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Contents.

Bucknill — County Asylum

SUGGESTIONS FOR THE ADVANCEMENT OF MILITARY MEDICAL LITERATURE,

WITH OBSERVATIONS ON MILITARY HYGIENE.

BY H. M. Henry Marsh

"The administration of an army is sometimes called a trade, but those who understand the subject, know that it is a science, and one of so complicated a character, that the study of one of its branches might occupy a long life. To comprehend even the elements of the administration of an army, it is necessary to know its origin, progress, and rules; the various means employed to raise soldiers, organize, arm, equip, pay, and put them in motion; to subsist them in health and in sickness; to command them in the field of battle; to profit by their success; to remedy their failures; to reward and to punish them; and to preserve an account of their fortunate and unfortunate operations."—*Audouin Histoire de l'Administration de la Guerre.*

The chief purpose of the writer of these observations, is to bring to the notice of the Military authorities, a measure which has long been followed in the French army, having for its object the preservation of the health of soldiers, and the collection and diffusion of scientific and professional information; which, in his opinion, may with much advantage be adopted in the British army.

In the year 1763, Dr. Richard, Inspector of Hospitals of the French army, represented to the Duke de Choiseul, then minister of war, that it would be of advantage to the public service, if the medical officers of the army were instructed to collect scientific and practical information, and to communicate it to the inspector of hospitals, the immediate object being, that those communications which he deemed of sufficient importance might be published at the expense of government. The Duke de Choiseul gave his sanction to the measure, and forthwith directed that it should be carried into effect. The first volume of the papers thus collected was published in 1766, being entitled, *Recueil d'Observations de Médicine des Hospitaux Militaires.* In this volume there is an excellent and comprehensive code of instructions addressed to medical officers, from the pen of Dr. Richard, wherein he particularly recommends them to devote much attention to the study of medical topography, and to the sanitary condition of garrison towns, barracks, prisons, and hospitals. He also contributed instructions and models for drawing up cases, describing epidemics, &c., and several topographical essays. The second volume, which, like the first, was a quarto, appeared in 1772, and contained four topographical memoirs, five memoirs upon epidemical diseases, and a number of valuable papers on military medicine, with several communications on pathological anatomy.

Dr. Richard had thus the merit of drawing the attention of government to an important means of collecting and circulating information, having for its object the preservation of the health of soldiers, and promoting their efficiency; and the minister at war deserves the highest praise, for duly appreciating the value of his suggestions, and promptly and effectually acting upon them. By collecting and publishing the professional labours of medical officers, their talents and attainments are exercised, their industry excited, and their self-respect gratified, while government is instructed by the facts and observations communicated.

For a number of years during the revolutionary war, the publication of this important work was much interrupted. But in 1815, when hostilities had ceased, it was resumed, and ever since has appeared at the rate of about two volumes (8vo.) annually; a copy being supplied gratuitously to the principal medical officer of each military hospital, and the surgeon-major of each regiment.

The circular letter addressed to the medical officers of the army by the minister at war, on the resumption of the publication of their communications, is a valuable document. It was therein stated, that the object of the publication was—

1st. To promote the improvement of the art of healing, in as far as regarded the health of soldiers, and to circulate scientific and professional information among all classes and ranks of the medical department of the army.

2ndly. To excite and sustain a spirit of emulation among medical officers, by affording them an opportunity of displaying their talents, professional attainments, zeal, and industry. Where there is no competition, there is little steady application to labour.

As the merits of individual officers became thus known, government was enabled to select the most able and the most deserving for promotion, and those best qualified to fill important situations.

The advantages which would result from the adoption of a similar measure in the British army are so obvious, that it would be a work of supererogation, and no compliment to the understanding, were I to obtrude arguments in its favour. From the varieties of climates and countries occupied by the British army, and the different races which compose it, medical officers have a much more extended field of investigation than in the French army. Were the emulation of the medical officers of the British army excited, it is presumed their talents and industry would become conspicuous. No man is independent of external stimulus, and the surest method of suppressing energy is to leave it to prey upon itself. "The natural gravitation of labour is towards idleness, unless there be an ever-present motive for exertion."

Among the numerous topics to which it is desirable the attention of medical officers should be directed, there is perhaps none of greater importance than the contribution of materials for a code of Military Hygiène. This branch of medical science comprehends the means of preserving the health of soldiers, and directing their intellectual faculties to a useful end. A work on Military Hygiène ought to embrace, in a general way, all that body of practical information which medical officers, who have been long in the service, acquire in a greater or less degree, but frequently not until they have committed blunders, which might have been obviated had they been earlier and better instructed. This information, although essentially necessary to the efficiency of a medical officer, is not commonly taught in the medical schools, nor has it hitherto been conveyed in a comprehensive manner, by books in the English language. Among the many subjects which would require to be discussed in a

treatise on Military Hygiène, the following should obviously be included: The recruiting of the army, pay, pensions, rewards, provisions, messing, cooking, &c.; barracks, ventilation, &c; transports and clothing; personal cleanliness; duties and exercise of soldiers; schools and regimental libraries; military discipline; punishments, coercive and corporal; habits of soldiers, virtues and vices; the constitution of the medical department, and the duties of the medical staff, both general and regimental; military hospitals, moral treatment of the sick, the compilation of numerical returns of the sick, and the mode of drawing up reports of diseases, both special and general; proceedings of boards, sick certificates, &c.; together with the general principles of military statistics, medical topography, and the doctrines of climate; lastly, instructions to young medical officers, respecting the general execution of their duties, especially in regard to their conduct towards their superiors, and the sick who may be placed under their care.

We have the high authority of Sir John Pringle for stating that "the prevention of diseases cannot consist in the use of medicines only, nor depend upon anything a soldier shall have it in his power to neglect, but upon such orders as shall not appear unreasonable to him, and such as he must necessarily obey."

A knowledge of the principles and practice of Military Hygiène is of great importance to every class of officers connected with the administration of the army; but it is essentially required by medical officers. Two remarkable examples of the happy effects of a due appreciation of the rules of this branch of preventive medicine, by the first authorities in the administration of the army, may be here noticed. Until 1830, wine or spirit rations were issued indiscriminately to soldiers on board ship, and in all foreign commands where British troops were employed. The evils resulting from this practice having been represented somewhat in detail to Lord Hardinge, then Secretary at War, he resolved to abolish the abuse in question, and he promptly effected his purpose. The gratitude of the army and the country is justly due to his lordship, for abrogating an injudicious usage, which, however well intended, was followed by most deleterious consequences. The practice of issuing spirit rations, as part of the diet of a soldier, amounting to about six ounces daily, one-half of which was usually swallowed before breakfast, had become so inveterate, that a large portion of all ranks in the army were not only blind to its evils, but considered it beneficial, and, indeed, indispensable; it required, therefore, a high degree of courage to propose a remedy, and an example of superior virtue and energy to carry so important a measure of reform into execution.

The other example is of a later date. The compilers of the statistical report on the sickness, mortality, and invaliding among the troops employed in the West Indies, which was laid before Parliament in 1838, recommended the adoption of certain measures, for preserving the health of soldiers, and reducing the mortality which usually occurred in the army serving in these colonies. The measures suggested were chiefly as follow:—

1. The selection of salubrious localities for the troops.
2. Improvements in barrack and hospital accommodation.
3. Improved rations and diet.
4. More frequent reliefs.

To these suggestions much opposition was raised by the subordinate authorities; but the highly enlightened and energetic Lord Grey, then Secretary at War, effectually adopted and established them, having surmounted every obstruction and obviated every difficulty. The results have been most fortunate. By an average of the returns of 1845 and 1846, it appears, that the mortality of the troops serving in the Windward and Leeward Islands is little above two-thirds of the average for 20 years preceding 1836; and in Jamaica, for the same period, it is rather less than one-fourth of the former average—*Vide a paper read before the Statistical Society, 21st June, 1847, by Lieut.-Colonel Tulloch.*

Ignorance of the principles of Military Hygiène, and an inveterate prejudice in favour of former usages, seemed to be the leading causes of the opposition to the measures recommended, the adoption of which has proved so singularly beneficial.

The ratio of mortality among almost all European armies, in time of peace, is considerably higher than the mortality which occurs among the civil male population during the military age. The average annual mortality among British troops serving in the United Kingdom, may be estimated at from 15 to 16 per 1000. The age of soldiers in the British army, ranges from 20 to 40 years. Now the mortality which occurs among the East India Company's labourers in London, some of whom are no doubt above 40, has been found to be 12·5 per 1000; and the mortality among parties insured in the Equitable office for 30 years, between the ages of 20 and 40, amounted to 9·1 per 1000. Insured lives are select, *i.e.* lives which are considered not unusually liable to fatal diseases. Soldiers are also selected lives, from 30 to 40 per cent of the recruits for the army being on an average rejected as unfit from various causes. If, then, the selection of recruits be of value as a means of preventing fatal diseases in the army, the mortality of troops in this country should be below what occurs among the general population at the same period of life. To what cause or causes therefore should the higher ratio among troops be attributed? With judicious care, might it not be reduced to 10 per 1000, which is the proportion of mortality that occurs among the male adult civil population of England, between the ages of 20 and 30 years; or even to 6 per 1000, which is the ratio of mortality that takes places among the corps of engineers in the Prussian army? Monsieur Boudin, an officer of rank in the medical department of the French army, seems to think that, "*avec de bonnes institutions hygièniques,*" such a reduction might be effected. These are questions of Military Hygiène which demand a careful investigation.

Attention has lately been drawn to the sanitary condition of persons in civil life; and I hope the inquiry will extend to the military branch of the population. Although much care has been taken, since 1815, not to admit any but well-educated candidates into the medical department of the army, military medical literature has in modern times made little or no progress. Hitherto, no complete code of Military Hygiène has been published by officers in the public service; and civilians cannot be supposed to write better on this head, than that author who composed a treatise on the art of war without ever having seen a campaign. Every medical officer in the service may adopt the following sentiments of Sarlandière, a surgeon in the French army:

"When I joined the army, rich in professional knowledge, but very inexperienced in all that concerned the soldier, how often would a book of instruction have saved me from the mistakes and ignorance very natural to a man unaccustomed to live among soldiers; and how much better could I have given that information which my commanding officer had a right to expect."

Sir John Pringle, who published his admirable work about 100 years ago, complains of the want of instructive books, "relating to the care of the sick;" and it may be observed, that, in as far as regards Military Hygiène, the defect of which he complained has not been remedied. We are accused of having no military literature, and it must be admitted that we are not rich in military medical literature.

Medical officers should not only be acquainted with the science of Military Hygiène, but they should be able to expound its rules, and qualified to instruct both officers and men in this popular but highly important branch of the art of healing. "One of the first steps," says Heberden, "towards preserving the health of our fellow creatures, is to point out the sources from which diseases are to be apprehended." Dr. Chaussier, a medical officer in the French army, long ago recommended to the government, to direct the surgeon-major of each regiment to consider it a part of his duty to instruct officers and soldiers in regard to the means of preserving their own health and the health of the men under their command. "We recognise," says our author, "the propriety, and even the necessity, of instructing officers how to preserve the health of horses, and we insist on their going to a college to study veterinary medicine; but no corresponding care is taken to qualify officers to teach soldiers how to preserve their health." How far this suggestion may, with advantage, be adopted in the British army, the writer leaves to the consideration of the responsible authorities. It is, however, obvious that a very moderate degree of knowledge of the common principles of *hygiène*, would enable officers and soldiers to appreciate and avoid some of the many causes of physical ailments and impaired health. By being thus instructed, the officers and men would become more efficient servants of the state. Information and exemplary conduct in officers promote discipline, and excite habits of subordination and obedience in the men. The writer ventures to go still further, and to add, that officers with cultivated minds, and who are comprehensively and practically instructed in their professional duties, have in general not only comparatively few delinquents, but also few men inefficient from sickness. Our present knowledge of the laws of health, of the causes of disease, and consequently of the means of preserving health, is imperfect; but it is much more accurate and extensive than formerly. The popular works of Dr. Southwood Smith, Dr. Andrew Combe, Dr. Hodgkin, and others, have placed within the reach of the middle classes, in civil life, many important practical doctrines, which were little thought of a century ago. The higher classes of the community owe their enlightenment in the principles of *hygiène* chiefly to the teaching of their medical attendants, who draw the attention of families to the sad and often striking consequences of neglect. By very simple means, much useful information, in regard to sanitary measures, might, with advantage, be communicated to all ranks in the army. Hitherto the art of preserving health has not been specifically taught in the medical schools of this country; and, indeed, it is greatly to be regretted that information on this subject is much undervalued by the public. Were a more enlightened policy adopted in the army, improved habits and practices, in regard to health, might, in progress of time, extend to the general population. For one thing, it is the immediate interest of the state to encourage measures which promote the physical and moral efficiency of the army; while the establishment of improved habits in soldiers may be of the utmost benefit to them in after life.

In 1818, the medical board of Bengal, in conformity with the orders of government, submitted a plan for the collection and accumulation of professional information, to the medical officers of the Presidency, and earnestly urged them to adopt the measure which had been suggested. In the circular letter which was issued on this occasion, the following passage occurs:—"India has scarcely given birth to a single important discovery or publication, of acknowledged merit, on professional subjects, since the first establishment of the British in this quarter; whilst in almost every other portion of the civilized world, scientific objects have been pursued with energy and success, and every successive year has largely added to the previous general stock of medical knowledge." The causes of this sterility of literary labour are not obvious, for as the board observes, "The individuals composing the medical department of the Indian army have ever been remarkable for the diligent and able performance of their duties. They would seem to be, by previous regular education, and by subsequent large acquaintance with the diseases usually prevalent in hot climates, peculiarly qualified to impart useful information to their less experienced brethren."

The plan suggested for exciting the industry of medical officers of the Indian army, closely resembled the measure adopted by the French government, and which has been already detailed. It consisted chiefly in government having resolved upon collecting and printing, at the public expense, select communications of interesting facts and particulars connected with the diseases of India, including an account of the best modes of treatment. The medical board was to carry the subordinate arrangements, for the success of the plan depending upon it, into effect. Copies of the volumes published were to be distributed to every medical officer throughout India. The medical board anticipated that, ere the lapse of many years, the medical officers of the Indian army would be "relieved from the reproach under which they had lain, of having failed to contribute their part to the advancement of science, and the lessening of disease and human misery." I am not aware that this appeal to the medical officers of the Indian army produced a single volume.

Fourteen years after the promulgation of this scheme for the diffusion of medical science, which seems to have completely failed, the following official advertisement, signed "H. S. Fleming, Secretary, Medical Board," was published, being dated "Fort St. George, Medical Board Office, 3rd May, 1832."—"*Fort St. George Gazette*, No. 38, dated 12th May, 1832.—Saturday.—Advertisement.—Medical Prize Essays.—With a view to aid the advancement of medical science, and to communicate useful knowledge, the medical board, under the sanction of government, announce to the medical officers under this

Presidency, whether of his Majesty's, or the Honourable Company's service, that a prize of rupees 500, or a gold medal of that value, with a suitable inscription, will be awarded, in the course of the year 1833, to the best dissertations on each of the following subjects:—1st. On the disease called *beriberi*. 2ndly. On rheumatism, and the neuralgic affection, occasionally a sequel to it, which is termed by the natives, *burning in the feet*." The remaining portions of the advertisement consist of subordinate arrangements for carrying the measure into effect.

On the 16th September, 1833, the medical board had the pleasure of informing the Right Hon. Sir Frederick Adam, Governor in Council, that four essays on "beriberi," and three on rheumatism and "burning in the feet," had been received; and they were much gratified in being able to state, that although there could be no difficulty in determining those entitled to the prizes, all of them possessed very considerable merit. Both prizes were adjudged to Assistant-Surgeon J. G. Malcolmson, of the Madras European regiment, whose essay on "beriberi" contained a very able and laborious investigation of the causes, nature, and treatment of the disease, which, in the opinion of the board, was eminently calculated to impart just views of its nature, and to render its treatment more discriminating and successful.

Here we have an example of the beneficial influence of emulation, of the prospect of labour being honorable and advantageous. Under certain circumstances, competition is as necessary to promote intellectual exertion, as it is to effect mechanical production. Where persons are remunerated by time, instead of according to the benefical result of application, or where there is an uniformity of reward without reference to that which is produced, competition may take a wrong course, and he who labours least think he has gained the prize. Establishments in which the enrolment and advancement in rank are chiefly awarded in accordance with length of service, or where the advantages are professedly administered on that principle, involve a spirit of *communism* which is very unfavourable to zealous intellectual industry beyond those routine duties which cannot be evaded, and without the energetic exertions of individuals we are not warranted in expecting much progress towards the cultivation of science, and the diffusion of information—a result which rarely occurs except from competition, honestly, impartially, and wisely administered.

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A COMPARISON

OF THE

MORTALITY FROM DIFFERENT CAUSES, IN AUSTRALIA AND IN ENGLAND.

By JOHN BEDDOE, B.A., M.D.,

PHYSICIAN TO THE CLIFTON DISPENSARY.

[REPRINTED FROM THE EDINBURGH MEDICAL JOURNAL, AUGUST 1859.]

Some months have elapsed since the public attention was called, by paragraphs in the *Times* and other newspapers, to the rate of mortality among infants in the Australian colony of Victoria, and particularly in the city of Melbourne, where it was stated to be alarmingly high. The few facts vouchsafed us, however, were by no means of a strength to bear the weight of assertion and comment raised upon them. Wishing for further light on the subject, I wrote to Melbourne for statistics bearing upon it, and in due time received some numbers of a publication styled *Facts and Figures*, conducted by Mr Archer, an able statistician, who holds the office of Registrar-General in the colony. These contained sufficient data to prove that the rate of mortality among infants in Victoria, in 1856–7,[1] did not exceed the English rate, while that of Melbourne itself fell below the proportions of most of our own large towns. It is true that dysentery, diarrhœa, etc., carry off numerous victims during the hot months, but their ravages are counterbalanced by the comparative infrequency or mildness of the exanthemata, and of thoracic inflammations.

Mr Archer's carefully compiled papers have furnished me with materials for the formation of comparative tables of the mortality from different causes, in Australia and in the mother country. The Fourteenth Annual Report of the Registrar-General for England and Wales exhibits the proportional numbers dying in 1851, from various causes, in England generally; and I have calculated per-

[1] From July to June inclusive, *i. e.*, from winter to winter.

centages from the reports of 1851, for the agricultural, mining, and maritime counties of Cornwall and Devon, and from those of 1857 and 1858, for the eight principal towns of Scotland.

The comparison of these has led me to results some of which were unexpected, and will, I hope, prove interesting. To any who may be disposed to undervalue them on account of the imperfection of mortality statistics in general, and of those of a newly-settled colony like Victoria in particular, I would reply that Australia is now pretty numerously supplied with practitioners, some of whom are thoroughly educated, and almost all of whom are alumni of our own schools; and that the common errors in diagnosis are therefore likely to run in the same directions in the colony and in the mother country, so as not to vitiate materially the comparison we are about to make between their respective registers. The death-rate of Victoria, which appears to have been gradually diminishing with the advance of the colony in civilisation and order, amounted in the year 1856–7 to 1·6720 per cent. This contrasts very favourably with the English rate, 2·1987; with that of the Scotch towns, 2·6824; and even with that of Scotland at large, 2·0548; and with that of Cornwall and Devon, 2·0153. It corresponds pretty closely with that of the country districts of Scotland, which is estimated by Dr Stark at 1·6438, but is almost certainly a little higher, his calculation having been made, almost unavoidably, on the not very probable hypothesis, that the rural population has of late years maintained a uniform rate of increase. It exactly equals that of Tasmania in 1856, according to the best estimate of the latter that I have the means of forming, but considerably exceeds those of New Zealand and South Australia, which, if the registers are even approximately correct, must be among the lowest in the world.

That the Victorian register is tolerably accurate I have very little doubt, as births appear at least as likely as deaths to escape registration; and the very high birth-rate recorded (4·0864) renders it probable that the former almost all come to book.

One important qualification should here be applied. The population of Victoria is known to consist mainly of adults in the prime of life, with a considerable proportion of children, aged persons being comparatively few. The effect of this must obviously be to lower the actual death-rate unduly, in comparison with that of the mother country, with its normal proportion of old people. For example, let us suppose the present population of Victoria to consist exclusively of persons from 0 to 50 years of age, in such proportions as occur in England.[1] Then, the actual death-rate being 1·6720, if we suppose individuals of 50 years and upwards to be added to the population in the normal ratio, and to die off at a rate accelerated

[1] This of course can only be, and is meant to be taken as, an approximation to the true state of things. No doubt there are a certain number of elderly and old people, and probably there is an excess of persons aged from 20 to 35. See Table II., at the end of this paper.

as in England, it would be raised to not less than 2·0432, or pretty nearly that of Scotland.

We may now proceed to compare the statistics of mortality from particular maladies.

Zymotic diseases, though they furnish nearly one-fourth of the mortality in Victoria, cause less destruction in proportion to the population than even in Devon and Cornwall, far less than in England generally, and not two-thirds of what occurs in the Scotch towns. Small-pox is absent: two deaths, reported from a country district in 1854 and in 1856, probably indicate mistakes in diagnosis, for it is hardly conceivable that this pest, if once imported, could have failed to spread and establish itself. Measles and scarlatina committed great ravages in Melbourne in 1854, but have since lapsed into insignificance. The annual mortality from hooping-cough[1] is small, and pretty uniform, whence we may fairly presume that the climate has some merits with respect to that disease. The same may be said of croup. Typhus, which some years ago committed great ravages in Melbourne, continues rife throughout the colony, destroying more lives than in England, and almost as many as in the Scotch towns. I have not been able to procure any information as to the prevailing type, nor do I know whether all the forms of continued fever have been observed.

True Asiatic cholera has never visited Australia, but, as might have been expected, alvine flux, under its three divisions of diarrhœa, dysentery, and cholera, furnishes a large number of victims, not less than ·2379, or more than double the English proportion, and almost double that of the Scotch towns. More than half of the deaths from diarrhœa, and nearly half of those from dysentery, occur in infants under twelve months old, among whom they constitute a fourth of the whole mortality. Their dependence, direct or indirect, on elevation of temperature, is clearly exhibited by the fact that considerably more than half (55 per cent.) of these infantile deaths occur in the three summer months of January, February, and March (av. temp. about 67° Fahr.), and only 13½ per cent. in the six cooler months from May to October (av. temp. about 53° Fahr.).

The great excess over English rates is ascribed in the returns wholly to dysentery, which appears, as compared with diarrhœa, to be more frequent in the country districts than in Melbourne; but it would be too exacting to look for much accuracy in the diagnosis of the two, the presence or absence of blood in the stools being the only point likely to be taken into consideration. Ague is absent, and it is not likely that the few deaths ascribed to remittent fever are really due to malaria. To this important subject I will return presently.

Notwithstanding the almost exclusively animal and farinaceous

[1] Hooping-cough was once introduced into Van Diemen's Land, and for a short time extended as rapidly and widely as in England, but gradually became milder, and in a few months disappeared.

diet of a great part of the colonial population, the deaths attributed to scurvy are exceedingly few. So are those set down to syphilis, contrary to what might have been looked for in a country where the sexes are so unequal in number, and where miners are congregated into disorderly armies. Erysipelas, a disease more rife in colder climates, seems to be rare in Victoria. Hydrophobia is happily unknown. The number of deaths under the miscellaneous class of hæmorrhages is somewhat remarkable. Great and sudden barometrical changes are said to be not infrequent. The number of deaths ascribed to carcinoma is very small, but it is quite unnecessary to seek the cause of this fact in climate, diet, or modes of life. It may be sufficiently accounted for, I think, by the great numerical preponderance of the male sex, and by the fact, already referred to, that the colony contains very few old people. Carcinoma is, to a great extent, a disease of declining years. I take for elements of the calculation the following data: that in Victoria males outnumber females in the ratio of 25 to 14, while in London the proportions are as 1000 to 1134; that in the latter place females furnished, in 1851, about 20 out of 27 cases of cancer; that about two-thirds of the male and four-sevenths of the female cases, occurred in persons above 50 years of age, though these latter formed but 118 and 130 per 1000 of the population of the two sexes respectively. If now we assume, as before, that the Victorian community consists of persons from 0 to 50 years of age, in the proportions met with in England, but contains no older people, we obtain 314 per million as the number of deaths that would occur in Victoria from cancer, if the sexes were equal in numbers and the distribution of ages were as in England. This is about equal to the proportion observed at home. By another calculation, based on the returns for all England in 1851, I make out that such a community as that of Victoria should not lose more than 94·5 per million annually by carcinoma, whereas the actual loss appears to be at the rate of 110.

Cancer has been supposed not to exist among the Maoris of New Zealand;[1] whether it has been met with among the native Australians I am not aware. Its apparent increase in this country of late years, lends some colour to their opinion who consider it to be eminently a disease of civilised life. Might not some further light be thrown on this subject by an examination of the records of insurance offices, etc., with a view to determining its relative frequency among the upper and lower ranks of society?[2]

By an analogous train of reasoning to that which has been employed in treating of cancer, it may be shown that the infrequency of dropsy is rather apparent than real, being due mainly to the absence of aged persons.

Widely discrepant opinions have been broached and maintained

[1] See Dr A. Thomson's papers on their diseases, in the *Med.-Chir. Rev.*
[2] Walshe *on Cancer*, p. 159.

as to the influence of the Australian climate on phthisical cases. These tables amply suffice to prove that it is, at all events, very unfavourable to the production of tubercular disease in any form. By no conceivable latitude of error can their evidence be explained away. The mortality from all kinds of tubercular disease, taken together, is less than that from phthisis alone in any county in England. This advantage on the side of Australia is most distinctly marked in the cases of pulmonary phthisis, and of scrofula (expressly so called); young children fall victims to hydrocephalus and tabes mesenterica in greater numbers than in some agricultural parts of England, but not nearly to the extent that they do in Scotch and English towns. A very great number of deaths of infants, especially in the city of Melbourne, are ascribed to atrophy and debility; in these ill-defined classes no doubt are comprised, in Victoria as at home, very many cases of tubercular disease.

In some of the warmer regions of the temperate zone, the comparative infrequency of phthisis is counterbalanced by the great fatality of inflammatory diseases of the respiratory organs; and I was fully prepared to find this the case in Victoria. However, it is not so, notwithstanding the great and frequent changes of temperature of which we have heard so much. The rarity of fatal bronchitis may in part, but in part only, be accounted for by the fewness of old people. In England, fully half the deaths from this cause are those of persons above 50 years of age.

Diseases of the nervous system, in the aggregate, are not particularly destructive. "Convulsions" furnish a large quota, but not so large as is the average of England. Dr Greenhow[1] combines deaths ascribed to convulsions and teething with those from hydrocephalus, under the title of "nervous diseases of children;" and this arrangement has at least the merit of convenience, as under the present classification cases identical in their pathology are set down sometimes under one, sometimes under another of these heads, and ultimately find their way into three different groups. Thus teething seems to be a favourite refuge of certifiers at Glasgow, Greenock, Paisley, and Perth; and convulsions at Aberdeen and Dundee, as in most parts of England; whereas hydrocephalus is boldly diagnosed in Edinburgh and Leith.

In England, the mortality ascribed to these causes collectively seems to vary very greatly in different districts, and to be highest among the mismanaged and neglected children of the operatives in manufacturing towns, especially in those where women are largely employed in non-domestic industrial pursuits. The rather low rate exhibited by Victoria, when the number of births or of living infants is made, as obviously should be, the basis of calculation, may be taken as evidence, *quantum valeat*, for the domestic habits of the

[1] "On the Different Prevalence of Certain Diseases in Different Districts" (*Parliamentary Paper*), pp. 113–122.

women of the colony, which seem to have partaken of the general improvement in its *morale*.

The rarity of apoplexy and paralysis is probably only apparent, and due to the same cause as that of dropsy and carcinoma. Tetanus is decidedly frequent, but perhaps not more so than may be accounted for by the frequency of external injuries, which we are entitled to infer from the great number of violent deaths. The combined effects of spirit-drinking and a hot climate are exhibited in the frequency of delirium tremens, a common sequel of the periodical drinking-bouts of stockmen and diggers. It is gratifying, however, to observe that the number of deaths from this disease has gradually declined during the last three years. The same causes that produce it have probably much to do with the excess of deaths ascribed to "insanity" and miscellaneous diseases of the brain, etc.

Diseases of the digestive organs are comparatively seldom fatal in middle life, but they nevertheless yield a large portion of the mortality in Victoria. Here occurs the indefinite and unsatisfactory head of teething. The frequency of gastritis would be remarkable, if we could at all depend on accuracy of diagnosis. That of liver diseases becomes so, when we consider that in England half the deaths ascribed to them occur in people above 50. Almost all the hepatic cases are enrolled under the name of hepatitis; but as this appears to have too wide a signification given to it, I have thrown it and jaundice together, and the sum may roughly represent the fatality of diseases of the liver.

The frequency of disorders of this class is probably to be ascribed to—1*st*, A too full and too highly animalised diet. An ordinary weekly ration consists of 10 lbs. of flour, and 10 or even 12 lbs. of meat, with tea and sugar. 2*dly*, The enormous consumption of alcoholic liquors. 3*dly*, The heat of the summer, acting either directly or through the intermediate production of dysentery.

Of splenic disease only one case is mentioned; this is corroborative of the absence of malaria.

Diseases of the urinary organs belong chiefly to old people; their rarity in Victoria is probably only apparent.

The deaths in childbed, though they appear numerous with respect to the female population, are not so in relation to the cipher of births, which, as has been stated, is very high.

Rheumatism is said to be common in Australia, as the habits of life of the population would have led us to expect. It is so in New Zealand, among both Europeans and Maoris.

The registered deaths in Victoria are, however, few. Possibly its influence, though not directly shown, may go for something in raising the mortality from cardiac affections, which, for so youthful a community, is very high.[1] Intemperance in drinking is probably,

[1] Some of the deaths returned under "heart disease" in the colony, would probably have appeared under the head of "sudden death" in England. But, after making every allowance for this probability, the proportion of cardiac disease still remains remarkably high.

however, a more extensive agent in this way. The preponderance of the male sex is not enough to account for the remarkable frequency of aneurism. Probably the equestrian habits of the pastoral and other settlers may have something to do with it.

A few, but of course very few, deaths are ascribed to old age. But the number attributed to external causes is something prodigious. After subtracting a considerable proportion due to intemperance and exposure, I find that from direct violence to amount to nearly one-eighth of the total mortality from all causes. No particulars are given in the returns as to the nature of the violence that causes death; but it is easy to comprehend that in a country where a large portion of the population is engaged in digging and mining for gold, and in herding cattle on horseback; where building and public works are being actively carried on; and where the high value of labour, and the feverish excitement of a new colony, induce, as they do also in the Western States of America, habits of severe exertion combined with a certain amount of recklessness, the number of fatal accidents must necessarily be very great.

The principal features of the medical geography of Victoria may now be summed up shortly as follows:—

1. Excess of violent deaths.
2. Excess of deaths from diseases of the bowels (alvine flux) and of the liver.
3. Excess of diseases of the heart.
4. Excess of some affections of the nervous system.
5. Small proportion of deaths from tubercular and pulmonary diseases and from croup.
6. Small proportion of deaths from the exanthemata and from hooping-cough.
7. Absence of malarial fever.
8. Gradual decrease of mortality from dysentery, typhus, measles, etc.

The unfavourable aspect of the 3d and 4th, if not of the 1st, of these points, will, it may be hoped, be somewhat lessened with the continued advance of the colonists in habits of temperance and order; and sanitary improvements may have some effect upon the 2d. On the other hand, we must recollect that the importation of small-pox may at any time diminish the advantage under point 6, and that the comparative infrequency of phthisis is probably as much, if not more, due to the cheapness and abundance of food, and the active out-door life of the colonists, than to any peculiar advantage in the climate. In the early days of the colonisation of New England, its climate was extolled, probably not without apparent grounds, for its anti-consumptive virtues; yet we know that at the present day the disease is at least as frequent and fatal there as in our own country.

At present, however, it is enough to state, that in none of those countries from which we have reliable statistics, has so small a mortality from phthisis or from other respiratory diseases been authenticated among the civil population.

Evidence drawn from our army reports, though of great value, is of course not direct or conclusive as to what occurs in civil life; but the inference I should draw from what we have of this kind would be, that in the Cape Colony, particularly in its eastern division, both phthisis and other pulmonary diseases are still more rare than in Australia, and that in some parts of India the same may be said of the former, but not of the latter.

With these exceptions, I know of no country that can be spoken of more favourably. The climate of Algeria has been much and not undeservedly praised, on the ground of the rarity of pulmonary affections there; but the evidence of M. Boudin[1] and of Dr Mitchell,[2] both advocates of its claims in this respect, is enough to show that inflammatory diseases of the chest do not partake of the rarity of phthisis, and that even the latter, though far less destructive than in most parts of Europe, is more so than in Victoria.[3]

These facts speak very decidedly in favour of the Australian climate, and its adaptation to the constitutions of the Anglo-Celtic family. Only the experience of generations can decide, indeed, whether these races can permanently establish themselves in Australia, without much degenerating from their pristine vigour and energy of body and mind. This deeply interesting ethnological problem will not be wrought out in our day. Several generations have not sufficed for the thorough demonstration of a similar one in North America. But this much at least is certain, that our countrymen can do in Australia what the French have hitherto failed to do in Algeria: they can endure severe agricultural and other labour, and at the same time not only maintain their numbers, but increase and multiply rapidly.

This comparison suggests itself to me as one peculiarly appropriate. In each case, the difference of temperature between the climates of the mother country and the colony may be estimated at 10 or 11 degrees, putting the average mean temperature of the British Isles at

[1] *Géographie Médicale* and other works.

[2] "On the Climate of Algiers," in *Med.-Chir. Rev.*

[3] If we estimate the population of Algiers at 50,000, M. Boudin's figures will yield the following results for that city:—

	Per million living.
Deaths from phthisis, . . .	2570
Do. other pulmonary diseases,	4800

Dr Mitchell's would give about 1470 and 3040, at the lowest possible estimate. False impressions have arisen in this, as in other cases, from taking the number of deaths from all causes, instead of the number of the living, for the basis of calculation.

48°30′ Fahr., of France at 54°30′, of Melbourne at 59°, and of the French settlements in Algeria (average of 13 towns) at 65°. In each case the change is from a cool and comparatively moist to a warm and dry climate. In each case, the colonists are chiefly composed of young adults, among whom males greatly preponderate, with a considerable number of children. The Algerine French have certain advantages over the Australian English: from the vicinity of their native country, invalids are more easily sent back thither; and from the presence of a large indigenous population, by whom the chief part of the agricultural labour is performed, the colonists have less occasion to expose themselves to any injurious influence the climate may have. Nevertheless, the mortality in Algeria is prodigious. The military and civil, French, Spanish, and Moorish populations, are so jumbled together in the colonial statistics, that it is difficult to give a correct estimate of the death-rate among the French, but it is calculated by Dr Boudin as high as 61·9 per 1000. This estimate, however, includes epidemics of cholera. In 1854, the latest year for which he gives the statistics, it seems to have been 48·893, including the Spaniards, Maltese, etc., who stand the climate better than the French. The births, which in only one year since the conquest had exceeded the deaths, were in 1854 at the rate of 42·619. Young children are said to be "impitoyablement moissonnés."

We can hardly, I think, refer this superiority, to any great extent, to the differences in the habits of the French and English colonists. If any such differences operated very powerfully, they would be apt to make themselves evident in other regions, where French and English settlements are found side by side; but it does not appear that in Pondicherry, in Senegal, or in the West Indies, the French population dies off faster than in those neighbouring British colonies with which a comparison may fairly be made. The more temperate habits of the one people may perhaps be set off against the superiority of the other in cleanliness and sanitary precautions.

The greater frequency of inflammatory diseases of the chest in Algeria does not go far towards constituting the excess of its death-roll. But there is one important differential element which has hitherto been but lightly touched upon. The southern provinces of Australia are almost if not altogether free from the intermittent and remittent fevers which in the northern hemisphere render many comparatively cool climates so deadly, which decimated British troops in the marshes of Walcheren, which make the European emigrant pay so heavily for the fertility of the fat plains of Illinois, and which render Sardinia[1] a more deadly abode for the neighbouring Piedmontese than are the hottest stations in India for the "toto

[1] Boudin (*Geographie Medicale*) states the mortality of the Piedmontese garrison of Sassari at 269·6 per 1000!!

divisos orbe Britannos." It is doubtless this absence of malarial disease that chiefly constitutes the salubrity of the Australian climate, as it does that of others in the southern temperate zone, such as those of the Cape,[1] of Tasmania, of New Zealand, and of Southern Chili. In the present state of our knowledge, or rather of our ignorance, as to the causation of malaria, we are not able positively to predict that this happy exemption will continue, when the introduction of European plants, and the extension of agriculture, have in some degree modified the present telluric conditions; but, at least, we have no reason to expect that that complete cultivation, which in Southern Europe generally goes far towards annihilating malaria, will in Australia have an opposite effect. And we have surely much reason to congratulate ourselves, that while other European nations have to send out the overplus of their population to regions where the individual and the race must wither, as do France and Holland, or to sever all connection with them, and yield them as a tribute to the growth of alien nations, as do the German and Scandinavian States, we have open to us lands, broad, healthy, fertile, and beautiful, where the English race—English in name, language, and politics, as well as in blood—may continue to settle, to multiply, and to thrive, for generations to come.

Table I.

METEOROLOGY OF MELBOURNE.

Annual Mean Temperature, . .	59° Fahr.
Rain-fall, ...	25·76 inches.
Number of days on which rain falls, ·	104.

More rain falls in winter than in summer.

MEAN MONTHLY TEMPERATURE.

Month	Temp.	Season	Month	Temp.	Season
September	54·6	Spring 58·3	March	65·8	Autumn 60·02
October	58·2		April	60·3	
November	62·2		May	54·5	
December	65·7	Summer 67·35	June	50·7	Winter 50·01
January	67·55		July	48·9	
February	68·8		August	50·7	

The temperatures are the means of those given by Sir James Clark, Archer, and Smyth; the rain-fall is taken from Sir James Clark (*On Climate*).

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[1] British soldiers and civilians enjoy even better health in the Cape colony than in Great Britain.—(Aitken, *Handbook of Medicine*, p. 736.)

Table II.

ANNUAL DEATHS FROM DIFFERENT CAUSES TO ONE MILLION PERSONS LIVING.

