Appendix 25), p. 269; (Thomson), 9790-3; (H. Smith), 10996-6.

CHRONIC ARSENICAL POISONING:

Accelerating death from tuberculosis and other causes (Reynolds), 8412-31; (Neech), 9160-7; (Delépine), Appendix 16, p. 189.

Toxic effect of arsenic when taken with alcohol (Reynolds), 8338; experimental administration to rats, influence of food (Delépine), 10388-424; (Appendix 16), pp. 183-195. Effect of small quantities of arsenic in beer (Reynolds), 8373, 8443-7; (Neech), 9100; (Delépine), 10400-16. Pathological changes in human and rat (Appendix 16), p. 189.

In Halifax outbreak. *See* HALIFAX.

In industrial poisoning (Legge), 11738-843.

CIDER:

Use of invert sugar in manufacture (Appendix 24), p. 241.

CIGARETTE PAPERS:

Imitation gold and bronze tipped, analyses for arsenic (Appendix 25), p. 274.

CITRIC ACID:

May contain arsenic (Davis), 6423.

Preparation of, in relation to arsenic; selection of acid and treatment with sulphuretted hydrogen by Bennet, Lawes, and Co. (Appendix 24), p. 233. Purchase and sale of (Howell), 11212-8.

COAL GAS:

No arsenic detected in (Fairley), Appendix 24, p. 257.

COKE, GAS AND OVEN (*See* FUELS, SMOKED FOODS.)

COLOURING MATTERS IN FOOD:

MINERAL COLOURS:

Arsenic in oxide of iron and "Bole Armenia" may be in large amount (Hehner), 10210, and Appendix 27, p. 277; (Pronk), 11444; (Appendix 24), p. 234; (Appendix 25), p. 268; (Appendix 22), p. 225. In oxide of manganese (Hehner), 10211.

Arsenic introduced into foods by: chocolate powders, anchovy paste, etc. (Appendix 27), p. 277; sausages, etc. (Appendix 24), p. 247.

Should not be used for food purposes (Pronk), 11401-5. No knowledge of arsenic in (Howell), 11253-5.

COAL TAR COLOURS:

Arsenic in various coal tar colours (Appendix 24), p. 234; in samples used in food, apple green, carnation, coffee colour, dragon's blood, "Saster" (Appendix 25), pp. 268-9; (H. Smith), 10964-6, 10944.

Organic matter must be destroyed in testing (McGowan), Appendix 22, p. 223; (Hehner), Appendix 27, p. 277.

Origin of arsenic, use of arsenic acid now rare, probably due to impure sulphuric acid (Appendix 24), p. 234; (Pronk), 11367-71. Arsenical process should not be used (Pronk), 11382-3. 11435.

System of testing: arsenical specimens set aside for textile purposes (Pronk), 11378-81. 11386-94; usually knows purpose for which required (Pronk), 11424-33.

Foods coloured with (Appendix 24), p. 247; advantages of using (Pronk), 11412-23.

CONFECTIONERY:

Use of ingredients in confectionery which are liable to contain arsenic: glucose, glycerine, colouring matters, lanoline, liquorice, etc. (Appendix 24), p. 240. Precautions taken by confectioners in ordering glucose, etc., p. 236; (H. Smith), 10922-7; (Walker), 11308-61; (Palmer), 11456-96. Arsenic in "chocolate" sweets (Hehner), Appendix 27, p. 277.

CORNWALL:

Symptoms occurring in arsenic workers in (Legge), 11807-27.

"COURT OF REFERENCE":

See "BOARD OF REFERENCE."

"CREAM OF TARTAR SUBSTITUTE":

(Palmer), 11469-72, 11492-3; (Howell), 11201, 11244.

CUMULATIVE EFFECT OF ARSENIC:

Relatively greater when doses small (Delépine), 10423-4 (Appendix 16), p. 190.

DEPARTMENTAL COMMITTEE ON TESTS FOR ARSENIC IN BREWING INGREDIENTS, ETC.:

Appointment of, by Board of Inland Revenue (Primrose), 11896. Work by, on electrolytic and zinc and acid methods, conclusions, and recommendations (Thorpe), 11654-737; Report of (Appendix 21), pp. 208-219.

DEXTRIN:

Manufacture of, and use in certain biscuits (Appendix 24), p. 243.

DUST:

Arsenic in, on laboratory shelves and bookcases (Fairley), 9824; in dust generally (Lyle), 11104; (Howell), 11233-6.

ELECTROLYTIC TESTS FOR ARSENIC:

See TESTS.

ELIMINATION OF ARSENIC FROM THE BODY:

Ways in which arsenic is eliminated (Reynolds), 8292-8314, 8360-72, 8448-53; (Delépine), 10423-4 (Appendix 16), p. 190; (H. Smith), 8628, p. 16. Hair experiments (Appendix 32), pp. 345-362. Arsenic in feathers of fowls receiving arsenic with food (H. Smith), 10997-11007; (Appendix 24), p. 252.

EMERALD GREEN, SCHEELE'S GREEN, and PARIS GREEN:

Nature, manufacture, and use of (Legge), 11775-8, 11796-800. Use of, as insecticides (Appendix 24), p. 251. Use to colour green tapers (Legge), 11769-73.

ENAMELLED COOKING UTENSILS:

Arsenic as an ingredient of enamel; use by English manufacturers discontinued: much arsenic found by Mr. Albert Smith in cheap Belgian ware: illness said to have been caused by arsenical enamel (H. Smith), 11008-23; (Appendix 24), p. 252.

REPORTS ON, IN APPENDIX 29:

Section I.—General account of Commission's inquiry and summary of results; collection of British and foreign made samples from various sources; manufacture of experimental saucepans using arsenic in enamel, p. 281.

Section II.—Solubility of arsenic in enamel of experimental saucepans (McGowan), p. 282-3.

Section III.—Examination for arsenic of the collected samples; results uniformly negative (McGowan), p. 284-5.

ENTRY:

Power of entry on premises of manufacturers. *See* OFFICIAL CONTROL.

EPIDEMIC DUE TO ARSENIC IN BEER, 1900:

Cases still under treatment in Manchester in 1902 (Reynolds), 8315. Total fatal cases in Crumpsall Infirmary (Reynolds), 8315-7, 8422-31. Pathological changes in fatal cases (Appendix 16), p. 189. Cases in Halifax in 1900 (Neech), 9128.

Class of persons attacked, influenced by feeding and other conditions (Delépine), 10389-416, (Appendix 16), p. 191.

Effect of, on birth rate in 1901 (Niven), (Appendix 17), p. 195.

Cessation of arsenical symptoms, "alcoholic neuritis," "alcoholic heart," etc., in Manchester since epidemic (Reynolds), 8287-8359, 8402.

EXPERT COMMITTEE APPOINTED BY MANCHESTER BREWERS' ASSOCIATION:

Final report (Appendix 19), p. 201.

Its object, work, and conclusions (Moulton), 9924-63; (Salamon), 9964-10091. Adoption of recommendations by brewers (Moulton), 9935; (Thompson), 9050; (Buckley), 9379-85.

Reinsch test for arsenic first recommended by (Salamon), 9964. Later test more stringent, and should be better known (Salamon), 10026-35. Advantage of easily applied test for unskilled use (Moulton), 9939, 9957-63; (Salamon), 9968-73, 10036-47.

Use of test recommended by (Fairley), 9820-3, 9879-80; (Hehner), 10109-13; at Halifax (H. Smith), 8628, p. 17; (Neech), 9208-13; (Buckley), 9389.

FININGS:

Appendix 21, p. 215.

FISH:

Arsenic in samples of preserved fish used on board ship; practically no arsenic in fresh fish samples (Appendix 31), pp. 332-3.

Process of drying over coke introduces scarcely any arsenic into bloaters, etc. (H. Smith), 10988-94; (Appendix 24), p. 249.

FOODS AND DRINKS (OTHER THAN BEER) IN RELATION TO ARSENIC:

REPORTS ON, IN APPENDICES 24 TO 27.