Causes of Death.	1. England and Wales, 1851.	2. 8 Scotch Towns, mean of 1857 and 1858.	3. Cornwall and Devon, 1851.	4. Victoria, year 1856–7.	5. No. of Deaths in England, in a population resembling that of Victoria in age and sex.	6.
All causes, .	22,055	26,688	20,153	16,720	18,422	17,571
Specified causes, .	21,987	25,432	19,901	16,495		
1. Zymotic diseases,	4,897	6,773	4,306	4,023		
Small-pox, .	396	442	393	0		
Measles, .	530	845	80	12		
Scarlatina, .	771	1,067	1,271	23		
Hooping-Cough,	447	1,112	468	120		
Croup, .	236	437	191	151		
Thrush, .	66	17	33	92		
Typhus, .	969	1,143	892	1,095		
Remittent or infantile fever, .	80	89	46	48		
Diarrhœa, .	833	908	397	818		
Dysentery, .	124	327	107	1,451		
Cholera, .	64	53	41	110		
Alvine flux (total),	1,021	1,288	545	2,379		
Scurvy and purpura,	14	17	11	25		
Syphilis, .	34	60	45	33		
Erysipelas, .	113	105	80	30		
2. Diseases of uncertain or variable seat,	1,098	903	1,285	607		
Hæmorrhage, .	78	70	111	130		
Carcinoma, .	295	290	320	110	122	122
Dropsy, .	558	436	698	225	222	243
3. Tubercular diseases,	3,625	5,008	3,227	1,738		
Scrofula, .	147	124	116	23		
Tabes mesent.,	255	423	159	179		
Phthisis, .	2,781	3,476	2,621	1,192	2,724	2,808
Hydrocephalus,	442	983	322	343		
4. Diseases of the nervous system,	2,820	2,156	2,278	2,202		
Cephalitis, .	205	183	157	87		
Apoplexy, .	450	418	472	266	297 (Apoplexy and Paralysis)	345 (Apoplexy and Paralysis)
Paralysis, .	429	509	508	66		
Delirium tremens,	28	35	17	82		
Epilepsy, .	100	62	125	48		
Tetanus, .	7	17	6	20		
Insanity, .	31	22	9	79		
Convulsions, .	1,391	574	700	1,048		
Sunstroke, .				23		
Disease of brain,	175	328	170	456	135	134
5. Diseases of heart, etc.,	668	828	569	584		
Pericarditis, .	32	20	19	46		
Aneurism, .	16	37	14	86	15	14
Disease of heart,	620	767	536	453	332	352
6. Diseases of the respiratory organs,	2,759	3,405	2,326	1,171		

Table II.—*Continued.*

Causes of Death.	1. England and Wales, 1851.	2. 8 Scotch Towns, mean of 1857 and 1858.	3. Cornwall and Devon, 1851.	4. Victoria, year 1856–7.	5. No. of Deaths in England, in a population resembling that of Victoria in age and sex.	6.
Bronchitis, .	978	1,653	629	333	563	550
Pneumonia, .	1,245	1,134	1,273	673	1,235	1,122
Pleurisy, .	56	103	80	23		
Asthma, .	277	297	207	28	89	102
7. Diseases of the digestive organs, .	1,314	2,021	970	1,528		
Teething, .	249	722	91	571		
Gastritis, .	41	49	40	141		
Enteritis, .	218	490	176	302		
Peritonitis .	71	79	50	97		
Disease of liver,	365	318	245	299	226	220
Disease of stomach (see gastritis),	126	116	152	5		
Disease of spleen,	4	5	6	2		
Hernia, .	40	31	26	20		
Colic, ileus, etc.,	78	73	80	59		
8. Diseases of the urinary organs, .	194	250	155	71	104	119
9. Diseases of the organs of generation,	188	192	156			
Do. including metria,	245	257	209	192		
Childbirth, incl. do.,	186	191	156	192		
10. Diseases of the organs of locomotion,	137	92	96	59		
11. Diseases of the skin, etc., .	47	25	77	10		
12. Malformations, .	45	58	30	72		
13. Debility, .	1,072	1,294	1,241	1,397		
14. Atrophy, .	690	251	600	464		
15. Age, .	1,471	1,350	1,912	90		
16. Sudden (cause uncertain), .	196	110	150	5		
17. External causes,	766	719	629	2,256		
Intemperance,	16	39	5	90		
Exposure, .	?	?	?	113		
Violent deaths,	712	623	610	2,054		734
Pulmonary diseases, including phthisis,	5,540	6,881	4,947	2,363		

Column 5 has been constructed by taking as a basis the supposition that there are in the colony no persons aged more than 55 years, but that below that period the proportions at the various ages are as in England.

Column 6, which is probably a much nearer approximation, though, of course, it can be but an approximation, to the truth, has for basis the following data: that there are in the colony twice as many persons between 25 and 35, one half as many between 45 and 55, and one quarter as many between 55 and 75, as in England; that there are none above 75, and that at the other ages the proportions are normal.

In both columns the males and females have been reckoned as 25 to 14.

Table III.

RELATIVE ORDER OF THE PRINCIPAL CAUSES OF DEATH IN ENGLAND AND WALES, AND IN VICTORIA.

Proportion dying annually per million living.	In England.	In Victoria.	In Victoria, as it probably would be, were the population normal as to age and sex.
Above 2500	1. Phthisis.		
Above 2000		1. Violent deaths.	
Above 1500			1. Violent deaths.
Above 1000	2. Age. 3. Convulsions. 4. Pneumonia. 5. Debility.	2. Dysentery. 3. Debility. 4. Phthisis. 5. Typhus. 6. Convulsions.	2. Dysentery. 3. Debility. 4. Phthisis. 5. Typhus. 6. Convulsions.
Above 750	6. Bronchitis. 7. Typhus. 8. Apopl. and paral. 9. Diarrhœa. 10. Scarlatina.	7. Diarrhœa.	7. Apopl. and paral. 8. Diarrhœa. 9. Disease of heart.
Above 500	11. Violent deaths. 12. Atrophy. 13. Disease of heart. 14. Dropsy. 15. Measles.	8. Pneumonia. 9. Teething.	10. Pneumonia. 11. Bronchitis. 12. Disease of brain. 13. Teething. 14. Dropsy.
Above 250	16. Hooping-cough. 17. Hydrocephalus. 18. Small-pox. 19. Disease of liver. 20. Carcinoma. 21. Asthma.	10. Atrophy. 11. Disease of brain. 12. Disease of heart. 13. Hydrocephalus. 14. Bronchitis. 15. Apopl. and paral. 16. Disease of liver. 17. Enteritis.	15. Disease of liver. 16. Atrophy. 17. Hydrocephalus. 18. Enteritis. 19. Carcinoma.

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THE

HYGIÈNE OF BREAD.

BY

HARRY WILLIAM LOBB, L.S.A., M.R.C.S.E.,

FELLOW OF THE MICROSCOPICAL AND HARVEIAN SOCIETIES, ETC.

TO WHICH IS APPENDED

THE PAPER READ BEFORE THE SOCIETY OF ARTS

BY DR DAUGLISH,

INVENTOR OF THE NEW AËRATED BREAD,

ON A

NEW SYSTEM OF BREAD MANUFACTURE.

LONDON:
C. DARBY, 20 KING WILLIAM STREET, STRAND.

1860.

PREFACE.

The articles upon "The Hygiène of Bread" published in the Medical Circular during the early part of the present year having excited some attention amongst the Medical and Scientific World, I have been requested by the Publisher to write a Preface to a new edition of these papers in the form of a pamphlet. I have the more pleasure in doing so, as I have reason to know that the perusal of my papers has been the cause of great good to many; that, acting upon the advice tendered therein, many have been restored to a state of health which they had never previously enjoyed, and which they had never hoped to have attained.

With the consent of Dr Dauglish, I have appended a portion of his paper upon Aërated Bread, read before the Society of Arts; and I am happy to say that, through the ventilation of the subject which has thus been effected, a Public Company has been originated, which will supply London with the best and absolutely pure Bread, at a moderate price; and that a discussion in the public prints has been stimulated, which has placed the whole subject in a much clearer light than has ever before shone upon our daily Bread.

Brook Street, Hanover Square,
December, 1860.

THE HYGIÈNE OF BREAD.

INTRODUCTORY.

Second only in importance to the atmosphere inhaled, and the peculiarities of climate, is the bread eaten by a nation. Water should have been placed second, were it not that it is so little drunk by Europeans as it comes from the spring or river; almost all civilised nations boiling their water before drinking it, as in beer, tea, coffee, chocolate, &c., whereby a change in the salts contained in solution takes place, rendering it more suited, in most instances, to the animal economy.

Bread is the "staff of life," the great pabulum which all classes, high and low, rich and poor, look to as the staple article of diet,—eaten at every meal, consumed by all, in smaller or larger quantities, from the Queen to the meanest of her subjects, from the nobleman and princely merchant to the prisoner in his cell, and the poverty-stricken recipient of the meagre dole at the night-refuge.

Large masses of the people exist almost entirely on bread, tasting bacon but once a week, and butcher's meat but once a year; their bones and muscles are formed of bread, their blood is bread and water, and their nerve force the spirit of bread. Such, then, is the paramount importance of bread as an article of diet, and as a question of domestic and political economy, that I feel that to draw the attention of the Medical Profession to the "Hygiène of Bread" will be of service to them individually, and, far more, through them to the great mass of the public.

The English word Bread is supposed to be derived from the Anglo-Saxon Bræd-an, to nourish, and it is in this sense that I propose looking upon it,—a model food, the only model food, with the exception of the maternal milk, which with water alone will support life. Bread may be defined as a food composed of water, starch—in a state easily converted into gum and sugar—gluten, and oil. These materials undergo various preparations before being eaten; still the ingredients are the same. Bread has been the principal article of diet from time immemorial; the earliest records, sacred and profane, allude to it; no historical work extant, however ancient the times treated of, has failed to recognise the great importance of bread as a food for the people.

Amongst ancient authors, the manufacture of bread is frequently spoken of. Hippocrates says: "And that from wheat, by macerating it, stripping it of its hull, grinding it all down, sifting, toasting, and baking it, they formed bread." "And this I know, moreover, that to the human body it makes a great difference whether the bread be fine or coarse, of wheat with or without the hull; whether mixed with much or little water, strongly wrought or scarcely at all, baked or raw, and a multitude of similar differences." Hippocrates, who wrote about 450 years before Christ, does not speak of fermented bread; he merely alludes to different forms of cakes, biscuits, &c. Galen, speaking of bread, says the best kinds are such as contain plenty of leaven, have been properly pounded, and exposed to a moderate heat in the oven. He objects to unleavened bread. Celsus, however, places "unleavened bread first among those things that do not spoil on the stomach;" and he says of bread, that it contains more nourishment than any other food. Although the ancients in general made use of leaven, still it is mentioned by Pliny that the Gauls and Spaniards made use of yeast to ferment their bread.

The Bible constantly alludes to bread, both leavened and unleavened; and showing the importance in which the Jews held it, we frequently have such passages as "The Bread of Life," "Wherefore do ye spend money for that which is not bread?" &c. Bread being to them of the greatest value, was made typical in many of their most solemn rites.

Even amongst uncivilised nations, except a few of the most degraded, bread is eaten in some form or other. Nomadic tribes eat bread; although they may cultivate no cereal, yet prolific Nature has placed at their command fruits which in their chemical composition resemble most intimately the bread of Europeans. The date of the desert grows aloft at every spring,

yielding to the wanderer its pleasant food, grateful to his hand; it affords him the same nourishment that bread does to the inhabitant of a colder clime, it is suited to his wants, and upon it he lives. The South Sea Islanders have their bread-fruit, which when baked resembles in its flavour sweet wheaten bread, and on which the natives live the whole year round, for the tree bears during nine months, and during the remaining three they eat the fruit, which has been harvested in pits, and which, after undergoing fermentation, being baked, yields a bread somewhat sour, still nutritious.

Many of the gramineæ, besides wheat, answer to the definition I have given of bread; still, wheat alone, ground, mixed with water, kneaded and baked, yields the loaf of the shops. Rye and barley give an inferior loaf; but Indian corn, oats, buckwheat, quinoa, and Indian millet, fail altogether to form that peculiar porous mass termed a loaf, and which has been always found to be more easy of digestion, as the fluids are enabled more readily to permeate the sponge to dissolve it.

The subject of bread has been a prolific one: numerous most valuable papers have appeared from time to time, scattered about in various works and periodicals; still, from the contradictory assertions they contain, and from the new processes for the manufacture of bread which have lately appeared, I believe there is plenty of room for the "Hygiène of Bread."

I purpose, therefore, in the forthcoming series of papers, to treat of bread principally as to its dietetic relations; and although I shall enter into the chemistry of the ingredients, and the process of manufacture, yet the various causes for its adaptability to certain states of the system, and not to others—the reasons for the digestibility of fermented bread by some, and unfermented by others—will be the chief aim I shall have in view. I believe I am in a condition to prove incontestably, by many authentic cases in my own practice and in that of others, that unfermented bread alone is a cure for many most serious forms of dyspepsia, in which medicines, &c., are merely palliative.

FLOUR.

Wheat flour is obtained by grinding and sifting the grain of various species of triticum, and during this process several different products are derived from the wheat grain, the chief being flour—middlings, fine pollard, and coarse pollard or bran, flour being about seventy-five per cent. of the whole. The wheat grains of the markets vary exceedingly in their value as a bread-forming menstruum, and the knowledge required to choose the grain is only to be acquired by long experience, and even then the best authorities are occasionally deceived. The value of the grain depends, firstly, upon the seed; secondly, upon the land upon which it is sown, and its climate; thirdly, upon the manure used; and fourthly, upon the care taken in harvesting and storing: and although to the senses the grain may appear sound, yet, after all, the bread made from it may be inferior or tainted.

If a grain of wheat be cut longitudinally, and a thin slice be removed and placed under the microscope, the mode of arrangement of the contents may be observed. Firstly, there is a tough, horny covering, formed of flattened scales, the walls of which are thick and silicious; beneath this is a layer of smaller, more compact cells; going still deeper, are a single row of brownish cells, larger than those above; the interior of the seed beneath these coverings consists of many roundish hexagonal cells, containing the large flattened oval and small round starch grains. The external covering cells form the pollard and bran, and around the starch grains are found the extractive matters. The gluten is found chiefly in the third layer of cells, and a machine has been invented to remove the outer coat, leaving the grain free from bran, so that it may be ground at once into whole meal.

If the flour thus obtained in its purity be analysed, the following tables will be found, upon an average, to give its component proximate principles.

Starch	69·00
Gluten	10·00
Nitrogenous matter, Starchy Sugar, Starchy Gum	6·00
Fatty matter	1·00
Water	14·00
	100·00

The ash of this, about 1·2 per cent., yields—

Potass	24·00
Soda	9·00
Lime	3·00
Magnesia	12·00
Oxide of Iron	1·00
Phosphoric Acid	50·00
Silica	1·00
	100·00

The meaning of starchy sugar and gum, being that the starch is not pure, but in a transition state, readily convertible into sugar, and yet in the best flours it is not yet sugar or gum. Dr Odling believes that sugar is very rarely found pre-formed in flour. With the gluten in the above table are some proteine compounds, albumen, &c., soluble in water, and highly nutritious.

If wheat flour be mixed with sufficient water to thoroughly moisten it, there is formed a tenacious, sticky mass, which may be drawn out into ribbons of some length. If this mass is placed under a stream of water and well washed, the water as it flows away will resemble milk; and when it ceases to be so, the remaining mass will be found to be still more tenacious, almost as much so as birdlime; this is termed gluten. If the milky fluid be set aside, a white deposit will form, consisting of wheat starch; the clear fluid upon examination will be found to contain the soluble portion of the flour; its albumen may be obtained from this fluid by boiling, when it is thrown down in flakes. Its dextrine, an intermediate stage between starch and gum, may be obtained by concentration or by adding alcohol, in which it is insoluble. It is amorphous, and resembles gum, but may be distinguished from it by its right-handed rotation of a ray of plane polarised light; also by yielding oxalic acid, not mucic acid, when heated with nitric acid. The remaining extractives are gum and a little sugar.

Flour suited for bread-making, therefore, is found to contain gluten, starch, and extractive.

Gluten very much resembles the fibrine of muscle; it is a nitrogenous substance, a stage farther advanced than albumen in its vital properties; it is prepared to undergo the next stage, that of disintegration. Shortly after gluten and fibrine have attained perfect organisation, they undergo a series of changes, eventually terminating in the disengagement of ammonia. We see this both in the animal and vegetable kingdoms.

Wheat flour contains an average of ten per cent. of gluten; but besides this there are about three per cent. of nitrogenised matters, albumen, &c. With the gluten is mixed a substance of a fatty nature, of great importance in the economy of bread. It is to its gluten that wheat flour owes its superiority in the manufacture of a loaf to the flours of other nutritious grasses, and not to any peculiar chemical ingredient; for the gluten of other seeds resembles it in its elementary formation, but it is in very much larger proportion in wheat flour, and its molecular cohesion is greater and peculiar to it.

It has usually been supposed by physiologists that the gluten is the nutritious or flesh-making portion of the wheat, but I believe that this is not the case. The gluten is the fibrine of the wheat, the highest state of perfection to which the various elementary matters can be combined, and the next stage is that of disintegration and destruction; it acts as a ferment to the conversion of starch into sugar, and dissolved yields up its salts and other elementary matters for the purposes of the economy; but it is the soluble albumen which is prepared with the oily matter to rapidly become converted into chyle, and so nourish the muscular system.

Starch consists of minute cells, small and rounded, and large, flattened oval cells; their external coat is insoluble in cold water, but a certain amount of heat causes the cell-wall to burst; and this heat is below the boiling point, for the heat of the stomach will burst the more delicate cells. However, there is another reason for the starch grains being burst in the stomach: the saliva contains a peculiar animal ferment, termed ptyalin, which has the power, with the aid of the heat of the stomach, to burst the starch grain, and to cause the contents to combine with the elements of water, converting it into sugar. Starch, therefore, should never be eaten raw, but should be either baked or boiled, to make it more easy of digestion. Heat will not convert starch into sugar, but it will into dextrine, a gummy matter—in other words, burst starch granules; this is merely a mechanical, and not a chemical change.

The starch is prepared to undergo certain most important changes, as sugar, gum, certain acids, and even alcohol, to nourish the nervous system, and to be converted into animal heat, nerve force, &c.

Authorities differ as to the presence of sugar in wheat flour. Dr Odling says: "From my own experiments, I am inclined to think that the existence of pre-formed sugar in flour is very rare." Theoretically, and in properly harvested and preserved wheat and flour, this is undoubtedly true; but flour is exceedingly hygro-

metric, and absorbs water readily; and this is all that is required for the gluten to convert a certain portion of the starch into sugar; and I believe that, in the vast majority of wheat flour for bread-making purposes, sugar exists in small quantities.

The extractive, a most important portion of the analysis of wheat flour, containing its soluble components, is principally indebted to the albumen, which is so highly nutritious and easy of absorption, for its value; the sugar and gum are of service, and the oil, which may be obtained from the gluten by solution in ether, is indispensable to the animal economy.

The salts of flour, principally phosphates of potash, soda, and lime, become converted into the skeletons of the blood corpuscles, which clothe themselves with the proteine and oily compounds, and serve to nourish the muscular, cellular, and osseous systems; and it is to the peculiar molecular condition in which these salts exist in the gluten of wheat flour, that the ability of the formation of a loaf chiefly depends.

Wheat flour is injured by several diseases peculiar to the grain, making it unfit for human food; but in these cases it does not appear in the market. Flour, however, undergoes deterioration by damp, and the gluten is affected by a peculiar molecular change, through which it loses its cohesive power; and when bread is attempted to be made with it, instead of forming a glutinous dough, it runs together like treacle—a portion of the gluten is converted into diastase, a nitrogenous ferment, having the power of converting, with the aid of water, starch into sugar. The bread made from this flour is so inferior that it could not be sold; the millers, therefore, are accustomed to mix with this flour, to correct such a condition, alum, powdered gypsum, bean meal, bone earth, or lime; and this probably not from any idea of adulteration, but absolutely to make the flour suitable for the manufacture of bread. Wheat flour, however, is adulterated by the addition of potato and other starches, the meal of buckwheat, Indian corn, barley, rye, rice, beans, peas, &c. These adulterations are easily detected, by those interested, with the aid of the microscope.

Rye flour, seldom used in England as a diet, except for adulteration, used in distilleries and breweries.

Oatmeal, rich in fatty matters and proteine; its gluten has not sufficient molecular cohesiveness to form a loaf: it is, however, a most nutritious food, more so even than wheaten bread; it is eaten as porridge, gruel, and oat-cake; it is more laxative than wheaten bread.

Barley meal contains little proteine, therefore alone is not fit for human food; it will not make a loaf. Its starch, however, is much used for mixing with wheaten flour, also for children's food, barley water, &c.; more laxative than wheat flour.

Indian corn flour contains less proteine compounds than wheat flour, and will not make a loaf; it is rich in fatty matter, and is very nutritious; it is laxative.

Rice flour contains a very small percentage of proteine compounds and fatty matter; it is therefore not a flesh-making diet; it will not make a loaf. Its starch is valuable; it is constipating.

Potato flour, a starchy preparation of the potato, used occasionally for mixing with wheaten flour; nutritious and unobjectionable.

The meals of peas, beans, vetches, gram, lentils, &c., are nutritious; contain much proteine matter, but little gluten.

FERMENTED BREAD.

The flour has now to be converted into a spongy mass, and baked, so that it may form a porous body, light, and easy of digestion. There are now many methods of inducing this state; let us proceed to their study. The most ancient, and that still in general use, is the disengagement of innumerable bubbles of carbonic acid within the dough by exciting the fermentation of the starchy sugar by leaven or yeast.

What is fermentation?—It is a state of change which all the higher forms of organic matter undergo during disintegration, having the power of inducing a like state in allied substances, and a complementary state in less elaborated principles. During this process oxygen is absorbed to unite with the disintegrating materials; and if there is a sufficient supply of this gas in its allotropic state of ozone, the change is a normal one: if, however, this is not the case, the fermentation is putrefactive, and detrimental to the existence of man and the higher animals.

Man lives in a condition of fermentation: the atmosphere he breathes contains materials undergoing fermentation; the water he drinks is full of fermenting matter; the food he eats is fermenting before it enters his stomach. Half his nervous energy is required to resist this catalytic state of change. More than half the sickness suffered by man is dependent upon this condition; the causes being imperfect drainage, on a fatal system of poisoning our waters; neglected hygienic conditions in our household arrangements, such as unscientific methods of heating and ventilating; and impure food, from bad farming, storing and preparing the materials of our diet. When shall we see the simplest common-sense rules govern our every-day proceedings? But to return.

Fermentation is the result of the disintegration of the proteine compounds, which according to the menstruum in which they find themselves result in fresh organisms: thus, in a saccharine fluid we find yeast, a vegetable; but if this yeast be removed from the saccharine fluid, and set aside and bruised, so that the vegetable growth is destroyed, what is the result? Innumerable monads appear; these monads exist upon decaying proteine matter, and are the second step—vibriones being the first—towards higher existence. Yeast is not the cause of fermentation, it is an accompanying phenomenon; and although it will excite fermentation in a menstruum prepared for it more quickly, still it will not do so more surely. The reason why it will do so more quickly is, that the spores of the yeast are in an active state, ready instantly to fructify; whereas the decomposing proteine has to undergo various internal changes and disintegrations before it is prepared to originate a new organism. The saccharine solution is the cytoblastema of the yeast-cells, containing not only the germs of their origin, but the fluids for their increase and growth; during their growth they decompose the ingredients in which they reside, converting them into other principles.

Wheat flour contains such a proteine compound, namely, gluten—the fibrine of the wheat; it is prepared under suitable circumstances to decompose, originating the fermentive state—this is termed leaven or sour dough; it is now never resorted to by bakers, as the process is a tedious one and not certain; the gluten may not be normally elaborated, or the external circumstances, such as temperature, moisture, &c., may be unsuited to the change, so that occasionally an acid or even caseous fermentation may be set up, and the starchy sugar may be converted into lactic, or even butyric acid.

Yeast is invariably employed by bakers to excite panary fermentation. *Fermentum Cervisiæ* is the best name for it, as it does not declare it to be of any particular order, species, genus, &c. Some authorities have placed it amongst the fungi, others amongst the algæ. Liebig, when he first studied the question, looked upon it as infusorial; and although this is laughed and jeered at, I believe it to be as near the truth as that it is a fungus or an algal. There are certain microscopical formations which are peculiar to both kingdoms, animal and vegetable, and yeast may be placed amongst these; the same germs may become infusorial or algal, according to the external influences to which they may be exposed.

Kützing has declared "beyond the possibility of doubt that simple globules, such as cryptococcus, palmella, and protococcus, can give birth to different formations, according to the influence of light, air, and temperature." In a paper read before the Microscopical Society, I continued the observations of Kützing, showing that there was a point in which the animal and vegetable kingdoms merged one into the other, and that within the vegetable cells of some confervæ embryos of animalcula were deposited, which under certain conditions of temperature could be developed into the perfect animalcule, or by cold and shade could be degraded into vegetable tubes and fibres. Now yeast is just in the same position—it is the result of the highest form of organised matter; decomposing fibrine, animal or vegetable, will under favourable circumstances become developed into yeast; under other circumstances the same matter may become developed into vibriones and infusoria.

Yeast is composed of the cell-walls and contents: the cell-walls are of a starchy nature, termed cellulose; the contents, of a proteine character with oil. Yeast will not germinate in a solution of pure sugar; it requires the presence of the extractive soluble albumen, &c., for the production of the proteine contents.

Yeast-cells are propagated in two modes: first, by the attractive force of the disintegrating molecules of the proteine compounds in a saccharine solution, cohering to form a nucleus, and from this a cell; and, secondly, upon this cell arriving at maturity, bursting and discharging nucleoli of a higher vital state, immediately prepared to attract materials for a nucleus and cell-wall. The former is very slow, the latter inconceivably rapid. As long as there is any sugar in the solution, the yeast continues to increase and multiply in this way; but when this is exhausted, it rises to the surface and fructifies in the air, becoming a true fungus, and is now termed *Mycoderma Cervisiæ*. The cells unite together; the diaphragms are absorbed; joints sprout out; a thallus is created; and we have a true fungus merely from the change of habitat and nutrition.

Yeast requires a certain temperature for its growth and propagation. The best suited for it is between 70° and 80° Fahrenheit. A higher temperature does not arrest it, except it be prolonged. Berzelius says that boiling for a short period injures, and for long destroys, the power of inducing fermentation by yeast. If the yeast be placed in a thick solution of sugar, it will grow rapidly, and, at the same time, convert it into alcohol and carbonic acid.

Thus we see that the gluten of the wheat has the power unaided to originate fermentation; but it requires time, some days even; and when it is set up, it frequently and generally proceeds too far, an acid fermentation taking place which makes the bread disagreeable to the taste. Yeast, being already in an active state, at once decomposes the starchy sugar, communicating to the gluten the like power. In England it is the custom amongst bakers to add the maximum of yeast, and to depend upon it for the fermentation process, as it is much more expeditious. In Paris and in Spain, generally, where the bread is so deliciously light and agreeable, and where the manufacture of bread is an art, and not a clumsy trade, the maximum of yeast is used to stimulate the gluten to rapid change; and it is upon the gluten they depend, and not the yeast; and, although the process is slower, the bread gains in purity, lightness, and digestibility.

The theory of the process is thus explained by chemists:—Starch is primarily converted by the action of the nitrogenous ferment into dextrine, that is to say, the external coat of the starch grain is burst, and it is now soluble; this is a purely mechanical change, for we find that they have the same elementary formation :—

$$\left.\begin{array}{l}\text{Starch .}\\ \text{Dextrine}\end{array}\right\} C_{12}\ H_{10}\ O_{10}$$

The yeast now converts the dextrine into sugar by causing its ultimate molecules to combine with the elementary gases of water :—

$$\left.\begin{array}{l}\text{Starch .}\\ \text{Dextrine}\end{array}\right\} C_{12}\ H_{10}\ O_{10} + 2\ HO$$

EQUALS

$$\left.\begin{array}{l}\text{Glucose .}\\ \text{Sugar . .}\end{array}\right\} C_{12}\ H_{12}\ O_{12}$$

This is an actual chemical change, but it proceeds further—the yeast in rapid growth decomposes the sugar, converting it into alcohol and carbonic acid :—

$$\left.\begin{array}{l}\text{Glucose .}\\ \text{Sugar . .}\end{array}\right\} C_{12}\ H_{12}\ O_{12}$$

EQUALS

$$\begin{array}{ll}\text{2 Alcohol . . .} & C_{8}\ H_{12}\ O_{4}\\ \text{4 Carbonic acid} & C_{4}\ \ \ \ \ \ \ \ \ O_{8}\\ \hline & C_{12}\ H_{12}\ O_{12}\end{array}$$

The baker is now satisfied, and arrests further action by placing the dough in the oven; for if he did not do this, further changes would go on, and the alcohol would be converted into acetic acid, and a sour bread would result.

Now let us see the mechanical effects of these theoretical changes. The flour is mixed with warm water, salt, and yeast, and set aside in a warm place for six or eight hours for the "*sponge to set.*" The fermentation already described is now going on: the liberated carbonic acid, as given off, is imprisoned by the gluten, which prevents its escape, and forming little cells, causes the dough to swell. When this has gone on for a certain time, more flour, salt, and water are added and well kneaded, so that the fermenting dough may be perfectly mixed with the whole mass; and it is upon the thorough manner in which the kneading is effected that the uniform lightness of the bread depends. In Spain much importance is given to the kneading, which is carried out in a most efficient manner. Machinery, too, is now being extensively introduced for the kneading process. The sponge, being again

set aside, is afterwards weighed, and allowed to ferment until about double the size. It is then placed in a hot oven. The heat causes an increased enlargement of the loaf by the expansion of the gas within each individual cell. The starch on the outside of each loaf is converted into a brown gum by the heat of the oven, forming the crust. Upon being removed from the oven, we have a hot loaf of fermented bread.

The batch of bread being placed in the hot oven, continues to rise for three-quarters of an hour, when it ceases; a vapour now escapes from it, containing the alcohol. Some years ago an experiment on a large scale was attempted to collect this alcohol. True, it was obtained; but the bread was spoilt; for after the vapour has risen, it is again condensed upon and absorbed by the bread, giving it its flavour, adhesiveness, and vitality. When this vapour is allowed to escape from the oven, the bread when drawn is found to be short, and eats like chaff, without the flavour of bread at all. Batch-bread should remain in the oven two hours, for it is not baked through in less than that time; in fact, even then much of the yeast in the centre of the loaf is not destroyed, although its vitality is much weakened. The best yeast for bread-making comes from Bicester: it is slow in exciting fermentation, being mixed with the flour at eleven o'clock in the morning, fermenting all day and during the night; the batch is not ready to be put into the oven until four o'clock the next morning, and it is drawn at six, taking nineteen hours to effect the process. On this account the journeyman baker's life is a hard one—for, although he does not work more hours or harder than other day-labourers, still his rest is disturbed, and he has less time at his own disposal.

German yeast being a very quick yeast, is used for the manufacture of buns, cakes, &c., where lightness is an object; small-beer yeast has the same effect: these yeasts will not make good batch-bread.

Wheaten flour contains about 16 per cent. of water, and in bread-making it absorbs 34 per cent. more, so that bread when it is eaten is half water. The gluten of good wheaten flour absorbs water readily, and will not part with it; it holds it with great tenacity: the gum also, to which some of the starch is converted, has a great affinity for water. But in inferior flours the gluten has not this tendency to hold the water. True, it absorbs it; but the loaf made from it is converted into a more or less slimy, sticky mass: this is effected by the gluten, from its inferior elaboration and vitality, becoming converted into cerealin, the diastase of malt, which has the power of converting much of the starch of the wheat into sugar. A good deal of the inferior low-priced wheat, both of home growth and imported from abroad, undergoes this change, consequently is unfit for bread-making purposes; the consequence is that the miller or baker adds to such flour about one pound of alum to two sacks, so that the gluten shall be able to adhere to form the cell-walls for the carbonic acid, instead of running into cerealin, and the starch into sugar. Dr Odling, in a valuable paper read before the Society of Arts, observes, "Bread made with infusion of bran or infusion of malt is very sweet, sodden, brown-coloured, and so sticky as almost to bind the jaws together during its mastication. But the addition of alum to the dough causes the loaves to be white, dry, elastic, crumbly, and unobjectionable both as to taste and appearance." The alum prevents the change of the gluten into cerealin: Liebig says that alum prevents the solubility of the gluten, which is the same thing in other words.

Much has been said upon the objectionable practice of adding alum to flour in bread-making, from its producing constipation, rickets in children, &c.; but the real reason has, I think, escaped the detection of those who have studied and written upon the subject. The best flours do not require, consequently have no alum added to them; inferior flours will not make a loaf without it: the injury is, then, in having inferior fermenting flour palmed off upon the public as good, sound flour—flour that will not nourish, and will not produce healthy blood, bone, muscle, &c.; for the moment yeast is mixed with it, fermentation commences, and the gluten being of a low vitality, runs into cerealin, originating changes in the starch which are abnormal and are unadapted for nutrition. If this inferior flour could be made into bread without passing through a previous stage of fermentation, it is possible that the bread made from it might be unobjectionable: but this would depend on direct experiment. At any rate, alum, which is used to cause bread made from inferior flours to resemble

that made from sound ones, is a fraud upon the public, most objectionable in its tendency.

Is this the fault of the ruling powers, the bakers, or the public? The first, most certainly, as they should not allow the public to believe that a loaf of bread made of good flour can be sold for less than a certain price. If the price of good flour, and the lowest price at which a loaf from that flour could be sold so as to allow proper remuneration to the baker, were published weekly in every newspaper in the kingdom, the public would not buy cheap and nasty bread, and the bakers would not be tempted to buy inferior flours. Of course, rogues who made inferior breads, and consequently larger profits, might be found; still it is to be hoped they are a small minority, and would soon be discovered and exposed. The arguments in the paper above spoken of, by Dr Odling, in favour of the use of alum in bread-making, are, although plausible, of a low class of morality, and should be condemned by all interested in "the hygiène of bread."

The addition of alum, then, is a decided fraud, from the ability it gives the baker to sell an inferior flour as sound bread, which is not so nutritious and already in a state of fermentation. The starch of this flour is doubtless as good as that found in the better flours, and might be used as such; but the gluten is not elaborated, and is unfit for bread-making purposes: it might probably be used by the brewer without detriment. In a day or two the loaf is stale; it is no longer soft and elastic, but harsh and crumbling: a molecular change in the particles of the gluten has taken place; the heat is removed, the loaf is cold; heat it again in a close oven, and it is again soft and elastic. This will continue until the bread has lost much of its moisture, when it ceases to regain its elasticity upon heating. If much of the water be removed, the loaf would become all crust, like a rusk; but although the oven may be heated to upwards of 400°, the interior crumb of the loaf seldom attains a higher temperature than 100°. M. Boussingault has made many experiments in this direction, and he found that it took twenty-four hours for a hot roll to attain the temperature—66°—of a room in which it was placed, and he concluded that staleness depended on the molecular state of the bread, caused by its loss of heat.

A loaf of bread comes under the head of bad conductors: its composition is exceedingly heterogeneous; the little cells containing gas are peculiarly adapted to prevent the escape of heat, and a loaf of bread may be looked upon as, perhaps, the most likely thing that could be devised to retain heat for a considerable period.

RUSKS.—Made from flour, white of egg, milk, a very little butter, and the smallest possible quantity of quick-working yeast; baked through; then removed, cut in half, and baked again. When cold, they are placed again in the oven, and remain there until cool. By this means they lose twenty per cent. of their water, and the vitality of the yeast is *entirely* destroyed, which is not effected in the loaf. These rusks are exceedingly nutritious, and are a very valuable article of diet.

BUNS, CAKES, &c.—Made with yeast; are but bread, with butter, currants, plums, and other abominations contained in them. The less said concerning them the better. They are admirably adapted for originating a bilious attack; and when a Bath bun is coloured yellow with a preparation of arsenic, something worse may be expected.

UNFERMENTED BREAD.

There are several methods of making unfermented bread; perhaps it would be better to take them in the order of their chronology, and the first is the dough cake, which is probably the very oldest method in which the cooking of the cereal grains could have been effected.

THE DOUGH CAKE.—The grain being ground, is mixed with water into a tenacious dough; then baked upon a tile, and browned before the fire. This, with some fatty matter, animal or vegetable, is exceedingly nutritious, and well adapted to form the chief ingredient in a diet. It is wholesome and unobjectionable: it, however, would not suit the dyspeptic, being too heavy.

THE BISCUIT is merely the dough cake more highly baked; it requires thorough mastication before it can be permeated by the juices to undergo digestion. It is well suited to some forms of dyspepsia.

SPONGY UNFERMENTED BREAD.—In 1836, Dr Whiting took

out a patent for rendering bread cellular, light, and spongy, without the aid of fermentation; this was accomplished by mixing together in the following proportions—

Wheaten flour, 7lb.
Carbonate of soda, 350 to 500 grains.
Water, 2½ pints.
Hydrochloric acid, 420 to 560 drops.

Upon being thoroughly mixed, the dough is immediately put into a hot oven. The whole process, from first to last, takes less than two hours. Mr Dodson purchased this patent, and, I believe, still continues the manufacture. The bread is scarcely so light as the ordinary loaf; its flavour is agreeable, resembling home-made bread, and it keeps well, without becoming sour or mouldy, except the brown bread in summer, which soon becomes ropy. The following formula I have used for many months in my own house, making very good bread. I preferred whole meal to make a brown loaf to the white, which is, however, very good:—

Flour, 1lb., white or brown.
Sesquicarbonate of soda, 40 grains.
Pure water, half a pint, or more.
Purified hydrochloric acid, 50 drops.
Salt, 15 grains.

Intimately mix the soda, the salt, and the flour in a large basin, with a wooden or china spoon. Then gradually add the water, with which the acid has been mixed, constantly stirring with the spoon. Thoroughly knead the dough for five minutes, divide into two loaves, and put *immediately* into a hot oven. The one I used for this purpose was one of Ball's revolving ovens, which, hung upon a jack before the kitchen fire, is quick and effectual: the common oven by the side of the fireplace will seldom bake bread well.

MR INNES, OF SOUTHAMPTON ROW, supplies unfermented bread made upon a formula somewhat resembling the above. He tells me he sells a great quantity of the brown bread, but not much white. It is well adapted to some forms of dyspepsia.

MR COOK, OF THE EDGWARE ROAD, also uses the above formula. He sells a very much larger proportion of the brown than white loaves. Mr Cook, a man of large experience, would very much prefer the general introduction of unfermented bread, requiring, as it does, but two hours to complete the process; whereas the ordinary fermented batch-bread takes seventeen hours.

AËRATED BREAD

Is the invention of Dr Dauglish, who, having triumphed over all difficulties, has at length perfected his ideas,—brought them into working order, and is now supplying the bread very largely to the public.

The idea Dr Dauglish wished to carry out was to make the mixture of flour and water spongy, without exciting fermentation in the flour. This, although apparently simple, has been found, on account of the difficulty in adapting machinery to it, to be exceedingly tedious; and even after the patent for the process was taken out, more than two years expired before the bread could be made in any quantity.

The process of manufacture is as follows. I shall confine myself more to general principles, than enter into the details already so ably done by Dr Odling and others:—Carbonic acid gas, prepared in the usual way, is forced by powerful pumps, working under a pressure of seven atmospheres, into a vessel containing water, by which it is absorbed. The carbonic acid water passes into an air-tight mixer, into which a sack of flour and three pounds of salt have been introduced beforehand, and in which a vacuum of thirty inches has been produced by an air pump. A kneading fan is now set to work in the mixer, and this process is easily and rapidly effected; the flour and carbonic acid water being incorporated under pressure, the dough cannot rise and become spongy to impede the process. Flours containing well-elaborated gluten take but three or four minutes' kneading; inferior flours, from five to ten minutes, so that the toughness of the gluten may be developed by working. After the kneading has been completed, a small valve is removed to allow the dough to escape through a pipe, which is trumpet-shaped, to prevent the sudden expansion of the dough as it escapes from the mixer; the aperture of the trumpet, as it leaves the mixer, is about the size of a shilling, and the mouth about

that of the closed fist, the dough gradually expanding to fill this as it is forced out by the pressure from behind of the condensed gas.

Before the opening of the trumpet, a boy sits with a large knife, and as the dough is forced out he receives it in a small wooden trough, holding sufficient to make a half-quartern loaf; when full, he cuts off the dough with the knife, and passes on the trough to the scale, where it is weighed, and made up to 2lb. 4oz. A series of tins are now placed upon the iron slide bottom of the oven, and into these the dough from the wooden troughs is placed, by which method, from the first placing the flour in the mixer to the moment when it is baked, it is not touched by the hand. The oven is a travelling one; that is to say, its bottom is made of a series of iron slabs linked together, revolving on drums, by which the speed is regulated; and in the case of 2lb. loaves in tins, takes one hour progressing from one end of the oven to the other, when the bread is baked. At the opposite end of the oven is a long trap which, when raised, allows the baked loaves to fall out.

The loaves, in their passage through the oven, rise above the tins by expansion, and lose by evaporation four ounces in weight. By this process 190 loaves, weighing two pounds each, are obtained from a sack of the best flour; and there is used, to produce the sponginess of the bread, fifteen to twenty cubic feet of carbonic acid gas, varying according to leakage. There are several different kinds of loaves baked; of two qualities, best and seconds. Messrs Peek and Frean having put up a new apparatus, are now able to supply aërated brown bread. The following remarks are extracted from a paper by Dr Odling, read before the Chemical Section of the British Association at Aberdeen, and sum up the advantages of the aërated process in comparison with the old method of bread-making by the aid of fermentation.

"1st. Its cleanliness. Instead of the dough being mixed with naked arms or feet, the bread, from the wetting of the flour to the completion of the baking, is not, and scarcely can be, touched by any one. 2nd. Its rapidity. An hour and a half serves for the entire conversion of a sack of flour into baked loaves; whereas in the ordinary process four or five hours are occupied in the formation of the sponge, and a further time in the kneading, raising, and baking of the dough. 3rd. Its preventing deterioration of the flour. In making fermented bread from certain varieties of flour, not in themselves unwholesome, the prolonged action of warmth and moisture induces a change of the starchy matter of the flour into dextrine, whereby the bread becomes sodden and dark-coloured. This change is usually prevented by the addition of alum, which is, indeed, an almost necessary ingredient in the manufacture of bread from glucogenic flour. But in operating by the new process, there is no time for the glucogenic change to take place, and consequently no advantage in the use of alum, even with any description of flour. 4th. Its certainty and uniformity. Owing to differences in the character and rapidity of the fermentation, dependent on variations of temperature, quality of yeast, &c., the manufacture of fermented bread frequently presents certain vagaries and irregularities from which the new process is entirely free. 5th. The character of the bread. Chemical analysis shows that the flour has undergone less deterioration in bread made by the new, than in that made by the fermented process. In other words, the percentage of extracted matters is smaller. The new bread has been tried dietetically at Guy's Hospital, and by many London physicians, and has been highly approved of. It is well known that, for some years past, the use of fermented bread in dyspeptic cases has been objected to by members of the medical profession, the *débris* of the yeast being considered unwholesome, and liable to induce acidity. 6th. Its economy. The cost of carbonic acid is alleged to be less than the cost of yeast. Moreover, in making fermented bread there is a small but necessary waste of the saccharine constituents, which is avoided in the new process. 7th. The saving of labour and health. It substitutes machine labour for manual labour of a very exhausting kind. The sanitary condition of journeymen bakers was investigated some time ago by Dr. Guy, and found to be most lamentable, from their constant night-work, and from the fatiguing and unwholesome character of their labour, particularly the kneading. In a politico-economical point of view, the process is as important as removing bread-making from a domestic manual work to a manufacturing machine-work. From the character of the apparatus, the process can only be used profitably on a large scale, and not in small bakeries."

DIGESTION.

Having studied the question of the manufacture of bread, it is necessary to proceed to its digestion, and the way in which it acts, and is acted upon, by the stomach.

Bread, upon entering the mouth, should be thoroughly masticated and mixed with the saliva, as this secretion acts a most important part in the digestion of bread. If bread be first masticated, and kept in a vessel at a temperature of 100 deg., a great portion of the starch will be converted into sugar, and this, again, into lactic acid.—requiring time, however, to effect it. In the stomach, bread takes about three hours and a half to become converted into chyme, according to Dr Beaumont. This, doubtless, is but an approximation, varying with each individual and upon different occasions; still it is probably about the time. Bread being composed of starch, gluten, and extractive, the following changes may be supposed to take place:—The starch is acted upon by the saliva, the fluid of which tends to separate the particles; the animal ferment contained in it, with the faint alkaline reaction of the saliva, together with the heat of the stomach, causes the chemical conversion of starch into sugar, which is the primary act of healthy digestion, the fluids of the stomach having a faintly alkaline reaction from the presence of saliva. In perfectly normal digestion of bread, it is most probable that this faintly alkaline reaction lasts for nearly half an hour—such is the result of my own experiments on this subject—when the peculiar secretion of the glands of the stomach begins to have the ascendency, and the pepsine and hydrochloric and lactic acids come into play to act upon the gluten, which is now dissolved, aided by the churning motion of the stomach, slowly rolling its contents along its internal walls, by which means every individual molecule of the food is separated from its fellow, dissolved, and acted upon by the digestive fluids. This solution is the chyme, consisting chiefly of sugar, lactic acid, albumen, and some other proteine compounds, and minutely-divided oil in a saline fluid. This may be looked upon as the normal digestion of bread, but who can possibly paint the innumerable changes which go on in the stomach of the dyspeptic? They are too numerous even to speculate upon. The most distressing are the rapid conversion of starch into abnormal and highly irritating acids, the perversion of gluten into low proteine compounds, with escape of nitrogen gas into the stomach, giving rise to the most painful flatulence; and the albumen itself converted into some proteine state, which will not nourish when absorbed by the lacteals. These three are the chief, and with these I shall be satisfied.

Fermented batch-bread, as I have already pointed out, never has the vitality of its yeast in the centre of the loaf wholly destroyed. Yeast, we know, has the power of converting starch into sugar, &c., and gluten into low proteine states; the saliva also has this identical power. The yeast, therefore, undertakes the work of the saliva in the stomach, and the two together most rapidly effect the process. Now, yeast in batch-bread made of inferior flours converts the gluten into cerealin, which is a low proteine state, rapidly convertible into ammonia, and unfit for nutritive purposes. Is it not a fair inference, therefore, to suppose that the saliva, acting upon fermented breads, easily converts it into this abnormal state in the weak stomach? Dr Prout has beautifully observed, in his valuable work, that the stomach supervises the process of digestion, and by its vital agency corrects any inclination to abnormal changes; but in a stomach in which the vital powers are weakened, it is unable to prevent these changes, which it deplores, but cannot counteract.

The instinct of the stomach — and this instinct is more marked in the debilitated organ than in the healthy one—is a beautiful provision of Nature. Without any aid from the mental faculties, this remarkable instinct will discover the food which is producing inconvenience. In many cases, without the patient being aware of the fact, the stomach has rejected the objectionable article of diet, and, upon questioning him, he says, "he eats little bread, the reason why he does not know." I have noticed this in numerous instances.

Infants fed upon fermented bread and milk generally waste away, and, if the diet is not changed, refuse food altogether, and die of atrophy. The little sufferers instinctively know that the food is bad for them, and at last, sooner than undergo the torments produced by the elimination of gas from it, go without; this is instinct. The aid of reason is not here called upon, but

it is a knowledge derived from the sympathetic nervous system, from the blood, from the secretions, the tissues; all cry aloud against the poison which is being introduced to them as aliment, and upon which they cannot exist.

A remarkable instance of this instinct of the stomach in domestic animals has been communicated to me by Dr Dauglish. He says: "Some dogs that would not touch fermented bread, will eat the aërated with avidity. My little girl told me with great glee, the other day, that her pet cat was very fond of the aërated bread, but that she would not touch the fermented. This may prove of interest, as showing an instinctive repugnance to fermentation in the brute."

THE AËRATED BREAD AS A DIET.

Myself and my whole household having used the aërated bread solely, for upwards of a year, I am in a position to speak of its dietetic value.

1st. The aërated bread sustains the economy longer than an equal quantity of fermented bread.

2nd. A larger quantity of the aërated bread is eaten than of the fermented. The desire for food returns at longer intervals, fewer meals being required.

3rd. Less meat is necessary, a greater quantity of bread being eaten.

4th. Dyspeptics who have been unable to eat any breakfast for years, can now eat a hearty meal of the aërated bread.

5th. Individuals accustomed to complain of "sinking," and a craving for food every two or three hours, find great relief by confining themselves to the aërated bread; in some instances I have found it specific.

6th. Individuals who suffer with acidity, heartburn, and flatulence after meals, and who seek relief by taking soda, magnesia, ginger, &c., are relieved by discontinuing beer and fermented bread, and taking the aërated bread.

7th. I have found it useful in many forms of disease, of which I shall speak further on.

The reasons for this superiority may be thus explained:—The constituents of the fermented bread have been altered; a large portion of its gluten has been deteriorated, or, according to Liebig, rendered soluble; a small portion has been destroyed by the development of the yeast during fermentation; and although these changes do not decrease the weight of the mass of bread, yet, from the deterioration and destruction of the gluten, it is less nutritious. Chemists tell us that the amount of nitrogen is not less in fermented bread than in flour; this is true, but then much of the nitrogen in the bread is found in the yeast itself, which has been abstracted from the gluten during fermentation.

Some of the starch also is converted into carbonic acid gas, a loss to the nutritive quality of the bread. Doubtless the changes produced by fermentation in the flour resemble somewhat the changes produced by the saliva and the gastric juice in the stomach; but then the beautiful harmony, or correlation, so to speak, of the functions of digestion are interfered with, and render insalivation and the gastric secretions non-essential; and, as has been proved by Paget, every secretion being an excretion, so much foreign matter in the economy not being eliminated, must prove prejudicial, and tend to derange the health.

The results of the changes effected in the flour by fermentation will be that the chyme is more rapidly formed, and possesses the acids in excess, as in the analyses of fermented bread small quantities of acetates and lactates are discovered, caused by fermentation: then it will be more rapidly hurried out of the stomach, before the absorption of some of its constituents has taken place. Nitrogen gas is frequently given off in large quantities, causing the most painful form of flatulence; biliary derangements follow, with all that fearful train of symptoms accompanying them. We may thus perceive that, in the strong and healthy, much nervous energy is required to counteract these abnormal changes; and although it is done so that the individual feels no ill-effects at the time, still he is laying up for himself, on some future day, a trouble which will tell upon him when he is debilitated by disease or weakened by exposure. To the weak and delicate, dyspepsia, like the dead body chained to the living, is the daily, hourly companion, whispering through the nerves the sad complaint, until disease or insanity severs the hated bonds.

I have taken some trouble to ascertain the opinions held by

our Profession on the subject of bread, and I have been somewhat surprised to find that the great majority of those I have questioned have, like myself, discontinued the use of fermented, eating some form of unfermented bread. Many of these gentlemen are unwilling that their names should appear, but I may say that some of the highest and most honoured are amongst them.

I have already quoted Dr Odling on previous occasions, who is greatly in favour of the unfermented bread, and who has written several valuable articles in its favour.

The following letter from Dr Waller Lewis is of importance, from the number and intelligence of the men employed in the General Post Office, and from whom he gathered his opinion:

"Medical Department, G. P. O., Jan. 19th, 1860.

"MY DEAR SIR,—As you wish to learn the results of my inquiries as to the nutritious properties of the new aërated bread made by Messrs Peek, Frean, and Co. by Dr Dauglish's patent process, I have to state that I was supplied with a considerable number of loaves by that firm before the bread was manufactured for public sale. At that time the process had not arrived at the state of perfection which it has now reached; and I do not consider the bread was so good an article in a mechanical point of view, certainly, as it is now. Yet the opinions of a great number of the officers attached to this establishment, to whom I distributed at various times the bread, were unanimous in its favour. They stated to me that they found it more agreeable to the palate, better when several days old, and, they believed, more nutritious, as it stayed the appetite longer than any other bread they had ever eaten.

"The above also is my own individual opinion. I eat no other bread, and I recommend it to all my friends and patients.

"A friend of mine, a well-known clergyman, is sending the poor recipients of bread-tickets in his parish to one of Messrs Peek, Frean, and Co.'s local agents, to be supplied with the bread in question; believing, as he does, from experience gleaned in his own family, that it possesses advantages, both as to nutrition and digestible properties, the ordinary bakers' bread can lay no claim to.

"I am, my dear Sir, very faithfully yours,

"WALLER LEWIS,

"Medical Officer in Chief to the General Post Office.

"Harry Lobb, Esq., 70 Brook Street."

When we compare the various unfermented breads, the advantage is very much in favour of the aërated.

1st. The aërated is far more spongy. If the aërated be examined with a magnifying glass, the cells will be found most evenly distributed over the whole mass of bread; whereas, in the bread made with soda and acid, the cells are larger and not so uniformly divided. This may be proved by soaking the two breads: the aërated will take up more fluid, and more rapidly, than the other bread.

2nd. The aërated bread is plain flour and water; whereas the bread made with soda and acid contains an excess of soda, small in quantity, it is true, but sufficient to be detrimental in some instances of dyspepsia.

3rd. Some change in the flour must take place by the addition of the hydrochloric acid—what has not been ascertained; but it can hardly be conceived that a powerful chemical mixed with flour can effect no change.

I have been informed by a physician who has used Dodson's bread for some years in his own house, that the brown bread will not keep for many days in the summer, as it becomes ropy: this, probably, arises from the acid acting upon the gluten, converting some of it into cerealin, which has a tendency to become sticky, &c.

M. Mège Mouries has attempted to prove that the proteine of bran easily undergoes metamorphosis into cerealin, and that the brown colour of bread containing bran is not due to their particles, but from the cerealin having converted some of the starch into dextrine and sugar. This is what takes place in the brown unfermented bread, and it becomes sticky and ropy in consequence.

M. Mège Mouries, in his new process of bread-making, whereby all the meal of wheat is to be converted into wheat-bread, has attempted to obviate this tendency by neutralising this property of the cerealin; he ferments the brown meal with water in which sugar and yeast have been allowed to proceed to the alcoholic fermentation. This prevents the acid fermentation; the remaining flour being mixed with this and kneaded, a dough results, in which the whole meal of the wheat is represented, and only the coarse bran rejected. This method is valuable, as more of the constituents of the flour are preserved for human food.

All such improved and economical processes would succeed very much better if the bread were made upon the aërated principle, as there would be no chance of the gluten being converted into cerealin by fermentation, nothing of the sort taking place. In fact, aërated bread is simply ground wheat and water; no chemical change whatever has taken place, and this accounts for this bread keeping good and pure for so long a period. I have a patient at Ipswich who has the aërated bread from London once a week, and he tells me the bread is just as good and sweet the last day as the first.

Much has been said concerning the nutritive qualities of gluten in wheat, some stating that the larger the percentage of gluten, the more nutritious the bread made from it; but in looking to Nature, beneficent mother, who never makes an error, we find that wheat grown in England contains less gluten than that grown in the South of Europe. Now, in hot countries less fatty matter is required as a diet; the starch of the various wheats is found well suited to sustain animal heat (life); therefore the reason why the English wheat is richer in starch is at once perceived. Again, the usual addition to bread is something of a fatty nature, butter or bacon, to increase this proportion. In hot countries, where less animal food is eaten, a larger proportion of gluten is required to afford nourishment to the muscular system: this fact, again, is beautifully exemplified in India, where the puny inhabitants, who by their religion and poverty are debarred from animal food, are forced to eat enormous quantities of rice, a grain containing but little gluten, but the starch of which counteracts the acidity of the fruits they largely consume.

Although these are well-ascertained facts, still we are as yet ignorant of the various minutiæ of the question; we do not know why wheat-starch should be so much more nutritious and suited to the inhabitants of cold countries than rice-starch; chemists have not yet succeeded in so far separating the various ingredients: but it is probable that the difference really lies in what has been very roughly termed "extractives,"—soluble matters which remain in the water, and which chemists have not yet clearly defined.

The hygiène of bread would not be complete without a few words on gluten bread and bran biscuits, which I shall insert in this place before entering on the therapeutics of bread.

GLUTEN BREAD

Has been originated especially as a diet for diabetic patients; it was introduced by Bourchardat, and a great quantity of the starch was removed from the flour, with the idea that the excretion of sugar would be arrested by cutting off the food from which it was derived. There is no doubt that much less sugar is passed under its use, but it does not appear that real benefit has been derived from this diet; the disease, when once it has taken hold of the patient, advancing steadily to a fatal termination. Lately, Durand et Cie., of Toulouse, have taken much pains in the manufacture of gluten bread, gluten chocolate, &c.; and M. Bourchardat says of it, that "it is the most nutritious aliment we have the power of administering." It is highly recommended as a food for infants, and as a very nutritious diet, in a small compass, in all cases of debility. It is peculiarly adapted to counteract the tendency to obesity some elderly people are subject to, and is said to be useful in diabetes and phthsis; it is, at any rate, worth a trial in these cases

Mr Van Abbott, 13 Basinghall Street, is the London agent.

BRAN BISCUITS have also been recommended as a diet in diabetes, I believe without much success.

The following letter from Dr Pavy, who has studied the pathology of diabetes deeply, and has added much to our knowledge of the disease, is well worthy of attention:

"33 Bedford Place, Russell Square, Feb. 7th, 1860.

"MY DEAR SIR,—I have tried the gluten bread in diabetes, and have been most satisfied with its effects. I consider it superior to the bran biscuit, but its price precludes it from being within the reach of all. Bran biscuit is so hard, and the teeth of diabetics are very often so loose and bad, that it is useless to order these biscuits, as they cannot be consumed. This same objection does not hold good with regard to gluten bread. I have not yet analysed it, but am given to understand that it contains a certain percentage of starch. Without any treatment beyond dieting with this bread and animal food, I have obtained the most marked benefit in diabetes; and when the use of ordinary bread has been resumed, the disease has immediately shown signs of increasing aggravation. I am quite satisfied our aim in diabetes should be to exclude as much as possible starchy and saccharine principle from the diet; and the gluten bread does this as much as anything I know, and at the same time supplies an azotised alimentary principle. If this information is of any use to you, it is quite at your service.

"Yours very truly, "F. W. PAVY.

"Harry Lobb, Esq., 70 Brook Street."

THE THERAPEUTICS OF BREAD.

Believing, as I do most firmly, that English fermented batch-bread is a most objectionable food, particularly to children, delicate adults, and the inhabitants of cities generally, it cannot be admitted under this head.

The unfermented breads made with soda and acid are much less objectionable, but still with some few are likely to disagree; and, as we now have a perfect bread, the aërated, I shall confine myself to that.

There is a class of cases, well entitled obscure, which puzzle our best Practitioners. The unfortunate sufferers wander from one medical man to another, receiving slight and transient benefit here, none whatever there, and, at last, disgusted with medicine, they fall into the hands of the "opathys," perhaps even of the advertising quacks. These unfortunates at first look well and stout, plump and fresh, and get no sympathy from their friends or their ordinary medical attendant; their pulses are good, tongues clean, skin cool, and they eat, drink, and sleep well; in fact, they are pooh-poohed, and are said to be hipped, in spite of which they are always more or less complaining. This may last for years without relief, although "everything has been tried in vain." But I will describe a case which came under my immediate daily notice for a considerable time.

A gentleman, aged twenty-seven, naturally delicate, but enjoying tolerable health, began to suffer from indigestion. About two hours after a meal, he would complain of a sense of fulness in the throat and eyes, as if they were swollen and puffed out: this would gradually extend downwards, until the whole chest and hypochondria seemed swollen ready to burst. If he could rid himself of the gas which was in the stomach, he obtained temporary relief; if not, this would continue until the next meal. Although not hungry, and with no appetite, he was always craving for food, as it afforded him some ease. Occasionally for days together he would be salivated; the saliva would flow in such quantities as to fill the mouth, requiring ejection: this was an extremely disagreeable symptom, of which he complained bitterly. With all this he got stouter, and looked well; at length the spirits began to sympathise, and there was every promise of his becoming hypochondriacal. Without mentioning the treatment which did him no good, and which was multifarious, it will be sufficient to state that which afforded temporary relief:—Nitro-muriatic acid with strychnia, half-an-hour after meals, slight relief; charcoal, in powder, after meals, slight relief; cod-liver oil, a table-spoonful after meals, great relief. This latter gave us great hopes that it might effect a cure; but in this we were mistaken: the moment it was discontinued, even for a meal, the symptoms returned. A series of experiments were now tried as to the diet, and each constituent was, in its turn, banished from the dietary, in order to discover the offending aliment; but when we were reduced to bread, "the staff of life," we were almost in despair, but let it go, and, to our astonishment and delight, the cause of all was discovered—the BREAD. The patient, from the very day he discontinued fermented bread, began to recover. Instead of bread, he ate biscuits; and with no other change in ordinary diet, he soon completely recovered, and has remained so now for three years. Not liking the biscuits, he baked at home, making use of soda and hydrochloric acid, which agreed very well; and when the aërated bread was introduced, he took to that, and has eaten it ever since. Even now, one meal of fermented bread will upset him for twenty-four hours, showing that it is the undestroyed yeast which is the cause of the abnormal fermentation in the stomach. When this gentleman was staying in Paris for a few days, he ate the French bread with entire impunity. These are small loaves, something like our rolls, and are made with leaven; very little yeast is used, and that with great care; and the Paris bakers depend principally upon the power of the gluten itself to give rise to fermentation. Then, again, the loaves being very small, and all put separately into the oven, the vitality of the yeast is destroyed during baking.

The salivation in this instance bears out some previous remarks, stating that where fermented breads were used, on account of the yeast having the ability to convert much of the starch of the flour into sugar, the secretion of saliva therefore was rendered non-essential, and every secretion being an excretion, so much foreign matter in the economy not being eliminated, it must prove prejudicial, and tend to derange the

health. The salivation, therefore, was an effort of nature to rid itself of this extraneous matter, and the patient told me that swallowing the saliva added to his troubles, more gas being eliminated in the stomach. I have no doubt the gas given off was nitrogen, as it remained in the stomach, puffing it out, instead of exciting it to contraction, as carbonic acid gas would have done.

This nitrogen was given off from the low proteine compound or soluble gluten into which the gluten had been transformed during fermentation, and might have been in the state of ammonia or ammoniacal vapour, for we know during the spontaneous fermentation of wheat-grain much ammonia is given off. This nitrogen is albumen lost to the system, and would account for the debility of the natural system; but the starch being converted into sugar, and being in the ascendant, the fatty tissues were more highly nourished, accounting for the apparent good condition of the patient. Then, again, the cod-liver oil afforded relief, by absorbing the nitrogen vapour as it was given off during fermentation, and thus preserving to the economy this most important element. But sufficient of explanations; the fact remains:—a gentleman suffered for years with a painful dyspepsia, and was permanently cured by discontinuing the use of fermented bread *in one day*. Of this form of dyspepsia, which is found amongst studious, sedentary people, I have had several instances, treated in the same way with like success.

A more advanced form of the same disease, termed by Watson chronic diuresis, (a very bad name for it, by the way, as the great quantity of water passed is but a symptom, and consequently does not deserve to give a name to the disease,) is more difficult of treatment. The essence of the disease is the formation of water out of the elements of the food; more water is secreted by the kidneys than is taken as drink, without mentioning that passed off by the skin and lungs. If the urine is carefully examined, it will be found to be almost invariably faintly acid, neutral, or even occasionally alkaline; much proteine matter is passed, seldom albumen; but if the urine be kept a few days, and boiled, a large quantity of an oxide of proteine may be obtained from it. The patient wastes, suffers thirst; he is costive, and the skin is dry; and, if he is not treated judiciously, some fatal disease will carry him off, such as phthisis, diabetes, or atrophy.

The treatment I have found specific is unfermented bread, particularly the aërated; brandy-and-water as a drink, and cod-liver oil, with such tonics as are most suited to the patient's constitution.

This disease I believe to be frequently the precursor of diabetes, and I hardly think that the removal of starch from the diet of a diabetic patient is likely to be of any very great advantage; it may for a time lessen the quantity of sugar and water, but does it cure the disease? I think not. I believe that the aërated bread would be of greater advantage to a diabetic patient than the gluten bread, as it is made, at present, with yeast; although I grant that if the gluten bread were unfermented, it would be the best form of diet to begin the treatment, gradually adding more starch as the patient improved. This is, however, hypothesis, as I have no facts to bring forward in evidence, beyond the success unfermented bread has in curing the earlier stages of diabetes.

We have all had described to us over and over again, by lady patients, what is termed by them "a feeling of sinking," referred to the epigastrium. It is a sense of emptiness, and arises from flatulence; it comes on an hour or two after food, with great depression of spirits and animal strength. They resort usually to some form of stimulant, such as camphor, ether, ammonia, &c., with temporary benefit. The secretions are vitiated, and if not relieved, some serious illness follows, or hysteria is originated. Now, unfermented bread is, with discontinuance of beer, a specific, acting like a charm; the patient rallies from the first day, and with a little judicious tonic treatment, and a few simple hygienic rules, such as regular exercise, cold bathing, &c., a complete cure is effected. No medicine would have had the slightest beneficial effect, as long as the objectionable fermented articles of diet had been continued.

Again, gouty and rheumatic subjects, whose secretions are generally of an acid nature, derive great benefit from discontinuing fermented articles of diet, and taking to the aërated bread.

Those patients who are frequently troubled with diarrhœa upon the slightest provocation, change of temperature, diet, &c.,

have changed their habit in this respect, and the absence of acidity dependent upon the use of the aërated bread has quite restored them to health, and rendered some almost, and others quite, independent of those strict dietetic rules to which they had hitherto been obliged to subject themselves.

These are some few examples of what I termed the "Therapeutics of Bread;" but as I sincerely believe that all, sick or well, healthy or unhealthy, would be materially benefited by the discontinuance of fermented and the adoption of the aërated bread, it hardly requires these examples of successful treatment of disease to strengthen my argument and position; the mere question of economy should be sufficient at once to place the aërated bread in the hands of every one who could possibly obtain it.

RECAPITULATION.

In the previous papers I have endeavoured to describe the elementary ingredients of flour, and their action upon one another when allowed to proceed to spontaneous fermentation; the more rapid fermentation produced by a substance already in a state of change and development, namely, yeast; the changes induced in the ingredients of the flour by the yeast; the various methods of the manufacture of loaf-bread, both fermented and unfermented; and the last great improvement, Dr Dauglish's invention of the aërated bread. In my last paper I mentioned a few of the conditions in which the sick received great relief from the discontinuance of the ordinary batch-bread, and their making use of the aërated bread. It may, perhaps, be as well summarily to recapitulate the various advantages the aërated has over the ordinary batch-bread of the bakers.

1st. Its Cleanliness.—The aërated bread is touched by no man's hand from the time it is first shot into the receiver, as flour, salt, and carbonic acid gas water, until the time it is removed from the oven a baked loaf: whereas ordinary bakers' bread undergoes every conceivable method of kneading, according to the idiosyncrasy of the journeyman, and his peculiar muscular development.

2nd. Its Rapidity of Manufacture.—One hour and a half is ample time for the conversion of a sack of flour into 190 thoroughly-baked loaves by the aërated process: whereas it takes nineteen hours from the time the yeast is mixed with the mashed potatoes until the batch of bread is drawn from the oven baked.

3rd. Its Uniformity of Manufacture.—The whole process being conducted by machinery, the bread is always the same: whereas every individual baker has his own peculiar method of manufacture; the amount of potatoes, rice, starch, bean-meal, and alum he mixes with the flour—the kind and quantity of yeast he employs, the number of hours he allows fermentation to proceed, the kind of oven, and the time the batch is baking, differ with each baker.

4th. Its Influence on the Journeyman.—By the aërated process, the men have their regular hours of labour, their hours for meals and rest, the same as any ordinary day-labourer: whereas the journeyman baker has no time to himself; the twenty-four hours are split up into small divisions—two hours of work, two hours of rest, and so on; he is working on and off all night; and the foreman must be awake and vigilant the whole night, otherwise the batch might be spoilt. The journeyman baker is seldom a healthy man or a long-liver, from his being compelled to neglect the ordinary rules of health.

5th. Its Retaining the Nutritive Qualities of the Flour Intact.—Aërated bread is simply flour, salt, and water, made spongy by the injection of carbonic acid gas into it, and baked: whereas it is quite impossible to say what ordinary batch-bread is. The best, most successful, and respectable bakers cannot be certain how their bread may turn out; according to the electrical and barometric states of the atmosphere, so may the fermentation be correspondingly affected; according to the quality of flour, the activity of the yeast, &c., so may the gluten undergo more or less deterioration, and the starch saccharine change. Then, again, the carbonic acid gas, which in fermented bread causes its sponginess, is derived from the destruction of some portion of its component starch; in fact, fermentation highly deteriorates the nutritive qualities of the flour from which the bread is made.

6th. Its Freedom from Adulteration.—The aërated bread cannot be adulterated without instant detection; as no change is

effected by fermentation, the flavour of the flour is undisguised, and, consequently, if anything were to be added it would be instantly discovered by the palate: then, again, no potato or any other starch is necessary to originate fermentation, as is the case with ordinary batch-bread. The flour remaining unchanged by the process of aëration, the gluten remains as gluten, undergoing no change into cerealin; so that the bread is a white bread, and requires no alum, bean-meal, &c., to arrest such change: whereas ordinary fermented bread is open, more or less, to all these objections.

7th. Its Economy.—Although the price of the aërated bread is the same as that of the ordinary bakers' bread, and although perhaps even more is eaten from the instincts of the economy recognising a suitable aliment to its wants, still is it economical, from its superior nutritive qualities—from its power of sustaining the muscular and nervous strength—from dyspeptics and infants being able to partake of it.

8th. As a Food for the Poor.—As bread is the real "staff of life" to the poor, it should be really a model food, upon which they may be nourished. Now, ordinary bakers' bread, as supplied to the poor, is an exceedingly inferior specimen even of the usual batch-bread—in fact, so bad is it in some parts as to be quite musty when sold. Now, the aërated bread, being only of two qualities, and made alike for rich and poor—in the same manner, with the same flour, and by the same machinery—offers great advantages to the poor; in fact, to them it will be a much greater boon than to the more wealthy classes, who, not being tied down to bread as their only article of diet, can, if they so desire, omit it altogether.

9th. As a Diet in Hospitals and Workhouses.—Here, again, is a vast field for its utility. For the sick and convalescent in our hospitals and workhouses to have a wholesome, uniform bread, will be, perhaps, the greatest boon the denizen of these establishments can be granted. The aërated bread has, I have been informed, been introduced into Guy's Hospital, and been greatly approved by the patients, as also the Physicians, of that institution.

The above may be considered some of the chief advantages the aërated bread has over the ordinary bakers' bread; and I feel that although I have not exhausted my subject, still nine papers on the "Hygiène of Bread" may have exhausted the patience of those who may have followed me so far. Therefore, to conclude: and I cannot do so without pronouncing a high and well-deserved eulogium on Dr Dauglish, primarily for the ingenuity he has brought to bear upon the invention of the aërated process, and secondly—and for this he deserves far higher praise—for the steady perseverance and unflinching belief in the value of his invention, with which he has overcome every difficulty; and although years have passed in perfecting the mechanical arrangements, still has he not faltered, and now may he indeed be proud of having given to his fellow-countrymen a boon which will be of greater value to the mass than any invention the present century has brought forth. True, there is nothing very striking about it—nothing astonishing, like the electric telegraph, for instance; true, it is not a curative agent—it will not allay pain in operations, like chloroform—but it will prevent much disease. The little infants will not now pine away and die of atrophy, many an invalid will now escape being blindly driven into a consumption by eating a food which, without being aware of it, is actually exciting the disease in a debilitated body which it had been given to nourish. The boon is merely PURE BREAD; but, simple as it is, it will place the name of the inventor amongst those great ones of our Profession who have ever laboured for the public good, and recognised the truth of the old Latin motto—

"Salus Populi suprema lex."

Extracts from a Paper read before the Society of Arts, April 25, 1860, by DR DAUGLISH, *on "A New System of Bread Manufacture."*

I FEEL that the importance of the subject of bread-making is a sufficient apology for my asking your attention to some remarks which I am about to make on a new system lately introduced, which I am sanguine enough to believe possesses many and great advantages over any hitherto practised.

Two years ago, Dr. Odling read a paper at a meeting of the Society of Arts, "On some Points in the Chemistry of Bread-making:" from that paper, those who are not practically acquainted with the working of the old system will at once perceive that nearly, if not quite, all the evils at present complained of, viz., the spoiling of the flour, the necessity for using alum, the long hours of labour, and the consequent unhealthiness of the trade of the baker, arise out of the employment of fermentation for the raising of bread. The new process removes the whole of these evils at once, by effecting the raising of bread by purely mechanical means.

Bread-making essentially consists in completely incorporating flour, water, salt, and carbonic acid with each other, in such a manner as that they shall form a tenacious, elastic, and bulky mass, in which the aëriform constituent bears to the solid a proportion of about three or four to one, and which, on being placed in the oven and thoroughly baked, shall swell to about double this proportion.

Until very lately the mixing and incorporating of the solid constituents have been performed by the hands and arms, sometimes assisted by the feet; but during the last few years, especially in France, there have been some very ingenious kneading and mixing machines introduced for this purpose, that of M. Boland being of especial merit. The mechanical part of bread-making is very easy of accomplishment, and its results, like all mechanical processes, can always be relied upon with certainty. It is the chemical part out of which all the difficulties and uncertainties arise, and which has presented the only obstacle in the way of bread manufacture participating in that marvellous progress of the industrial arts which is the distinguishing feature of the present age—and of its taking that position as a manufacturing institution of the country which its magnitude and importance really deserve.

The chemical changes within the substance of the dough which it is the object of the baker to effect, are those which shall result in the alcoholic fermentation of transformed starch or glucose, whereby these bodies are broken up into alcohol and carbonic acid, which latter is the only product desired, but which cannot be obtained without the previous transformation or degradation, more or less, of the constituents of the flour. It is not necessary for me here to give an account of all those complex changes which constitute the chemistry of bread-making, as this has already been so ably done by Dr Odling in the paper before referred to, but I will simply mention those which are the source of so much uncertainty and variation in the preparation of bread.

In the first operation of bread-making—the preparation of the sponge—the baker mixes up together, into a soup-like paste, flour, warm water, and yeast or leaven; this he allows to stand for some hours, during which active fermentation is set up, and bubbles of carbonic acid are rapidly formed, and rise to the surface. In fact, the prolonged action of warmth and moisture, combined with that of the yeast or leaven, change the whole body of paste into a ferment sufficient to affect a very large quantity of flour when incorporated with it. You will hence perceive that by thus forming a sponge, the necessity to use large quantities of yeast is avoided on the one hand, and on the other the length of time that would otherwise be required for putting the whole of the flour into a state of active fermentation is considerably shortened, and the deterioration of the flour, which is caused by the prolonged action of warmth and moisture, is proportionally lessened.

The advantages thus obtained will be more readily seen when it is remembered that the true alcoholic fermentation is only the later stage of what is termed the panary fermentation. It is that stage wherein the metamorphic nitrogenous body or yeast acts directly upon glucose or grape sugar, breaking it up into alcohol and carbonic acid. But before this can take place, since in sound flour there is very little, not more than a trace of sugar, and the gluten is wholly or almost wholly unaltered, certain portions of the gluten

and starch must have passed through the necessary changes for the alcoholic fermentation to act. This then is done in the sponge; when the mixture of flour, yeast, and warm water is made, and the temperature is maintained at about 84 deg. Fahr., the gluten, by virtue of its own spontaneous tendency to change under these conditions, assisted by the yeast, becomes metamorphic, and immediately acts upon the starch, changing it into dextrine and grape sugar; whilst at the same time the yeast plant is propagated at the expense of a small portion of the changed gluten, &c. Thus we have in the sponge all the materials, the dextrine and glucose, the diastase and the yeast, in a state ready to pass into active alcoholic fermentation, and to give out the necessary bubbles of carbonic acid, immediately their complete incorporation with the flour is effected, so that the least possible injury to the bulk of the flour is secured.

But when unsound flour is used in bread-making, we have a very different state of things. Unsound flour is flour in which some of the changes on which panary fermentation depends have taken place to a greater or smaller extent, and which are somewhat analogous to malting. The gluten has already become metamorphic, and the starch partially or wholly changed into dextrine or glucose. The gluten has lost more or less of its elasticity, and is ready immediately on the application of warmth and moisture, not only to pass rapidly into a state of solution, as Liebig has termed it, but to act with the greatest energy on the partially-changed starch, completing its alteration into glucose, so that a running, sticky mass results from the attempt at fermentation. Such a state of things, however, may be and is frequently brought about, even when good sound flour is used, either by inexperienced persons, who do not understand the management of fermentation, and the length of time and the temperature necessary, or by peculiar states of and changes in the atmosphere, by which the fermentive operations are so rapidly hastened in the earlier stages as to become almost or quite unmanageable.

Between perfectly sound flour and that which runs in the manner above referred to, on the application of a ferment, there are indefinite shades of variety; and between the temperature and the state of atmosphere least liable to produce derangement and that which is most, there are also indefinite varieties. Now, it is these liabilities to derangements and irregularities which have rendered the preparation of bread so precarious, and, going along with the absolute necessity to have the article ready always at the same hour of the day—an article which, in the event of its spoiling, cannot be re-prepared under eight to twelve hours—have raised an effectual barrier to its becoming an extensive manufacture in large establishments, employing large capital, and deriving the peculiar profits arising out of the division of labour.

Having thus pointed out the distinctive features of theordina ry process for obtaining the complete incorporation of the essential materials of spongy bread, I will proceed to describe the process which it is proposed to substitute for it.

It essentially consists, as I have said, in doing away entirely with fermentation, and with all those chemical changes in the constituents of the flour which are consequent upon it; and, having obtained the necessary carbonic acid independently of and separate from the flour, incorporating the materials, including the carbonic acid, wholly by mechanical means, so as to secure the bulky elastic mass which is capable of being baked into light, spongy bread.

When wheaten flour, salt, and water are thoroughly incorporated in due proportions, we have a heavy, soft, tenacious substance, called dough or paste, the tenacity of which is wholly dependent on the mechanical condition or properties of the gluten of the flour, the starch, when in a sound state, possessing of itself no cohesive properties whatever, which is easily demonstrated by kneading a mass of dough carefully in a small stream of water, when the starch granules will be carried away by the water, and the gluten will remain behind in a tough, tenacious, semi-transparent mass. The process of kneading or incorporation, then, consists in mixing the materials together in such a manner as that the gluten, becoming well saturated with water, shall form a soft, adhesive mass, as a matrix, in which are embedded and bound together the minute particles of starch; and if the kneading is carried on in a very thorough manner, and for a prolonged period, the dough becomes tough by the particles of gluten being driven close together, and forming a kind of sticky coat or shell around the particles of starch which thus adhere firmly to each other. When this mass is obtained, the point afterwards to be effected is the liberation of minute bubbles of gas within each sticky coat, surrounding each granule of starch.

We have seen that in the ordinary process of bread-making by fermentation, the carbonic acid, which is the agent of distension, is obtained from the decomposition of the starch or glucose, by the action of a ferment, which being thoroughly incorporated along with the other materials into the dough or paste, is thus brought into contact

with the starch, and with the gluten with which the starch is surrounded. It is easy, therefore, to understand how, when a mass of dough thus constituted is left for a time in a temperature suitable for the fermentive change, each of the minute particles of starch imprisoned in a covering of gluten is made the centre of a distinct chemical action, and yields up its bubbles of carbonic acid to distend its gluten coat; and how, by the aggregation of such particles, a mass of spongy dough is formed; and how, also, when the materials have not been thoroughly incorporated, and the action of the ferment is not uniform, or when the gluten is not of a firm yet elastic quality, the generation of the gas will be unequal—the minute bubbles will be burst into large ones, and the texture of the dough be impaired accordingly, rendered, as it is termed, "full of eyes"—instead of being dispersed in minute bubbles, as numerous, or nearly so, as the particles of starch from which it is given off. In the new process, as the gas is not given off by the particles of starch within the gluten coat, it has to be obtained from another source within the mass of dough, in order that the minute spongy texture may be secured; and this source is the water with which the gluten which envelopes the starch is saturated, and which is held, as it were, by capillary attraction also around the particles of starch.