Mr. Hammond Smith's inquiries and report:

Nature and methods of inquiry (Appendix 24), p. 230. Section I., Food Ingredients liable to contain arsenic, pp. 230-7. Section II., Certain food substances liable to contain arsenic by reason of their manufacture with these ingredients, pp. 238-248. Section III., Foods dried by exposure to products of combustion, pp. 249-50. Section IV., Miscellaneous: Flesh of fowls receiving arsenic, arsenical insecticides, etc., pp. 251-2. Addenda, Arsenic in glycerine and in gas products, pp. 255-9.

Summary of Mr. H. Smith's report, p. 253. Evidence on report (H. Smith), 10911-11026.

Analyses by Dr. McGowan of certain foods obtained during above inquiry (Appendix 25), pp. 261-275.

Preparation of maltine (Appendix 26), p. 276.

Letter from Mr. Hehner on arsenical contamination of food by certain colouring matters (Appendix 27), p. 277.

Inquiries as to addition of mineral acids to whisky and gin (Appendix 28), pp. 278-80.

FOOD AND DRUGS ACTS, SALE OF:

Authorities appointing public analysts, total number (Lithiby), 11505. Local authorities have specific duty of administering Acts since 1899 Act, 11501.

PRESENT ADMINISTRATION AND USE OF:

Mainly directed to well-known forms of adulteration (H. Smith), 10929, 10931. Use to prevent deleterious substances limited (Lithiby), 11511; insufficient for this purpose (Allen), 12005.

Total samples under Acts increased since 1899 Act (Lithiby), 11500-4; increase largely milk and butter, 11586-8, due to pressure by Board of Agriculture, 11645; increase also due to arsenic question, 11596-9.

FOOD AND DRUGS ACTS, SALE OF—*continued.*

Few samples of beer now received from local authorities (Hehner), 10206-7; none taken in Halifax or Huddersfield in 1901 (H. Smith), 8826-30; (Neech), 9193. Food samples seldom taken for arsenic analysis (H. Smith), 10930.

Penalties often inadequate: Home Office circular (Lithiby), 11506.

See also ANALYSTS, PUBLIC.

LOCAL GOVERNMENT BOARD AND ADMINISTRATION OF:

Duties of Board under Acts very limited before 1899 Act (Lithiby), 11499; additional powers since, 11499. Extent to which these have been used, 11500, 11537-41. Issue of circular as to arsenic, 11513, 11541.

Extent of advice by Board to local authorities (Lithiby), 11513. No organised system, 11514. Board have no special expert staff to advise, etc., on food questions, 11519, 11537; or to recommend sampling of particular articles, 11642-4. Advice in this direction is needed (Allen), 12008, 12048-50, 12054.

POWERS UNDER:

Action under Acts must be taken against retailer (Lithiby), 11507, 11616-7; person responsible often cannot be reached (Allen), 12013-4. No powers to take samples from places of manufacture of food (Neech), 9224-9, 9246-51; (H. Smith), 10958-9; (Lithiby), 11508; (Allen), 12012.

As to samples in transit (Lithiby), 11507; object, 11558-61. Samples cannot be taken outside the district, 11605-6. Samples taken and divided must be "separate articles" (Allen), 12034.

WARRANTY:

Effect of (Lithiby), 11618-28; (Allen), 12013-9. Evasion of Acts by notices (Allen), 12021-31.

Advantage if warrantor could be reached on first hearing of the case (Allen), 12062.

OFFICIAL "STANDARDS" FOR PURPOSES OF:

Need for such "standards," particularly as regards arsenic; nature of "standards" required, etc. (Thomson), 9765-9; (Moulton), 9942, 9954-6; (Hehner), 10154-9; (Lyle), 11074-6, 11154; (Allen), 11981-2, 12006, 12040. Illustrations of need for "standards" or definitions of foods (Allen), 12006-14, 12020, 12069. *See also* BOARD OF REFERENCE.

FUELS:

SELECTION OF FUEL BY MALTSTERS:

Use of gas-coke. In Halifax district in 1900-1 (H. Smith), 8628, 8647. Still used at certain maltings, 8628, 8764-8, 8807; in some cases 85 per cent., 8741-2; (Thompson), 8933-5. Gas-coke discontinued at Halifax (H. Smith), 8724-8; (Thompson), 9055-61; (Buckley), 9293, 9369-84; (Worsick), 9431-2; use generally abandoned, should be prohibited (Salamon), 9976-9.

Anthracite preferred to *oven coke* (H. Smith), 8728-36; (Buckley), 9293-9300, 9368-84; (Salamon), 10050-3; (Appendix 19), p. 203. Recommended (Chapman), 10355; now almost exclusively used (Thomson), 9691-4.

TESTS FOR ARSENIC IN FUELS:

See TESTS.

ANALYSES OF FUELS FOR ARSENIC:

Fuels seldom analysed for maltsters (H. Smith), 8628, p. 21, 8807; (Thompson), 8935-7, 9044; (Appendix 30), p. 298.

Difficulties of sampling for analysis; importance of accurate samples; objections to relying on analysis for selection of fuel (Worsick), 9447; (Thomson), 9787-9 (Moulton), 9935, 9950-2; (Salamon), 9984, 10059-64; (Chapman), 10353; (Ling), 10490-525, 10533-5, 10661-79; (Appendix 30), pp. 290, 308-9.

Guarantees of freedom from arsenic given by collieries; such guarantees have little value (H. Smith), 8769-83; (Thompson), 8938-41; (Salamon), 10059-64; (Chapman), 10356-67; (Appendix 30), pp. 290, 304-7.

FUELS—*continued.*

"VOLATILE" AND "FIXED" ARSENIC IN FUEL:

Methods of determination and significance (Ling), 10451-683, 10697-708; (Thorpe), 11671-719; (Appendix 20), p. 207; (Appendix 21), pp. 210, 214; (Appendix 23), pp. 227-9; (Appendix 30), p. 311. Observations on results (Appendix 30), pp. 289-90.

GAS COKE:

Amounts of arsenic in different samples (Ling), 10536; (Appendix 30), p. 288.

OVEN COKE:

Amounts of arsenic in different samples (Ling), 10536; (Appendix 30), p. 320. Comparison with gas coke and anthracite (Ling), 10540-9; (Beaven), 10886-90; (Salamon), 10050-3; (Appendix 19), p. 203; (H. Smith), 8728-36; (Buckley), 9293-300, 9368-84; (Appendix 30), p. 288.

Manufacture of, and hand picking of coal (H. Smith), 8751-61. Suggestion of coking with base (Ling), 10621-6. Advantage of oven coke treated with lime (Ling), 10627-31. Sulphur in foundry coke (Fairley), 9899-9904.

ANTHRACITE:

Amounts of anthracite in different samples and "impurities" of anthracite (Ling), 10536; in sample analysed for Commission (Appendix 30), pp. 286-321; colliery analyses (Appendix 30), p. 306. Unequal distribution of arsenic (Ling), 10490-525; recent samples have been better, 10526.

Presence of lumps of pyrites in anthracite supplied to maltsters (H. Smith), 8736-41; (Appendix 30), p. 298.

Necessity of careful picking over (H. Smith), 8757-61; (Salamon), 9981, 10054-5; (Chapman), 10356-67; (Ling), 10661-5; (Appendix 30), pp. 286-310.

REPORTS ON MALTING ANTHRACITE IN APPENDIX 30:

Part I.—*Account of Commission's Inquiry, and Summary of Results.*—Presence of impurities (pyrites, shales, etc.) in anthracite seams, and their removal at collieries; arsenic in clean anthracite and in impurities; fixed and volatile arsenic, pp. 286-90.

Bearing of results on selection of malting anthracite by collieries and maltsters, p. 290.

Tabular summaries of results, pp. 291-7.

Part II.—*Mr. H. Smith's Notes* on inquiries as to anthracite used by certain maltsters, p. 298.

Part III.—*Mr. A. Strahan's Notes* on visits to S. Wales collieries supplying malting anthracite. Seams worked for malting, p. 299; occurrence of impurities, p. 303; methods of removing impurities, p. 303; samples recommended, p. 304.

Part IV.—*Mr. S. W. Price's Report* on collection of samples. Samples taken underground, p. 308; samples of malting coal, p. 309. Picking and screening of anthracite, p. 309.