It has been long known to chemists that water will absorb its own bulk of carbonic acid, whatever the density, with great readiness when agitated with it: that is to say, supposing you placed water in a closed vessel, along with carbonic acid—in a bottle, for instance—filling it half with water and the other half with the gas, then corking it up; if the water and the gas be pure, and both at a temperature of 62° Fahr., and at the atmospheric pressure of thirty inches of mercury, when the bottle is thoroughly agitated, the gas will be immediately diffused through or absorbed by the water, until there is an exact balance between the quantity of gas held in solution by each cubic foot of water and that contained in each cubic foot of space within the bottle not occupied by the water; so that, supposing the bottle at the commencement of the experiment to have been exactly filled half with water and half with gas, after complete agitation the barometric pressure within the bottle will have fallen to fifteen inches of mercury. This law of absorption is persistent at all pressures, so that, by increasing the density of the gas, the quantity absorbed by the water will be increased in an equal ratio; and so long as the water is retained under the pressure due to the density, so long will it hold the gas in solution: but whenever it is released from the pressure, the gas will escape from it with effervescence, a familiar example of which is that of a bottle of soda-water when the cork is withdrawn.

It will now be apparent that if water, holding in solution the necessary quantity of carbonic acid gas, could be used to incorporate with flour, &c., in the preparation of dough, without any of the gas being allowed to escape from it until after the paste is fully formed, but then allowed to escape, it would cause the formation of the necessary minute bubbles of gas, which would distend the dough into a perfect sponge, even more perfect than that which is obtained by fermentation, since every atom of water would yield its atoms of gas, not only between the particles of starch and their gluten coat, but also within the substance of the coat itself, rendering that porous.

Now, since the water will retain the gas in solution so long as it remains in an atmosphere of the necessary density, it is evident that if the materials of which the dough is to be formed can be brought together in a closed apparatus in an atmosphere superior in density to that at which the water has been saturated, and then thoroughly incorporated, the gas will remain in the water during the incorporation, and until such a time as the dough is released from the pressure; but that directly it is released from the pressure due to such density, the gas will escape from the water, and in so doing will distend the dough into a perfect spongy mass. This, then, is the new process of bread-making.

I do not propose here to enter into the details of the mechanical arrangements which are necessary to reduce such a process to one sufficiently simple and practically workable, so that it may be carried on by journeymen of ordinary intelligence. But I may state, that so successfully has this been accomplished, that it is found there are few workmen who, having given their hearty attention during a week's instruction and observation of the working of the apparatus, are not competent to take the whole charge of the process. The baking of the bread, like the baking of any bread, of course requires the management of a man who has the necessary judgment and knowledge for the task.

The apparatus essentially consists of a gas-holder and a generator, similar in construction and principle to, but larger in size than, what are used by the makers of aërated waters; of pumps suitable for pumping elastic fluids, and of a mixing-vessel, and a water-vessel in connection, both made so that they can be tightly closed to sustain an internal pressure of from 100 to 200 lb. on the square inch. The mixing-vessel is supplied with flour through a

shoot, passing from the floor above, and the water-vessel with water through a pipe from a cistern at the top of the building.

The mixer is capable of being closed perfectly tight, and opened by means of a proper mechanical contrivance, with the greatest facility, by one man in a few seconds.

The order of working, and the time required for making a sack of flour of 280 lb. into dough, are as follows :—

Opening lid of mixer and fitting within the neck the end of flour-shoot, and turning water-cock to fill water-vessel . .	1 minute.
Passing from top of machine to floor above, and shooting down a sack of flour	3 „
Returning, closing water-cock, removing end of shoot, and closing mixer	2 „
Withdrawing atmospheric air from mixer	3 „
Pumping gas through water into mixer, &c.	10 „
Mixing	7 „
Total . . .	26 minutes.

At the end of which time the dough is ready to be drawn into loaves, from a nozzle or mouth, through which it is forced by the pressure within the mixer; and as it expands or rises in the act of leaving the mouth, it is ready to be baked immediately. One boy is capable of drawing the dough from one sack of flour into loaves in fifteen minutes, as fast as they can be weighed and placed in the oven.

Thus, in the short space of twenty-six minutes, which is subject to no variation, the baker can always rely upon having his dough ready for the oven, and this with a certainty, when the labour is well organised, which is nearly mathematical.

Hence this process at once removes all the obstacles which have hitherto rendered a perfect system of machine bread manufacture an impossibility; which obstacles I will definitely state as follows:

1. The length of time (from eight to twelve hours) required by the process of fermentation to prepare dough for the oven, and the great space required for storing the masses of dough whilst undergoing the process.

2. The uncertainty of its results, and the many vicissitudes arising from susceptibility to delicate influences.

3. The degradation or spoiling of the flour produced by fermentation, which is equal to a money value of three to six shillings per sack.

4. The necessity for the use of alum with poor flours, and the temptation to use it with all.

In comparison with the above, the new process shows the following:

1. It reduces the time necessary for the preparation of the dough (from eight to twelve hours) to less than thirty minutes, and requires no space whatever for the storage or keeping of dough larger than the mixers themselves.

2. The results are absolutely certain and uniform.

3. No spoiling or degradation of flour taking place, the quality of the bread produced is equal to that made by the old process from a flour three to six shillings per sack dearer.

4. As no change in the flour takes place, against the evils of which alum has hitherto been used, there is no gain whatever by the use of alum. Indeed, alum is absolutely prejudicial, by destroying the cohesive properties of the gluten. Even flour which is made from wheat harvested in bad weather makes a most delicious bread, without any addition of alum.

In order to estimate the probable influence which the introduction of such a process is likely to exert upon the baking trade, I have endeavoured to obtain from reliable sources some account of the method, if method it may be called, on which the trade is at present conducted.

In the baking trade, as in most trades, there are different grades of respectability and credit, but there are two great divisions—the high-priced and the low-priced, or "cutting," as they are called. In each of these two divisions there are, of course, many sub-divisions. There are some, but these are comparatively very few, who are men of substance, possessing considerable capital of their own, and are perfectly independent of any system of credit allowed by the millers. They are consequently in the most favourable position possible for the purchase of their flour, both cheap and good. But by far the greater number of bakers trade almost entirely with the capital of the millers, through a most vicious system of credit, which operates most prejudicially in their purchases of flour. It is this system of credit that has given rise to, and perpetuates, most of the commercial evils of which the baker has to complain, and which, whilst it exists, will ever oppose the most effectual obstacle in the way of permanent amendment.

In England, where the trade of the baker is not interfered with by legal restriction, any man is at perfect liberty to commence it whenever he pleases; and as the article bread has not only become the essential want of every individual, but a daily one also, a single

addition to the enormous number of bakers engaged in the production of small quantities increases the total of production so imperceptibly, that a new beginner has but comparatively little difficulty in finding, where every man is a consumer, an immediate market for his commodity among that large class of persons who are always ready to patronise the last new-comer.

The question of connection, as bearing upon obtaining customers, need not trouble the man who proposes to commence the trade of a baker; the one which he has to consider is, whether sufficient means can be scraped together to rent and fit a shop, and to build an oven and furnish the necessary utensils of a bakehouse. If this can be done, any journeyman baker may marry and commence business on his own account, as the working capital for his business is readily found by the miller, who will supply him with the necessary flour upon credit, taking for security a bill of sale on all that his premises contain, which is not only sufficient to protect the miller from loss, but it secures to him all the baker's future orders for flour, since, should any one deliver flour to the premises of the baker, the miller can immediately take possession of it, should a debt be owing to him, by virtue of his bill of sale. I hope that the trade in London is not thus carried on; but that such a system is practised, and increasingly so, in many provincial towns, I have been assured by several respectable millers.

The facilities of credit afforded by the millers have, probably, chiefly arisen out of the excessively keen competition between millers themselves, which the introduction of steam for the purposes of grinding has given rise to, by destroying the virtual monopoly which the limited amount of available power previously existing created.

If we consider the chief causes that operate to render trades, handicrafts, and manufactures prosperous, we shall find them to be the following, viz.:—1st. Improvements in the methods of manufacture, by which production is greatly enhanced in value, or greatly lessened in cost. 2nd. Great capacity of increase in the ratio of consumption of the article produced. 3rd. The protection afforded to a trade against a rapid increase of competitors, from the difficulty of new ones engaging in or entering it. Now, these are altogether wanting in the baking trade. In the first place, the method of manufacture has remained a common handicraft, in which there has been no substantial improvement since it was first begun. In the second, bread is an article the consumption of which is incapable of being increased in the same ratio as nearly every other commodity;

and thirdly, we have seen that the facilities for entering the trade are so great as to lay it open to the very keenest competition. When a trade is labouring under such disadvantages, it must necessarily follow that the public supplied by it suffer accordingly. For when remuneration cannot be obtained by fair means, the dishonest in the trade will use foul, and in the long-run the honest men will become fewer and fewer, until there be few left, when the race will remain to those who can bring the greatest keenness and the least conscience to bear in accomplishing the most dishonest thing with the least prospect of detection. It is not for me to point out what description of dishonesty is mostly prevalent in the baking trade; this has been most fully done by the public press, and consists in supplying bread deficient both in quality and quantity, exposure of the one being prevented by the use of deleterious drugs, and of the other by the excessive trouble which an efficient means of detection would impose on the consumer. The new process of bread-making promises to effect a complete change in this unhealthy state of things. 1st. Because by improvements in the method of manufacture, and in the value of the article produced, it promises good remuneration to, and necessitates the employment of, capital. 2nd. Because such employment of capital, as well as the protection afforded for several years by patents, gives the necessary security against excessive competition. But, whilst it will prevent excessive competition, it will produce none of the evils of a monopoly, because it leaves the consumer at all times in possession of his former means of supply, to be resorted to immediately the monopoly becomes prejudicial.

By erecting, then, the preparation of bread into a system of wholesale manufacture, not subject to the vicissitudes and evils of fermentation, but exact and certain in its results, the trade can be raised from its present degraded and unsatisfactory state to one that will be worthy of engaging the capital, energy, and talent of our best men of substance and enterprise. Nor will the manufacturer alone reap the benefit, for the public and the journeyman will be even more benefited. As the trade itself will be rendered commercially healthy, there will not be the same inducements to resort to fraudulent means to obtain a profit; and as journeymen will be employed in large numbers under masters of capital and social standing, they will be in a far more independent position than at present, whilst the nature of the process will relieve them from those necessarily long hours of labour which the present system necessitates.

I say the journeymen will be in a more independent position; but as among workmen generally there is an impression that capitalists and the owners of large works are grinding taskmasters, who tyrannise over their workmen and grasp an unfair proportion of the profits of their labour, I wish to speak of what has come under my own observation in the machine biscuit bakery of Messrs Carr and Co., of Carlisle, as a practical illustration of the benefits to be derived from conducting baking in large works. In this bakery, the welfare of the working man is an object of great care to the proprietors. The head of the firm is a man of much kindly feeling and benevolence of heart, and has studied to make arrangements that will conduce to the comfort of his men, which, whilst not destroying the spirit of self-dependence and self-help, shall assert the principle that the men should share each other's burthens, by making the prosperity of one department the prosperity of all, and the depression of one the depression of all. The consequence is, that the material well-being of the workmen is such as to remove them entirely from that class which excite our sympathies for their sufferings, and call forth our efforts for their amelioration. Now, I was in direct personal contact for nine months with the whole of these men, conversing with them in periods of leisure, and during working hours drawing upon their knowledge and experience, and I must say that, in no class of society with which I have happened to mix, have I met so much kindly feeling towards one another, or so much substantial respect for superiors.

On comparing such a state of things with what Dr Guy has described of the condition of the journeymen employed by small masters in London and the provinces generally, I think that workmen will admit that the argument from experience is all in favour of the capitalist; nor is the above a solitary instance of the advantages accruing to the working man from large factories, and the employment of large capital in the baking trade.

I don't know from personal observation, but I am told that in the great bakery of Messrs Huntley and Palmer, of Reading, the condition of the operatives is equally an object of solicitude on the part of the firm, and that they are generally in a most comfortable and prosperous condition. And what is likely to perpetuate this favourable state of things is, that such firms find that the taking care of their workmen, and making them happy, and prosperous, and contented, is a good paying speculation. The work is better and more heartily done—first, because good masters and comfortable works necessarily attract the best workmen, so that the master has always the greatest choice of workmen from whom to select; and secondly, because justice, righteousness, and mercy, more especially when administered by a superior, will rarely fail in the long-run to beget honesty of purpose and of feeling in subordinates. I am happy to say that masters are now generally beginning to discover that the prosperity and well-being of their workmen are essentially bound up with the prosperity and well-being of the employer, so that before long we may expect to see that practical Christianity will be recognised as sound commercial policy.

In the admirable lecture of Dr Guy, delivered now nearly twelve years ago, on the condition of the journeymen bakers, bearing upon the efforts that were then being made to secure for them some amelioration by State legislation, the arguments then put forth, justifying the interference of the State as not opposed to the principles of free trade, have proved to be peculiarly sound, by the experience since obtained of the working of the Factory Acts, which were framed on the principles of State protection to certain defenceless classes; principles which have lately had a fresh expression by that mouthpiece of public feeling and intelligence, the 'Times,' on the subject of the bill before Parliament for limiting the hours of work in bleaching and dyeing works. The revelations of the hours of labour, and of the physical state of the operatives in these works, are not worse than were made by Dr Guy of the condition of the journeymen bakers generally; and it would appear a monstrous anomaly that one trade should be protected by legislation which is refused to another; but in framing legislative acts, it is necessary, above all things, first to consider the possibility of enforcing their provisions, otherwise they will prove sources of weakness rather than of strength. I fear that it would be next to impossible to enforce by legislation any rules as to hours of labour, &c., in the baking trade as at present conducted, without producing a state of things worse than now exists; for it is evident that, if it is now really necessary that a man should labour eighteen to twenty hours a day to get through a certain amount of work, it will be necessary to have two men to get through the work when it is to be done in ten hours only, and this will increase the cost of production, which will have to be paid by the consumer. But as baking can be, and is carried on by some masters themselves, without the employment of any journeyman at all, and as I am not disposed to think that any Act of Parliament could interfere sufficiently with the liberty of the subject to prevent a baker working for himself as long as he likes, it is evident that the master baker employing operatives would be put to great disadvantage in competition, and would be beaten from the field by the little baker who employed no operatives; so that, in course of time, we should find the whole of the baking trade in the hands of men of this description—a consummation not devoutly to be wished in the interests of the customer.

It would appear, then, that legislation in these matters can only be applied when any industrial pursuit is raised from a handicraft to the dignity of a manufacture, employing operatives; and in proportion to the magnitude of the works, and the number of hands employed in each, is the ease with which the provisions of any act can be carried out.

In the lecture of Dr Guy above referred to, there is an intimation of another remedy for the journeymen bakers' evils than that of legislation, in the following passage: "I should be the last person to interfere between the League Bread Company and the Carlisle Biscuit Manufactory, or any other association for converting the baking of bread and biscuits from a handicraft (which I think it ought not to be) into a manufacture (which I think it might be), and the single-handed master baker. If such a change could be brought about, it would be cheaply purchased by some present inconvenience and suffering." I believe myself that there is no other way possible of raising the condition of the journeyman baker, than by converting bread-making into a system of machine manufacture, which will necessarily, in a natural and healthy way, at once effect the object.

In considering the obstacles to the rapid adoption of the new process, and the establishment of wholesale bread manufacture, the first that presents itself is the fact that a class of manufacturers will have to be created specially for the purpose, since the existing bakers possess neither the capital nor the qualifications necessary; whilst the millers, the parties next most deeply interested in the baking trade, are for the most part too closely interwoven with the welfare of the smaller bakers to admit of their becoming manufacturers of bread, because in doing so they would provoke so much hostility among their present customers as to risk the entire loss of their existing trade, and along with it a large proportion of their capital, now in the hands of the baker, under the system of credit before named. I am happy to say, however, that in one or two instances I have found millers who, having satisfied themselves as to the extraordinary advantages to be derived from the new process, are sufficiently far-sighted to see that these advantages must inevitably attract the attention of capitalists to establish a new trade, and they have preferred themselves to take licences for their own districts, for the purpose of establishing with their own capital bakeries capable of being worked either by themselves, or by an association of their present customers, the small bakers. I fear, however, that such men of foresight and enterprise bear but a very small proportion to those who are incapable of passing beyond the very narrow circle of their own limited experience and immediate wants.

I am, therefore, disposed to think, from the experience I have already obtained, that the new process, so soon as its advantages and the profits to be derived from working it are more generally known, will create an entirely new class of manufacturers, more especially since the several years' protection afforded by a patent presents a security and freedom from competition enjoyed by no other article approaching to bread in importance and magnitude of consumption.

There is another method of bringing the new process into general operation, which, I think, would accomplish it most satisfactorily, and with the least injury to existing interests; and that is by the formation of a large central joint-stock company, whose operations should consist in organising a perfect system of wholesale bread manufacture and delivery, and carrying that system by simple multiplication into every important town in the kingdom. Such a company would become a far more substantial customer for the flour of the miller than the present small baker, whilst the small baker might become a bread-seller instead of a bread-maker. It is commonly urged that public companies can never enter into competition with private firms in trading operations, and this is true decidedly when individual management and skill play the most important part in the determination of profit and loss; but I am prepared to maintain that the manufacture and supply of an article of such extensive and universal cousumption as bread, reduced by the new process to one of so much certainty and extreme simplicity, should be undertaken by a public company, in the same manner as gas and water are supplied. In Birmingham there already exist two public companies for the supply of both flour and bread. These pay excellent dividends, the smallest being equal to nearly double the dividends paid by our most prosperous railway companies, and this notwithstanding the difficulties arising from working without machinery and by the old method; difficulties which are felt most severely by the companies, on account of one of their fundamental laws being that they must not use alum to secure to the bread the colour and appearance which the small baker's bread possesses,

with which they have to compete. This exclusion of the use of alum from the bread made at large establishments has hitherto been the chief obstacle to the success of most of the co-operative bakeries that from time to time have been started to compete with the small baker, and this has been shown by evidence given before committees of the House of Commons.

The steadiness of the consumption of bread also renders it an article peculiarly suitable to be prepared and supplied by a public company. And since the new process removes all the vicissitudes of manufacture, and the expense of the plant required gives a comparative monopoly, the supply of bread is placed at once in the same category with gas and water.

That wheaten bread has not hitherto entered so extensively into the diet of the poor man in England as oatmeal has done in Scotland, is not to be attributed to a deficiency of nutritious matter supplied by wheat, but to the method of preparing and grinding it, for the wheaten grain prepared by simply taking off the external coat by the American process will present a larger amount of nutritious matter than oatmeal, and in a form infinitely more fit for digestion by delicate stomachs. Oatmeal, as you are probably aware, is prepared for food by simply boiling it in water in the form of porridge, so that all the elements are presented to the system uninjured by chemical processes, and the system accordingly assimilates them with ease; whilst our bread has been prepared in a manner which robs it of those essential elements which are necessary to enable the system to appropriate the nutriment which it offers.

Before concluding, I would just touch upon the much-vexed subject of adulteration by alum. In all the discussions that have taken place as to the injurious effects of alum upon the system, I think the most injurious have been overlooked, viz., its effect upon mucous secretions, and its preventing the action of solvents in the process of digestion. Its peculiar action on mucous secretions leads me very much to doubt whether it is capable of being absorbed from the alimentary canal into the circulation at all, except in quantities so small as to produce no recognisable physiological action. Its effect in the system is principally as a topical astringent on the surface of the alimentary canal, producing constipation and deranging the processes of absorption. But its action in neutralising the efficacy of the digestive solvents, is by far the most important and unquestionable. The very purpose for which it is used by the baker, is the prevention of those early stages of solution which spoil the colour and lightness of the bread whilst it is being prepared, and which it does most effectually; but it does more than is needed; for whilst it prevents solution at a time when it is not desirable, it also continues its effects when taken into the stomach, and the consequence is that a large portion of the gluten and other valuable constituents of the flour are never properly dissolved, but pass through the alimentary canal without affording any nourishment whatever.

It has been both asserted and denied that alum produces an effect upon the gluten of wheat analogous to tanning, so that it is rendered very difficult of solution. Now, I am disposed to believe that the alum does really produce a kind of tanning effect upon gluten. In some of the experiments conducted by Mr Darby, flour was washed in the ordinary way to obtain the gluten: after the gluten was obtained it was divided into equal parts, from each of which the water was well pressed; to one part was afterwards added alum, and thoroughly kneaded; after a very short period of time the alum caused the gluten to shrink and to give off water, and it became hard and tough, like a piece of india-rubber, losing its elasticity, and breaking short when pulled with violence. After the gluten and alum were kept in contact for several days, the gluten became so altered in character that it could be rubbed down in a mortar.

In another experiment, alum was mixed with the water used to wash the flour for the gluten, and its effect in this case was so completely to destroy the adhesive properties of the small particles of gluten that they formed no cohesive mass at all, and could not be separated from the starch by washing, but passed away with it.

It is scarcely necessary for me to point out the advantages to society which would follow the establishment of an extensive system of machine-bread manufacture by the new process. I would mention among the first and most important, that of the restoration to the wheaten bread of that most valuable substance cerealine, and the sweeping away of all those evils which the necessary use of alum entails. If the extraordinary value of cerealine and the evils of alum are such as I have stated, the absence of the one, and the presence of the other, must not only lie at the root of nearly all the diseases which are the result of mal-nutrition in the poor, but of those multitudinous forms arising out of dyspepsia in the more comfortably circumstanced, so that it would probably not be too much to say that disease would be lessened one-half in all our large cities and towns by supplying a bread that is perfectly free from alum, and contains the due proportion of the necessary solvent cerealine.

Arising out of the sanitary and physiological advantages of the

new process, is the economical, as tending to substitute wheaten grain for animal food. When we consider the extraordinary and steady increase in the price of meat relatively to that of grain which has taken place of late years, and that in the very nature of things this increase must continue so long as they bear their present proportion to each other in human diet, the importance of the new process in an economical point of view can scarcely be overrated. Of late I have been told that in some districts meat has fetched so high a price, and wheat has been so cheap, that it has paid to fatten cattle with the corn in preference to selling it for human food. In order that the waste attendant upon such a practice may be understood, I would merely point out the fact that the whole of that portion of the food—amounting to some 70 per cent.—which undergoes combustion in the animal, and passes away from the lungs and skin in the form of gas or vapour, is so much absolute loss, which taken as human food, in the form of wholesome bread, might have been saved.

I have now given you a very imperfect outline of what I believe the new process is capable of effecting. I have felt that in speaking of a process which has originated with myself, it has become me to speak as modestly as possible of its value; but I fear, notwithstanding, that there may be many who will think that I am too sanguine as to its merits. It may be I am. But I would offer as an excuse, that I have been made sanguine by what others more able than myself, and totally disinterested, have expressed regarding it.

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☞ *See* 'MEDICAL CIRCULAR,' *February* 15, 1860; 'MEDICAL TIMES,' *June* 23, 1860; 'BRITISH MEDICAL JOURNAL,' *November* 10, 1860.

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X.—*On the Influence of Atmospheric Changes upon Disease.*

By Arthur Ransome, M.B., *B.A. Cantab.* M.R.C.S., *and* George V. Vernon, F.R.A.S., M.B.M.S.

Read April 17th, 1860.

Two hundred years ago the remark was made to Sydenham,* and the statement holds true now, that "no physician hitherto has attentively considered the force and influence of the atmosphere upon human bodies; nor yet has he sufficiently ascertained the part it plays in prolonging human life."

From very early ages men have observed that certain diseases prevail most during certain seasons, and have ascribed to atmospheric changes an important influence upon health, but, until recently, no solid foundation of accurately observed facts had been laid.

Most of the old medical writers deal with the subject—some of them very carefully. Hippocrates devoted one of his works to "Airs, Waters and Places;" and his writings upon epidemics, and his aphorisms, abound with remarks on the influence of various states of the air upon the human frame. Since his time many others have very fully noticed the coincidence between these phenomena, as

* Letter to Dr. Sydenham, from Dr. Thos. Brady. — *Sydenham Society's Transactions*, vol. ii. p. 1.

Aretæus,* Sydenham,† Boerhaave,‡ Vitet, Ramazzini,§ Baglivi,|| and more modern authors. Still, owing perhaps to the imperceptible and apparently mysterious way in which atmospheric changes take place, and more to the necessity for well organized and simultaneous observations in both branches of the inquiry, little further progress towards a true science of medical meteorology has been made until lately. The first attempt upon a comprehensive plan to advance this subject was made in January 1844, by adding meteorological tables, furnished by the Astronomer Royal, to the weekly returns of the Registrar General, these returns being for London only. Somewhat later, monthly returns were obtained from stations in different parts of England, and appended to the quarterly returns of the Registrar General; and from the year 1849 these stations have gradually increased in number, and at the present time there are about sixty in England and Wales. Similar returns from about forty-five stations are now added to the monthly and quarterly returns of the Registrar General for Scotland.

Some years after these returns were commenced, it was thought that more useful information might be obtained by similar comparisons with respect to disease; and in 1853 an attempt was made by some members of the Provincial Medical Association to compare meteorological tables for different places, with the diseases prevalent in those districts, but unfortunately these records were not continued for more than two years and a quarter.

In 1857 the General Board of Health in London took up this question; and from the week ending April *11th*

* περι Αἵματος Ἀναγωγῆς.

† *Observationum Medicarum.*

‡ *Causes of Disease.*

§ *De principium valetudine tuenda*, cap. iii.

|| *De aeris influxibus investigandis ac perdiscendis, ad morbos dignoscendos et curandos.*

1857, to the week ending November *6th* 1858, they published a carefully compiled weekly return of new cases of disease in London, furnished by the voluntary efforts of upwards of two hundred gentlemen connected with the medical profession. The tables are accompanied by meteorological observations made at six stations in and out of London, and although not perfectly accurate, yet they are of great value; it is much to be regretted that they were carried on for so short a period.

Hitherto careful collation of the two classes of facts recorded in these tables seems to have been wanting; and in the present paper we have endeavoured to supply the deficiency, and to deduce from the comparison some general conclusions.

We must here state that our inquiry originated in some investigations which were made for the Manchester and Salford Sanitary Association by a committee consisting of Messrs. Curtis, Ransome and Vernon.

The method we have employed in making the necessary comparisons of the two series of observations has been as follows:

1st. We have projected the medical and meteorological returns upon separate charts, so as to form curves, which represent the prevalence of the disease or the state of the atmosphere at any particular time; and then, by comparing the two charts, and noticing any evident coincidences, we have been led to the conclusions specified in the paper, respecting the following diseases: Diarrhœa, dysentery, pneumonia, bronchitis and catarrh, pleurisy, continued fever, rheumatic fever, measles, whooping cough, and scarlatina.

Diarrhœa.

A high mean temperature (above 60°) would seem to have a powerful influence in predisposing to this disease;

when continuous, causing a rapid increase in the number of cases.

A temperature below 60° appears to be unfavourable to its progress.

The above action is generally most evidently shown when the temperature is above or below the average of the season.

In the spring of 1857, from April *11th* to June *20th*, there is a gradual, and at first scarcely perceptible, rise in the diarrhœa curve, the number of cases being comparatively very small.

The temperature in April and the early part of May is much below the average (8° on May *2nd*), although, on the whole, gradually rising.

From June *20th* to July *11th* the rise of the disease curve to 2,000 cases is more rapid—the temperature is above 60°, and on June *27th* 7° above the average.

From July *18th* to August *15th* there is a very great increase in the number of cases (even to 5,600), but from the latter date until September *12th* the curve sinks at nearly the *same rate* to 2,200 cases.

The number of cases then continues to diminish, but at a rather slower rate, until October *10th*, when it is 600.

The mean temperature during the *whole of this period*, from July *18th* to October *10th* is above 60°, and considerably above the average, sometimes as much as 7°. In the weeks ending July *18th* and *25th*, it is stationary at 68° (the highest point this year), but it then gradually falls to 63·5° on August *15th*; and after a temporary rise in the week ending August *29th* it continues to fall until October *10th*, thus throughout bearing a close relation to the disease.

From the week ending October *10th* (the temperature being 1·5° below the average) the number of cases still

remains low (still diminishing as the temperature falls until January *9th*), and it does not again rise until May *22nd*, 1858.

In the two weeks preceding May *22nd* 1858, the temperature is below the average as much as 6°, but it now begins rapidly to rise, and from May *29th* to June *26th*, 1858, it is considerably above the average (on June *5th*, nearly 10°).

In accordance with the rise of the temperature curve the number of cases increases, and continues to increase steadily, as in the preceding year, until July *10th*, when it is 1,200 (on July *1st* 1857 it was 1,400).

But a remarkable difference between the two years must now be noticed, as it affords a striking illustration of proposition (*b*).

In 1857 the disease runs on after July *11th* to an amazing prevalence, but in the present year (1858) there seems to be a sudden arrest, the number of cases remains almost stationary for a fortnight, and then slightly diminishes until August *7th*. When we inquire into the causes of this difference, we find that whereas in 1857, from June *20th* to September *26th*, the mean temperature never sinks below 60°; in 1858, for the first two weeks in July, the mean temperature is below 60°; and on July *10th* nearly 6° below the average. It seems as if the germs of the disease were so far destroyed by the unusual cold, that even the moderate warmth that follows could not again rouse them into activity.

The mean temperature in 1858 does not remain above the average, as it did in the preceding year.

From August *7th* to August *28th* 1858, the diarrhœa curve rises and falls with the mean temperature, but on August *28th* the thermometer again sinks below 60°; and although it again rises in September to 63·5°, it is accompanied by no corresponding increase in the number of cases, — the diarrhœa agent has again received a check from which it does not recover.

Dysentery

(1) Seems to be influenced by the variations in the mean temperature, but in less degree than diarrhœa, the effect not being generally traced in the lesser undulations of the curve.

(2) Increased atmospheric pressure seems to be unfavourable to the progress of the disease, high readings of the barometer being nearly always accompanied by diminished prevalence of dysentery.

The dysentery curve rises, on the whole, from the week ending April *11th* to the week ending September *12th*. Fostered by the unusual warmth of the season, the disease seems to gather such strength that for a fortnight after the mean temperature begins to decline, it rushes on to still greater prevalence, and reaches its highest point when the mean temperature has fallen from 68° to 60·5.°

The diminishing autumnal temperature, however, seems at length to produce an opposing influence, for the disease from this point gradually subsides, with occasional fluctuations, until the week ending January *16th*. There is then a sudden temporary rise in the disease curve, the mean temperature being now above the average, but having been very variable in the preceding three weeks.

During February 1858, there is a rapid increase in the number of cases which is associated with a temperature very much *below* the average (as though great cold as well as great heat were favourable to the disease); but it must be noticed at the same time that the barometric reading during the month was very low.

The disease curve now falls until April *17th*, and continues low until June *19th* (nearly the same date as that

on which the disease took its first decided rise in the preceding year). The mean temperature has now been very high for a fortnight (from 8° to 10° above the average); and the number of cases rapidly increases until July *10th*, when it may be noticed that the mean temperature falls suddenly to 56° (6° below the average), and the further progress of the disease is checked.

After a short rise on July *24th* (the mean temperature having then again risen 5° above the average for the week) the dysentery curve now gradually subsides, with many fluctuations, until October *2nd*; and it may be noticed that the most decided rise is in the week ending September *25th*, following the unusually high temperature of the preceding week (64° or 6·5° above the average).*

Pneumonia

Seems to be very greatly influenced by the mean temperature, the disease curve rising as the temperature falls, and *vice versâ*.

The above statement receives its best illustration in the spring, summer, and autumn of the year 1857.

In the early part of the year, while the temperature remains low, the disease is still prevalent, but as the

* Hippocrates, *Aph.* 22, book iii., speaks of dysentery as an autumnal disease: "With regard to the seasons, if winter be of a dry and northerly character, and the spring rainy, and southerly, in summer there will necessarily be acute fevers, opthalmics, and dysenteries, especially in women, and in men of humid temperament." — *Aph.* 3, xi.

Sydenham mentions dysentery, amongst other diseases, "which commencing in August run on to winter."

In the report upon the status of disease, drawn from returns made at the time of the census of Ireland for the year 1851, Messrs. Donnelly and Wilde conclude that diarrhœa and dysentery prevail more in the summer and autumn than at any other season.

"They occur in the season of summer; next in autumn; less in spring; least of all in winter." — Aretæus, *On the Causes and Symptoms of Chronic Diseases*, book ii. ch. ix.

warm weather advances it gradually declines, and remains low throughout the unusually warm summer, being least prevalent when the mean temperature is highest in July and August. The number of cases begins to rise in the latter end of August, and reaches its maximum on November 28*th*, the mean temperature being then 42°.

During this period, the way in which the two curves of mean temperature and pneumonia supplement one another is very remarkable. From April 11*th* to November 28*th* (thirty-four weeks) there are only seven exceptions to this rule, and when we examine these we find that most of them may be accounted for without much difficulty.

The first of the exceptions occurs in the week ending May 9*th*, when the disease curve rises considerably, the temperature also rising, but it must be remarked that the temperature is still 7° below the average, and that in the preceding week it was 7·5° below the average.

In the week ending May 23*rd* another, but very slight, deviation from our rule may be noticed, — the pneumonia curve continues to descend, while there is a slight fall (half a degree) in the temperature.

In the week ending June 20*th* there is a temporary rise in the number of cases, together with the mean temperature, but this seems again to be accounted for by the occurrence of a temperature 2° below the average in the preceding week.

In the week ending August 29*th* there is a slight rise in the number of cases, which cannot be accounted for by any fall of the mean temperature (68° or 9° above the average). (The N.E. winds prevailed this week, following a long continuance of S.W. winds, and the degree of humidity rapidly fell.)

In the week ending September 26*th* the number of cases diminishes during a falling temperature, but in the preceding week the mean temperature was 5·5° above the average. Lastly in the week ending November 7*th* the onward course of the disease does not seem to be checked by the temporary but unusual heat.

In the spring of 1858 the very close accordance between the two curves is not observed. Although the mean temperature falls lower than it has yet done, and the number of cases of pneumonia is still very great, yet it never again reaches the height that it did in November.

It must, however, be observed that the highest point of the curve this season corresponds with the period of the greatest cold, the week ending March 13*th* having a temperature of 35° (6° below the average), the preceding week being still colder (32° or 8·5° below the average). The waves of the disease curve apparently lay behind those of the mean temperature. (The humidity is now diminishing and N.E. winds very prevalent.)

The mean temperature now begins to rise, and the disease diminishes in prevalence on the whole until August 21*st*, many fluctuations intervening, until with the advancing cold of the autumn an increase again takes place.

In the lesser modulations of the two curves from April 10*th* to June 26*th* (eleven weeks) there is again a very close correspondence, there being only one exception in the week ending May 8*th*; the disease curve then falling, after a short rise, while the mean temperature continues to diminish.

From June 26*th* to July 24*th* there is apparently an important departure from our rule. In the weeks ending June 26*th*, July 3*rd*, while the mean temperature is falling, the number of cases of pneumonia continues to diminish. It seems probable, however, that this may be owing to the unusual heat of the preceding week (69° or 8·5° above the average), and the discrepancy in July seems to be due to the disease curve rolling up behind that of temperature, the rise in the pneumonia curve following the unusual fall in the mean temperature of the preceding week (to 6° below the average).

In the week ending August *21st* the departure from our rule is very slight; the disease curve continues to fall together with the temperature, apparently in consequence of the continued influence of the heat of the preceding week, which is 3·5° above the average.

In the week ending September *18th* the disease curve rises, and in that ending October *2nd* it falls in accordance with the curve of temperature, but in the latter instance the preceding high temperature seems to display its influence.

Out of the seventy-nine weeks which we have now examined, twenty-three (29 per cent) exhibit departures from exact accordance with our rule; but, as we have seen, most of these are still to be accounted for on the supposition that the mean temperature influences the progress of the disease; but it seems probable that other elements, such as N.E. winds, also exercise some effect.

Bronchitis and Catarrh.

The curve of these diseases, although drawn from ten times the number of cases, is almost identical with that of pneumonia, its highest and lowest points coinciding exactly with those of the pneumonia curve.

It will be unnecessary, therefore, to trace it throughout its course, since it is evidently affected by temperature in much the same way as pneumonia.

The correspondence of the mean temperature curve with that of bronchitis is even closer than with that of pneumonia, the exceptions being only 26½ per cent.

It may be observed that in the year 1857, when the disease curve marks a deviation from the rule of temperature, it may generally be ascribed to a change in the degree of humidity, the disease curve rising as the amount of moisture diminishes, and *vice versâ*.

The chief discordance between the pneumonia and the catarrh-bronchitis curves takes place in the latter end of September and in October, which may possibly be due to the greater influence of the moisture upon bronchitis and catarrh than upon pneumonia; the degree of humidity at this time rises rapidly.

In June and July 1858, the catarrh-bronchitis curve seems to answer more rapidly to the influence of the temperature than the pneumonia curve does.

Pleurisy.

This disease is too irregular in its course to yield any information in the present investigation, as the meteorological elements under consideration do not appear to have any apparent connexion with it.*

Continued Fever.

It is difficult to trace any connection between the progress of this disease and the meteorological elements under consideration, but on the whole high temperatures seem rather favourable to its production, and extreme cold is probably opposed thereto.

From April *11th* 1857, the *fever curve*, frequently fluctuating, on the whole ascends until November *7th*, when a sudden fall takes place, and it sinks rapidly until February *13th*. In the first part of its course, from May *9th* to August *29th*, it accompanies the rise of the mean temperature, but after the latter begins to fall the fever curve goes on rising as steadily as before for two entire months, and is not affected by the advancing cold until the week ending November *14th*, when the thermometer stands at 45°.

* Among the seasons of the year, winter more especially engenders the disease, next autumn, spring less frequently, but summer most rarely.—Aretæus, *Causes and Symptoms of Acute Diseases*, book i. chap. x.

As though the heat had called into activity some agent which resisted moderate fall of temperature, but which was destroyed by the cold of November, December, and January.*

During the whole time of the gradual increase of the disease the mean temperature is throughout above the average.

From February 1858 the fever curve does not rise much until the week ending June *5th*, when a sudden increase of 110 in the number of cases accompanies a rise of 12° in the mean temperature.

From April *11th* 1858 to October *23rd*, there is the same gradual advance in the disease curve as in the corresponding period of 1857, with the exception of the month of June 1858. The temperature this month was excessive, and to this in a great measure must be attributed the sudden rise in the number of cases. The month of July, which followed, had a temperature considerably below the average, and this checked the rapid advance of the disease for a time; but it will be seen that leaving the month of June out of the question (as being abnormal) the curve gradually ascends up to October *23rd*, when our observations end.

Of the lesser modulations of the fever curve 61 per cent take place in accordance with the variations of the mean temperature, the disease rising and falling with the temperature; and in many of those weeks which present deviations these seem to be due to the lagging of the disease curve behind that of temperature; as in the weeks April 18, 25, May 2, June 6, 13, August 15, 22, 29, and September 5 and 25, 1857; also March 27, May 1, June 26, September 4, 11, 1858.†

* Drs. Donnelly and Wilde remark that fever, although very prevalent in spring, seldom rises to its intensity until summer and autumn.

† It takes birth when spring passes into summer, and it rises towards maturity as the year advances; with the decline of the year it declines also. Finally the frosts of winter transform the atmosphere into a state unpropitious to its existence. — Sydenham, *Medical Observations*, iii. 2 (5).

Rheumatic Fever.

The curve of this disease is not sufficiently extended to admit of accurate comparison with the meteorological curves, and therefore no decided conclusion can be drawn respecting it.

Our data, however, would bear out the observation of Sydenham: "This disease may come on at any time; it is commonest, however, during the autumn." — *Obs. Med.* vi. 5 (1).

Measles.

In its chief undulations, the measles curve seems to rise with the fall of the temperature, and *vice versâ*; and the influence of this element is best marked when it is above or below the forty-three years' average.

These two propositions will be proved by the following observations.