Part V.—*Dr. McGowan's Report* on arsenic in malting anthracites and other specimens. Observations, p. 311. Tables, pp. 312-321.

Part VI.—*Account of two experiments at Newark maltings*, pp. 322-5.

TREATMENT OF MALTING FUEL:

Addition of lime to "fix" the arsenic (Ling), 10458-60, 10467-8, 10477-8, 10536, 10555-69, 10588-92, 10627-31, 10660.

Now adopted at Halifax (Buckley), 9316-7.

BRIQUETTES:

Possible advantage of (Salamon), 10088-91, if made with a base (Ling), 10614-20.

GAUTIER, M.

Statement that arsenic is normally present in thyroid gland (Reynolds), 8307-12.

GLASS:

Arsenic in glass bottles and flasks (Reynolds), 8364; (Thomson), 9741; (Fairley), 9824.

Jena glass flasks should be used for storing acids (Appendix 20), p. 206. Manufacture of special bottles without arsenic for storing re-agents (Appendix 22), p. 220.

GLUCOSE:

Use of, in various articles of food: General memoranda as to manufacture of, and arsenic in; precautions now taken or neglected by food manufacturers in ordering; guarantees; tests (Appendix 24), pp. 234-6, 238-243.

Use of, by Messrs. Castell and Brown: guaranteed as regards arsenic, analysis unnecessary (Walker), 11308-61. Looseness of guarantee system (H. Smith), 8794; (Primrose), 11959-60.

Arsenic in certain recent samples (Appendix 24), p. 235; (Ling), 10576-8, 10632-6; (Primrose), 11847, Table II.; (Allen), 11988.

Numerous instances where brewers' glucose recently found practically free from arsenic (Thorpe), 8847; (Thomson), 9669; (Primrose), 11847, Table I.; 11874; degree of purity attainable (Chapman), 10285-8; (Primrose), 11934-8.

Treasury Order prohibiting use of arsenical glucose in breweries: samples obtained by Inland Revenue officers from British factories, and from brewers using imported glucose without guarantee (Primrose), 11844-7. Difficulty in accurate sampling small (Chapman), 10340-3; 10352.

GLYCERINE:

Use of, in food: as addition to cakes, jujubes, meat extracts, etc. (Appendix 24), pp. 234, 240-4; (H. Smith), 10912; (Howell), 11173-4; (Palmer), 11473; (Allen), 11998-12004. Food manufacturers often ignorant that glycerine may be arsenical (H. Smith), 10923; (Palmer), 11463-4.

Manufacture of, in relation to arsenic (Appendix 24), p. 233. Amounts of arsenic in various specimens (C. Brown), Appendix 24, p. 255. Uncertainty of limit of arsenic as defined by Gutzeit test of B.P. (C. Brown), p. 256; (H. Smith), 10916-8.

GOVERNMENT LABORATORY:

Various work done at, in reference to arsenic, since 1901 (Primrose), 11844-11967. Results of testing large numbers of brewing ingredients, etc. (Primrose), 11847. Analyses of various substances in connection with Halifax outbreak (Thorpe), 8847.

Work at, in reference to tests and inquiry of Inland Revenue Departmental Committee (Thorpe), 11654-737, (Appendix 21), pp. 208-219.

Extent of testing for arsenic at (Salamon), 9974-5, 10072-6. Control by, at brewery, might be exercised by testing wort (Salamon), 9991-3, 10077-80; (Chapman), 10317-48, 10349-51; (Primrose), 11948.

GRILLED FOODS:

Arsenical contamination from fumes of open fire negligible (H. Smith), 10988-94, (Appendix 24), p. 250.

GUARANTEES: AS REGARDS ARSENIC:

Advantages and limitations of (Moulton), 9936-8; trade customs regarding (H. Smith), 8794, 8781-2; (Howell), 11195-6; (Walker), 11341-3, 11349-59; objections to, if based on "blunt" tests (Hehner), 10147-53.

In respect of brewing ingredients: Recommendations of Expert Committee (Appendix 19), p. 203; (Moulton), 9936. Methods of testing, on which guarantees could be based (Departmental Committee), Appendix 21, p. 208; (Primrose), 11940-50, 11956-8. Guarantees in respect of imported glucose (Primrose), 11959-60. Guarantees obtained by Halifax brewers (H. Smith), 8777-82; (Buckley), 9398. Not usually given with malt (Worsick), 9442-3, 9484-7. Sampling in relation to, *see* MALT.

GUARANTEES: As regards Arsenic—*continued.*

In respect of fuel used by maltster: Guarantees of "freedom from arsenic" in anthracite supplied and accepted (Thompson), 8938-40; (Buckley), 9404; (Appendix 30), pp. 298, 304, 306. May be of no value, owing to sampling and other considerations (H. Smith), 8769-76, 8783; (Thomson), 9787; (Salamon), 9984, 10060; (Chapman), 10353-67; (Ling), 10524, 10667-80; (Appendix 30), p. 290. Guarantees as to hand picking, or origin of anthracite (Salamon), 10060-3; (Chapman), 10367. Guarantee that no gas coke used (Expert Committee), Appendix 19, p. 204.

In respect of sulphuric acid, colouring matters, and chemical substances used in food: (Lyle), 11045-9; 11132-5; (Howell), 11195-9, 11247-9; (Walker), 11312-24, 11349-59; (Palmer), 11492-6; (Pronk), 11453; (Appendix 24), p. 235.

See also WARRANTY, OFFICIAL CONTROL.

HAIR:

Arsenic in, in cases of arsenical poisoning (Reynolds), 8292-3, 8298-8306, 8360-2, 8448-9. In hair of rats receiving arsenic (Delépine), Appendix 16, p. 188. In cases of beri-beri (Reynolds), 8381, 8389-91; (Appendix 31), pp. 333-4, 344.

REPORTS ON ARSENIC IN HAIR, IN APPENDIX 32:

Part I.: General account of Commission's inquiry and tables giving analysis of chief results: Preliminary specimens; specimens from arsenic takers; control specimens; specimens from brewers' draymen and alcoholic neuritis cases, pp. 345-350.

Part II.: Mr. Wood Smith's report on methods of testing hair samples, p. 351.

Part III.: Detailed tabular statements, pp. 352-62.

HALIFAX, ARSENICAL POISONING AT, IN 1902:

DR. E. S. REYNOLDS:

Arsenical poisoning from beer in 1902 at Halifax, 8403-8442.

MR. H. HAMMOND SMITH:

Origin of his inquiry as Assistant Commissioner; cases reported in infirmary; inquest on McNulty, etc., 8628, p. 15.

Details and symptoms of Infirmary cases: Case in private practice. Review of cases; outbreak one of arsenical poisoning, p. 16. Other cases suspected both in and outside the Infirmary, 8628-34, 8719. Dr. Woodyatt's view of outbreak, 8635, 8710.

Beer implicated; local inquiry and action with regard to outbreak, 8628, p. 16. Analyst's results, p. 17. Attitude of brewers, 8628, 8800-4. The Halifax brewery implicated during 1900 epidemic had destroyed their beer, 8746-9.

Inquiry as to suspected beers; origin of ingredients used; source of arsenic, 8628, pp. 18-20, 8640.

Malt seldom tested for arsenic: Malts used in implicated brews prepared in 1900-1 season mainly by use of local gas coke. Greater care since taken in most instances, 8628, p. 21, 8665-6.

Evidence implicating gas coke dried malt as the cause of outbreak, 8628, p. 21; 8647-744. Mr. Firth's malt previously found to contain 1-30th grain arsenic per lb., 8647-8660. Inadequacy of brewers' precautions since Manchester scare subsided, 8669. Little or no testing by maltsters for sale, 8695.

Maltsters abandoning gas coke, 8724-7. Brewers demanding malt prepared with anthracite, 8728-9. Maltsters who continue to use gas coke, 8741, 8764.

Halifax Town Council and Medical Officer of Health's report, 8701. During 1901 no samples of beer submitted to public analyst, 8702; or at Huddersfield, 8829. Halifax public analyst used test first recommended by Brewers' Expert Committee, 8833-6. Brewers' records of analyses not kept systematically, 8706-9.

No action by local Excise officers as to arsenic before outbreak, 8837.

Representations made to Coroner on behalf of brewers, 8839-8843.

Dregs of casks containing much arsenic, 8844.

HALIFAX, ARSENICAL POISONING AT, IN 1902—*continued*

PROFESSOR THORPE'S MEMORANDUM on Halifax beers and brewing materials tested for arsenic at the Government Laboratory. (Excise samples and special samples obtained by Mr. Hammond Smith.) Results. Arsenic in urine of Halifax patients, 8847.

MR. G. S. THOMPSON:

Evidence in respect of Whitaker's brewery. Observations on Mr. Hammond Smith's report, 8849-63, 8900. Recent precautions against arsenic, 8901, 8938-41, 9044-54. Malting fuels used, oven coke substituted for gas coke, 8901-8, 9055-64. Gas coke, 85 per cent. used before outbreak, 8933-7.

Construction of Messrs. Whitaker's kilns claimed to safeguard against arsenic, 8864-8882, 8986-9023, 9065-81. No recent change in their construction, 8883. Arsenic in kiln dust, 8954-8, 9009-9016; cleansing girders, etc., 9017. Brushing of malt, 8888-90, 8942-9, 9082-9; found to remove arsenic, 8950-3.

Extent of analyses of beer and malt and results, 8909-32, 8973-85, 9023-35. Recommendations of Brewers' Expert Committee not adopted at this brewery, 9060-4. Formation of Brewers' Association in Halifax, 8858.

DR. J. T. NEECH:

Evidence by Borough Medical Officer of Health. Observations on Mr. Hammond Smith's report, 9092-6. Notes of five additional cases, 9097. Cases were arsenical poisoning, 9096, 9111-2; due to malt, 9123.

Difference between malts of 1900-1 and 1901-2 seasons, 9114-9120. Implicated beer from 1900-1 malt, dried over gas coke, 9121-7.

McNulty's case: Dr. Woodyatt's evidence at inquest, 9146-55; Lee's case, Dr. Woodyatt's evidence, 9156-67; other infirmary cases, 9168-91. Whalan's case one of arsenical poisoning, 9174-82.

No samples of beer taken under Sale of Food and Drugs Acts between Manchester scare and present outbreak, 9193-9200. Action by Medical Officer of Health regarding outbreak: beer samples taken, reports by Mr. Ackroyd (public analyst), and by Mr. Richardson, 9202-12; difficulties owing to divergent results, 9107, 9257. M.O.H.'s inquiries outside Halifax, 9218-9; given facilities by Halifax brewers, 9220-3; samples taken at breweries, etc., 9230-1; no powers to take malt officially under Sale of Food and Drugs Acts, 9224-9, 9246-51. M.O.H.'s report to Town Council, 9214-6, 9238-40.

Arsenical poisoning in Halifax during 1900 epidemic, 9128.

MR. F. BUCKLEY:

Evidence in respect of Webster's brewery. Extent of analyses made in 1901 for brewery, 9268-74; and since outbreak, 9275. Precautions taken against arsenic, 9281. Divergent results of analyses in a recent instance, 9300-3, 9318-46. Chemist of brewery is public analyst of Halifax, 9389.

Implicated beer made from gas-coke malt, 9276-7, 9348-9350. Kinds of fuel used, gas coke now abandoned, 9293-9, 9368-84. Brushing malt practised, but no experiments as to its effect on arsenic, 9282, 9351-6. Construction of his malt kilns, 9358-67. Contamination of malt by kiln dust, 9412-9.

Formation of Brewers' Association in Halifax, 9287-90.

MR. A. WORSICK:

Evidence in respect of Worsick's maltings. Precautions adopted since 1900 epidemic; anthracite substituted for gas coke; malt brushed, etc., 9425-37; precautions have reduced aresenic, 9441; advantage of brushing, 9457, 9488-90. Construction of his kilns and their cleansing, 9478-83.

Some gas coke used in 1900-1 season, 9451; possible use of gas-coke malt in August, 1901, at Alderson's brewery, 9463-70.

DR. J. F. WOODYATT:

Cases in Halifax Infirmary, 1902; arsenical poisoning diagnosed in certain cases but not in others, 9501-9641.

HALIFAX, ARSENICAL POISONING AT, IN 1902—*continued.*

Dr. J. F. Woodyatt—*continued.*

Case of McNulty, 9508-10; inquest, 9545-60; Whalan, 9511-3; diagnosis of "pernicious anæmia" in his case, 9572-92, 9652; and certificate of death given by witness to that effect, 9606; no post mortem, 9599; inquest in this case undesirable, 9619; Dr. Mantle consulted, 9593, 9608-14, 9624-8; after communication with brewers, 9594-5; evidence of arsenical poisoning in Whalan, 9598, 9615; Lee, 9563, 9571; statement to Coroner of cause of his death, 9564; Wilkinson, 9538; Shearing, 9541; Lowrie, 9543, 9639.

Cases not reported to M.O.H. of Halifax, 9633. Opinions regarding outbreak, 9652-3.

MR. T. FAIRLEY:

Arsenic in Halifax beer, 9923.

HEART:

"Alcoholic heart," no longer observed in Manchester since 1900 epidemic (Reynolds), 8288, 8322-7.

HOPS:

In relation to risk of contamination by arsenic (Thorpe), 8847; (Thomson), 9669; (Primrose), 11847; (Expert Committee), Appendix 19, pp. 202, 204. "Hop Compo" (Primrose), 11879-93.

HYDROCHLORIC ACID:

Arsenic in (Fairley), 9824; (Appendix 24), p. 231; use of, for food purposes (Appendix 24), pp. 231, 243-4.

Purification of, for testing purposes (Thomson), 9741; (Hehner), 10116, 10129; (Appendix 20), p. 206; (Appendix 21), p. 212; (Appendix 22), p. 220.

INDUSTRIAL POISONING BY ARSENIC:

Various forms of, occurrence, and symptoms; reports on to Home Office, etc. (Legge), 11738-11843.

INLAND REVENUE, BOARD OF:

RECENT ACTION BY, IN RELATION TO ARSENIC IN BEER:

Issue of Treasury Order under 1888 Act, prohibiting arsenical glucose and invert sugar, October, 1901; instructions to Revenue officers thereon; samples of various brewing ingredients, worts etc., obtained; results of analyses in Government Laboratory (Primrose), 11844-51.

Action taken in certain cases, on report of arsenic in malt, malto-peptones, "regenerators," beer softening material, glucose, colouring solutions, caramel, "hop compo." (Primrose), 11852-95. *See also* HALIFAX.

Appointment of Committee on Tests (Primrose), 11896-9; question of utilising their report for purpose of "standards" (Primrose), 11896-9, 11940-58. *See also* DEPARTMENTAL COMMITTEE.

Extent to which Inland Revenue control could be utilised for protection against arsenic (Primrose), 11900-23; (Moulton), 9939-46; (Salamon), 9989-93, 10072-82; should be limited to breweries and brewing trade (Primrose), 11903-4. Revenue officers no power of entry on maltster's premises, 11954. No increase of staff required in consequence of recent action, 11953-7.

Revenue officers now take samples from factories of brewers' glucose and "invert" (Primrose), 11847; (Lyle), 11060-2; visit his works, re rebate on essences (Howell), 11237-9; do not visit (Walker), 11360-1.

INSECTICIDES:

Use of, in relation to contamination of fruit and vegetables by arsenic; experimental application of Paris green to gooseberry bush (Appendix 24), p. 251.

INVERT SUGAR:

Use of, in brewed "temperance" drinks, cider, etc. (Appendix 24), pp. 236, 241. Confectioners' sugar not "inverted" by mineral acid, p. 240.

INVERT SUGAR—*continued.*

Recent analyses for arsenic of brewers' samples (Thorpe), 8847; (Thomson), 9669; (Primrose), 11847. Treasury order prohibiting use of arsenical invert in preparation of beer, and consequent sampling (Primrose), 11844-7; (Lyle), 11060-2. Analyses by Expert Committee (Appendix 19), p. 201.