In the spring 1857 the largest number of cases occurs in the week ending May *2nd*, when the temperature reaches its minimum (42°) this season, and when moreover it is 7·5° below the forty-three years' average. The disease curve then gradually declines as the temperature rises until August, when there is a sudden temporary increase in the number of cases (of whooping cough also), and a considerable fall from the July temperature, although the latter is still above the average, and remains so throughout the autumn. After this temporary deviation the temperature rises to 68° (7° above the average), and the number of cases diminishes again, but continues to do so for a fortnight after the temperature begins to fall.

From September *12th* the disease curve rises gradually while the temperature falls, and it continues to rise until November *7th*, and then falls until November *21st*, as though checked for a time by the temporary rise in the temperature of the preceding week (when it is 8° above the average). The disease attains its maximum in the week ending March *13th*,* the temperature having reached its lowest point in the week preceding, and being moreover 7·5° below the average.

The temperature now rises, and the disease diminishes in prevalence during the month of April: the week ending April *10th* alone has a temperature below the average, and the number of cases again slightly increases for that one week.

During the month of May the disease increases in prevalence, although accompanied by an advancing temperature which, however, is below the average; but after the week ending June *5th*, which has a mean temperature no less than 10° above the average, the disease curve gradually declines until July *10th*. The temperature in the week ending July *10th* sinks to 56° (6° below the average), and from July *24th* to August *7th* it is 2·5° below the average; and in all these instances a slight rise in the number of cases follows. With these exceptions, however, the disease curve rapidly declines until the week ending October *2nd*; this week the temperature sinks to 51° (slightly below the average), and the depression is immediately succeeded by a rapid increase in the number of cases.†

Comparisons of the daily mean barometer readings, during the period April 1857 to October 1858, tend to show that during the time this disease was most prevalent

* "They begin as soon as January; they increase gradually; they reach their height about the *24th* of March; they then gradually decline, so that, with the exception of a few that may attack isolated individuals, they disappear by midsummer." — Sydenham, *Med. Obs.* i. 3.

† Dr. Mühry states that measles in the temperate zone experiences no change with the temperature.

the fluctuations in the atmospheric pressure were far greater than when it was less rife.

Measles seem to be much influenced by the same conditions as whooping cough, since it is usually most prevalent during the same seasons; and yet it is evident that this relation is not exact, since in many of the lesser undulations of the measles-curve the variations take place in the opposite direction to those of whooping cough. (This is the case in twenty-nine out of the seventy-five weeks noticed, about 38 per cent.)

On comparing the curve from April 1857 to March 1858 with the degree of humidity, it seemed that this element had some effect upon the lesser undulations of the disease-curve, since the number of cases rose and fell with the humidity in 72 per cent of the weeks; but on comparing the second period, from April 1858 to October 1858, this hypothesis is not borne out, and the coincidence may be accidental, since in one half the weeks the variations went with the degree of humidity, in the other half they went in the opposite direction. Moreover, although in October, while the degree of humidity is rapidly rising, the disease prevails very greatly, yet in March 1858, when the number of cases reaches its maximum, the degree of humidity is very low; and in September and October 1858, when the relative amount of moisture in the air is the greatest, the number of cases is at its minimum.

Whooping Cough

Seems to be much influenced by the extremes of heat and cold, the curve, on the whole, rising with the fall and sinking with the rise of temperature.

The disease remains apparently unaffected by the gradually increasing warmth of the spring of 1857, but a decided diminution of the number of cases follows as soon as the mean temperature of the week rises to 67°, which takes place in the week ending June *27th* 1857.

From June *27th* until October *3rd* the temperature remains high (above the forty-three years' average nearly every week), and during this time the disease is at its minimum (between forty and fifty cases per week).

The number of cases does not again increase until the sudden fall of temperature in October and November, after which the weekly average remains pretty constant until February *13th*, unaffected by the great fall of temperature in the week ending January *9th* 1858, but it again rises rapidly after the extreme cold of February and March (which was much below the forty-three years average).

It remains very prevalent during the spring of 1858, but the remarkably warm June appears to check its progress, just as it did in the preceding year.

It is important also to notice that an increase in the number of cases again takes place in July, the temperature being much below the average; the year before the curve declined much more regularly and continuously.

During the summer of 1858 the disease remains almost stationary, as in the preceding year; but while it may be observed that the temperature is never so high as then, the number of cases never sinks so low (seldom below sixty).*

Scarlatina.

A large amount of aqueous vapour in the air appears greatly to facilitate the formation and action of the peculiar scarlatinal poison, especially when this is accompanied by sudden fluctuations in the atmospheric pressure as shown by the barometer; a diminished pressure being favourable to the disease.

It is rather difficult to separate the influence of temperature from that of humidity, but a moderately low temperature seems to be favourable to the progress of the disease, whilst the extremes of both heat and cold seem often to exert a disturbing influence one way or the other; a temperature above the average generally diminishing, cold increasing the number of cases.

* Drs. Donnelly and Wilde remark that spring affords rather more than the average amount of small pox, measles, scarlatina, and whooping cough. *Census of Ireland for* 1851.

From May *9th* to August *8th* 1857, the degree of humidity remains low (below 0·7), although fluctuating considerably, and the number of cases is small; but in the lesser fluctuations the two curves rise and fall together in a remarkable manner. In the seventeen weeks from April 11 to August 8 1857, there are only three exceptions to this observation; the first two exceptions occur together in the weeks ending May *23rd* and *30th*, the number of cases increasing while the degree of humidity falls, and it may be noticed that the first decided rise in the temperature occurs in the preceding week; the mean temperature then rose from 45° to 56°, and during that week and the next it remained nearly 6° above the average—the barometer regularly descending for three weeks.

The second exception is in the week ending June *27th*, and at this time again the perturbing influence of heat seems to act, the mean temperature rises 7°, and is 7° above the average. The humidity increases, and the barometer goes down, but the number of cases diminishes.

On July *18th* the scarlatina-curve begins to rise, and on the whole continues to do so until October *31st*, thus accompanying very closely the degree of humidity; but in the week ending August *29th* there is a sudden fall both in the degree of humidity and in the number of cases, the mean temperature being very high (68°) and 7° above the average.

From August *29th* there is a steady rise in the number of cases until October *3rd*, but the following week a slight fall occurs, and it may be noticed that in the two preceding weeks there has also been a slight fall in the degree of humidity, and in the week ending October 10*th* there is a great diminution of atmospheric pressure (barometer 29·4ins, the lowest this year), and this is at once followed by a further rise in the degree of humidity and the number of cases.

From October 10*th* until November 21*st*, both the curves remain high, but in their secondary undulations, instead of being in accord, they supplement one another.

In the week ending November 14*th*, the highest degree of humidity accompanies a decline in the disease curve, but is followed in the week after by an increase in the number of cases. The two curves then decline on the whole until December 5*th*, when the returns of disease are discontinued for six weeks.

In the spring of 1858 the degree of humidity remains tolerably high, without any great prevalence of the disease; but here again may be noticed for twelve weeks an almost exact accord between the rise and fall of the secondary waves of the two curves. There are two exceptions to this rule: First, in the week ending March 6, the number of cases continues to fall after the sudden depression of the degree of humidity has ceased. In this week the atmospheric pressure is again very small (29·6ins), and the week following there is again a sudden rise in both the disease and the humidity curve.

In the week ending March 20*th* there is no material change in the degree of humidity, but the mean temperature rises 13°, and is 6° above the average, and the scarlatina-curve descends again.

During April the number of cases diminishes gradually, and on the whole the humidity-curve declines, but fluctuates remarkably, the scarlatina-curve marking these fluctuations by slighter variations in accordance with them.

An apparent exception to the rule which we have hitherto noted now takes place. From May 8*th* the disease-curve begins on the whole to rise, while the degree of humidity with great fluctuations seems to descend until the middle of June (as in the preceding year the secondary undulations corresponding with those of the disease). At the same time, however, it must be noticed that the mean temperature in the beginning of May is very low (46° or 6° below the average), and it does not rise materially until the week ending June 5.

For a fortnight after this date the temperature rises, and remains very high (66°), nearly 10° above the average, while the number of cases diminishes during the same time.

From June 26*th* the humidity and disease curves on the whole rise until October 23; but from July 10 to July 24 the degree of humidity falls as the disease curve rises; and here again we may perhaps trace the disturbing influence of temperature, the week ending July 10*th* having a a mean temperature of 56·5° (6° below the average).

In the week ending August 7*th* the disease-curve rises very rapidly (sixty cases), while the degree of humidity remains low; but the preceding week the mean temperature has been 2·5° below the average.

During the four following weeks the variations in temperature would seem to have the chief influence upon the disease, the rise and fall of the fluctuations of temperature and scarlatina supplementing one another very closely.

In the week ending September 4, the barometer is very low, and the following week the degree of humidity rises considerably, while the temperature remains stationary, but there is a rapid rise in the disease curve.

The number of cases again falls greatly in the week ending September 18, probably from the action of the unusual heat, the temperature rising to 63·5° (6·5° above the average), while the degree of humidity continues to rise.

From this time, however, until October *16th*, the humidity again appears to exert its influence, and the curves are in accordance.

The disease curve reaches its highest point for the year (200 cases) in the week ending October *16th*, the degree of humidity rising rapidly until October *23rd*, but the temperature not descending much, and remaining 2° above the average.

It is interesting to observe the manner in which the curve of scarlatina supplements the curves of whooping cough and measles. "Thus they vex humanity by turns, as the constitution of the year and the sensible temperature of the air most assist the one or the other." — Sydenham.*

In the foregoing examination into the effects of the several meteorological elements upon scarlatina, it will be seen that we have ascribed to humidity the chief influence, but at the same time have carefully noted the effects of variations of temperature and pressure of the atmosphere; but it may be that we have not sufficiently indicated the reasons for our opinion.

Without very close comparison it would be very difficult to decide whether temperature or humidity had the greatest influence upon this disease. First, if we take the correspondence of the curves during the same times, we shall find that in 64 per cent of the weekly periods the number of cases rose and fell with the fall and rise of the thermometer, and in 63 per cent with the rise and fall of the degree of humidity; in 42 per cent of the periods

* Sydenham states that scarlet fever may appear at any season, but oftenest towards the end of summer. — *Med. Obs.* vi. 2, 1. He also speaks of one epidemic being driven out by another "ut clavum a clavo." — *Med. Obs.* ix. 1, 7.

these two elements might act together, the temperature falling as the degree of humidity and disease-curve rise, and *vice versâ*. Of the weeks in which the degree of humidity and temperature rise and fall together, the apparent effects, as shown in the rise and fall of the disease-curve, are almost exactly balanced, there being fifteen points of agreement with the temperature, sixteen with the humidity-curve. The fact of accordance between the rise and fall of the curves, however, must be of little importance in determining the influence of the element upon the disease, compared with observations upon the *actual state* of the air at the time of prevalence or absence of the disease.

A few instances will, we think, show that the temperature, although by no means inactive, exerts less influence than the humidity.

While the degree of humidity is at its lowest point in 1857, between June 6 and July 18, the number of cases is also the least, scarcely rising above thirty. During the corresponding period in 1858, between April 1 and July 10, although the disease is rather more prevalent than in the year before, yet the number of cases rarely exceeds fifty, and does not increase until the degree of humidity begins on the whole to rise.

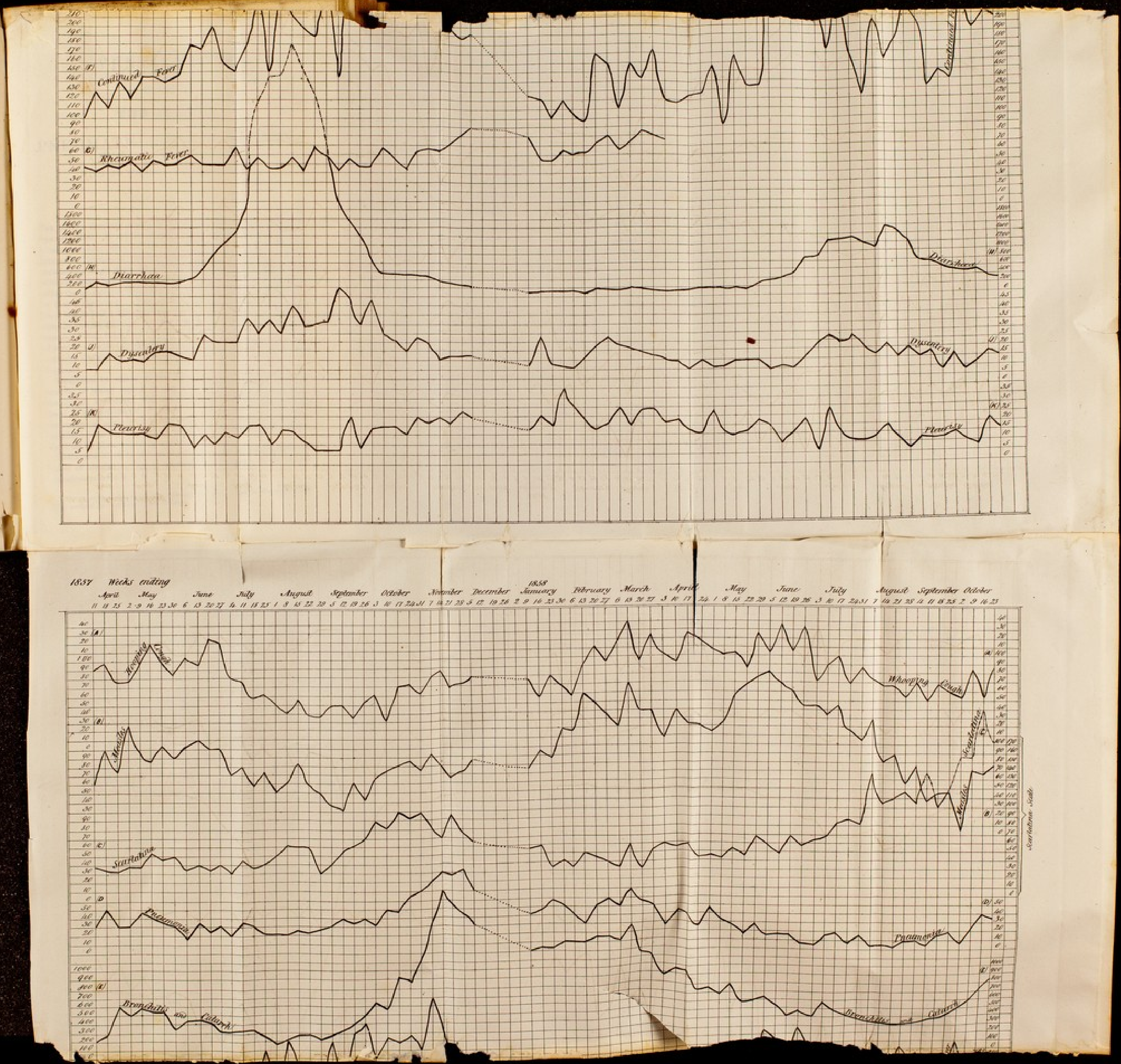
Both in 1857 and 1858, when the amount of moisture in the air is greatest, the disease-curve is at its highest point.

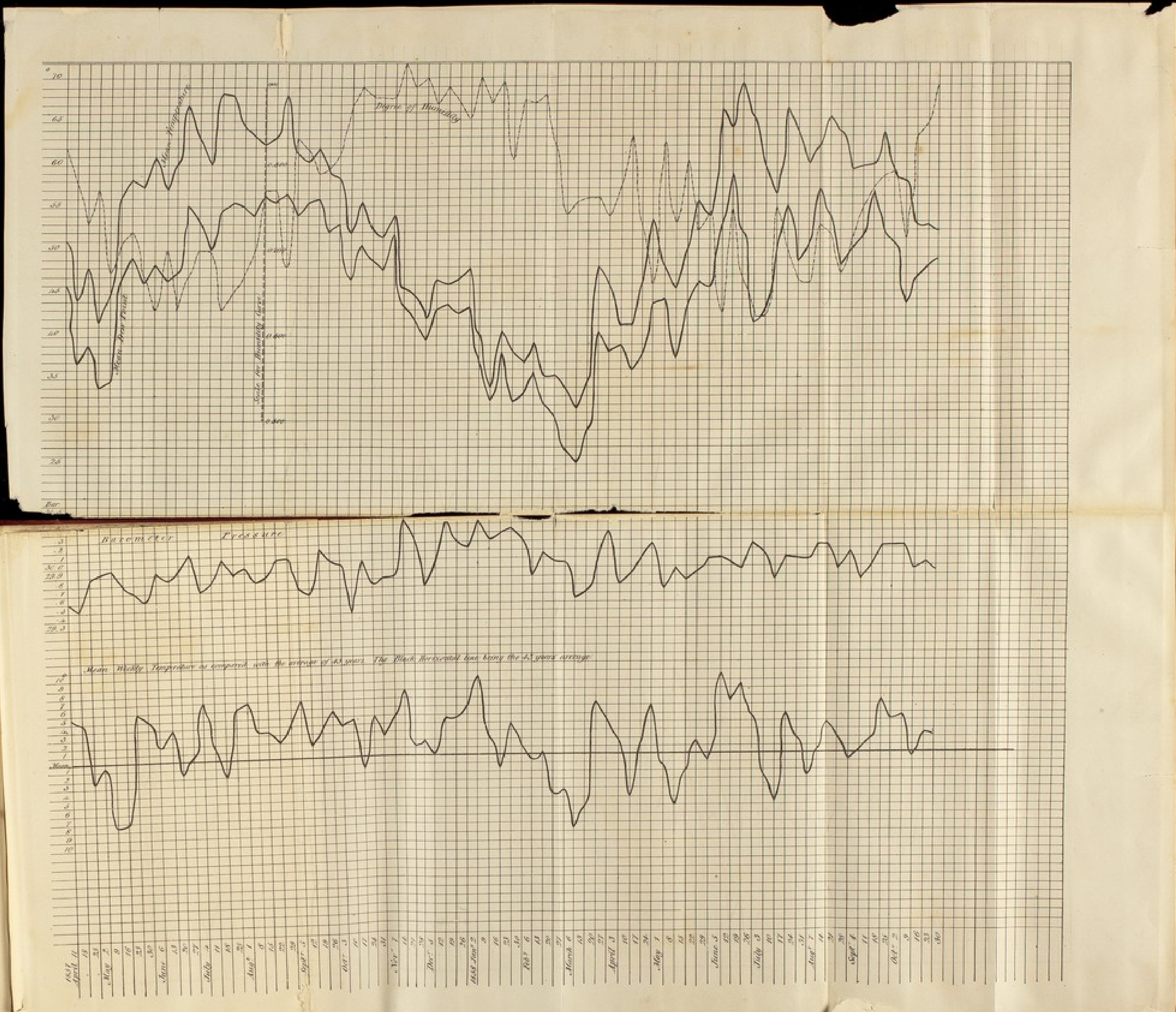
On the other hand, a low degree of temperature accompanies both the smallest and largest number of cases in both 1857 and 1858, and the same is true of a high temperature; *e.g.* on July 18, 1857, the mean temperature is 68° while the disease is at twenty-five, and in August 1858, with the mean temperature above 60°, the number of cases remains above 100. Notwithstanding this remark, however, many of our observations will prove that temperature has an important modifying action.

Thus far has our investigation carried us. We already trace, though often but faintly, the influence of the few meteorological elements which we have studied. Taken in connection with large numbers of cases of disease, although a clearly defined and exact accordance cannot be found, still we perceive a certain general relation existing between them, and enough may perhaps have been done to prove the value of such an inquiry. The returns for several of the weeks, especially those ending August *22nd* and *29th*, 1857, and March *6th*, 1858, are very imperfect; but after careful examination we do not find that these deficiencies affect the conclusions at which we have arrived. In each instance, when appreciable, the probable amount of error arising from this source had been marked in pencil upon the chart.

Before closing this paper we must state that it seems very desirable that many other branches of meteorological research should be included in the inquiry, and compared with disease; among these may be mentioned winds, electricity of the atmosphere, rain, microscopical and chemical analyses of the atmosphere. Under the last-named head regular series of observations, made at various stations with the sepometer of Dr. R. A. Smith, F.R.S., would be of very great importance.

Charles Simms & Co., Printers, Manchester.


Continued Fever
Rheumatic Fever
Diarrhœa
Dysentery
Pleurisy
1857 Weeks ending
1858
April May June July August September October November December January February March April May June July August September October
Hooping Cough
Whooping Cough
Measles
Scarlatina
Pneumonia
Bronchitis and Catarrh
Scarlatina Scale



Mean Temperature
Mean Dew Point
Degree of Humidity
Scale for Humidity Curve
Barometer Pressure
Mean Weekly Temperature as compared with the average of 43 years. The Black Horizontal line being the 43 years average
Mean

VENTILATION

BY MEANS OF

THE PATENT

PNEUMATIC OR AIR-SYPHON,

WITH OR WITHOUT ARTIFICIAL HEAT.

THE process does not require a fire, or any other artificial heat, or moving power. It consists of the practical application of operations constantly taking effect in the atmosphere, which cause a current to take place through an inverted syphon, having one of its branches considerably longer than the other (whether it be in the open air or with the shorter branch communicating with a room or other place), into which the air enters at the orifice of the short branch, and is discharged by that of the longer. This process is not prevented by making the short branch hotter than the long. When it is proposed, in the hereafter described arrangements, to use the chimney as the long branch, it is because of there being such a channel at hand, and because it is capable of serving a double purpose when the season requires fire, and is conveniently available for the single purpose (ventilation) when fire is *not* required.

Ventilation by means of the Air-syphon has for its objects the removal of heated and of all impure air that has become diffused through an apartment; the removal of hot and impure air, produced by the combustion of gas, &c., *prior* to its being diffused; the prevention of accidents from the escape of gas in apartments thus ventilated; and the removal of impure air from vaults and cellars; and from all places requiring ventilation.*

The means of carrying these objects into effect are the adaptation of a way or channel, or ways or channels, to the agency of the natural operations referred to.

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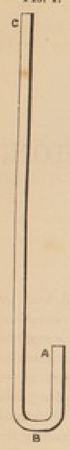
* The prevention of accident from the accumulation of gas in the goaves, and other confined parts or apartments of mines.

Fig. 1.



A syphon-shaped tube, having one of its branches longer than the other, represents the way, or channel—the short branch A (Fig. 1,) constituting the channel of entrance, and the long, B, that of exit, C the intermediate branch. There may be two or more short or receiving branches, and they may enter the long branch separately, or unite, and enter by a common channel.

The syphon exercises a demand upon the apartment for air; the demand is greater in proportion to the excess of altitude of the long branch over that of the short. Free admission of pure air is necessary, as in all other systems of ventilation. The success of the air-syphon would be defeated by the absence of a supply to the demand which it exercises.

External air is preferable to air from the passages. It should not pass behind skirting-boards, under floors, or within partitions of lath and plaster, *except* in tubes. The place of ingress might be any part of the room, where it would be least inconvenient to the occupiers; it is not necessary that it should be at the lower part of the room; that it should enter by small orifices, apart from each other, is preferable to its entering by one large orifice.

The advantages afforded by the pneumatic syphon, like those afforded by the hydraulic syphon, are, that it gives a command over currents, which enables us not only to conduct them in horizontal directions, but to occasion their taking place in courses apparently contrary to their natural tendencies; the heavy liquid water, for example, *rising* in the former, *apparently* in opposition to laws by which its weight should oblige it to fall, and light air descending in the latter, *apparently* in contradiction of laws which should oblige it to rise.

In the event of its being necessary for the removal of impure air, that it should be made to descend from the upper parts of an apartment, whether a vault, or a cellar, or inhabited room, or other place, down to the floor, or under the floor, and to pass under or through a partition or wall into the flue of another apartment, or into a flue on the outside of the building,* the pneumatic syphon supplies the means of so causing it to descend, and of its being so conducted away.

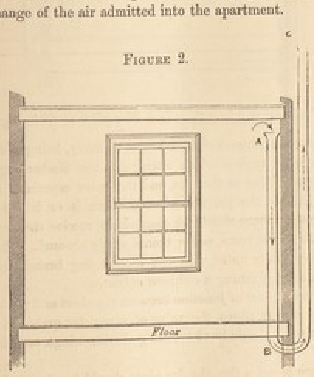
* Although the short branch may in some instances be carried with a successful result into the chimney of another apartment having a fire in it, yet there is always risk of its failing, owing to the complication of influences which come into operation, unless those influences are taken into consideration and provided against.

One of the peculiarities which may be enumerated amongst the advantages of the system is, that in proportion as the scale (that is to say, the magnitude of the apparatus) is increased, so does its acting power increase.*

Ventilation where there is no Fire-place or Chimney.

Figure 2 represents a room (in the lower or lowest part of a house, as the basement, for example) without a fire-place, and a syphon, of which the short branch, A, descends from near the ceiling, down to and through the floor; the bend, or connecting portion, B, passes through the external wall, and the long branch, C, ascends in the open air above the top of the house or building. A channel so placed will keep up a constant change of the air admitted into the apartment.

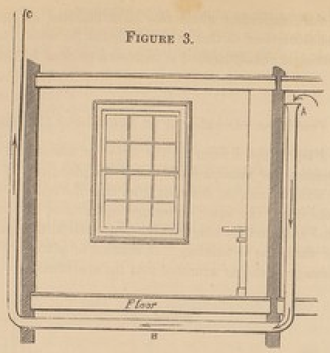
Figure 2.



That portion of the syphon, B, which connects the short and the long branches, A and C, might be carried under the floor of a second room (or rooms), as represented in Figure 3, (page 4); thus, the most central room, or closet, or compartment of any kind in a building might be made to be in direct communication with the external air.

* Mr. Burn, in his very useful work, replete with practical remarks on ventilation, says, with reference to the *air-syphon ventilation*, after having experimented satisfactorily with a tube on a small scale—"If acting with certainty on a large scale, we hail the invention as one of the most important of the day; so simple in its nature, so easy in its application, it really is a boon to the community."

FIGURE 3.



Ventilation where there is a Fire-place or Chimney.

Every apartment, however, that has a chimney, being provided with that portion of a syphon which constitutes the discharging branch, it might be appropriated to that use, and the more especially, as it might be made to answer the purpose whether there is or is not a fire. It is preferable that there should be channels to receive the impure air at different parts of the room, rather than a single channel. The receiving branches may finally unite with the discharging branch, either separately or together, forming a common entrance.

The preferable place of junction between the short and the long branch or branches is just above the valve of a register-grate, or, in the absence of a valve, it should be above the gathering wings, and in the throat of the flue.*

When there is not a fire, the fire-place should be closed either by the valve, or other convenient means, or by a chimney-board. When by the latter, the place of junction might be through the chimney-board, and at any part, however low.

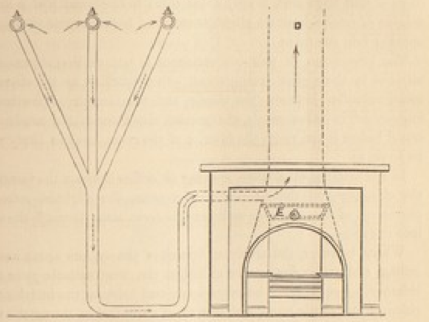
The register-stove, or any other grate having a valve, is preferable to

* A great advantage arising from the junction being at this point, instead of at a greater height, is, that the heat causes the current of air making its exit from the receiving branch to be more rapid, and by consequence the entrance of air into it to be more rapid, occasioning, in a given time, a larger removal of impure air from the upper part of the room.

a grate which has not. A suitable valve, however, might be put into any chimney.*

Assuming that the Figure 4 represents a grate with the valve closed below the place of junction, between the receiving branches A A A, and the discharging branch D, they together form a continuous channel or syphon.

FIGURE 4.



Chimneys having down-draughts, or subject to gusts of wind blowing down them, are not favourable to ventilation, either by the air-syphon, or by any other method, in which the chimney is to be the channel of exit.

It is *necessary* to distinguish between down-draughts and *down-blowing gusts.*

The cause of down-draughts is deficient supply of external air to the interior of the house, or to the individual apartment. They are more common at night, when the windows, window-shutters, doors, &c., &c., being shut, the usual inlets of external air are closed. Air should be supplied to the house through pure channels or apertures; as, otherwise, it descends through the chimneys, bringing impure smells, &c., with it.

Chimneys liable to down-blowing gusts are those adjacent to chimneys or chimney-pots higher than themselves, or in the vicinity of lofty buildings, trees, &c., &c. The best remedies are adding height to the chimney, or a wind-guard.

* A valve so introduced should not have the area of the valve greater than that of the smallest part of the smoke-flue, or of the exit at the top.

Although it is only in certain chimneys that these gusts drive the smoke so low as to make it visible at the fire-place, yet few are wholly free from occasional slight checks. The irregular movements of the wind at all times, produce eddies and evolutions sufficient to cause such checks, which, however, are comparatively momentary, and the smoke at once resumes its course. When, however, there is an opening into the chimney, and the distance between the smoke and the interior of the room at that open part, is only about equal to the breadth of a hand, a descent of smoke, however slight, is sufficient to force some through the opening into the room.

The prevention of this inconvenience is one of the objects to be attained by the syphon arrangement. In proportion as the channel of communication between the smoke, and the interior of the room is longer—or, in other words, the greater the distance the smoke must travel before it can reach the interior of the room, the less likely will it be to do so.

In the instance of a mere opening or orifice between the interior of the chimney and the interior of the room, the slightest retrograde movement of the smoke is sufficient to force some through the orifice into the room.

Where, however, the receiving branch of the syphon opens near the ceiling, and passes down to be united at the most suitable place to the chimney, a long distance becomes interposed between the interior of the chimney and of the room, and, instead of a few inches, the smoke would be obliged to traverse many feet before it could escape. Thus, the light and transitory checks given to the progress of the smoke, which, where the distance is short, force smoke into the room, have no effect of the kind where a long channel has first to be traversed.

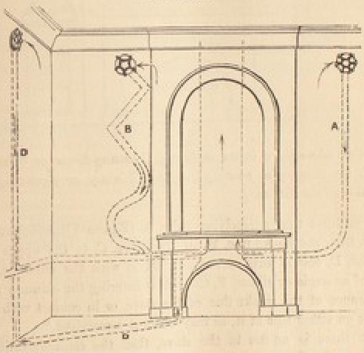
Indeed, even in the event of strong gusts, still the smoke, before it could escape into the room through the channel forming the receiving branch of the syphon, must force its way into the room at the opening of the fire-place itself—that being the nearer and readier place of escape. Thus, even in extreme cases, where down-blowing gusts actually force the smoke into the room at the fire-place, it is not forced through the channel appropriated to ventilation.

Buildings and Alterations.

It is scarcely necessary to say, that houses in progress of building, or of undergoing repairs, afford the best opportunities of providing for ventilation—that is to say, for the free *admission* of pure air by proper

channels and at proper parts, and for the egress of the air that has become impure. That free admission of air is indispensable, has been already said; as, also, that although a chimney and fire-place are not necessary, yet, there being a chimney available, it may be used. Assuming it to be so used, a hollow channel or channels, having their receiving orifices at any required elevation, and at any part of the room, may be formed or chased in the brickwork, constituting receiving or short branches. These may be conducted to the point of junction with the chimney by leading them under the floor from one side of the room to another, as represented in Figure 5, D D. Those on the same side of the room as the fire-place may pass in any direction, as A, or have any angles or curves, as B. It may, however, be regarded as a rule, that the fewer its angles or curves, in passing to the long branch, the friction and obstructions being less, the ventilating power will be better preserved.

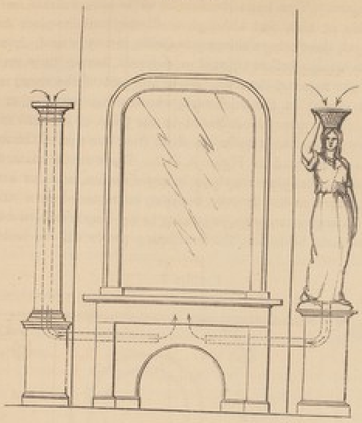
Figure 5.



Where it is preferable, or more convenient, the channels* may be in the interior of the room, either as columns or pilasters, or passing through ornamental figures, as represented in Figure 6, (page 8.)

* The channel constituting the short branch may be on the outside of the house where the chimney is in an outer wall, its lower extremity entering the chimney by being carried in through the brickwork to the proper place, just above the register valve of the stove, and its upper extremity entering the room through the brickwork at the required height; thus the receiving orifice *alone* being within the room.

FIGURE 6.



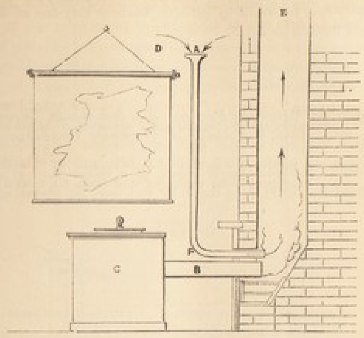
Ventilation where there is an ordinary Counting-house or other Stove, with the Smoke-flue passing into the Chimney, or ascending on the outside of the Building.

This requires that a receiving tube, A (Figure 7), sufficiently long to reach from the smoke flue, B, of the stove, C, to the upper part of the room, D, should form a communication with the chimney, E, by means of an angle or elbow, F, the elbow entering the chimney near to the entrance of the smoke flue of the stove, or in contact with it, and above or on either side of it, as may be most convenient.*

When there is no fire in the stove, then the communication with the chimney by the smoke-flue should be cut off by a damper, in order that the short branch, A, and long branch, E, may together constitute a continuous and unbroken channel or syphon.

* The receiving branch, A, might, if preferred, be carried down on the inside of the chimney, having its receiving orifice still opening by an elbow into the room, and its lower elbow in juxta-position with the termination of the smoke-flue of the stove within the chimney.

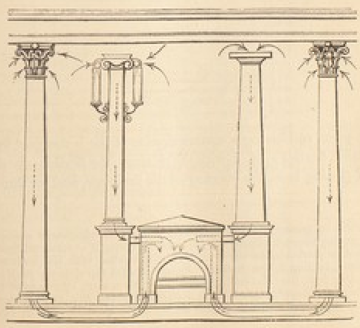
FIGURE 7.



Ventilation where there is a Fire-place with a Descending Flue into a Chimney.

These stoves, as represented in Figure 8, which perform so well their duty as grates in giving warmth, may have that of ventilating the

FIGURE 8.

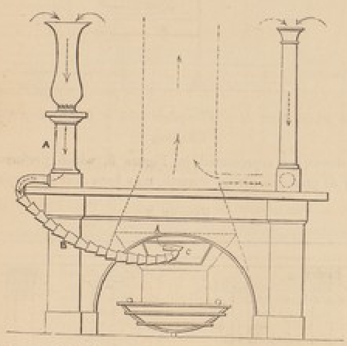


upper parts of the room superadded, a duty which, by suitable arrangements, they may be made to perform, whether they are at the time being used for fires or not.*

Ventilation for Temporary Purposes, as in Sick Rooms, Nurseries, or other Places, by Portable and Temporary Ventilators.

A portable ventilator might consist of a hollow channel or tube (represented in Figure 9 by the pillar and vase, A), placed upon the

FIGURE 9.



chimney-piece, and having a communication at the lowest part by means of a metallic, flexible tube, B, with the chimney; the flexible tube descending, and passing in at the opening of the fire-place, and up through the

* Channels or passages, either originally formed, or afterwards chased in the walls, or passing through pilasters or columns, or through ornamental figures, may descend and be carried under the floor, and be connected with the horizontal flues under ground, leading to the shaft or chimney, or with the chimney itself; or channels extending from near the ceiling down to the stove may, by means of openings, pass laterally or otherwise through the ironwork into the flue, or be otherwise connected with the smoke-flue. To any of the receiving channels, gas or other lights may be affixed.

aperture in the register valve, C, into the chimney. The bend or elbow, left visible in the Figure, might be carried up into the opening of the valve, and the tube might be suspended by it. The elbow does not interfere with the free passage of the impure air into the chimney.*

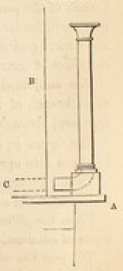
A portable ventilator might be also placed on the floor, in the form of a pillar, or of any other form, having similar means of communication with the chimney.†

When there is a fire in the grate, then the adjustment described supplies all that is necessary, but when there is not, then a chimney-board should be used, and the tube of communication might be inserted through an opening left in it for that purpose.

Ventilation by means of Rout-Forms, &c.

The forms may themselves constitute channels, or metallic or other channels may be fixed under the seats, these being made to communicate with each other, and the nearest to the fire-place with the chimney, by a tube or tubes for that purpose. Upright tubes, as represented (Figure 11), communicating with the channels in the forms, might be carried to the higher parts of the room, at any convenient parts, to receive and carry away the heated and impure air. When there is a fire in the room, they should be carried up into the chimney above the

FIG. 10.

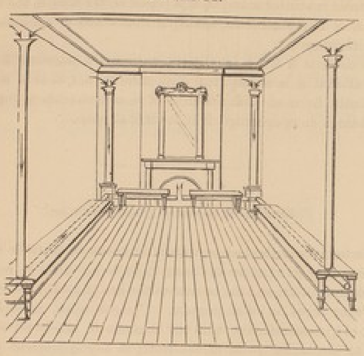


* Or an opening might be cut through the brickwork in the front of the chimney-breast, and fitted with a collar or socket, through which a communication with the chimney might be made by a portion of tube (to fit the collar), proceeding from the back part of the column represented in the diagram. An ornament might be made to fit the collar, so as both to close and to conceal the opening, should it be desired to remove the ventilator. Figure 10 represents a sectional view of such movable ventilator, with the tube of communication at the bottom of the pillar, and the collar fixed in the brickwork to receive it. A, the chimney-piece; B, the face of the chimney-breast; C, the collar in the brickwork.

† The modes may be various. Stoves may be cast with special arrangements for ventilation, admitting of the ready application of the portable ventilator. Chimney-pieces may be formed with a view to the same object, &c. The form of the portable ventilator might be varied, so as to suit any particular place or occasion. The place of the flexible metallic tube might be supplied by common metallic tube when convenient, having the necessary angles and joints. The size of the tubes must be determined by the dimensions of the room.

register-valve; when there is not a fire, a chimney-board should be used, with apertures in it, to admit of the necessary communication.

FIGURE 11.



Gas and other Lights so arranged that their Heat and Smoke are not permitted to diffuse themselves into the Apartment, and that general Ventilation is at the same time accelerated.

The fact that heated and even hot air descends through the shorter branch of the pneumatic syphon, and is discharged by the longer, supplies facilities for ventilation which admit of almost universal application, and a more positive or more useful example can scarcely be given, than in the effect of certain adaptations in connexion with the burning of gas.

The subjoined figure (12) represents, in the form of a pillar, the short branch of a syphon communicating with the long branch (the chimney) through a chimney-board.

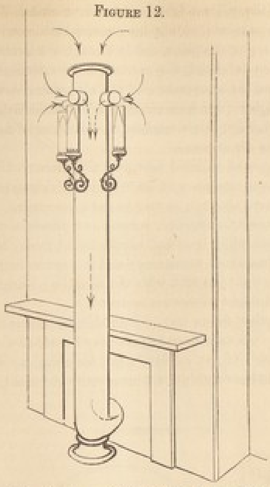
The figure is, however, a mere sketch of the first apparatus of the kind put into operation, in its crude state.

To this pillar, branches with Argand gas-burners are attached, furnished with the usual glass cylinder around each flame.

From the pillar, lateral tubes project horizontally, to receive the products of combustion as they escape from the top of the glass cylinder.

The position of each gas-burner is so arranged, that the upper edge of the glass cylinder, on that side nearest the pillar, shall be on a level

FIGURE 12.



with the lower edge of the projecting tube, and so *near* to its under edge as almost to touch it.