IRON:

Reduced iron of British Pharmacopœia, arsenic in (Reynolds), 8456-8462.

Iron oxide in food, *See* COLOURING MATTERS.

Iron salts impairing estimation by Marsh Test, *See* TESTS.

JOINT COMMITTEE OF SOCIETIES OF PUBLIC ANALYSTS AND CHEMICAL INDUSTRY.

Appointed to investigate tests for arsenic: work by, report, and recommendations (Hehner), 10092-10225; (Chapman), 10226-372. Report (Appendix 20), pp. 206-7; discussed at joint meeting of societies (Hehner), 10094; opinion of Society of Public Analysts also obtained by circular (Chapman), 10223; general favourable opinion of the Marsh-Berzelius method recommended (Hehner), 10109; objections mainly in respect of minor details of procedure (Chapman), 10228; Hehner), 10115-8. Use by chemists of methods recommended (Ling), 10469; (Allen), 11976-80; (Appendix 21), p. 212; (Appendix 22), p. 220; (Appendix 27), p. 277.

KERATIN:

Affinity of, for arsenic (Appendix 24), p. 252.

KERATOSIS:

None seen in Manchester patients since 1900 epidemic (Reynolds), 8287; arsenic in keratosis scales (Reynolds), 8295-7. In Halifax cases (H. Smith), 8628, p. 16.

KILNS:

Structure, cleansing, etc., in relation to arsenic. *See* MALT.

LANOLINE:

Use of as a substitute for cocoa-butter; found arsenical, due to sheep-dip (Appendix 24), p. 240.

LEMONADE POWDERS, "FRUIT CRYSTALS," &c.:

(Appendix 24), p. 242; (Appendix 25), p. 266.

LIME:

Addition of, to coke or other fuel used in malt drying, in order to "fix" the arsenic (Ling), 10440-708; (Buckley), 9316.

Use of, in malt kilns, to absorb volatilised arsenic (Beaven), 10787, 10818-32; use of heated limestone blocks as absorbents (Appendix 18), p. 199.

Use of, in estimation of arsenic in organic substances. *See* TESTS.

"LIQUID TARTARIC ACID":

Contains little or no tartaric acid (Howell), 11201.

LIQUORICE:

Arsenic in certain samples (Thomson), 9794-6; its possible origin (H. Smith), 10912 (Appendix 24), p. 241; analysis of four samples (Appendix 25), p. 267.

LIVER:

Arsenic found in, in fatal case at Halifax (H. Smith), 8628, p. 14; in liver of beri-beri cases (Appendix 31), pp. 333, 342.

LOCAL GOVERNMENT BOARD:

Relation of, to administration of Sale of Food and Drugs Acts, etc. *See* ANALYSTS, FOOD AND DRUGS ACTS, OFFICIAL CONTROL.

MAIZE:

Flaked maize found free from arsenic (Thorpe), 8847; (Primrose), 11847; (Appendix 19), p. 202.

MALT:

ARSENIC IN MALT:

Responsible for contamination of beer sufficient to cause illness (Reynolds), 8357; medical evidence (Moulton), 9931. Responsible for Halifax outbreak, 1902. *See* HALIFAX.

Quantity of arsenic in malt (H. Smith), 8628, 8650-61; (Thorpe), 8847; (Thomson), 9669, 9691, 9758-64; (Fairley), 9820-9, 9853-7; (Salamon), 9982, 9994-5; (Chapman), 10282-4; (Ling), 10536, 10684; (Beaven), 10869-82; (Primrose), 11847-52; (Appendix 19), p. 203.

Recent improvement in malts (Reynolds), 8353; (Worsick), 9441-2; (Thomson), 9706-7; (Salamon), 9977, 9994-5; will not be maintained without official control regarding arsenic (Ling), 10596-7.

More arsenic in northern malts in 1900-1 (Moulton), 9948; at Halifax, more than in 1901-2 (H. Smith), 8628, 8665-9; (Neech), 9113-24; (Buckley), 9276.

Increase of arsenic in malt as season progresses (Ling), 10693-5.

Unequal distribution of arsenic in malt (Thomson), 9699-9700. Sampling malt (Salamon), 10065-7; (Chapman), 10337-40.

Analyses of malt for brewers and maltsters. Few or none at Halifax (H. Smith), 8628, 8668-95, 8805-25; (Thompson), 8909-16, 9031-41; (Buckley), 9267-74. Analyses for maltsters (Worsick), 9424-36. Frequent analyses for certain breweries (Thomson), 9675, 9719-21; (Fairley), 9824; (Salamon), 10067-8; (Chapman), 10282.

See also FUELS.

PREPARATION OF MALT:

Fumes of fire should not pass through malt (Thomson), 9697-8, 9701-2, 9771-8. This would involve great interference with trade (Salamon), 9980, 10048; (Ling), 10612; (Beaven), 10836-42. Products of combustion necessary for flavour (Salamon), 9980; (Beaven), 10735-71; may not be essential (Ling), 10605-13.

MALT KILNS in relation to arsenic:

Structure of Kilns (Beaven), 10709-910; kilns in which drying largely effected by hot air without fumes, 10733-4, 10897-10; furnace gases, 10713-34, 10771-5; use of screens for condensing arsenic, 10775-86; use of lime to intercept arsenic, 10787-832, 10844-8, and Appendix 18, p. 199. Construction of Messrs. Whitaker's kilns (Thompson), 8864-9081.

Cleansing of Kilns (H. Smith), 8754; (Thompson), 8894-8; (Buckley), 9304-7; (Worsick), 9480-3; (Fairley), 9861, 9920; (Salamon), 9987, 9996; (Ling), 10693-6.

KILN DUST, arsenic in:

(H. Smith), 8752-3; (Thompson), 8955; (Buckley), 9305; (Salamon), 9988. From various parts of kiln (Fairley), 9859-60, 9905. Present as arsenious oxide (Fairley), 9912-3. Risk to malt from dust carried mechanically is small (Ling), 10570-3. Volatilisation of arsenic (Thorpe), 11691-4.

BRUSHING in relation to arsenic:

(Thomson), 9780; (Fairley), 9863-4; (Salamon), 10018-24. Effect of moisture (Neech), 9130-45. Brushing in the case of Halifax malts (H. Smith), 8628, 8795-9, 8810; (Thompson), 8942-53, 9082-9; (Buckley), 9277-83, 9353-6; (Worsick), 9425, 9457-62, 9488-90.

MALT CULMS:

Arsenic in (Neech), 9138; (Salamon), 9987; (Overbeck), 11297; (Appendix 19), p. 203; (Appendix 19), p. 204.

MALTED FOODS:

Various foods of which malt is an ingredient (Appendix 24), p. 245, largely imported; no knowledge of precautions against arsenic in their manufacture (H. Smith), 10935; no information available in the case of maltine made in America, 11496, and Appendix 26, p. 276. Four samples free from arsenic (Appendix 25), p. 262. Arsenic in "Carnos," p. 262.

MEDICAL OFFICER OF HEALTH:

Powers of, with regard to condemnation of arsenical products (Neech), 9224-51; (Lithiby), 11497-512; 11548-9; 11580-3.

See also FOOD AND DRUGS ACTS, OFFICIAL CONTROL.

MINERAL WATERS:

(Appendix 24), p. 241.

NASAL SEPTUM:

Perforation of, through exposure to arsenical dust (Legge), 11779-82.

NEURITIS:

Seldom a symptom of industrial poisoning by arsenic (Legge), 11754.

Rarity of neuritis caused by alcohol without arsenic (Reynolds), 8338.

In rats receiving arsenic for considerable periods (Delépine), 10006 (Appendix 16), p. 191.

See also ALCOHOLIC NEURITIS, HALIFAX.

OFFICIAL CONTROL:

IN RESPECT OF DELETERIOUS SUBSTANCES, ETC., IN FOOD:

Precautions against arsenic will become lax unless official control exercised (Ling), 10576-82, 10596-7; (Thomson), 9782-3; (Allen), 12037.

POWERS OF ENTRY, SAMPLING, ETC., ON PREMISES OF FOOD MANUFACTURER:

In general, Medical Officers of Health and other local officers have no such powers (Lithiby), 11508-9, 11533, 11548-55, 11608. Facilities may be given to M.O.H. notwithstanding absence of powers (Neech), 9220-30, 9246-51 (Lithiby), 11580-3. No powers in respect of new preparations, or new methods of manufacture, of food (H. Smith), 10950; (Lithiby), 11568-76.

Exist in certain instances, Bread Act, 1836; Revenue Acts; Margarine Act; Horseflesh Act; local Acts (ice-cream, etc.) (Lithiby), 11510-1, 11533-4.

By Revenue officers where articles subject to duty (Lyle), 11060-2; (Howell) 11237-9; (Walker), 11360-1; (Primrose), 11844-923; no powers on maltsters' premises (Primrose), 11954.

POWERS OF SEIZURE AND CONDEMNATION of contaminated food or food ingredients:

Powers under Public Health Acts (Lithiby), 11510, 11562-4. In general, no power when article not on sale, 11512, 11547-9, 11610-2. Duties of Medical Officer of Health in relation to unsound food, 11514-5, 11547-9.

No power to lay an embargo on suspected food, etc., pending analysis (Lithiby), 11613-5.

CONTROL UNDER SALE OF FOOD AND DRUGS ACTS:
See FOOD AND DRUGS ACTS.

RESPONSIBILITY OF VENDOR OF FOOD UNDER COMMON LAW:

(Lithiby), 11518-9, 11520-9.

SUGGESTED POWERS OF INSPECTION AT PLACE OF MANUFACTURE:

Question of providing official control respecting purity of food ingredients, etc., and methods of manufacture (H. Smith), 10298, 10932-3, 10950-63; (Lyle), 11060-3, 11141-7; (Howell), 11241-2; (Overbeck), 11286-7; (Walker), 11336-8; (Allen), 12012, 12046-7, 12071. Objections to (Lithiby), 11519, 11530-1; especially if powers given to

OFFICIAL CONTROL—*continued.*

Suggested Powers of Inspection at Place of Manufacture—*continued.*

officers of local authorities, 11533-6, 11565-76, 11605. Less objection by manufacturers to officers of Government Departments (Lithiby), 11602-4; (Legge), 11838-43. Many manufacturers would not object to inspection (H. Smith), 10960-2.

Suggested schedule of dangerous foods or ingredients (H. Smith), 10932-8; (Lithiby), 11517, 11519, 11651. Prohibition of arsenical sulphuric acid and of use of gas coke in malting advocated (Salamon), 10009, 10086-7.

SUGGESTED OFFICIAL "STANDARDS":

In respect of arsenic in various ingredients of food; relation of "standards" to prescribed methods of testing; principles on which official limits and tests should be prescribed; extent to which they might be "advisory" or penal (Thomson), 9770, 9809-15; (Moulton), 9936-46, 9950-63; (Salamon), 10007-8; (Chapman), 10290-1, 10318-51; (Ling), 10668-82; (H. Smith), 10928-49; (Thorpe), 11720-37; (Primrose), 11931-50, 11956-8; (Allen), 12061, 12069, 12072-7.

B.P. "standards" as to arsenic at present of little service to food manufacturer (H. Smith), 10912-8; (Appendix 24), pp. 240-3; (C. Brown), pp. 255-7.

"Standards" for purposes of Sale of Food and Drugs Acts. *See* FOOD AND DRUGS ACTS.

Authority by which standards might be prescribed. *See* BOARD OF REFERENCE, INLAND REVENUE.

ORGANIC MATTER:

Considerations as to possible combination of arsenic with organic matter of beer (Delépine), 10380-4; in the case of stale beer (Hehner), 10219-25; as to organic combination in plant tissue (Angell), 8514-8; 8610-20; (Fairley), 9875; (Voelcker), 12118.

Advantage or necessity of destruction of organic matter in beer and various organic substances preliminary to "Marshing" (Angell), 8472-518; (Thomson), 9688-9, 9755-7; (Hehner), 10132-9, 10179-85; (Chapman), 10262-71; (Voelcker), 12139; (Appendix 20), p. 207; (Appendix 21), p. 213; (Appendix 22), p. 223; (Appendix 32), p. 351. Importance in case of coal tar colours (Appendix 22), p. 223; (Appendix 25), p. 268; (Appendix 27), p. 277.

Destruction unnecessary when beer and wort are tested electrolytically (Thorpe), 11658-9; (Appendix 21), p. 212.

OXIDE OF IRON:

Arsenic in, and use of in various foods (Hehner), 10210, and Appendix 27, p. 277; (Pronk), 11444; (Appendix 24), pp. 234, 237.

PARIS GREEN:

See EMERALD GREEN.

PHARMACOPŒIA, BRITISH:

Official tests for arsenic (H. Smith), 10912-8; (Appendix 24), pp. 230-3; (C. Brown), pp. 255-7.

"PHOSPHOCITRIC" ACID:

Contains very little citric acid (Howell), 11201; (Appendix 24), p. 232. Use in aerated waters (Appendix 24), p. 241.

PHOSPHORIC ACID AND PHOSPHATES:

Arsenic in (Appendix 24), pp. 231-2; (Appendix 25), p. 265. Use of phosphates, under various names, in foods (Appendix 24), pp. 238-243; (Howell), 11167-9, 11201, 11256; (Palmer), 11470, 11492.

Purity attainable commercially, in case of phosphoric acid (Lyle), 11042-4, 11095.

Arsenic in phosphates used as manure. *See* VEGETABLES.

PIGMENTATION:

As a symptom of poisoning by arsenic and observed during epidemic; less seen since epidemic; pigmentation attributed to vermin may have been arsenical (Reynolds), 8287-95, 8326-9. In Halifax cases (H. Smith), 8628, p. 16; (Woodyatt), 9506.

PLANTS:

Grown on arsenical soil. *See* VEGETABLES.

POST-MORTEM EXAMINATIONS:

In Manchester cases (Reynolds), 8429; (Delépine), Appendix 16, p. 189; in Halifax cases (H. Smith), 8628.

POULTRY:

Use of arsenic in fattening (Smith), 10997-11005. Experimental administration of arsenic to fowls; analyses, little arsenic in flesh and liver, considerable amount in feathers. (Appendix 24), p. 252; (Appendix 25), p. 273.

PRESERVATIVES:

In beer (Primrose), 11847; (Appendix 19), p. 202.

Boron preservatives in relation to arsenic (Appendix 24), pp. 233, 248; (H. Smith), 10984; (Howell), 11224; (Appendix 25), p. 265.

PYRITES:

Formation of, in coal (Thorpe), 10708. Presence, appearance, and distribution in anthracite, and analyses (Appendix 30), pp. 288-321; (Ling), 10490-523. Proportion of volatile arsenic (Ling), 10647-59; (Appendix 30), p. 290.

QUANTITIES OF ARSENIC DETERMINED:

IN BEER:

In recent beer in Manchester (Reynolds), 8444; in Halifax beers, 1902 (H. Smith), 8628, pp. 14, 17; 8649; (Thorpe), 8847; (Buckley), 9318-46; (Fairley), 9923; in various samples of beer and brewing ingredients (Thomson), 9669, 9758; Fairley, 9824-52; (Chapman), 10277; (Primrose), 11847.

IN MALT:

(H. Smith), 8628, 8650; (Thorpe), 8847; (Thomson), 9669, 9691, 9758-64; (Fairley), 9820-9, 9853-7; (Salamon), 9982, 9995; (Chapman), 10282-4; (Ling), 10536, 10684; (Beaven), 10869; (Primrose), 11847-52.

IN OTHER FOODS AND INGREDIENTS:

See under several headings.

RATS:

Action of arsenical beer and other solutions administered in small quantities to. Experiments by Prof. Delépine: alterations during life of experimental animals; estimation of arsenic in tissues after death; pathological appearances; general summary of results; note on development of paralysis in experimental animals; tabular statements. Delépine), Appendix 16, pp. 183-195; 10388-424; deductions as regards human subject (Delépine), 10389-98.