Under this arrangement, the current of air passing from the apartment, over the top of the glass cylinder into the projecting lateral branch (in the course indicated by the arrows), carries with it the heat and the noxious vapours (produced by combustion) through the projecting tubes to the interior of the pillar, down through which they descend, and pass to the long or discharging branch of the air-syphon.

The lateral projecting tubes may be placed on any part of the pillar—that is to say, on either side or around the pillar, and as much lower than those represented in the figure as convenience may require.

They may be in any number, according to the space afforded by the surface of the pillar on which to fix the necessary lateral tubes.

As the number is increased, and the temperature of the air passing down through the pillar becomes raised, the currents will be quicker, and the ventilating power exercised on the whole atmosphere of the apartment, as well as on the heat and vapour of each individual burner, will be stronger.

The top of the pillar might be opened or closed. When the top is opened, the currents of air take place, both down through the opening at the top of the pillar, and in through the lateral tubes.

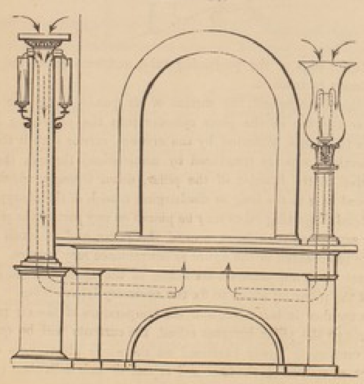
When the top is closed, the currents will be stronger through the lateral tubes, and the temperature of the air passing down through the pillar will be higher. Such an arrangement is particularly advantageous in shops, warehouses, large workshops, workrooms, &c., where large quantities of gas are consumed.

The advantages of radiated heat from the surface of the pillar may be had, or a non-conductor of heat might be employed to form the pillar, or be placed about it, as may be most convenient.

Where ornament is required, columns, or pilasters, or figures, may be made the descending branches, having lateral tubes, either visible or concealed in ornamental structures; and the descending branch might be made to form its junction with the ascending branch, or chimney, in any way that might be more convenient.

Burners of other forms may, by suitable adaptations, be used with similar results. A vase-shaped glass may be added to the short, or descending branch of the syphon, (thus becoming an elongation and portion of it,) and have within it a burner with the usual glass chimney.

FIGURE 13.



The necessary arrangements being made for supplying the burner with air, independently of the descending current, the heat and products of combustion descend with that current, and pass away.

By either of these arrangements, as represented above, with the lateral tubes on the one hand, or the vase-shaped glass on the other, not only are the products of combustion carried away, but the open orifices become ready and very *capacious* channels of active ventilation to the whole apartment.

NOTICES OF THE PRESS.

Literary Gazette, September 8th, 1849.—"*Important Discovery in Ventilation.*—The improvements are based on an action in the syphon. A more useful and important discovery has never been made, for the comfort and health of civilized man. We see no end to its application. There is not a sanatory measure suggested to which it may not form a most beneficial adjunct.—We have witnessed the experiments in various ways, with tubes from less than an inch to nearly a foot in diameter, and we can vouch for the fact being perfectly demonstrated. Light gas does descend the shorter leg when heated, and ascend the longer leg when the column of air is much colder."—Ed. *Lit. Gaz.*

Bell's Life in London, September 9th, 1849.—"*Free Ventilation.*—The *modus operandi* is on the principle of the syphon or bent tube—the new, or 'air-syphon'—by which this object may be most effectively secured. There is not the slightest ambiguity as to the principle of the action, or of complexity in the mechanical aids, required to give it full effect, and yet to see it in operation, it practically contradicts the commonly received notions of aerial circulation."

Lady's Newspaper, September 16th, 1849.—"Improvements in ventilating rooms and apartments, of the perfect efficacy of which we believe there cannot be a doubt—the improvements are based on an action in the syphon. It is easy to see how readily this can be applied to any chamber."

Illustrated London News, October 6th, 1849.—"*Patent Air-Syphon Ventilation.*—The advantage of every step in science, by which our knowledge is increased, even to the extent of one additional fact, is the almost certainty that it may be turned to useful account. A peculiar fact is, that this mode of ventilation affords facilities hitherto not known for carrying away the heat, and other products of combustion from gas burners, and other lamps of which the products are offensive. Again, wherever the 'air-syphon' ventilation is in operation, it is certain that should any accidental escape of gas take place, it will not accumulate, but descend from the upper part of the room by means of the syphon. The formation of the necessary channels appears to be compatible with the preservation of architectural ornaments. The applications of this important discovery will doubtless be very numerous."

Family Herald, October 6th, 1849.—"*New Mode of Ventilation, based upon the action of the Syphon.*—It is easy to see how readily this can be applied in a chamber, in order to purify its atmosphere."

Chambers' Edinburgh Journal, October 14th, 1839.—"A means of ventilating rooms and houses has just been patented, which promises great results. It is an application of the inverted syphon. If the instrument be generally available, we shall have obtained at last the long-desired possibility of breathing pure air within our habitations."

The Illustrated London Almanack for 1850.—"*Patent Air-Syphon Ventilation.*—The air-syphon ventilation admits also of being extemporaneously and temporarily set up in a sick room, so as to cause a constant removal of air from the upper portion of the apartment, where it is so apt to hang about the curtain furniture of the chamber, and to impregnate it with the exhalations, which are so often both the results, and generators of disease. This mode of ventilation affords facilities for carrying away the heat and other products of combustion."

Savill & Edwards, Printers, 4, Chandos-street.

EXPERIMENTAL RESEARCHES

ON THE

MOVEMENT OF ATMOSPHERIC AIR IN TUBES.

By W. D. CHOWNE, M.D.

BEING AN ABSTRACT OF A PAPER READ BEFORE THE ROYAL SOCIETY JUNE 21, 1855.

Communicated by John Bishop, Esq., F.R.S. Received June 14, 1855.

In the year 1847, the author of this paper made numerous experiments for the purpose of ascertaining what are the conditions under which atmospheric air is placed with regard to motion or rest, when within a vertical tube having one extremity communicating within the interior of a building, and the other in the open atmosphere.

The paper now submitted to the Royal Society contains the results of investigations undertaken in the year 1853 and continued to the present time, to ascertain whether the ordinary state of atmospheric air contained in a vertical cylindrical tube, open at both ends, and placed in the still atmosphere of a closed room, is one of rest or of motion; and if of motion, to investigate the influences of certain changes in the condition of the atmosphere which either produce, promote, retard, or arrest the movement.

He demonstrates, by a series of experiments, that when a tube, open at both ends, is placed in a vertical position, every precaution being taken to exclude all extraneous causes of movement in the surrounding atmosphere, an upward current of air is almost immediately established, and continued so long as these conditions are maintained.

The experiments were made in a room 12 feet square by 8 feet 6 inches high; the window and chimney being carefully secured, and all crevices closed, by pasting paper over them, the floor carpeted, the door double, and the inner door surrounded with list. The outer wall, having a north aspect, was so sheltered by surrounding buildings that the direct rays of the sun never fell upon the window. Discs of delicate tissue-paper were suspended in several parts of the room, to indicate currents of air, if any existed, and observations were taken only when these were perfectly quiescent.

Mason's hygrometer was first employed in these experiments, to test the presence of a current of air in the tube; on the principle that as evaporation produces cold, and as evaporation is increased by a current of air, the wet-bulb thermometer would show a greater depression if any current existed, than if the air were perfectly quiescent within the tube. The tube (fig. 1) was placed in the middle of the room, and isolated from the floor by a cylinder of thick glass laid under it.

It was found that in ninety-one observations of the hygrometer, suspended in the free air of the room, the mean depression of the wet-bulb thermometer was 3°·9 Fahr., while in ninety corresponding observations, with the hygrometer at the lower aperture, O, of the tube, the mean depression was increased to 4°·9 Fahr., clearly indicating the existence of a current of air within the tube.

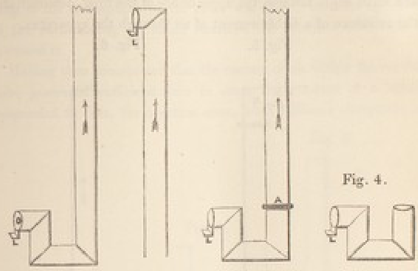
Partial closure of the upper orifice of the tube, by placing a piece of fine muslin upon it, produced a sensible influence on the hygrometer. In seventeen observations with the tube thus partially obstructed, the mean depression was 2°·5 Fahr.; but in an equal number of comparative observations, with the tube perfectly free, the mean depression was increased to 3°·12 Fahr.; showing a considerable diminution of the force of the current within the tube, as a result of the partial obstruction of its upper aperture.

Similar comparative observations, with the hygrometer placed at the upper aperture of the tube (fig. 2), yielded similar results.

In these experiments the lower extremity of the vertical tube was

bent thrice at right angles*, for convenience in making the observations, and it appeared desirable to ascertain what influence the long branch of the siphon-like tube had in the production of the cur-

Fig. 1. Fig. 2. Fig. 3. Fig. 4.



L. A ledge or step to place the hygrometer upon.
O. Orifice against which the bulbs were placed.

rent. For this purpose the long vertical tube (fig. 3) was made moveable at A, so that the apparatus could be alternately converted into a siphon with equal limbs 4 inches in length (fig. 4), or one with a short leg of 4 inches, and a long one of 96 inches (fig. 3). In twelve observations, when the long leg was inserted, the mean depression of the hygrometer was 2°·5 Fahr.; when the limbs were of equal length, 2°·25 Fahr.

Considering it possible that the current of air existing in the tube might have sufficient force to move a light body delicately suspended in its track, an elbow, E (fig. 5), was inserted into the upper orifice of the tube, to which a piece of glass tube, G, of the same diameter, was adapted, 6 inches in length, and a disc of tissue-paper, weighing one grain, which nearly occupied the area of the tube, was delicately suspended by a hair, at right angles to the axis of the tube. A slide valve was so adapted to the lower orifice, that this aperture could be opened or closed without entering the room. The air of the room being qui-

* The tubes used in these experiments were bent either at their lower or upper extremities for convenience merely.

escent, it was found that when the slide valve closed the lower orifice of the tube, the disc of tissue paper remained perfectly quiescent; but that when the slide valve was withdrawn, leaving the lower orifice open, oscillations of the paper occurred, and it was projected at a small angle towards the upper orifice of the tube, demonstrating the existence of a feeble current of air through the apparatus.

Fig. 5.

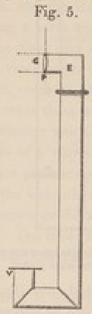
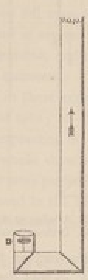


Fig. 6.



V. Slide valve. D. A disc which occupies nearly the whole area of the tube.

The preceding experiment having proved the existence of a current of air within the tube, of sufficient force to move a light body, the author next proceeded to ascertain the velocity of the current by means of an anemometer, in the form of a horizontal fly-disc, D, suspended within the lower orifice of a tube (fig. 6), bent twice at right angles below. The revolving disc was made of a circular piece of stout writing-paper, cut into twenty-four equal segments, from the circumference to near the centre, each of the segments being afterwards inclined at an angle of twenty-five degrees*, like the vanes of a windmill; so that when properly suspended, a current of air entering the lower orifice of the tube would cause the disc to revolve from right to left. The disc was suspended in the same manner as the needle of the mariner's compass, and by the same means.

* A nearer approach to an angle of 45 would have crippled the paper, so that it would not have preserved the horizontal position.

When the apparatus was arranged, the door of the room closed, and the atmosphere in a quiescent state, it was found that a constant regular rotation of the disc was established, and kept up by the upward current of air through the apparatus, and continued so long as the atmosphere of the room was quiet; but that agitations of the surrounding air either rendered the rotation uncertain, or reversed it.

Having thus ascertained that the current of air within the vertical tube possessed sufficient force to cause the rotation of a lightly suspended fly-disc, the question arose, what influence elongation or

Fig. 7.

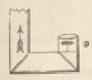


Fig. 8.

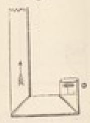
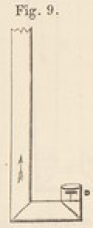


Fig. 9.

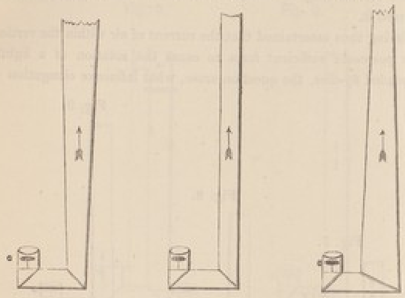


shortening of the tube would exert on the velocity of the current. For this purpose three tubes (figs. 7, 8, 9) of precisely similar construction, but with long limbs of 12, 24, and 48 inches respectively, were fitted as before with fly-discs, D, D, D, and placed near each other in the centre of the room.

In nineteen observations, the number of revolutions in the tube, with a long limb of 12 inches, varied from 0·75 to 4·5 per minute; in that with a long limb of 24 inches, from 1·5 to 9·0, and in that with the long limb of 48 inches, from 3·75 to 14·0 per minute. The gross number of revolutions in the three tubes, in the nineteen observations, were respectively 51·25, 111·25, and 199·75; and the mean revolutions per minute, 2·697, 5·855, 10·513, which, allowing for errors of observation, yield the ratios 1, 2, 4 nearly; so that it may be said that the velocity of the revolutions is in a direct ratio to the lengths of the vertical tubes.

The influence of the conoidal form of the tube being suggested by Dr. Roget as worthy of investigation, a tube (fig. 10), 96 inches long by 3 inches diameter below and 6 inches above, was fitted to a rectangular tube containing the rotating disc D. Another tube (fig. 11) of the same length, 3 inches in diameter throughout, was

Fig. 10. Fig. 11. Fig. 12.



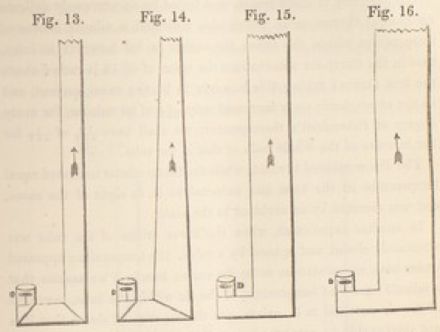
placed near the conical tube as a term of comparison. The revolutions of the disc in the conical tube were more rapid than in that of uniform diameter, in the proportion of 8·8 to 3·0. When the position of the cone was reversed (fig. 12), and the entrance and exit orifices were equal, the revolutions still continued more rapid than in the tube of uniform diameter.

To determine the influence of the area of the tube on the velocity of the current, four tubes (figs. 13, 14, 15, 16), 96 inches in length in the long, and 4 inches in the short branch, but varying in diameter, were placed in the room near each other and simultaneously observed.

In a tube of 3 inches uniform diameter (fig. 13), the revolutions were 3·0 per minute; in one of 5 inches (fig. 15) 9·15, and in one of 6·75 inches (fig. 16) 13·15; their respective areas being 7·065, 15·708, and 21·205. In the conical tube (fig. 14) on its base, whose area was 14·529, the revolutions were 8·8 per minute. It would seem, then, that the velocity has relation rather to the mean

area of the tube than to that of the entrance and exit orifices, as the latter were the same in the tube of 3 inches uniform diameter, and in the conical tube on its base, while the revolutions of the disc were 3·0 per minute in the former, and 8·8 per minute in the latter.

Fig. 13. Fig. 14. Fig. 15. Fig. 16.



When the exit orifice of the tube of 6·75 inches diameter was reduced to 3·5 inches, the rapidity of the revolutions was reduced only about 10 per cent.

The influence of temperature in accelerating or retarding the currents through the tubes next engaged the author's attention; but before entering into direct experiments, he found by very numerous observations, that on some occasions no appreciable difference could be observed in the temperature of the atmosphere of the room near the floor and the ceiling, while on others there was a mean excess of 0°·17 Fahr. near the ceiling without causing any perceptible difference in the velocity of the revolutions of the discs. In forty comparative observations of the temperature of the external surface of the tube (fig. 13) and of the surrounding air, that of the tube was 0·09 higher; in twenty-three it was equal, but in only five was it lower than the surrounding air.

Of thirty-six comparative observations of the temperature of the air within, and external to the tube, by a delicate mercurial thermometer, it was found to be slightly higher within the tube in twenty-seven, and in the remaining nine it was equal, but never lower than that of the external air. The greatest excess was 0°·4 Fahr., and the mean excess 0°·14 Fahr.

The accuracy of these results was tested by an extremely delicate differential thermometer, which also indicated a minute excess of temperature within the tube; the author is led however to infer, that in the thirty-six observations the mean of 0°·14 is rather above the true excess; taking this however to be the exact amount, and as the atmospheric air is increased only $\frac{1}{480}$ of its volume, for every degree of Fahrenheit's thermometer, we shall have $\frac{14}{100}$ of $\frac{1}{480}$ for the increase of the whole bulk of that in the tube.

The disc continued to rotate while the thermometer indicated equal temperature in the tube and external to it, in eight of the cases, and was arrested by an accident in the ninth.

In another experiment, when the lower orifice of the tube was alternately closed and opened by a valve, the temperature appeared under both circumstances to be the same; hence, if we assume that a minute excess of temperature of the air within the tube, over that of the air external to it, exists, yet the experiment shows that it is not attributable to any heat being disengaged by the movement of the air itself.

Increase and decrease of the temperature of the room exercised a considerable influence on the velocity of the rotations of the discs, which increased as the day advanced, and declined as the temperature fell towards evening, although the direct rays of the sun never fell upon the window of the room.

Partial exclusion of light, by a blind covering the whole window, produced a considerable reduction in the velocity of the rotations of the discs, but a screen of a foot in breadth, interposed between the window and an individual tube (fig. 13), merely reduced the velocity of the rotations from 12·5 to 11·0 per minute.

The influence of reduction of temperature of the long branch of the tube, by placing around it two coils of wet tape*, reduced the revolutions of the disc from 4·0 to 1·75 per minute; a third reduced the revolutions to 1·0; a fourth to 0·5; and a fifth caused complete cessation.

* Half an inch broad, and not so wet that any of the water ran away from it.

To ascertain the influence of the abstraction of aqueous vapour on the rotation of the discs, a shallow vessel, containing strong sulphuric acid, was placed, at the suggestion of the Rev. Dr. Booth, immediately below the disc (D), in the short branch of the tube (fig. 17). After the lapse of thirty minutes, the rotation had ceased altogether; at the commencement the disc was rotating at the usual rate. The same vessel, placed in the tube without the sulphuric acid, had no effect on the rotation.

In another experiment a bell-glass was suspended over the short branch of the tube (fig. 18), so that the short branch projected into it,

Fig. 17.

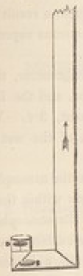
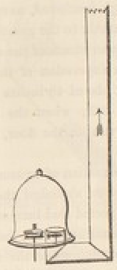


Fig. 18.



and a saucer (*s*), containing concentrated sulphuric acid, was also placed under the bell-glass, on a level with the orifice of the tube. The rotations of the disc were accelerated by placing the warm hand for a few seconds in contact with the long branch of the tube; but at the end of five minutes after it was withdrawn, and the room left and closed, the disc had ceased to rotate.

To determine the influence of partial abstraction of aqueous vapour from the entire atmosphere of the room on the velocity of the rotations, the three tubes (figs. 7, 8, 9), with long limbs of 12, 24, and 48 inches, employed in a previous experiment, were placed near each other, and three bushels of quicklime were spread in shallow vessels on the floor and other parts of the room. Before the lime was placed, the disc in the 12-inch tube was revolving at the rate of 0·75 per minute; that in the 24-inch tube at 2·0; and that in the 48-inch tube at 4·0 per minute. At the end of fifty minutes the rotation had ceased in the 12-inch tube, and was reduced to 1·75, and 3·5 in the 24- and 48-inch tubes. After seventy minutes, rotation had ceased in the 24-inch tube, and was reduced to 3·75 in the 48-inch tube. Finally, after ninety minutes, the rotations in the 48-inch tube were reduced to 2·75 per minute.

Similar reductions in velocity were observed after the removal and reintroduction of the quicklime in a second and third series of observations. Thus in all these experiments the rotations in the 12- and 24-inch tubes entirely ceased; and those in the 48-inch tube, although continued, were much diminished; a result most probably attributable to the greater quantity of aqueous vapour remaining in the upper strata of the air in the room.

The mean depression of the wet-bulb thermometer, the hygrometer being placed 48 inches above the floor, and the lime being absent, was 3·2; when the lime was present, 3·4. When the hygrometer was on the floor, the depression of the wet bulb was 3·5.

As the abstraction of aqueous vapour from the atmosphere diminished and even abolished the currents of air within the tubes, it was to be expected that increase of vapour in the atmosphere would produce the contrary effect, and accelerate the currents and the corresponding revolutions of the discs, and the following results coincide with that expectation.

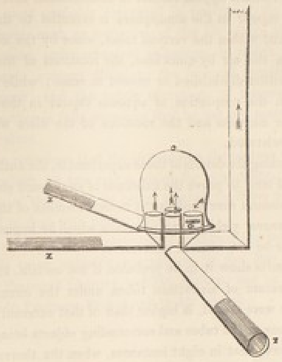
In the first experiment, the tube and bell-glass previously described (fig. 18) were employed, but substituting folds of damp linen for the saucer of sulphuric acid, so as fully to charge the air in the bell-glass with vapour, the rotations rapidly rose from 4·0 to 17 or 18 per minute.

But as the cold produced by the evaporation of the water in this experiment might be a source of fallacy, an arrangement was made (fig. 19) to supply the bell-glass with air, previously charged with vapour, formed at a distance of 5 feet from the glass. The rapidity of the revolutions was however still considerably increased.

Augmentation of the quantity of aqueous vapour, in the general atmosphere of the room, by spreading wet cloths on the floor and

other parts, also produced increase in the rapidity of the rotations, though to a small extent.

Fig. 19.



Z, Z, Z. Tubes containing wet linen within their remote extremities.

These experiments* would seem to demonstrate that the ordinary condition of atmospheric air within vertical tubes, open at both extremities, is one of continual upward movement.

If the atmosphere were a strictly homogeneous elastic fluid, and in a state of perfect equilibrium, any portion of it contained in a vertical tube would of course be perfectly stationary unless some adventitious cause produced disturbance of its equilibrium. But our atmosphere being a mixed fluid, and the aqueous vapour being of a much lower specific gravity at all atmospheric temperatures

* Throughout the entire series the results were carefully observed during the night, when the atmosphere of the room was free from solar influences. The dry- and the wet-bulb thermometers yielded the same relative differences, and the discs rotated with the same constancy. The night as well as the day observations were continued through all the changes of temperature, from March 1853 to the present time.

than the compound of which it forms a part, it is constantly rising within a tube, as in the free air; entering at the lower, and making its exit at the upper orifice of the tube.

The experiments appear further to demonstrate, that the presence of aqueous vapour in the atmosphere is essential to the production of the current within the vertical tubes, since by the abstraction of vapour from the air by quicklime, the rotations of the discs were invariably either diminished or caused to cease; while on the other hand, when the proportion of aqueous vapour in the air was increased, the currents and the rotations of the discs were simultaneously accelerated.

In concluding the details of these experiments, the author considers that they all tend to prove the existence of an upward current, under the circumstances described in the commencement of this paper.

They moreover yield a series of results which he hopes the Society will deem to be not without interest.

These results show it to be probable, if not certain, that the ordinary temperature of air within tubes, under the circumstances in which these were placed, is higher than of that external to them, all other relations of the tubes and surrounding objects being the same; they also show, that in eight instances, when the thermometers indicated an equality of temperature, within and external to the tube, the rotations of the discs still continued; and that when four coils of tape, moistened with water, were applied round the external surface of the tube, the rotations of the disc did not wholly cease.

They also show, that when the atmosphere of the room, in which the tubes were immersed, contained a larger or smaller proportion of aqueous vapour, all other things being equal, the discs revolved with more or less velocity; but that when the atmosphere was deprived in a great degree of aqueous vapour by the presence of quicklime, the thermometric state in all other respects remaining the same, the revolutions of the discs ceased.

Adverting to the indications cited above, of a minute excess of temperature in the interior of the tubes, and assuming that even that slight excess would be sufficient to rotate the discs, still the rotations diminished or ceased in proportion as the aqueous vapour was withdrawn.

Any increase of temperature which might have been produced by

the quicklime would have had a tendency rather to increase than diminish the revolutions of the discs, but we have seen that the abstraction of the vapour entirely arrested their rotation.

With regard to the specific influence of each of the circumstances and agents most probably concerned in producing the phenomena described above, such as protection of the air within the tube from lateral expansion and mechanical agitations, to which the external air is exposed; gaseous diffusion; the unequal specific gravity of air and vapour; and the subtle operations of temperature at all times, the author is fully conscious that he has not ascertained their respective values.

He is also conscious that the phenomena themselves are the chief ground on which he can rest a claim for originality, and that the explanation of them may be better treated by those who are more accustomed to deal with similar researches.

In the course of these experiments the author has been especially indebted for many valuable suggestions to the Rev. Dr. Booth, Dr. Roget, Professor Sharpey, and Mr. Bishop; and he is also under obligations to Professor Stokes and to Mr. Brooke.

[*From the* Proceedings of the Royal Society, June 21, 1855.]

NOTICE

ON

DR. VAN HECKE'S SYSTEM

OF

WARMING AND VENTILATION.

BY

W. WEATHERLEY PHIPSON,

CIVIL ENGINEER.

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1862.

DR. VAN HECKE'S SYSTEM OF WARMING AND VENTILATION.

The substance of this paper was read at the last meeting of the Metropolitan Association of Medical Officers of Health, Dr. R. Dundas Thomson, F.R.S., President, in the chair.

The Van Hecke System of Warming and Ventilation, already so well known on the continent of Europe, is now about to be introduced into England by Mr. W. Phipson, who has convinced himself of its manifest superiority over all other systems both in efficiency and economy, and who has assisted Dr. Van Hecke in the ventilation of many of the more important buildings that have been placed under his charge by the French, Dutch, and Bavarian governments. "The system of Van Hecke," says a great modern authority, "has completely upset all our ventilation traditions." Mr. Phipson shows that this result, the fruit of long and untiring labour, has been attained by the application of scientific principles and mathematical calculations by means of which the supply of air and heat are completely under control.

It is only of late years that ventilation has been at all understood or studied as a science; the most expensive, and at the same time most absurd, ideas and plans have been put in operation by men whose knowledge of mechanics and physics must have been extremely limited. None of them have succeeded. Indeed, it is impossible that such attempts, unguided by physical and mathematical knowledge ever can succeed. Where there is true science there is also simplicity. Nature our only guide is both simple and economical in all her works.

The advantages of the Van Hecke system may be concisely stated as follows:—

1. It affords perfect ventilation without draughts, the introduction of pure air *to any amount* being reduced to a mathematical certainty.
2. The air introduced is moistened, heated, cooled, all its quantity regulated, increased, or diminished at will, and every variation tested and proved.
3. It is capable of supplying the warm-baths and vapour-baths in hospitals, which it warms and ventilates.
4. Its simplicity, and
5. Its economy.

Mr. Phipson illustrated his paper by plans of the Chambers of Representatives of the Hague (Holland), the Hospital Necker of Paris, the Asile Impériale of the Vesinet, and several large buildings warmed and ventilated on the Van Hecke principle; the success of which in these buildings had been reported upon by some of the ablest men of the day.*

Before describing the apparatus which appears so simple, we should state, perhaps, that the success of the operation depends rather upon the manner in which it is disposed and made to work, than upon the apparatus itself.

The fresh air taken in at an appropriate spot in the garden or court of the hospital or other building, is propelled along an air channel by means of a peculiarly constructed fan, patented by Dr. Van Hecke, into an air-chamber, containing a warming apparatus where it is warmed and moistened, and from whence it is distributed over the building. An anemometer and dynometer placed before the fan indicate at any moment the exact amount of air supplied to the building. The amount in hospitals is 2200 cubic feet (*minimum*) per bed and per hour, but it is capable of being doubled if requisite. The vitiated air escapes through flues constructed for that purpose in the walls and having free access to the external air. That the pure air is introduced without any perceptible draught has been frequently tested by observers curious to note that point. Around the air-grating in the ward of an hospital, for example, the flame of a candle remains motionless. The exit-orifices for the vitiated air are placed near the floor and near the ceiling. The former are used in winter, the latter in summer; thus economising heat in winter, the vitiated air escapes from that part of a ward where the temperature is always lowest. Not the slightest current of air can be perceived within a yard of these openings. The thermometers in all the wards of hospitals ventilated and warmed by Van Hecke at Paris, stand constantly in winter at 60 deg. fahrenheit.

The quantity of air employed to warm being so considerable, it is not necessary to elevate its temperature to a high degree; it is, therefore, never *burnt*: moreover, a special vessel of water is placed in the warming apparatus to give to the warmed air its proper degree of moisture. On entering the wards the air is generally about 98 deg. fahrenheit.

The heating chambers vary in number according to the requirements of the building. Enclosed in each is a warming apparatus consisting of a cast-iron cockle from the summit of which depart a series of sheet-iron smoke flues which, circulating round the cockle, conduct the smoke to a chimney. Thus the heat of the waste smoke of the warming apparatus is almost completely utilised. In the same manner the waste

* Dr. Pettenkoffer, Dr. Grassi, Dr. Max. Vernois, M. Blondel, General Delprat, &c., &c.

steam from the small steam-engine which works the fan is utilised for warm baths and vapour baths.

In the Hospital Necker, Dr. Van Hecke's apparatus supplies with hot water (by means of the waste steam) 134 baths per day; before his apparatus was installed, the hospital consumed three and a half tons of coal per month for the sole purpose of warming 100 baths.

The quantity of air supplied to the building is determined at any moment in the following manner:—A counter in communication with an anenometer placed before the fan indicates the number of revolutions performed by the former. To know the volume of air injected in a given time, we must know the volume corresponding to one revolution of the anenometer. For instance, in the following example, this co-efficient was found by experiment to be 1·8 cubic metre; the strokes of the engine per minute were forty-five in number, the revolutions of the anemometer 164; the volume of air supplied in one minute 296 cubic metres (1 cubic metre being equal to 35·316 cubic feet), or in one hour 17,760 cubic metres, which volume, in the example before us, being distributed to 180 patients, gives 98 cubic metres per hour per patient. 51 strokes of the engine gives 117 cubic metres of air per hour, per bed; and 60 strokes, or 1 stroke per second, 132 cubic metres of fresh air per hour per inmate. So that this tiny engine (about 1½ or 2-horse power), working at only one stroke per second, will supply 4,620 cubic feet (English) of air per bed per hour—a quantity more than double that required in ordinary circumstances.

The immense power of this simple apparatus, so clearly shown by the above figures noted at the Hospital Necker, is again seen in the following curious experiment made at the offices of the journal, *Le Moniteur Belge*, of Bruxelles, where the Van Hecke system is employed. In this experiment the fan by reversing its motion, was made to *extract* the air instead of propelling it into the building:—A quantity of saltpetre paper and damp hay was burnt in the centre of the rooms and a dense smoke created. The apparatus being set in motion, the rooms measuring 39,690 cubic feet were *completely* freed from smoke in *fifteen minutes*. During that time 774,600 cubic feet of air were extracted, and the temperature only fell one degree. In a second experiment precisely similar, it was endeavoured to clear the rooms by the ordinary method of opening the windows; notwithstanding the draughts thereby produced, and a fall in the temperature of nearly two degrees; a *small portion* only of the smoke was dissipated *in thirty-seven minutes*.

After this the windows were closed and the ventilator set in motion directly,* when the rooms were entirely cleared of smoke in eight minutes without lowering the temperature. The Commission then tested for draughts and proved by lights carried through the rooms while the ventilation was active, that the flame preserved its vertical direction everywhere; it was necessary to bring the candle within twenty-one inches of the openings to obtain the least deviation.

One kilogramme (2¼lbs) of coal will renew, by Van Hecke's apparatus, 86,065 cubic feet of air. In other systems previously employed in Paris 2lbs. of coal will only renew 35,000 cubic feet of air. In the heat of summer the temperature of the air injected is cooled about eight degrees fahrenheit below that of the external atmosphere, by means of a refrigerator of simple construction placed near the fan.

We will now turn to the economical side of the question. And first of all let us remark that by the regulated flow of fresh air of required temperature properly moistened, and admitted without perceptible draughts, wards comparatively low are rendered more healthy than those not ventilated but built very high, at great expense, in order that the inmates may have as much air as possible. Thus in the Asile Impériale du Vesinet the projected heights of 14 feet 7½ inches, was reduced, when the Van Hecke system of warming and ventilation was adopted, to 11 feet 4 inches, thus effecting a saving of upwards of £10,000 in the erection of this hospital. This is easily conceivable, for by the mechanical ventilation the supply of pure air is furnished faster than vitiation is produced, and the vitiated air forcibly expelled; and this no *natural means* can by any possibility effect, however lofty and expensive the rooms, without great draughts (which are fatal to invalids), or what is termed a "*flushing of the wards.*"

The cost of the establishment and maintenance of the different systems of ventilation and warming successively used in Paris, have been determined by the French government, whose figures Mr. Phipson produced from its reports. A great effort was made by one of the commissions to ascertain the cost of the *unit of warming and ventilation*, whereby the different systems might be compared. By this is meant the price of a cubic metre of ventilating air supplied during the whole year, per hour and per bed, the air being properly warmed in the winter. The following is the price of this unit:—

	f. c.		s. d.
For the System of M. Duvoir	3 36	or about	2 9¼
" " MM. Thomas et Laurens	1 76	"	1 5¼
" " Dr. Van Hecke	0 64	"	0 6½

* That is with its ordinary direct or propelling motion.

In hospitals where the Système Van Hecke is established in Paris, the warming, ventilation, and hot baths cost 25f. 27c. per patient per annum; whilst in La Pitié, l'Hotel Dieu, la Charité, and other hospitals, *the warming alone* without ventilation costs 27f. 02c., 25f. 87c., 22f. 80c., &c.

Thus, in Paris where fuel is dear, to warm and ventilate by Dr. Van Hecke's system costs exactly £1 sterling a year per patient. This must not be taken for the cost of warming and ventilating each patient *in England*. It is obvious from the moderate price of fuel in this country, that the cost here would oscillate from ten to seventeen shillings, according to the advantages presented by the buildings, the locality, &c. Now Mr. Phipson has found that in provincial towns where fuel is cheaper than in the metropolis, the *warming alone* (often unsatisfactory) amounts to about fifteen shillings, and in London from twenty to twenty-seven shillings.

As regards the outlay for installation it depends much, of course, upon the disposition and requirements of the buildings, we can only state in general terms that for hospitals it averages from £3 to £7 per bed, and for schools, courts of justice,
10s/ prisons, &c., from ~~£1~~ to £2 per inmate. These are, indeed, moderate figures for so efficacious and successful a system when compared with the expense of those already experimented with in England, where the cost of installation has risen as high as £20 and £30 per bed.

The following is a list of the principal buildings where the Van Hecke system of warming and ventilation may be seen in operation:—

Hôpital Beaujon, female block, 60 beds.
Hôpital Necker, Paris, men's block, 180 beds.
Asile Impériale du Vesinet (near Paris), 350 beds.
Hôpital de la Croix Rouge, Lyons, 200 beds.
Hôpital de Châtres, Châtres, 200 beds.
Chambers of Representatives, the Hague (Holland).
State Libraries, The Hague.
The Students' University Club, Leyden (Holland).
Parochial Schools, Nivelles (Belgium), 500 children.
Printing Offices of *Le Moniteur Belge*, Bruxelles.
Club of Commerce, Bruxelles, &c., &c.

In construction:—

Hôpital de St. Antoine, Paris (500 beds ?)
Hôpital des Incurables, }
Hôpital de St. Charles, } Amiens.
Hotel Dieu, }
Hôpital de Nivelles (Belgium).
Hôpital de Rotterdam, &c., &c.

The diagrams on the opposite page will serve to illustrate this paper.

At the conclusion of this Paper the President of the Association, Dr. R. D. Thomsom asked if any member present desired to make any observations upon the interesting paper they had just heard.

Mr. Chadwick, C.B., rose and gave an account of the economical manner in which the warming and ventilating of hospitals was conducted in Paris, insisting upon the importance attached to these subjects by the French government. Having visited the Paris hospitals previous to the introduction of the Van Hecke system, he could only speak of that of M. Duvoir, which already surpassed anything of the kind in England. He would ask Mr. Phipson if he was acquainted with the system referred to, and if so, what comparison it held in reference to the Van Hecke system.

Mr. Phipson, in reply to the learned member, stated that he had made himself thoroughly acquainted with the different systems of ventilation and warming employed in Paris previous to that introduced by Dr. Van Hecke; and, as Mr. Chadwick had stated, the system of M. Duvoir appeared to be the best of them, though it had neither the power, nor the economy of Van Hecke's system as the author showed by referring to the government reports he held in his hands.

Dr. Greenhow congratulated the meeting upon hearing so important a subject discussed, dwelling upon the great want Van Hecke's system appeared calculated to supply. He drew attention to a large manufactory recently visited by him, and which was ventilated upon a principle somewhat similar to that explained by Mr. Phipson, and he was glad to be able to state, after repeated visits to that manufactory, that it was the best ventilated place he ever entered.

Dr. Lankester stated that he had witnessed many systems of mechanical ventilation in operation, and that in all, without exception, some important point appeared to have been omitted. In the system before him, however, he saw everything that could possibly be desired. He would only recommend that in such towns as London and Manchester, the air for ventilation should be filtered.

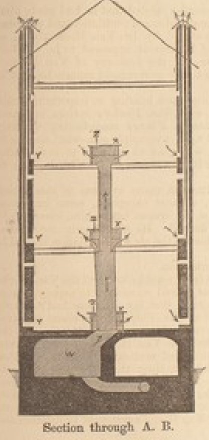
Mr. Phipson stated that such was his intention.

Dr. Sanderson then rose and said that from what he knew of the Van Hecke system of ventilation and warming, it was indeed calculated to supply a great want; he thought he might venture to state that Mr. Phipson had scarcely done sufficient justice to the system which he (Mr. Phipson) was about to introduce into England. He could not too strongly draw the attention of the members present to the circumstance that the Van Hecke system had been investigated by some of the highest scientific and medical authorities, and that the extremely favourable reports brought before them that evening were made by several European governments, so that we are forced to look upon them as the most authentic and satisfactory documents. He would also state that upon his (Dr. Sanderson's) recommendation, a committee was now sitting to discuss the question of introducing Dr Van Hecke's system of ventilation and warming into St. Mary's Hospital.

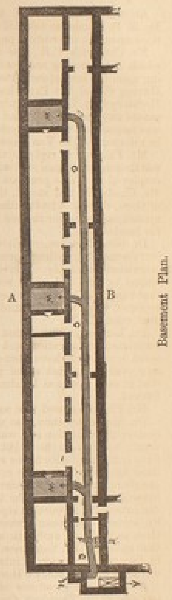
After various questions of detail from several other members, and at the proposal of the President, the thanks of the meeting were unanimously voted to Mr. Phipson for his interesting and valuable paper.

10, Salisbury Street,
Strand, W.C.

MEN'S BLOCK
(180 Beds)
HOSPITAL NECKER,
PARIS.
Warming and Ventilation System
Van-Hecke (patent).



Section through A. B.



Basement Plan.

Description of Plans.

H. Entrance of air, propelled along the air channel G. G. G., to the air chambers containing warming apparatus, W. W. W., by the fan F., worked by engine E.

X. X. X. Are the entrance of the air to wards after having been warmed and moistened.

Y. Y. Y. Are the escape flues, vitiated air.

A. Boiler for engine, and hot water for baths.

Before fan is the anemometer to indicate the amount of air supplied.

Z. Z. Z. Are used to keep things warm, having a partition in the middle, and also used as a table.

Dr E. A. Parks.
&c &c &c.
Rochester.

E. A. Parkes.

ALE, WINE, SPIRITS, AND TOBACCO.

A LECTURE

DELIVERED BEFORE THE

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BY

JOHN BARCLAY, M.D.

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ADVERTISEMENT.

This Lecture is published at the request of many friends, who desired to see a more full account of the views I propounded than it was possible for the necessarily condensed, and in some instances, accidentally inaccurate newspaper reports to convey; and because it has been represented to me that a common-sense view of the question is much called for at present, which this Lecture may perhaps help to supply.

Another and the most cogent reason for publication is, that as a strenuous and uncompromising advocate of true Temperance, I believe and trust it may tend to promote that cause, and to strengthen the hands of those who, along with me, lift up their voice against our national sin of intemperance, and labour to promote habits of sobriety among all classes.

In writing on such a subject after the perusal of much published upon it, it is almost impossible not to borrow the ideas of others. Wherever I have quoted the words of any author, I have sought to acknowledge it, but if it should be found that any instances have escaped me, they have done so unintentionally.

The Newarke, Leicester,
Feb. 1st, 1861.

ALE, WINE, SPIRITS, AND TOBACCO.

Mr. President, Ladies, and Gentlemen,

A little more than ten years ago, I did myself the honour to occupy your attention with a paper entitled *Alcohol Philosophically Considered.* You received me then most kindly, and my views, if not acquiesced in by those whose opinions I combatted, were applauded by many. If I may judge of the force of my arguments by their explosive effects, they must have been strong indeed, for I was challenged by some orator to a public discussion, I was roundly abused in a pamphlet, and sneered at as an encourager of vice.

Ten years, as I say, have elapsed, and I am not aware that any one has, during that period, come forward on this platform to advocate the other side of the question, and I need hardly add, that it is only here that any discussion raised before this Society can with propriety be continued or concluded. In those ten years this audience has, of course, considerably changed; in them science has made some advances, and some pseudo-science has been exposed and its fallacies refuted; in them my own experience has been increased, as well as that of others; in them a new scheme, that known as the Maine Liquor Law, has been propounded and advocated.

I feel that my former lecture was to a certain extent misunderstood, or at any rate that I was misrepresented. Perhaps I did not dwell with sufficient force on the crying evils consequent on the abuse of stimulants, and I think, even if I fail in producing any novel arguments,—if I fail in investing the subject with much interest, or in delivering a very enlivening lecture, still the matter of it is of such vast importance to us all, to the rising generation, as well as to those whose opinions are already formed, that, though with some diffidence, I request your attention to the stimulants I have enumerated, their use and their abuse.

I desire to do all honour to those who consider it their duty to set an example by total abstinence; I desire to acknowledge the vast benefits that have accrued, from their efforts, in the reclamation of the inveterate drunkard, and to insist on it, even more than I did on a former occasion, that the only probably successful remedy for that form of insanity which consists in the irresistible desire for strong drink, is to be found in total abstinence from the temptation; but I am as far as ever from advocating this as proper for persons of sound mind; as far as ever from any desire to deny to the respectable mechanic or workman his glass of beer; as far as ever from thinking that total abstinence can be substituted for moral self control, or for that temperance which is enjoined, not only in drink, but in "all things."

When your reverend and talented President asked me to contribute a paper during his tenure of office, it happened that my attention had been just then specially drawn to the subject of disease produced mainly, if not entirely, by the abuse of drink; and such cases do cause the medical man to feel the most sad sorrow. I hope to be able to show you how much we are improving as regards this vice of drinking; but yet, how many have you and I seen, who had youth, who had every worldly prospect before them, who had all that riches could purchase, or a cultivated taste command,—sink into untimely graves, the victims,—it is not fair to say, of the bottle—but of their own vicious and depraved and uncontrolled desires!

Another reason for just now inveighing against the abuse of stimulants is, that the last few years have given, if not birth, form to a new medical heresy, for it deserves no better name, and that

in high quarters. It is well known that all disease has undergone, in the last forty or fifty years, a great change of type; that whereas formerly, in congestive and inflammatory diseases, the full pulse demanded of us frequent blood-letting, and long delay in having recourse to tonics and stimulants, it is now most seldom that one finds inflammation acute enough to call for the abstraction of blood. Our fevers especially have put on that adynamic or feeble type, which calls for the early administration of ammonia, of wine, of brandy, and which is cured by those means,—that is, the patients are kept alive by them, and are so enabled to work off the disease by the different excretions. But the late Dr. Todd, an eminent physiologist, as well as successful physician, introduced a system of stimulation of *all* disease; not only that of exhaustive and debilitating character, but of acute and inflammatory type.

To show you that I am really in earnest in the matter, I will read to you one sentence of a communication that I sent in September last, to one of the Medical Journals:

"I consider the system of indiscriminate use or rather abuse of stimulants, has done more harm than good; for the profession in this country was already well aware how useful, in rational doses, at rational times, was alcohol in all its forms. Alcohol can no more cure all diseases than any other drug. A system of stimulation is no better, as a panacea, than a system of globules or hydropathy,—nay, it is infinitely worse, for it is infinitely more dangerous. There are those that I have met with in my little experience who have to curse the day they were advised by high medical authority to use stimulants to excess; . . . there is such a thing as rational treatment of disease; there is such a thing as cutting short disease by depletion, judiciously employed; there is such a thing as the rational use of all forms of stimulation, when the disease, or rather the constitution, calls for it; there is such a thing as hastening or producing death by the indiscriminate abuse of a powerful remedy; there is such a thing as moral responsibility." *

This heresy, as I call it, is one which is, unfortunately, acceptable to many patients, and is likely to be productive of most dis-

* Medical Times and Gazette, 1860, vol. ii. p. 342.

astrous results, both to rational medicine and to science; but it is only a fresh example of the truth of the axiom that 'demand will ever create a supply.' The public *will* always have something of this kind on hand: since the earliest dawn of medical science it has been so: anything that claims a little mystery in its operation, or a little of the supernatural, or a spice of evil, such as the sorceries of "wise women," (at Wing, for instance,) or spiritual mediums and spirit-rapping, is sure to draw away a certain, and a very considerable number of followers. In our own day, I need only refer to metallic tractors, to St. John Long, to Mesmerism and all its sequences, to the inanities and the inconceivable absurdities of Homœopathy, to the national institution of Holloway's Pills and Ointment, and the "British College of Health" for Morrisonian propagandism. We have also, in our day, educated people seeking help from illiterate and ignorant herb-doctors, and Hydropathy applied, as a system, to all diseases. The last of all the newest novelties is the Turkish, or rather the Roman Bath,—a most elegant and useful hygienic appliance, but almost sure to be travestied into some quackery by and bye.

In the same way, indiscriminate stimulation, as a system, in the treatment of all disease, of whatever type it may be, must be denounced as medical heresy and quackery. It is indeed in disease, even more than in health, that the beneficial effects of wine and other stimulants are seen, but they must be used with discretion and with discrimination:

"In medio tutissimus ibis."

All persons who have delivered themselves over to the power of the demon of drink,—the demoniacs, the insane, as I call and consider them,—are anxious to find some well-sounding excuse for their lapse, and none is more frequently, or I believe more falsely put forward than this, that "the doctor ordered it," during a fever, or after a confinement, as the case may be. Probably to this very order of the doctor do such people owe that life which they have since prostituted to this vile propensity.

There is no more noble, no more glorious position for a man of science than that of a physician by the bedside of fever, when life is balanced in the scale against dissolution, when he can take, as it were, the disease in his hand, and pouring in the wine and brandy, save the life of a fellow-creature. As I have often said in the Fever house, "such cases are worth living for." My profession has been called a *God-like* one, it is never more felt by oneself to be so, than on such happy occasions.

Mrs. Wightman of Shrewsbury, the authoress of a little book you have many of you seen, entitled *Haste to the Rescue*, a collection of thrilling anecdotes of the results of her noble efforts for the reclamation of the drunkards in her husband's parish, says:

"Is it not a fact that in *nearly every case* when any man consults a medical man, beer, wine, porter, ale, brandy, rum, whiskey, are among *the first things recommended to him?*"

I answer in the name of all scientific medical men, most emphatically, No! It is only when we know it to be needful that we advise any stimulant at all, and in very many cases we prescribe total abstinence both from stimulants and tobacco: you will be surprised perhaps to hear, by and bye, *how* often.

I fear some of my teetotal friends will be disappointed when I say that the whole of my arguments against universal, and especially against enforced abstinence, rest upon the distinction between the use and the abuse. It is the mistake of not observing this distinction which runs through the whole of their system; a sophistry, I must call it, which illogically lays hold of facts resulting from the abuse, and turns them against the use; or that says, without proper grounds for the assertion, that the use invariably, or in the great majority of instances, leads to the abuse. I have dipped largely into teetotal literature (I must here remark that I use the word *teetotal* in no offensive sense, or as a nickname, but merely as the shortest word available) and I find that all the writers found their main arguments on the *abuse;* at whatever point they begin, and however strong their assertions that it is the *use* that is pernicious, within the limits of a few paragraphs they are sure to be arguing solely on the abuse.

Again, they assert as I have just said, that the use *invariably* results in the abuse. Is there no one moderate? Am I not, are you not? They speak of the "one fatal glass of beer or wine,"—are you never content with one? Do we not,—I speak in the name of all moderate and sensible men and women,—go on from year to year, with a stated and occasionally varying allowance, without ever feeling the desire for increasing our potations? Does one drink double one's allowance at twenty when one comes to be forty? or am I to find myself inclined to treble it, if I live to be sixty? No, surely not,—not any more than one increases one's cups of tea or coffee. They are only other forms of stimulants; the effect of theine and caffeine, the alcohols, I may call them, of tea and coffee, is that of stimulants and intoxicants,—but who ever heard of any body going on to six or seven cups of tea because two are refreshing? But, just in the same way as we find an extra cup of tea of use, when anxious to keep off sleep while watching, it may be, at a sick bed, or as a suitable refreshment, which does not impair the appetite, so there are times when a little extra allowance of beer or wine or spirits is the most agreeable, and so the most beneficial form in which the necessary stimulant can be taken, and, I may add, with no more risk of its resulting in disgusting debauchery in the one case than in the other.

I have stated that we are, not only here, but everywhere, very much improving, as regards habits of intemperance. The police statistics prove it, as is seen in Tables I. and II.

TABLE No. I.

Leicester. — Police Cases of Drunkenness.

Year.	Males.	Females.	Total.
1848	421	43	464
1849	358	49	407
1850	373	57	430
1851	333	43	376
1852	283	36	319
1853	262	31	293
1834	302	36	338
1855	262	32	294
1856	283	39	322
1857	269	46	315
1858	240	41	281
1859	269	30	299
1860	185	45	230

It is a curious fact that the women do not seem to improve, but the whole 45 are probably made up by some half-dozen drunken characters who appear over and over again.

TABLE No. II.

Proportion of Police Cases of Drunkenness to Population.

All England	1 in 222
Leicester, 1848	1 in 124
„ 1860	1 in 302
Edinburgh *	1 in 23

* Some years ago.

Now, to whom is this improvement due? Again, I would do all honour to the efforts of the total abstainers—I would give them credit, and no small credit it is, for almost the whole of the 234 fewer cases brought to the Police Office during the year 1860. But there is also an improved state of matters among the upper classes, and those who do not figure on the Police Sheets. This there are no statistics to prove, but I would appeal to every one who goes into society, in confidence of my statements receiving confirmation. The progress may be slow, but it is steady, and there is much less indulgence, not to speak of excess, *now*, than there was twenty years ago—very much less than there was forty years ago—and very very much less than there was sixty years ago. Now, to whom is this change due? I say most emphatically not to the teetotallers, but to us moderate men—to the temperate, not to the total abstainer. The example of the latter is as nothing, in the rank of life of which I am speaking, when compared with that of the man who shows his "moderation to all men."

It is not for me, it is for no man, to condemn those who feel that their duty is to abstain entirely. We know that such vows were taken at a very remote period of the history of the Jewish nation. The vow of the Nazarite is as lawful in its entirety, under the Christian dispensation, as it was under the Jewish; nay, any father may impose such restrictions on his children as Jonadab, the son of Rechab did; only, let the story of Sampson remind him of the awful responsibility of his act. And so, when we are told by missionaries, and especially by female missionaries, often ministering angels, that, among the heathen of our towns they find it a powerful means of dealing with drunkards to be able to say they themselves are under a vow,—most heartily must all good men and women wish them God-speed; only, let them not hastily conclude that what is good for them, is, of necessity, good for all whose callings are wholly other, and who have a liberty that is not depraved into licentiousness. That very same argument which is powerful when used by a missionary to a poor debased drunkard, would, from the lips of a doctor, only lead a rich man to consider his physician a fool.

Before going further, I feel it to be quite necessary that I should let it be clearly understood how fully I admit the evils resulting from the abuse of drink, and how emphatically I condemn it in all its forms. Judges, magistrates, gaol chaplains, all concur in stating that drunkenness is the main source of crime, even to the extent of three-fourths of all offences. It is also a source of much wretchedness and misery and poverty; and when I tell you that, in 1859, coroners' inquests were held on 306 persons—206 males

and 100 females, who died from actual excessive drinking, it is plain that much disease is also attributable to this degrading vice; for if 306 died, how many more must have drunk to excess, so as to produce serious, yet not fatal results? I will yield to no one, teetotaller or Maine Law advocate, in the emphasis with which I condemn all this disgusting and brute-like sensual indulgence—the just judgment for which comes speedily on the head of the drunkard.

The drinking customs of society, especially among the lower upper classes, are one most fertile source of evil. When a gentleman buys a horse, he never thinks of confirming his bargain over a glass, but the horse-dealer invariably does. When a child is born, when a daughter is married, alas! when even a parent is buried, drink, in the lower and upper-lower classes, is the invariable accompaniment of congratulation or condolence. Again, the paying of wages at night and on Saturdays is a constant and an easily remedied source of evil. Among workmen themselves, there are rules and regulations of the greatest tyranny,—footings and fines, as they are called, that are even unknown to their masters, and are a most infamous means of debauching the young and inexperienced, who are most frequently the fined as well as the ruined.

Sick clubs have been, rather unjustly, accused of doing harm by the convivial terminations of their meetings, which are necessarily held at public-houses. Against the risk of excess there is the very powerful, very salutary influence of the presence of the other members of the same club, of those who would have to pay in cases of illness; and all that I have ever personally seen of sick-club meetings have been perfectly correct. We must not forget, in passing judgment on others, what a vast difference there is between the classes of society, as regards refinement either of language or manners, while the honest and upright man may perhaps be even more frequently met with in that class whose manners are the roughest.

The holding of festivals has been a human phenomenon ever since men had daughters to marry, or prodigal sons to return safe home, and the exhilaration from a moderate allowance of stimulants on such occasions is justifiable, but excess is a sin. The difference is as marked as that between water, the warmth of which is agreeable, and boiling water, which will scald the experimenter. So with stimulants. Beneficial to many—certainly not to all—in moderation; the excess is poison. But to argue against the use, from the existence of the abuse, is illogical, as truly in the case of the wine as in the case of the water.

If the arguments of the advocates of universal and total abstinence are in one point illogical, in now proceeding to deal with the physiological aspects of the question, I fear I must try to show that their facts on this part of the subject, are fallacies. But above all, and fatal in its results, to any thing like general success among the educated classes, has been the mistake they have made in attempting to deny the beneficial effects of stimulants in moderation—and that under all circumstances. Dr. Carpenter's assertion, that

"Even in the smallest and most diluted doses, alcohol exerts an influence on the vital properties of the tissues with which it is brought into contact, that is never manifested by proper alimentary matters,"

has been contradicted even by himself, and has been assumed to mean a great deal more than the words strictly convey. It has been a mistake to attempt thus to deny what the great majority of mankind know and feel from their own experience, to be a truth—such a truth, that the desire for some form of alcoholic stimulant may be almost denominated an *instinct*. Hear what the editor of the *Band of Hope Review* states:

"That, of 500,000 in the United States who had taken the solemn vow of abstinence, 350,000 had broken it."

Truly has this been characterised as "an awful outburst of nature." What other solemn obligation has ever been thus overruled by what I am justified in calling an instinct? The truth which the 350,000 vow-breakers testify to is that which modern philosophical investigations *prove*, that alcoholic drinks in modera-

tion, are real savers of food, and indirect producers of vital force, and are thus to be considered as "proper alimentary matter."

We have several other instances of an almost universal instinctive desire on the part of human beings, such as that for tea, and its congeners, coffee and chocolate. These are all stimulants on which we spend twenty-six millions sterling annually. Without the aid of physiological chemistry, we should suppose that this sum was expended on a mere gratification of the palate, and that just as much food is necessary without them as with them; but what is the fact? The German physiologist Böcker finds from experiments most carefully conducted, that the effect of tea is precisely analogous to that of alcohol in moderation; that

"When the diet is insufficient, tea limits very much the loss of weight thereby entailed;"

that

"When the diet is insufficient, the body is more likely to gain weight, when tea is taken, than when not."

Again, Dr. Julius Lehmann finds that coffee

"Raises the activity of the vascular and nervous systems, and protracts remarkably the decomposition of the tissues."*

This is therefore the secret of the desire for tea or coffee, so universal among all nations of any rank in civilization,—a knowledge, by experience, of benefit derived from their use, and now proved to be physiologically correct. And they too are liable to abuse—many a gouty man, who cannot afford to have the metamorphosis of his tissues thus arrested, suffers for years from his tea and his coffee, till he comes across a doctor who is a physiologist as well as a physician, and who reduces him to water alone.

Salt is another substance the craving for which exists not only among men, but among graminivorous animals, who will travel many hundreds of miles to a "salt lick" and depends on an occult physiological effect. It is a solvent of the albuminous

* Medico-Chirurgical Review, 1854.

matters in the food while in the stomach, so that they pass more readily into the circulation. But again, taken in excess, it produces exactly the converse effect of alcohol and tea, and favours the metamorphosis of the tissues, the extreme results of which are known as scurvy. It creates a necessity for an additional supply of food; in short, the excess of it is a waste.

I was taken to task, on a former occasion, for characterising the theories of Liebig as fanciful, but I had the advantage of being correct in my surmises. His idea was that alcohol merely afforded fuel to the body, carbon, charcoal, to be burnt in respiration. He says,

"There can be no doubt that the elements of alcohol combine with oxygen in the body; that its carbon and hydrogen are given off as carbonic acid and water;"

he argues that this is an expensive fuel, and may be advantageously replaced,—if you prefer it,—by train-oil.

Dr. Carpenter says:

"The action of alcohol upon the animal body in health is essentially poisonous; producing such a disturbance in the regular current of vital action, as, when a sufficient dose, or succession of doses, is administered, becomes fatal."

He assumes that whatever is true of a large dose, is true of a small one in a mathematical ratio. It is not so. It is, chemically, the same action that makes a bar of iron rust slowly away, and that ignites the brilliant sparks from the anvil of the blacksmith. But what a difference! the spark may explode a mine, the worst that the rust can do is to iron-mould a pocket handkerchief. *Abuse* is represented by the one, and *use* by the other.

Now, it may appear rather a bold thing for me to stand up and call in question the theories of Liebig and the assertions of Carpenter. But, I have read to you what the latter says when he was writing his prize essay,—he denies any food-quality in alcohol. In his *Principles of Human Physiology*, however,

"He holds somewhat different language; he divides food into four groups: Saccharine, Oleaginous, Albuminous, and Gelatinous. The Saccharine group, he says, includes all those substances derived from the vegetable

kingdom which are analogous in their composition to sugar. To this group belong starch, gum, woody fibre, and the cellulose of plants, which . . . may be converted into sugar . . . whilst alcohol, which is derived from sugar by the process of fermentation, has a composition which rather connects it with the next group."*

Again, Liebig says:

"Alcohol stands high as a respiratory material. Its use enables us to dispense with starch and sugar in our food."

And this, remember, with no loss to the economy. Can any one deny that this acknowledges alcohol to be bonâ fide *food*? Under the term "*nourishment*," not only the public but all physiologists agree to include those substances which consist chiefly of respiratory materials. But more than this, let us see what is the effect of using none. Liebig tells us

"How Temperance families, depriving their servants of beer, gave them compensation in money; but they soon found that the monthly consumption of bread increased so strikingly, that the beer was twice paid for,—once in money, and a second time in bread."

I have known precisely parallel cases in my own circle of friends. The Peace Congress was held at Frankfort, and the landlord of the Hôtel de Russie, a magnificent establishment there, found that every day there was a shortcoming of certain dishes, farinaceous dishes and puddings especially. In such an establishment the occurrence was a scandal, for the cuisine of that Hotel is famous even in that region of inexhaustible tables-d'hôte. Liebig attributes this excessive consumption of pudding to the fact that most of the members of the Peace Congress were also teetotallers, and what they lacked in wine, they had to make up in pudding. Now it is impossible to say that wine is not food, if it replaces pudding, and if pudding is necessary to replace wine: and if wine be in any sense food, it is not poison. †

The more recent investigations regarding the physiological action of alcohol have been carried on chiefly in Germany by

* Carpenter, "Human Physiology."
† See Westminster Review, 1855.

Professor Donders at Utrecht, Professor Bischoff of Giessen, and Moleschott of Erlangen, also by Dr. Hammond of the United States, but above all by Dr. Böcker.*

The results obtained by all these experimenters, though differing perhaps in trifles, are identical in all essential points. Some of them were wholly unexpected. Such, for instance, as the effects of water taken to excess.

I cannot relate Dr. Böcker's entire experiments, because the details of the precautions taken against error are not fitted for this audience, but his results were, that water, when taken in excess, "increases the interstitial metamorphosis of tissue:" that is to say,—you all know that there is constantly going on in the minutely subdivided cells of the body, a change of structure; the fresh particles of blood, charged with oxygen, come upon the heels of the effete particles, are seized upon and made into invisible atoms of bone, of muscle, of nerve, of brains, while the used up material is carried off partly by the veins, partly by the various organs which concoct the diverse secretions of the body. Now this action is directly and rapidly *increased* by water when taken in excess, (Dr. Böcker took seven pints daily,) all the excretion of solids and fluids are rendered very much greater, and to supply this waste, it is necessary to consume a considerable additional quantity of food. "The necessity for food keeps pace with the metamorphosis" of the tissues, which are, as it were, washed away by the water, which can only be looked upon as an extravagance.

But I am sure to be asked, "Is not this very 'metamorphosis of tissue' only a hard name for life?" It is. "Is not the most rapid metamorphosis of tissue the highest form of life?" I answer again, Yes: and I believe if we had no other calling, no other object, no other troubles and trials, but so to feed ourselves that we should prolong our existence to the latest possible period, we should eat as much meat as a butcher, as many vegetables as a

* See "Zeitschrift der K. K. Gesellschaft der Aertze zu Wien," 1854.

green-grocer, and drink as much water as a hydropathist. This is very much our condition during the first few months of our life, when fed on milk, but is quite incompatible with anything beyond the mere sensual animal existence. You may have heard of the enormous appetites at water-cure establishments; you see by these experiments how they are produced, and in very many cases a most beneficial result ensues, and a man is really renovated by this internal washing, particularly those who have been eating and drinking too much. But the brain and nervous system is incapable of much exertion during this water-drinking, for it is this nervous system in particular that water begins by washing away; and where there is a proclivity to insanity, reason is sometimes upset by it, as is witnessed by the number of suicides at hydropathic establishments.

The division of food by Liebig was into that which supplied the interstitial deposits of the body, the "building materials,"—and that which supported the respiratory combustion, the "fuel,"—but it is found that there is no such absolute distinction in nature. Dr Chambers has suggested a more easily understood one, of complementary and accessory foods. The first consisting of all the protein compounds, hydro-carbons and oils with water and salts, which each have their existence in milk in some form or other, and all of which are absolutely necessary to replace the continually decaying organs. The accessory foods embrace alcohol, flavouring ethers, essential oils, gelatine, tea, coffee, tobacco, spices. These are what man can do without if he chooses to live with no other object than to live—as a vegetable does.

Now, to begin with alcohol; what are its real effects when used as wine or beer, or watered so as to be of a similar strength, and used in a temperate manner? It limits and checks the metamorphosis of tissue. It acts in precisely the opposite way from an excess of water, and economises the amount of food required by the wants of the system.

"Alcohol" says Dr. Moleschott, "is a *box for savings*. A man who eats little and drinks moderately of alcohol retains in his tissues and blood more than he who, under corresponding circumstances, eats more, without taking beer, wine, or brandy." *

For instance, if a man who has one shilling to spend on his dinner, spends it *all* on meat and bread, he will not do so much work for it as he who spends ninepence on meat and bread, and threepence on wine or beer.

Dr. Hammond, who also experimented in his own person in order to test the accuracy of Böcker, says:

"I arrive at the conclusion that alcohol increases the weight of the body by retarding the metamorphosis of the old tissues, promoting the formation of new, and limiting the consumption of fat. . . . Alcohol, instead of preventing the elimination of the decayed tissues, acts by preventing in a great measure, their primary destruction." †

This effect of alcohol, to arrest the destruction of the tissues, and utilise them to the utmost, is followed by a reaction, during which the tissues are more rapidly disposed of, and if another dose of stimulant be taken before this reaction have set in, or if the dose, in the first instance, have been too large,—if elevenpence have been spent on spirits, and only one penny of the shilling on bread,—as Prince Hal exclaimed, "O monstrous! But one half-penny worth of bread to this intolerable deal of sack,"—the amount of vitality in the body is lessened, the effete particles are not renewed and disease supervenes. How beautifully does philosophy thus explain the action of alcohol on the system, such as we know it to be from experience. A man coming home just before dinner exhausted, wet, and weary, if he be foolish enough to take a glass of brandy and water, will eat no dinner—he has *arrested* the molecular change, the philosopher says. If he drink the hot water without the brandy (a most capital receipt, by the way, given me by an old fox hunter) he will find his appetite ravenous—the philosopher finds he has *increased* the metamorphosis of tissue.

Let us again look at the effects of stimulants in disease, when

* "Lehre der Nahrungsmittel."

† "American Journal of Medical Science, 1856."

rationally employed. In the exhaustive stage of fevers, in consumptions, in colliquative diseases, stimulants, we know, will keep life from being lost, though it may hang on a thread for days. Experience, not theory, has taught us that we must keep up the effect of the alcohol, that we must not leave the patient more than an hour or two without food or drink (not so long as that often), so that the nurse is frequently as important a person as the doctor. In Hospital practice I have foretold whether a fever patient would be alive in the morning by knowing the name of the nurse who was to sit up. It has also twice occurred to me to detect, on most important occasions, the abstraction of wine from patients, by the symptoms they manifested, so well marked is the beneficial effect of alcohol judiciously administered. This is the practical observation, and philosophy steps in to corroborate its accuracy, by showing how the continuous and continued supply of alcohol, when life is apparently ebbing away, will arrest the progress of decay, till nature can again assert the power of the stomach to assimilate food.

In chronic cases also, particularly in those people whom we call in Scotland "unwholesome," whose stomachs cannot digest, whose brains cannot sleep, whose spirits are low, who have not energy enough to be ill-natured, whose circulation is languid, and their nervous power sluggish,—such may often be roused, and kept in a comparatively normal state by the judicious employment of alcoholic stimulants. It is Dr. Carpenter himself who says:

"There is another class of cases in which we believe that malt liquors constitute a better medicine than could be administered under any other form; those, namely, in which the stomach labours under a permanent deficiency of digestive power. . . . . There are many such cases in which no form of medical or hygienic treatment seems able to develop in the stomach that spontaneous power, which it has either completely lost, or which it never possessed, and in which the artificial excitement of an alcoholic stimulus affords the only means of procuring the digestion of the amount of food which the system really requires."*

But there are other forms of disease, in which any stimulant

* Scottish Review, No. I.

whatever is found to be injurious. In the full-blooded, in some of the gouty, the excitable, the florid, the man with a head, the man with a temper, the irascible, very often in various forms of skin diseases and eruptions,—total abstinence is absolutely necessary to secure health. I am speaking of cases with which one deals solely as a physician, where there is no question of anything like excess, or want of moral power.

On examining the notes of the first 100 private patients and consultations I had last year, excluding children under ten years of age, I confess I was surprised to find the memorandum made in 33 out of the 100, that they were wholly to abstain from stimulants while under treatment, and I may add, that but 2 of the 33 had been drinkers. I was so surprised at this result that I further analysed the notes of the first 500 poor patients I had in 1860, excluding children under ten years of age. I find that in no less than 105 cases I have forbidden all stimulants during treatment, that is, in 21 per cent., and in but one of those did the illness depend on dissipation. These statements may convince the incredulous how fully aware physicians are of the benefits to be derived from total abstinence in disease.

I would now draw attention to

TABLE No. III.*

Deaths per annum of Persons between the ages of 45 and 55.

Farmers	11.99	per 1000	Labourers	17.30	per 1000
Shoemakers	15.03	"	Miners	20.15	"
Weavers	15.37	"	Bakers..........	21.21	"
Grocers	15.79	"	Butchers........	23.10	"
Blacksmiths	16.51	"	Innkeepers & Licensed Victuallrs.	28.34	"
Carpenters	16,07	"			
Tailors..........	16.74	"			

The annual deaths per 1000 of a trade between the ages of 45 and 55, are, in the class of publicans, 28.34,—while in the class of farmers they are not quite 12 per 1000. This is a surprising but well authenticated fact. The innkeepers and publicans are

* Fourteenth Annual Report of the Registrar General.

a most respectable class of persons; I believe there are very many of them who do not drink so much as the farmer class, who certainly never transgress the bounds of propriety, and yet, not only the farmer, but the proverbially dissipated and drinking tailor dies in only a little more than half the numbers found to pertain to the publican; and this cannot be attributed entirely to the late hours he has to keep, to the little rest he enjoys, nor to the risks of contracting contagious diseases from intercourse with a large number of persons. It arises, I believe from the habit of frequently taking a drop; for even the same amount of spirits taken at a bout of intoxication once in a week, will do a man an infinite deal more harm if divided into repeated doses, and taken at short intervals during every day. And why? Philosophy again tells us that there is an absolute necessity that a sufficient period of time should elapse, before the decay, the moulting of the tissues, be again arrested.

The man of experience, as well as the philosopher, drinks his modicum of stimulants at his meals, and so far from being the worse for it, he is the better.

In further illustration of this fact, I would point to the class just above the innkeepers, in Table No. III., the butchers; they die in double the number of the farmers almost. Yet why? They are a most temperate class, they have abundance of food, the rubicund butcher himself, his ruddy errand boy, his rosy wife, have all the appearance of health, yet they die in this large proportion. And why? Because, I believe they all eat too much animal food without using any means of getting rid of the large amount of effete matter in the body. There is nourishment in the very smell of fresh meat, and according to the philosophical theory, all butchers who also drink spirits should die very fast, and I have little doubt it is so, and that my having no personal knowledge of any butcher who is not sober in his habits, arises from there being so few drinkers among them, experience having taught them, as a class, their danger: the changes cannot go on rapidly enough, the new tissue is deposited faster than it is removed; the man first grows fat, and then he dies,—his capillary system choked. It is precisely a parallel disease to that of the drunkard, who also gets fat; the one takes too much for the vessels to dispose of,—the other arrests the process of disintegration so continually, that sufficient new material is not laid hold of and edified into the system, and he too dies,—actually, as well as metaphorically, rotten.

I am very desirous of making no assertion which I cannot bring forward independent evidence to support. I therefore call attention to Table No. IV.* It shows that total abstinence actually predisposes to some diseases. The observations were made by a scientific medical man, with no prejudice either way, and during a time of peace. The three diseases I have selected are epidemic in their character, and the seeds of them are more easily implanted in any one suffering from nervous depression, and the impending attacks may more than in any other diseases be averted by a timely use of moderate stimulation. You know how fevers, dysentery, cholera, follow in the footsteps of a retreating army. Let the commander only again order an advance, the diseases slacken their hold, wholly independent of change of place, and do not re-appear when positions are re-occupied, where on retreat they had suffered. This influence is dependent on the state of the nervous system, and, if the philosophical explanation of the action of alcohol on that system be correct, we should find total abstainers more subject to attacks of diseases which invade most easily those whose nervous system is below par. Now, look at the

TABLE No. IV.

European Regiments in India.

Class.	FEVER.		DYSENTERY.		DIARRHŒA.	
	Sick to strength per 100.	Deaths to strength per 100.	Sick to strength per 100.	Deaths to strength per 100.	Sick to strength per 100.	Deaths to strength per 100.
Teetotallers ..	31.33	0.22	11.55	0.66	11.11	0.22
Temperate ..	17.78	0.02	7.96	0.71	8.05	0.09
Intemperate..	20.16	0.21	11.88	1.59	11.46	0.00

* Indian Annals of Medical Science, 1856.

In fever the admissions are nearly double that of the temperate, half as many again as that of the drunkards; (and remember, the class of temperate includes all who manage to keep out of the guard-room for intoxication, more than six times in a year as well as the really moderate). One in 450 of the teetotallers died of fever; only 1 in 4,318 temperate soldiers.

In dysentery again, the admissions of teetotallers are relatively as great as those of the drunkards, and greater than the temperates.

In diarrhœa the temperate are again the most healthy, and no drunkard dies at all. This is probably to be accounted for by the teetotaller eating fruit without taking any stimulant to assist the stomach in the digestion of it.

I do not wish to mislead by this Table, so I refer to Table No. V. from the same author, which includes all cases of disease of every kind.

TABLE No. V.

European Regiments in India.

ALL DISEASES.

Class.	Sick per cent.	Deaths per cent.
Teetotallers	130.88	1.11
Temperate	141.59	2.31
Intemperate....	214.86	4.45

The per centage of admissions is greater in the so-called temperate, only by 9, but the per centage of deaths is double, and that of the intemperate is four times as great as that of the teetotallers. Real moderation, real temperance would keep the men out of hospital, which teetotalism does not, and would not ruin their constitutions as intemperance does. The special effect of alcohol is to strengthen the nervous system temporarily, transiently, to carry off the chill of a melon, to throw off the effects of the stench emitted by some forms of disease, to counteract the effects of malaria. Objection is of course taken to the words 'temporary' and 'transient'. It has been well answered. All things are temporary as regards this world,—even life itself. We are not always eating melons, we are not always smelling stinks, we are not always in the Pontine marshes, no more is it necessary to be always drinking.

You all know the story of the gallant Havelock, a man who feared God, as well as honoured his king,—a man who had the boldness to stand up for morality and religion in the midst of wickedness and infidelity. However much I may think he was mistaken in some of his views, in one point he was deserving of the highest praise: he tried to stem the stream of drunkenness in the Indian army; and this he did in a thoroughly common-sense way. I quote from his *Life* by Marshman.

"He had always felt the importance of sobriety to the welfare of the men, and to the consummation of military discipline. When invested with the authority of Adjutant he redoubled his efforts to promote habits of temperance among them. It was through his influence that a Temperance Society was formed in the regiment of which Col. Sale . . . and Capt. Chadwick . . . enrolled themselves as members. A coffee-room was built and every accommodation provided which could attract the men from the canteen. In that coffee-room Havelock was accustomed frequently to address them, with the view of encouraging sobriety and mental improvement."

To such an extent did he succeed in this noble endeavour, that we hear of Sir Archibald Campbell, when a sudden attack was made, and the first called troops were not prepared, saying, "Then call out Havelock's saints, they are always sober and can be depended upon." The very sneer only heightens the praise.

Let us now follow our gallant Havelock through sundry vicissitudes, neglected by his superiors, till, at length, his own merits forced him into the position of the reliever of Lucknow. You remember his fight along the banks of the Ganges before he reached Cawnpore; day by day almost were his troops engaged in battle, and they still pushed on, regardless of fatigue and of sickness. The soldiers had not even food before his final attack on Cawnpore; they had had no meat for forty-eight hours, and happily some porter was served out; it made some of them almost stagger, but—I quote from Havelock's *Life*—

"But no one who heard their cheers as they marched off, and marked their invigorated step, when they subsequently came into close contact with the enemy, could doubt the beneficial result of this stimulant."

You know how bravely these men fought, and how they entered victorious the stronghold of that miscreant fiend, the Nana, who I fear still lives in spite of the assurances to the contrary. You know the horrors of Cawnpore, how the men's minds were depressed by that hideous spectacle, by their repeated endeavours to reach Lucknow without success, how the nervous system gave way, and the men dropped with cholera, with dysentery, with fever, the sure followers of nervous depression. How then does Havelock write to General Neill at Allahabad for reinforcements?

"If the road behind me is open, as I believe it to be, I trust you will be able to prevent the necessity of our being reduced to half-rations of *rum*, which would be a most trying deprivation to troops exposed to the fatigue and hardships that my men have endured."

These are his own words. He was a sensible man and a practical philosopher; he advocated temperance, but he was no teetotaller, and you see he thought moderation practicable even in dealing with the Indian army.

A parallel, if not a similar effect is produced by food. It is as notorious how a *full* stomach will prevent the risk of infection, as how the depressed spirits and the empty stomach of—it may be a mourner following a coffin—expose to the greatest probability of catching such a disease as the small-pox. It is quite possible that funeral-drinking may, while acknowledging its origin as heathen, have been kept up and adopted by so many Christian nations, in consequence of some observation of the use of stimulants in the way I have mentioned.

Food alone, without any drink at all, has been known to produce all the symptoms of intoxication. For instance, in children, after hearty meals of animal food: if you or I were to be so riotous after dinner as our children are, who have had nothing but water, we should lay ourselves very open to the charge of incipient intoxication. I mention this merely to illustrate my position that that exhilaration, that cheerfulness, that gladdening of the heart, that merriment, if you will, produced by a moderate amount of wine, is not only not wrong, but is justifiable and right in the sight of God and man. This is what in the nauseous phraseology of one of my own profession, a Dr. MacCulloch, of Dumfries, is

> "Swallowing a stimulant, a corrugator of the living tissue, an irritant, and worse than all, a narcotic!"

Further:

> "The act of swallowing the liquid and the loss of resolution and self-control, are inevitable cause and effect, and nearly simultaneous."

And remember this is in any quantity—however small—it is

> "Taking in our hands an extraneous and material poison, and wilfully and knowingly introducing it into our stomach without any plea of necessity whatever."

It is such language as this that places the advocates of total abstinence at a disadvantage,—nay, worse,—it tends to drive away from them earnest preachers of temperance, and leads the ignorant, who still have sense enough to see through the shallow sophistry of such maxims, to class arguments in favour of moderation along with such wild principles as these, and to reject both—the good with, and because of, the bad.

I have blamed the teetotallers for attempting to invent philosophical objections to the use of stimulants. I desire not to fall into a similar snare, and invent reasons for the use, so I would very sincerely add, that too much must not be made on either side of arguments, deduced from physiological experiments. The body, after all, is a living organism—not a machine or a chemical apparatus; and experience, if based on a sufficient number of observations, is a safer guide, even than philosophy.

I have now to draw attention to some very remarkable Tables I have drawn up. I refer to Nos. VI., VII., VIII., and IX., compiled from notes of my own cases, taking the first 100 and the first 500 of each class in each year.

TABLE No. VI.

Own Cases.—Private Patients over 20.

Year.	No.	Disease dependent on Drink.	Disease dependent on Tobacco.	Total.
1856	100	15		15
1857	100	11		11
1858	100	11	1	12
1859	100	14	1	15
1860	100	16	1	17
Total per cent.	500	13.4	0.6	14.

TABLE No. VII.

Own Cases.—Poor Patients over 20.

Year.	No.	Disease dependent on Drink.	Disease dependent on Tobacco.	Total per cent.
1856	500	19	2	4.2
1857	500	16	3	3.8
1858	500	11	3	2.8
1859	500	18	5	4.6
1860	500	18	3	4.2
Total per cent.		3.28	.64	3.92

TABLE No. VIII.