REBATE OF DUTY:

None claimed since 1900 epidemic in respect of arsenical beer destroyed (Primrose), 11961.

RICE:

Possibility of contamination of, by arsenic; use of arsenic on rice fields (Reynolds), 8381-6. Amounts of arsenic in rice taken by beri-beri cases in Kuala Lumpor, and on ships, very small, if any (Appendix 31), pp. 332, 334.

ROOTS:

Grown on arsenical soil, arsenic in.

See VEGETABLES.

SAMPLING FOR ANALYSIS:

IMPORTANCE OF CAREFUL SAMPLING, AND DIFFICULTIES:

In the case of Malt:—(H. Smith), 8666-7; (Thomson), 9699; (Salamon), 10065; (Chapman), 10337-40; (Ling), 10681-2.

In the case of Fuels:—(Thomson), 9787-9; (Salamon), 10064; (Chapman), 10353; (Ling), 10490-679. System adopted in collecting samples for Commission (Appendix 30), p. 287, 290, 308-9.

SCHEELE'S GREEN:

See EMERALD GREEN.

SHALE:

Presence of, in anthracite seams, much arsenic in some specimens (Ling), 10494-7; (Appendix 30), pp. 289-295.

SMOKED AND DRIED FOODS.

Process of drying over gas coke introduces scarcely any arsenic into bloaters, hams, etc. (H. Smith), 10990-4; nature of foods so dried (Appendix 24), pp. 249-50; analyses (Appendix 25), pp. 269-72.

See also CHICORY.

SOIL:

Arsenic in cultivated soil, and manuring with arsenical super-phosphates. *See* VEGETABLES.

SPIRITS:

Analyses of whiskey and gin for mineral acids and for arsenic. Results negative (Appendix 23), pp. 278-80; (Allen), 12020.

"STANDARDS":

As regards arsenic and other impurities and adulterations of food, for purposes of Sale of Food and Drugs Acts, and of manufacturers.

See FOOD AND DRUGS ACTS, OFFICIAL CONTROL.

SUGAR:

Arsenic in certain samples of "Demerara" or West India sugar, possibly due to phosphoric acid or chloride of tin (Appendix 24), p. 239; (Lyle), 11064-6; uncommon, and avoidable (Lyle), 11067-8; analyses of ten samples (Appendix 25), p. 263.

In German beet sugar, attributed to lime or strontia process (Hehner), 10208-9.

SULPHITES:

(Ling), 10635-6; (Appendix 20), p. 207; (Appendix 21), p. 215; (Appendix 24), pp. 233, 248.

SULPHUR:

In fuel, in relation to arsenic (Fairley), 9896-9904. Arsenic in (Appendix 21), p. 215.

SULPHURIC ACID:

Price of different kinds of (Salamon), 10009; (Appendix 24), p. 230.

No evidence of its addition to spirits (Appendix 23), p. 278; (Appendix 24), p. 231; (Allen), 12020.

Should be penal to use arsenical acid for food purposes (Salamon), 10009.

Use of, in preparation of various foods and ingredients (Appendix 24), pp. 230-248. Precautions by manufacturers of treacle and syrup in purchasing, p. 238; (Lyle), 11032-41, 11077-95.

Commercially attainable free from arsenic by delicate tests (Salamon), 10009; (Lyle), 11032-41; (Howell), 11229; (Appendix 20), p. 206; (Appendix 22), p. 220; (Appendix 25), p. 275; (Appendix 32), p. 351.

Purification of, for testing purposes (Thomson), 9747; (Appendix 20), p. 206; (Appendix 22), p. 220.

SUPERPHOSPHATES:

Arsenical, effect upon plants.

See VEGETABLES.

SUSCEPTIBILITY TO ARSENIC:

(Neech), 9264-5; (Reynolds), 8373-7; 8447; (Moulton), 9931; (Delépine), 10390-418.

SWEETS:

See CONFECTIONERY.

SYMPTOMS:

Of poisoning by arsenic in beer (Reynolds), 8287-8388.

See also HALIFAX.

Of industrial poisoning by arsenic (Legge), 11738-11843.

SYRUP, GOLDEN AND TABLE, AND TREACLE:

Manufacture of golden syrup and treacle; precautions taken against arsenic (Appendix 24), p. 238; (Lyle), 11028-11160. Use of golden syrup in certain biscuits, etc (Appendix 24), p. 243; (H. Smith), 10954.

"Table" and other syrups, consisting largely of glucose; precautions taken, or neglected, by manufacturers in obtaining glucose used (H. Smith), 10953-4; (Appendix 24), p. 238, 235-6; (Walker), 11308-61.

Fruit syrups (Appendix 24), p. 242.

BOSTOCK'S TABLE SYRUP.

Manufacture, sale, and disposal of; amount of arsenic in (H. Smith), 10971-82; (Appendix 25), p. 265.

TARTARIC ACID:

Preparation of, in relation to arsenic; selection of acid and treatment with sulphuretted hydrogen by Bennet, Lawes and Co. (Appendix 24), p. 232. Retail sale of (Howell), 11172, 11212-8. Analyses (Thomson), 9659, 9758.

Use in confectionery, baking, and beverages (Appendix 24), pp. 240-3; no arsenic in various "fruit and lemon crystals," etc. (Appendix 24), p. 242; (Appendix 25), p. 266.

TESTS FOR ARSENIC:

Reports and Evidence as to Marsh-Berzelius method, as applied to various substances:—

MR. W. THOMSON'S DESCRIPTION OF METHODS:

Apparatus, and preliminary treatment of various substances (Thomson), 9688-9; diagram, p. 200. Delicacy of test after destruction of organic matter, 9686, 9755-7. Size of flask, 9735. All arsenic present recovered in mirror, 9736.

REPORT OF "JOINT COMMITTEE" ON ARSENIC (IN APPENDIX 20):

Materials employed: Hydrochloric, sulphuric, nitric acids, zinc, lime, calcium chloride. Apparatus. Mode of testing. Preparation of standard mirrors. Destruction of organic matter (acid and basic methods). Fuel. Sulphites. Procedure without destruction of organic matter. Delicacy of method (Appendix 20), pp. 206-7; (Hehner), 10092-10225; (Chapman), 10225-10372; (Ling), 10469; (Allen), 11970-80.

REPORT OF INLAND REVENUE DEPARTMENTAL COMMITTEE (IN APPENDIX 21):

Application of Marsh-Berzelius (zinc and acid) method to various substances used in brewing. Materials employed: Zinc, hydrochloric acid, fuming nitric acid, copper sulphate. Preparation for test of malt (basic and acid methods); malt substitutes; wort (basic and acid methods); hops; beer; yeast and yeast foods; chemicals; finings; fuel. Mode of working; preparation of standard mirrors (Appendix 21), pp. 212-219; (Thorpe), 11654-737.

TESTS FOR ARSENIC—*continued.*

DR. MCGOWAN AND MR. FINLOW'S DESCRIPTION OF METHODS (IN APPENDIX 22):

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):

Preliminary experiments: Method of estimating "total" and "fixed" arsenic; preparation of standard mirrors, (Appendix 23), pp. 227-9.

MR. WOOD SMITH: METHODS OF TESTING HAIR FOR ARSENIC:

Account of methods (Appendix 32), p. 351.

OTHER REFERENCES to use of Marsh-Berzelius test (Angell), 8472-518; (Fairley), 9852, 9882-88; (Salamon), 10007; (Lyle), 11051-4; (Allen), 11975-87.

Preferable to Reinsch test for skilled chemists (Salamon), 9968. Unskilled man can be trained to use (Hehner), 10167-8.

MIRRORS:

Comparison of mirrors obtained when hydrochloric and sulphuric acids are used respectively (Angell), 8481-2; (Thomson), 9749-50; (Fairley), 9885-8; (Hehner), 10179-82.

Time allowed for deposition of mirror (Angell), 8512; (Thomson), 9736. "False mirror" (Angell), 8506; (Appendix 29), p. 285. Action of light on mirrors (Thorpe), 11706-10. All arsenic recovered in mirror (Thomson), 9736-7; probably so (Hehner), 10139.

Effect of volume of liquid, etc., on mirror formed (Hehner), 10141-4; (Ling), 10470-3. Margin of experimental error (Hehner), 10146; (Chapman), 10369-72; (Allen), 12040-1; (Appendix 22), p. 222.

Preparation of "standard" mirrors with arsenic-free samples of material tested (Appendix 21), p. 214; (Thorpe), 11687-90; (Appendix 22), pp. 222-5; (Appendix 23), p. 229.

ZINC:

(Angell), 8475; (Thomson), 9750-4; (Fairley), 9882-8; (Hehner), 10096-7, 10105, 10119, 10129; (Chapman), 10236-49; (Thorpe), 11666-74; (Appendix 20), p. 207; (Appendix 21), p. 212; (Appendix 22), p. 221; (Appendix 32), p. 351.

PRESENCE OF IRON AND OTHER METALS:

Effect on "Marsh" estimations (Thomson), 9689, 9752-4; (Hehner), 10102; (Chapman), 10236-51, 10299-304; (Ling), 10486-9, 10645; (Appendix 22), p. 225; (Appendix 23), p. 227.

DESTRUCTION OF ORGANIC MATTER. *See* ORGANIC MATTER.

DETERMINATION OF ARSENIC IN FUEL:

Basic method (Ling), 10451-89, 10646; (Appendix 23), pp. 227-9; (Appendix 30), p. 311.

Oxygen method (Appendix 22), pp. 210, 214; (Thorpe), 11691-719.

Reports and Evidence as to Electrolytic Method:—

Possible advantages of electrolytic method (Hehner), 10098-10108; (Chapman), 10252-8. Advantages found by Departmental Committee, (Thorpe), 11656-85. Now preferred at Government Laboratory, 11682. Delicacy, 11675-81.

REPORT OF INLAND REVENUE DEPARTMENTAL COMMITTEE (in Appendix 21):

Description of apparatus. Application to malt, malt substitutes, wort, hops, beer, yeast and yeast foods, chemicals, fuel. Mode of working. Preparation of standard mirrors. Advantages of method (Appendix 21), pp. 208-212.

TESTS FOR ARSENIC—*continued.*

Reinsch Method:—

Use of, for beer and other samples. Quantities of arsenic detected by (Fairley), 9820-9, 9879-80; (Salamon), 9968-73, 10026, 10036-47; (Hehner), 10109-13; (Appendix 19), p. 204. Unsatisfactory for quantitative estimations (Thomson), 9738-9, 9806-7; (Hehner), 10127. *See also* EXPERT COMMITTEE.

Quantitative estimation by extracting arsenic by means of copper gauze (Allen), 11975.

Quantitative estimation by comparison of sublimates, (Delépine), 10375-80, 10425-39.

Gutzeit Method:—

Not reliable for quantitative estimations, (Thomson), 9740. Uncertain value of B.P. test for arsenic in glycerine (C. Brown), pp. 255-6.

THYROID GLAND:

Gautier's statements as to presence of arsenic in require confirmation (Reynolds), 8307-12.

TOLERANCE OF ARSENIC:

(Reynolds), 8375-7; (Delépine), 10411-13; (Legge), 11738-43.

TREACLE:

See SYRUP.

TUBERCULOSIS:

Chronic poisoning by arsenic increases susceptibility to; many fatal cases in 1900 epidemic died from (Reynolds), 8315-7; 8424-31.

URINE:

Arsenic in (Reynolds), 8363-6, 8450-4; (H. Smith), 8628, p. 16; (Thorpe), 8847, p. 31; (Woodyatt), 9515.

VEGETABLES:

Arsenic in various vegetables when grown on soil containing arsenic or manured with arsenical superphosphates.

Opinion that barley and roots may be contaminated in that way (Salamon), 9999-10006; 10013-17. Effect of ferruginous soil on absorption of arsenic, 10056-8.

MESSRS. A. AND A. F. ANGELL'S EXPERIMENTS AND RESULTS (8463-8627).

Mode of applying the manure to experimental plants, 8470-1, 8485, 8526-35, 8603. Nature of experimental plants and results, 8524. Places of experiment, 8593-5. No arsenic in ripened fruit or grain, 8541, 8555; traces of arsenic found in some roots and young leaves, and in green pods, 8543-90. Form in which arsenic taken up by plant, 8566; such arsenic not necessarily assimilated, 8568.

Methods employed in testing, 8472-93, 8540; control and blank experiments, and their sufficiency, 8499-8521. Organic matter not entirely destroyed before testing, 8494; desirable to investigate effect of destroying organic matter, 8514-8, 8610-5; comparison with phosphorus, 8614.

Quantity of superphosphates usually applied to land, 8599; amount of arsenic in commercial superphosphates, 8575.

MR. T. FAIRLEY'S EXPERIMENTS AND RESULTS (9824):

Amount of arsenic in certain speciments of soil; traces in stubble, possibly due to soil contamination; no arsenic detected in ears, grain, or roots of barley and wheat, 9824; possible retention of arsenic due to iron in soil, 9876.

References to literature on subject, p. 66, note.

DR. J. A. VOELCKER'S EXPERIMENTS AT WOBURN, AND RESULTS, 12078-12163:

Experiments restricted to barley, mangels, and swedes, tabular statement of results, 12088. Mode of applying manure in different experi-

VEGETABLES—*continued.*

ments; controls; quantity of arsenic in superphosphates used, 12089-97, 12120-2. Soils of fields used for experiment, 12086-8, 12123-9, 12141-5; two specimens of soil contained arsenic apart from recent manuring, 12160-3. No arsenic found in bulbs or grain in any case, 12089-90, 12120; small amounts in straw and leaves, partly due to adherent soil, 12120-2, 12153. Sampling, 12136-7.

Organic matter destroyed in each instance before testing; analyses made by Mr. Hehner, 12088, 12139.

Quantity of superphosphates usually applied to land, 12094; amount of arsenic in commercial superphosphates, 12094, 12135.

VINEGAR:

Manufacture of, in relation to arsenic; use of malt, raw grain "converted" by mineral acid, sour beer, etc. (Appendix 24), p. 246.

"VOLATILE" ARSENIC, IN FUEL:

Relation to "total" arsenic, and significance (Ling), 10671-80, 10697-708; (Thorpe), 11691-705; (Appendix 30), pp. 289-90, 325.

Tests for (Ling), 10451-75, 10479-89; (Appendix 20), p. 207; (Appendix 21), pp. 210, 214; (Appendix 23), pp. 227-9.

VOLATILISATION OF ARSENIOUS OXIDE:

(Thorpe), 11691-4.

WALL PAPERS:

No guarantee as to arsenic demanded by purchaser of colours for (Pronk), 11424-32, 11449-53.

WARRANTY:

Defence of, in prosecutions under Sale of Food and Drugs Acts (Lithiby), 11618-28; (Allen), 12013-9, 12062.

WINES:

Use of glucose in certain wines, (Appendix 24), p. 242.

WORT, BREWERS:

Advantage in obtaining control by analysis of (Salamon), 9993; (Chapman), 10318-324, 10324-35; (Thorpe), 11726; (Primrose), 11948.

YEAST:

Affinity of, for arsenic (Neech), 9104, 9257-60; (Appendix 19), p. 202. Action of yeasts and moulds upon various arsenical solutions (Delépine), 10384-5. Bakers' yeast (Appendix 24), p. 243.

YEAST AS AN INGREDIENT OF CERTAIN FOODS: (Appendix 24), p. 244; (Overbeck), 11262.

"YEAST FOODS": Nature and use of; examination for arsenic; certain samples arsenical (Primrose), 11847, 11856-68; (Appendix 24), p. 243.

ZINC:

Nature of zinc recommended for "Marsh" estimations. *See* TESTS.

"Sensitiveness" of (Thomson), 9750-4; (Hehner), 10096-10119, 10129; (Chapman), 10236-49, 10299-304; (Thorpe), 11655; (Appendix 20), p. 207; (Appendix 21), p. 212; (Appendix 22), p. 221; (Appendix 32), p. 351.

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 = $\frac{1}{150}$
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