Own Cases.—Infirmary In-Patients over 20.

Year.	No. of cases.	Disease dependent on Drink.	Per cent.
October 20, 1856, to Nov. 16, 1860 ..	476	25	5.25

TABLE No. IX.

Summary of Own Cases.

No. of Cases of Illness over 20.	No. dependent on Drink.	No. dependent on Tobacco.	Total.
3476	174	19	193
Total per cent.	5.	.55	5.55

The heading "Disease dependent on Drink," includes all medical diseases of every kind, that could be said to depend on the abuse or even on the habitual use of liquors of any kind, where such was injurious. Thus it includes some cases of skin disease, where the irritation had been kept up by the use of beer—it includes some of gout and rheumatic gout, in which the stimulants taken had merely brought out—had not given rise to the complaint.

I confess the figures, as they came out on my paper, perfectly astonished myself; I have no doubt they will much surprise many others. The labour is not small of going through so many notes, but I have done it carefully and honestly, and you see the result. I admit I had expected to find an average of at least one third of all medical cases produced by drink; in place of which the total per centage of the three tables, including 3476 cases, is five per cent.

The result of such an investigation shows the folly of trusting to vague ideas of numbers. It is stated, on medical authority too, in some of the teetotal books that

"The diseases, distinctly referrible to ardent spirits alone, amount to 75 cases out of the 100." . . . .

"About 50 per cent. of all the sickness admitted to the Glasgow Infirmary, is connected, more or less, with the use of spirituous liquors."*

I quote these two assertions, to show their utter fallacy; they are the only two distinct asseverations of numbers that I can find to lay hold of. Such expressions as "tens of thousands" dying, "destroy more lives than the sword," "vast amount of disease," "large proportion of all diseases," are quite common in the mouths of all. And though it be very gratifying to find what gross exaggerations have been uttered about it, it is sad enough to find that even five per cent. of disease is produced by drink—especially that 13.4 per cent. among the better and upper classes depends upon indulgence.

The same exaggeration has prevailed with regard to cases of lunacy. Lord Shaftesbury stated publicly, that 60 per cent. of them could be traced to intemperance. I have taken some returns at random, which you will see in table No. X., even in Edinburgh and Glasgow, the numbers are only 24 and 21.

* Reid's Temperance Cyclopædia.

TABLE No. X.

Insanity.

Asylum.	Proportion per cent. dependent on Intemperance.
Hull	.. 6.6
Charenton	.. 10.
Glasgow	.. 21.
Edinburgh	.. 24.
Leicester..	.. 14.
United States.. ..	.. 10.6
Total average per cent.	14.36

If Lord Shaftesbury's statement were true, we should have very few cases of insanity among Quakers, the great body of whom are total abstainers. But it is well known that while intemperance hardly ever figures as a cause, mental alienation is at least quite as prevalent among Quakers as among the population at large.

The duty of the physician in these days is a very different one from what it was in the days of Gregory, of Heberden, of Pitcairn, even of Abernethy, when the greatest excess was indulged in by the better classes on almost all occasions. There is hardly a medical anecdote of that period, which does not (while illustrating the grossness of the age) proclaim the physician as the pioneer in the path of improvement. It is the science of medicine which has shown disease to result from excess. It is the science of medicine which has assisted in the reform of manners in society. But, as it was the duty of the physician then to censure the universal excess of his day, it is no less his duty now to warn those who still indulge.

It is better for a man to practise abstinence and preach moderation, than to preach moderation and practise excess. The physician himself should not only be strictly temperate, but notoriously so; for it is only the man who does not indulge himself, whose eyes are thoroughly open to the evils of indulgence in others. But on the other hand, a teetotal doctor is as bad as a dyspeptic one.

A patient is sure to disregard the injunctions of a total abstainer, who parades his abstinence, just as he would disregard the denunciations of the dyspeptic, who cannot digest a stick of celery, while the patient knows very well *he* can.

In disease also, it is the duty of the physician to form an opinion as to the treatment, wholly unbiassed by any vows he may have taken, or any notions he may have of the value of a teetotal example. There is no such thing as routine. The London heresy of promiscuous stimulation will, by and bye, be repudiated by the public as well as the profession, however easy a path it may be to present popularity and pecuniary success; and while I am confident that no one would ever give a professional sanction to the gratification of a depraved taste, I also think great care should be taken that no bad habits be formed during illness, when stimulants have been necessary; and that we should carry out in private practice, what is done in hospital and fever house practice; breaking off gradually, before discharge, the use of the wine or brandy which has saved life, but is no longer necessary.

The length to which my paper threatens to extend, warns me that I must not, on this occasion, give too much time to the consideration of the processes of manufacture or chemical composition of the particular stimulants mentioned in my title, though passing them briefly in review. And first, of distilled spirits.

TABLE No. XI.

	Alcohol per cent.		Alcohol per cent.
Gin	51.6	Irish Whisky	53.90
Brandy	53.39	Scotch Whisky	54.32
Rum	53.68	Hollands (real)....	55.44

This Table shows the per centage of pure alcohol which each contains—rather over one-half. Be it gin, brandy, rum, or whisky, in each the spirit is produced by the fermentation of sugar. Fermentation changes it into carbonic acid, which escapes, and alcohol

which remains behind, and is then distilled over. The different flavours depend on minute quantities of the various foozle oils, derived from the husks and refuse of the substance from which the sugar is obtained.

Rum is the least sophisticated of all, and curiously enough, it can only be made from the *juice* of the sugar cane. If you ferment molasses and sugar, which are the whole product of the juice, you get nothing but a coarse whisky, while the juice itself produces rum.

The adulteration of all spirits is practised to a most pernicious extent. Gin is that, which, as being most in use among English spirit drinkers, has been subjected to the closest analysis. Water is largely added—one-fourth or one-fifth part usually, and the alcoholic per centage is found to vary in retail samples from 48.8 to as low as 22.35; but besides this watering, there is put in it oil of vitriol, oil of almonds, oil of turpentine, lime water, and rose water; besides the juniper berries—sulphate of alum and sulphate of zinc; and almost worse than all—capsicum, cayenne pepper, and grains of paradise; and thus is formed a compound which no stomach can long withstand the evil effects of. Brandy, again, we are told by an author of a *Handbook for Publicans*, should be made up for retail thus:

"Add 10 per cent. of flavoured raisin wine, a little of the tincture of grains of paradise, cherry laurel water, and spirit of almond cake . . . add also ten handsfull of oak saw-dust, and give it complexion with burnt sugar."

It is not easy to compute exactly the amount of spirits consumed in different parts of the country. You will see in Table XII., a calculation I have made from the latest returns, which gives nearly a gallon a-head for every soul in England, and *two* for Scotland; while, taking the males over twenty at one-fourth the population, it gives twenty bottles a-head in England, forty-five in Scotland. Now this is undoubtedly a grossly large allowance. Compare it with wine, in Table XIII.*

* Page 35.

TABLE No. XII.

Annual Consumption of Spirits.

ENGLAND.

	1851	1859
Population	18,000,000.	20,000,000.
Gallons	14,000,000.	17,000,000.
Per head	6¼ pints.	6¾ pints.
Per adult man	18½ bottles.	20 bottles.

SCOTLAND.

	1851	1859
Population	2,000,000.	3,000,000.
Gallons	7,000,000.	5,000,000.
Per head	19½ pints.	13½ pints.
Per adult man	59 bottles.	30½ bottles.

IRELAND.

	1851	1859
Population	6,500,000.	6,000,000.
Gallons	7,800,000.	5,900,000.
Per head	9½ pints.	nearly 8 pints.
Per adult man	28½ bottles.	23 bottles.

I believe if we had the means of strictly analysing it, we should find that the real excess is confined to a comparatively small number, who thus swell the annual total. In my own household, for instance, of twelve souls, we do not consume half-a-dozen bottles in a year, including cookery and every thing; that is 4 pints, but the average should be 81 pints, so here are 77 pints out of one family alone, to be accounted for by the excesses of others.

It is especially in warm climates that the full evils of raw spirits, as an article of diet, are seen, but our gin palaces also show many victims. Here, be it remembered, even if it were wanted by the dissolute dram drinker, there is no water to be procured. I consider raw spirits, drunk undiluted, to be, unless under the most exceptional circumstances, a most injurious potation, and in no sense whatever to be considered as an ordinary article of diet, such as those which follow in the course of my lecture.

Having spoken thus cursorily of spirits, I must deal much in the same way with wines, which are undoubtedly the simplest,

and therefore the most natural of all stimulants. In Table No. XIII. I have made an estimate of the quantities used in 1851 and 1859.

TABLE No. XIII.

Annual Consumption of Wine.

UNITED KINGDOM.

	1851	1859
Population	27,400,000.	29,000,000.
Gallons	6,280,000.	6,800,000.
Per head	35 oz.	37 oz.
Per adult man	5 bottles.	5½ bottles.

In 1700, the consumption was one gallon a head; in 1800, it was half a gallon a head; and in 1859, you see it is hardly one quart.

This has been the effect of high duties, imposed, not in the interests of morality, but for political reasons both foreign and domestic. I think that this diminished consumption is greatly to be regretted, as, in Scotland particularly, it has tended to bring into constant and familiar use the stronger drinks, the ardent spirits, so much more liable to be abused, and so much more injurious when abused. I, for one, hailed the proposals of the Chancellor of the Exchequer for the introduction of the lighter wines, which was carried into effect last year, as a step in the right direction.

Whatever may be said to the contrary, it is undoubtedly the fact, that in countries where wine is cheap, there is much less intoxication than in those where spirits are used as the ordinary drink. It is notorious to all who have resided in such countries. Dr. Guthrie of Edinburgh says, that in seven weeks you will not see so much drunkenness in Brussels or in Paris as in seven hours in London or in Edinburgh. Even the Chairman of a meeting for the formation of a Maine Law Alliance was obliged the other day to admit that

"He had lately travelled through some of the largest towns and cities in France, and in all his travels he had not met with a single drunken character."*

* Alliance Weekly News, 1860.

A special correspondent of the *Alliance Weekly News* writes last week only:

"I have been puzzling myself with the question, Why are the Italians so sober? Only a month here yet, and I have not failed to notice the extraordinary temperance of the people;"

but he wilfully blindfolds himself as to the true reason,—the cheapness and mildness of the wine. I therefore look on the late measures, calculated to bring again into use the light wines of France, as a great boon to the country, both dietetically and morally. The wines we want are the light Burgundy and Bordeaux: such as are even now, before the full reduction of the duty, sold at 2*s.* and 2*s.* 6*d.* a bottle. France produces ten hundred million gallons yearly. A reference to Table No. XIV. will show that the expectations of a large demand for these wines have been great, and have led to large importations, while the fact that 430,000 gallons more than in 1859 have been entered for home consumption, cannot but be regarded as a good omen for the future.

TABLE No. XIV.

Wines imported in the first 11 *months, ending Nov.* 30.	
1859. Gallons, 6,914,000.	1860. Gallons, 11,381,000.
Entered for Home Consumption.	
1859. Gallons, 6,742,000.	1860. Gallons, 7,172,000.

I believe that the prejudice against these wines, especially among the tradesman and country class, will gradually be removed; and as a physician, I rejoice that the very potent means of cure in many cases—the substitution of light wine for heavy ales or spirits, is brought thus within the reach of a class formerly almost excluded from its advantages by the high prices,—the duty being now only 1s. a gallon on light wines, in place of 5*s.* 9*d.* I speak of wines exclusively as of the produce of the grape. There are so-called home-made wines, which are simple—nay, very often compound abominations; the acid which the fermented

kinds contain, being the malic—one of the most indigestible; while the unfermented, such as Ginger wine, are simply more or less disagreeable forms of cold toddy or punch,—diluted spirits in fact. All wines then, properly so called, contain alcohol in varying proportions; all of them contain free acids, and almost all of them sugar.

Table No. XV. I have compiled from some analyses of Dr. Bence Jones, of wines, as supplied in the London market.

TABLE No. XV.

Wines.

	Alcohol per cent	Acid per oz.	Sugar per oz.		Alcohol per cent	Acid per oz.	Sugar per oz.
		grains.	grains.			grains.	grains.
Port	21.5	4	20	Bordeaux ..	10.	5.	0.
Sherry	20.	3.8	9	Burgundy ..	11.	5.5	0.
Mansanilla	15.7	4.5	2	Sauterne ..	13.	5.5	5.
Marsala....	20.8	4.3	10	Hock	10.5	5.3	0.
Madeira ..	19.	4.8	20	Moselle	9.	6.	0.
Tokay	16.	9.	74	Champagne.	14.5	5	26

The spirit is derived chiefly from the fermentation of part of the sugar of the grape. But in almost all cases the analyses of Bence Jones show a larger proportion of spirit than do those of Mulder and others, who treated the wines in the countries where they were manufactured; and the addition of a certain proportion of brandy, to the lighter wines especially, is almost necessary to enable them to bear transport and change of temperature, and is hardly to be considered in the light of an adulteration. If the casks be kept always filled up, the transformation of sugar into spirit goes on in a minor degree, as long as the wine is kept in wood; and it becomes stronger, as, curiously enough, the water passes off more rapidly than the more volatile alcohol.

Free acids are found in all wines. The tartaric and the acetic are the principal. Their uses are not only to give the agreeable acidulous taste, but also in bottle to act chemically upon the alcohol, and thus to produce the ethers on which the flavour greatly depends. This action goes on very slowly indeed, hence the value of wine long in bottle, when it was good in the first instance. It is well to remember that it is only strong, pure, good wine that will keep long enough to bring out the finer flavours so valued in old port.

The amount of acids varies very considerably, as you see, and it is hardly credible that there is nearly double the amount of acid in the luscious Tokay, that there is in what many people call sour Claret or Hock. The taste of it is masked by the enormous amount of sugar. As a rule, where the wine is very highly flavoured when new—as in Madeira for instance—the proportion of acetic acid is larger, for acetic ether is the more fragrant; but as acetic acid is much more difficult of digestion than the tartaric, such wine is not eligible for dyspeptics,

The sugar in wine is, in the more perfect—such as port and Madeira, simply the excess of sweetness in the grape itself. This excess checks the fermentation before it has all been converted into spirit; therefore, where no sugar is added, as it is in Tokay and Malaga, the richest in sugar are likewise the richest in alcohol.

Dr. Bence Jones did not detect any sugar at all in the Rhine wines or the Clarets, but it is believed to exist in very minute quantities, and has been found in the Rhine wines by the German chemists.

The flavours of wine, I have said, depend on the action of the ordinary acids on the spirit, but they are also due to something more. You are perhaps aware that confectioners now use for the flavouring of their comfits butyric ether,—this is made by pouring spirits of wine on rancid cheese, and produces, in minute proportions, the pine apple flavour; while caproic ether gives the melon, and another the pear flavour, while these substances themselves are excessively fœtid. The foozle oil which gives the peaty flavour to whisky, has its counterpart in wine in œnanthic ether, produced by the action of œnanthic acid on alcohol. This œnanthic acid is one of what is called the fatty acids, precisely analogous to the rancid cheese. But where, it may be asked, does

this exist in the grape? It is found in the skins, the stones, and the stalks; the *bloom* on the grape, with which you are all familiar, is the waxy fat which is the groundwork of the flavour; and if grape juice be filtered before fermentation, it produces indeed wine, but this is totally destitute of bouquet or aroma. It is well known now that wine merchants improve the flavours of their wines by the direct addition of these ethers, and in the wine countries the flowers of the lime and the elder, and some fragrant leaves are added to the fermenting must. In like manner the colouring matter is in almost all instances heightened by the addition, in the wine countries, of elderberry or blackberry juice. This is a very harmless sophistication; there is a very simple test for it, and the only wine I have ever examined and found the colouring matter perfectly *true*, was a sample of African port, sent by Lord Howe for recommendation to the Infirmary. The nauseous earthy flavour of all the real African wines, however, quite nullifies their otherwise laudable purity. If ever you taste *nice* African wine, you may be sure it was entirely made in London.

So far I have spoken of pure wines—wines comparatively pure, but the cupidity of dealers has led to all sorts of abominable adulterations. This detestable crime of falsifying and deceit is perhaps more prevalent in the wine trade than in any other, because it is so difficult of detection. With all the aids of chemistry, the only safeguard against gross fraud is to deal with old established houses, whose good name is at stake, should they palm off inferior articles. Dr. Chambers says:

"The most conscientious wine merchants in the city refuse now a days to assign different names to their samples of French wines."

They do not offer you Château Margaux, or Lafitte, or Clos Vougeôt, or St. George, but Bordeaux or Burgundy, of the first, second, or third growth, as the case may be,—growth being synonymous with quality.

"As a universal rule, if your wine merchant be very pedantic about the names of his French wines, he is either deceiving you, or he is very ignorant of the Bordeaux and Dijon markets. All that he can know is that it comes from one or the other district" and its quality.

It is true that the produce of some of the finest vineyards is kept distinct; some of it is engaged seven and eight years beforehand, for crowned heads and millionaires, but such is of course, except under most peculiar circumstances, not to be obtained by private individuals, and is utterly inaccessible to the trade. This rule is equally applicable to French, Spanish, Portuguese, and Madeira wines; it is not so strictly correct with regard to Rhine wines, which are not so completely mixed and blended. But even those I have personally tested, and found my bottle of Hock at 1*s.* 6*d.* identical with that of a neighbour at the table d'hôte, who thought it inconsistent with his dignity to drink anything under 6*s.* or 7*s.*

In the *Wine and Spirit Merchants' Own Book* are to be found receipts for making all kinds of wines without a drop of the juice of the grape.

"Macon, from raisins and elderberries; white wine from pears, perfectly equal to the best white wine from grapes."

Again, beet-root juice is called

"A truly precious substitute for the grape must in the manufacturing of all artificial wines, as by mixing it with various aromas, it can be made to imitate all wines."

Chalk, marble, molasses, potato-sugar, are all directed to be used.

"To keep wine from turning sour, put in the cask 2lbs. 3oz. of small shot." That is bad enough, but "In extreme cases, when all the previous receipts have been tried without any satisfactory result—"

that is to say, when the wine already contains lead, zinc, sulphate of iron, alum, cider, perry, tartaric and acetic acids, brandy, chalk, charcoal, chloride of lime, sugar, honey, &c., we are directed to "take a small pinch of *oxalic acid* and put it in the bottle."

The village of Cette, in the bay of Lyons, is the head quarters of adulteration in France, but our own wine merchants prefer keeping the adulteration and the profits of the iniquity in their own hands, and so the other day in a trade catalogue of the sale of an importer's stock at Liverpool, I saw to 50 hogsheads of port, 100 hogsheads of Roussillon, a strong cheap French wine, sold in this country, under its own name, in only the most fractional quantities.

It was stated in evidence before the Committee of the House of Commons, that

"No natural sherry comes to this country; that no wine merchant will send it;"

and so they consider it necessary to doctor it as they do. I say the sooner we have the genuine article the better.

"We are all of us," says Dr. Wynter,* "familiar with the announcement 'Fine Old Crusty Port 2*s.* 9*d.* a bottle,'—and the extraordinary thing is, that upon opening the sample, we often find that *it is* crusted, and that the cork *is* deeply stained. . . . . Wine, crust, and stained cork, are all fabricated. There is a manufactory in London, where, by a chemical process, they get up bees-wing to perfection . . and exactly imitate the natural crust; and corks are here also stained to assume any age that is required. The wine itself contains a very little inferior port, the rest being composed of cheap red French wine, brandy, and logwood as a colouring matter."

Dr. Hiram Cox, of Cincinnati in the United States, bears testimony that it is not only the English who are thus victimised: he says, in 1856:

"I analysed samples of sixteen different lots of liquors, among them were port, sherry, and Madeira. The distilled liquors were, some pure, and some vile and pernicious imitations. But the wines had not one drop of the juice of the grape: the basis of the port wine was dilute sulphuric acid, coloured with elderberry juice, with alum, sugar, and neutral spirits. The base of the sherry was a sort of pale malt, sulphuric acid, bitter almond oil, with a per centage of alcoholic spirits from brandy. The basis of the Madeira was a decoction of hops, with sulphuric acid, honey, spirits from Jamaica rum, &c."

Such disclosures much invalidate all arguments deduced from the ill effects of excess in wine, for if that be bad, what must the effect be of an excessive use of such filthy preparations, as I have just described, and which are sold to us under the name of "wine"? It is not of this it can be said that "corn shall make the young men cheerful, and new wine the maids;" † it is much more likely to disorder their stomachs.

A great deal of nonsense, I am sorry to say, has been written

* Curiosities of Civilization. † Zechariah ix. 17.

to attempt to show that the wine of Palestine was unfermented and unintoxicating. If it were so, it was not wine at all; and such a supposition renders perfectly pointless all the strong denunciations in holy writ against the sin of excess and of drunkenness. I find it asserted by a correspondent of the *Alliance Weekly News*, that it is quite possible and most desirable to make this unfermented wine. However desirable, I believe it to be quite impossible, except by boiling down to the consistence of a syrup, and rigid exclusion of air, for wherever sugar, water, and air meet they must ferment. This same correspondent I claim as a witness on my side. He says:

"It is idle to say, as many do, there is no occasion for it, and that a substitute for alcoholic drinks is unnecessary. I contend that there is occasion for it, and that a substitute is, with our growing taste for luxuries, absolutely necessary."

There is human nature again contradicting, in spite of himself, the teetotaller; and it is a sign of a re-action when such a sentence can be admitted into the columns of the *Alliance* newspaper, whence I also cull these advertisements.

פרי הגפן

PASSOVER OR SACRAMENTAL WINE,
Unfermented and Unintoxicating.
Prepared from the Finest Lisbon Grapes, and preserved *in vacuo*, at the suggestion and under the direction of Dr. F. R. Lees, by . . . . .

Price 36s. per dozen.
Orders should specify whether Pale or Red Wine is required.

TEMPERANCE CHAMPAGNE, unfermented and entirely free from spirit. This new Temperance beverage is strongly recommended to Abstainers, as one of the most refreshing and delicious of unfermented drinks. Made only by . . . . .
Price 15s. per dozen quarts; 9s. per dozen pints.

It is very difficult to form even an approximate estimate of the quantities of beer, ale, and porter consumed in England. We can tell the quantities of malt used and of hops, but we cannot tell what is brewed by private families, only what is brewed for sale; and as sugar and molasses are largely used in addition to malt, all the tables of statistics are probably below the mark. It is a fact however, that even with much less home-brewing than there formerly was, there is actually also less brewed for sale than there was in the first years of this century. The consumption then was estimated at nearly 25 gallons a head, now it is supposed to be only 21. In Scotland, I may mention, that the consumption is not quite six gallons a head, as a set off to our lamentably large consumption of spirits.

In beer, as in spirits and in wine, we have to contend with the vile system of adulteration, and to this may, I believe, be attributed much of the besotting effect of malt liquors on the lower classes. There is also the evil of large brewers owning numbers of houses licensed to sell beer, in which, of course, none can be kept but that brewed by the proprietor. This is usually supplied at a price which should ensure a reasonable profit to the retailer, but a reference to Table No. XVI. will show you how the public is served.

TABLE No. XVI.*

	Alcohol per cent.
STOUT:—	
From Brewers	7.15 to 4.53
From Publicans	4.87 to 3.25
PORTER:—	
From Brewers	4.14
From Publicans	2.88

It is true this only appears to be a dilution, and diminution of strength, but where water is added, it is very unlikely that something else is not also added to conceal it. In some cases in London, Dr. Hassall found that

"A publican could not afford to sell porter at the price which he pays for it, in the state in which it is supplied to him by the brewers, and realise a profit on it, unless he had recourse to adulteration."

* From Hassall on Food and its Adulterations.

I see that in fifty-two different analyses which the same gentleman made, in every instance he found salt in very considerable quantities. The pernicious effect of this in causing a call for additional potations is most evident, and calls loudly for legislative interference with regard to adulterations.

Dr. Wynter says:

"The reports of various committees prove that in times past, porter and stout were doctored in the most ingenious manner, and so universally and unreservedly, that a trade sprung up termed 'Brewers' Druggists,' whose sole business it was to supply to the manufacturers and retailers of the national beverage, ingredients for its adulteration . . . nay, one genius, hight Jackson, wrote a hand-book to show the brewers how to make beer *without any malt or hops at all.*"

"Mr. Child, in his *Practical Treatise on Brewing,* after . . . mentioning a score of pernicious articles to be used in beer, remarks in the mildest possible manner, 'that however much they may surprise—however pernicious or disagreeable they may appear, he has always found them requisite in the brewing of porter . . . and though several Acts of Parliament have been passed to prevent porter brewers from using many of them, yet the author can affirm, from experience, he never could produce the present flavoured porter without them. *The intoxicating qualities of porter are to be ascribed to the various drugs intermixed with it.* It is evident some porter is more heady than other, and it arises from the greater or less quantity of stupefying ingredients. Malt, to produce intoxication, must be used in such large quantities as would very much diminish, if not totally exclude, the brewer's profit.' . . . .

"Mr Morris, another instructor in this black art of brewing, tells us that 'among the ingredients requisite to produce a popular article are cocculus indicus, and St. Ignatius' beans as intoxicators; calamus aromaticus as a substitute for hops; quassia as a bitter; coriander seeds to give flavour; capsicums, carraway seeds, ginger, and grains of paradise, to give warmth;' . . . oyster shells to make old beer taste new, and alum to give a 'smack of age' to new. Sulphuric acid to bring it more rapidly forward, and to produce the fine foaming tankard, a detestable compound called 'beer headings,' composed of green vitriol, alum, and salt."*

* Dr. Wynter, Curiosities of Civilization.

I must now glance briefly at tobacco. Three centuries elapsed last year since the seeds were sent to France by Nicot, the ambassador to Hispaniola, and Sir Francis Drake and Sir Walter Raleigh, soon after that event familiarised the English nation with their use. In 1859, nearly 35,000,000lbs. were consumed in Great Britain, besides what is smuggled. This is upwards of 1lb. a head of the population; nearly 5lbs. for every adult male. It is just about the same amount per head as was consumed at the beginning of the century. If smoking have increased, snuffing and chewing have greatly decreased. It is satisfactory to learn from Dr. Hassall's investigations that the only adulterations at all common in smoking tobacco, are—water to increase the selling weight, and sugar or molasses to give consistence in making it up. Cigars he found, except in the most rare instances, to be always made of tobacco and no other leaves. The previous drying, however, gives to home-made cigars a flavour not at all acceptable to the connoisseur in smoking. The popular idea that there is opium in Manilla cheroots is found to be quite a mistake; and their more stupefying effect is to be accounted for by some variety in the constituents of the tobacco itself; a variety which also exists, to a certain extent, in all Turkish tobaccos.

The adulterations of snuffs are much more serious; we have the harmless but cheating water again; salt, lime, and earthy carbonates; iron, earth, chromate and oxide of lead, bichromate of potash and powdered glass; yellow ochre, quassia, calumba and gentian roots, rhubarb and coltsfoot leaves, saw dust and potato skins. The salts of lead and the bichromate of potash are, as you know, most deadly poisons; and when applied to the delicate mucous membrane, and swallowed, as they are by most snuff-takers, are calculated to produce most serious symptoms, which they undoubtedly often do.

The effect of tobacco on the body is that of a depressor of the nervous system, and a narcotic. Taken in moderation, the soothing effect is very marked; taken in excess, and especially by those whose digestion is weak, and whose nervous powers are feeble, there is no doubt that tobacco is highly injurious, and that such persons should abstain from it altogether. On the other hand, in the plethoric and excitable, in the nervous and irritable, tobacco *in moderation*, is productive of very beneficial results. I believe many a quarrel has ended amicably, where the hot-tempered man has had time to smoke his pipe over it, before proceeding to extremities. I am informed that no great criminals have been great smokers; and many a wife, I believe, has to thank tobacco for the neutralising of acerbities of temper in a husband, that might have otherwise ended in an appeal to the jurisdiction of Sir Cresswell Cresswell. The desire for some soothing narcotic of this kind is so universal as to be like that for stimulants—almost an instinct; and we find that all nations have something of the sort,—tobacco, Indian hemp, hachshish or opium, &c.

The attempts to prohibit and discourage the use of tobacco were almost coincident with its introduction to Europe. King James, who did not leave his taste for whisky behind him in Scotland, led off with his famous *Counterblaste to Tobacco*, to

> "Compound for sins we are inclined to,
> By damning those we have no mind to."

There are scores of books written in this style—

> "It fills the brain with fuliginose black vapours, or smoke like the soot of a chimney. Pauvius, a great anatomist, and Talkenburgius affirme, that by the abuse of this fume, the brain contracts a kind of black soot, and they prove the opinion both by experience and reason. Raphelengius relates that Pauvius, dissecting one that had been a great smoker, found his brain clothed with a kind of black soot; and Talkenburgius proves by three reasons that not only fuliginose vapours, but also a black crust, like that of the soot on the chimney back, is contracted on the skull by the immoderate use of tabaco."

The attention of the public has been lately largely drawn to the subject by a letter of Sir Benjamin Brodie, and still more recently by an edict of the Emperor Napoleon III., prohibiting the use of tobacco—and most properly—in schools and gymnasiums. As Sir B. Brodie's letter has been largely misunderstood, I must cull

from it, in his own words, his real opinions. After remarking that one or two drops of the empyreumatic oil will kill a cat:

> "Still I am not prepared to subscribe to the opinion of those who hold that, under all circumstances, and to however moderate an extent it be practised, the smoking of tobacco is prejudicial. The first effect of it is to soothe and tranquillize the nervous system. . . . It allays the pains of hunger. It relieves the uneasy feelings produced by mental and bodily exhaustion."

That is quite enough, and all I ask or say. Sir Benjamin then goes on to describe, in somewhat exaggerated terms, the evils of excess, most properly condemns the practice in schoolboys, and groundlessly ascribes the generally-believed-in degeneracy of the Turks, to tobacco smoking. It is childish almost to be always trying to find out occult causes, that we know nothing about. It would be quite as reasonable, quite as just, to attribute the character of the Turk to his total abstinence from drink. Why, the Turks of the lower orders are among the noblest specimens of mankind, and it is to the absence of Christianity you must look for the real causes of sensual indulgence in every form. If that happy light from heaven shall dawn again in that land which was the cradle of Christianity, if the whole race of Sultans, and Pashas, and Aghas, and corrupt ministers, and dragomans, be swept away, there may yet be a noble future for Turkey.

Sir Benjamin goes on to say:

> "In all ages of which we have any record, mankind have been in the habit of resorting to the use of certain vegetable productions, not as contributing to nourishment, but on account of their having some peculiar influence as stimulants or sedatives (or in some other way) on the nervous system. Tobacco, alcohol, the Indian hemp, the Kava of the South Sea Islanders, the Paraguay-tea, coffee, and even tea, belong to this category. A disposition so universal may almost be regarded as an instinct, and there is sufficient reason to believe that, within certain limits, the indulgence of the instinct is useful. But we must not abuse our instincts. This is one of the most important rules which man, as a responsible being, both for his own sake and for that of others, is bound to observe,"* &c., &c.

Why, it is very like what I have been writing regarding wine.

* Sir B. Brodie's Letter as published in the *Times*.

There are undoubtedly many to whom tobacco is injurious, just as there are many to whom it is nauseous. If either class attempt to use it in any form, they are simply very foolish. So also in boys, it is not only silly, but hurtful, and so long as they remain under the rule of preceptors, the latter are very wise in prohibiting it, as indeed it is forbidden, except under the rose, in all our public schools.

If I be asked, is tobacco a necessary, I answer most decidedly, *No*; but it may be very useful in a variety of ways for all that, as I have shown you. But what *are* necessaries? Are the fashions of dress? Is dress at all a necessary? Is the opera, the theatre, newspapers, novels? Are flower shows? Are Literary and Philosophical Societies necessaries? Pre-braccal man had neither clothes nor books, nor wine, nor tobacco, and he was supremely happy. In our day, we know the superiority of good stone and brick walls over the mud and sticks of our ancestors; and it is just as unreasonable to say that we ought to do without tobacco because it was not known 400 years ago, as to say that we ought to live in mud huts, or do without books now, because house architecture and printing are modern inventions. There is not one of the things I have mentioned that is not liable to abuse. There is hardly one of them that you will not find some one to condemn as virulently as the Anti-Tobacco Society (which actually exists), will condemn the 'weed.'

The gross amount of revenue derived from the excise, the taxes on, and the licences to deal in liquors of all kinds, was, during 1859, 21 millions, exclusive of hop duty. An enormous sum,—twenty-one times ten hundred thousand pounds! In Table XVII. you have the amounts.

TABLE No. XVII.

Liquors.—Revenue from Duties, Excise, Licences, &c.

United Kingdom.

1851	Population, 27,400,000. £16,700,000. Per head, 12*s*. 2*d*.	1859	Population, 29,000,000. £21,000,000. Per head, 14*s*. 6*d*.

Besides Hop Duty.

Undoubtedly the first object of government in imposing taxes is the obtaining of revenue, and no class of articles is a more just subject of such taxation than luxuries in general use. Keeping revenue only in view, the taxes should be fixed at a point which will not check consumption; but with regard to spirits in particular, the taxes have been regulated partly with the object of restraining excessive consumption. This restrictive taxation is perfectly legitimate, and the duty should be fixed at the highest point which will not encourage illicit distillation and smuggling; for low duties certainly cause increased consumption. All recent legislation has been progressing on this path, and it is to the raising of the duty on spirits in Scotland, from 3*s*. 8*d*. per gallon in 1851, to 8*s*. 1*d*. in 1860, that much of the decreased consumption shown in Table No. XII.* is due.

But restrictions on drinking are carried further than this, and also justly; and so we have public house Acts, and tippling Acts, and beerhouse Acts, all of which are good in their way; the danger here again is of overdoing it, as for instance, in the Forbes Mackenzie Act for Scotland. By this no grocer may even *give* a glass of wine to a customer. No confectioner or dealer in provisions or eatables of any kind can receive a license to sell wine or spirits, thus actually discouraging the proper and dietetic use of stimulants, and encouraging drinking for drinking's sake. No hotel can supply any public or private party or ball with wines or spirits later than eleven o'clock. No such inn or hotel is allowed to supply a townsman during any part of Sunday; nor is a lodger in any hotel permitted on Sundays to invite a resident friend to any meal where wines or spirits are required. This is actually the law, inquisitorial enough to have been framed by John Knox himself.

The effect of this law has been that the detected cases of drunkenness on Sundays have decreased. People now drink on that day where the police cannot go; the cases on the other days of the week have, it is said, increased, and the sin of hypocrisy

* Page 34.

has been added to the sin of intoxication. Among the lower classes the artisans have formed themselves into clubs, by which the stringency of the law may be evaded. The number of unlicensed dealers has been largely increased; and besides all this, a vile system of spies and traps has been instituted,—so obnoxious that police officers can hardly be found to carry it out. In October last, a grand ball was given at Thornhill, in Dumfriesshire, to Lord and Lady Dalkeith; a few days afterwards, a justice of peace court was held, and three innkeepers were fined £1. 5*s*. each, for infringing the Forbes Mackenzie Act,—the real delinquents being the Sheriff of Dumfriesshire, a number of Magistrates, and the Lord Lieutenant of the County himself, who was their guest. Thus may legislative meddling bring the law itself into contempt.

Knowing well how fallacious statistics are, unless you take into consideration all subsidiary agencies, such as the state of trade, the state of the weather, the vigilance of the police, nay, the prejudices of the magistrates, I do not ask you to do more than look at

TABLE No. XVIII.

Liverpool.

Year.	New Licences granted.	Increase of "Drunk" Cases subsequent year.	Decrease of ditto.
1846	17	—	256
1852	0	1144	—
1854	2	1018	—
1857	32	—	1259

It seems at least to show that drunkenness is not to be kept in check by the mere refusal of licences, and the diminution of public houses. No one has ever proposed free-trade in such articles, but I do believe that if wine and beer, &c. were sold as groceries and consumed at home, it would be far better for both morality and health, and I do not believe that this would lead to any increase of the gross annual amount, probably to a very considerable decrease.

But some persons, thirty years ago, deeply impressed with the evils of excessive drinking, established Temperance Societies,—the only obligations incurred being abstinence from spirits, and moderation. This was very well in its way, for all who chose to join, but the fallacy had already crept in, that it was *possible*, by any rules of any kind whatever, however stringent, however moral, however good, to *make* men bear the fruits of Christianity while it was not yet in their hearts. This I call a fallacy, and it *is* one quite as much in the political as in the moral aspect.

"It would be an evil worse than that of drunkenness, if a nation learnt to lean on the rotten reed of external enactments, and thus sapped the very foundations of right, and destroyed the springs of all moral action." *

And *I* say true religion wants no such vows and pledges.

Ten years after this first commencement, that is, about twenty years ago, temperance had ripened into total-abstinence; and again I desire to bear witness to the good, the immense good, which has resulted to the community at large from the reclamation of drunkards, and the imposition of restraint on the man who cannot practise moderation. But hear what total-abstainers now say of total abstinence. Dr. M'Culloch says:

"You will find, 1st, that it takes a long time to persuade many men to become abstainers; 2nd, that of those who do become abstainers, *by far the greatest number relapse into drinking, and but too often into greater drinking than before.*"

Again:

"The truth must be told; the total-abstinence movement has *failed*, lamentably failed, of itself, to remove the liquor-traffic, or to stem the tide of drink and drunkenness in the nation." †

A writer in the *Alliance Weekly News* of November last says:

"Abstinence societies have been diligently and laudably at work for many years; and though they have effected good, very great good, yet we may ask, What perceptible impression have they made on the entire community?

* Westminster Review.

† Address to Medical Students, by J. M. M'Culloch, M.D.

Shall we say *None?* As the direct consequence of their labours, how many distilleries have been closed? how many breweries? how many public houses? Shall we again say, *None!*"

And so on, Temperance is no longer thought of; even total-abstinence is thrown aside, and the great monster evil is no longer said to be the *drinking*, but the *selling* the drink.

SUGGESTIONS FOR BILL TO PREVENT THE TRAFFIC IN INTOXICATING LIQUORS, (as agreed upon by the General Council of the United Kingdom Alliance.) Being mere general suggestions, much detail is intentionally avoided in the following clauses.

PREAMBLE to set forth that

WHEREAS the common sale of intoxicating liquors is a fruitful source of crime, immorality, pauperism, disease, insanity, and premature death; whereby not only the individuals who give way to drinking habits are plunged into misery, but grievous wrong is done to the persons and property of Her Majesty's subjects at large, and the public rates and taxes are greatly augmented; and whereas it is right and expedient to confer upon the ratepayers of cities, boroughs, parishes, and townships, the power to prohibit such common sale as aforesaid—be it therefore enacted:

I.—To be lawful at any time from and after the passing of this act for any   or more ratepayers residing in any municipal or borough town, or in any parish or township, or part of parish or township, not within the municipal boundary, to require by notice, under their hands, the mayor, provost, or other public officer, to take the votes of the ratepayers of such borough, parish, or township, or part of parish or township, as to the propriety of bringing into operation the provisions of this act.

The mayor, provost, or other public officer, within *seven* days after receiving requisition, to give public notice of a day, not earlier than   days, nor more than   days after notice, and of a place or places within such borough, parish, township, or part of parish or township, when and where the ratepayers are required to signify their votes for or against the adoption of this act.

The votes to be personally delivered by the voters at the appointed voting places.

II.—The mayor, provost, or other public officer, to appoint places and persons for taking said votes.

Every person who is rated to the relief of the poor within the said borough, parish, or township, or part of parish or township, to be entitled to one vote for or against the adoption of this act.

The mayor, provost, or other public officer, to examine the votes, and to declare within two days of the close of the voting, by public notice, the numbers for and against. The adoption of the act to be decided by the number of votes. But the act not to be adopted unless the number of votes for its adoption be at least *two-thirds* of the aggregate number of votes given.

Notice to be given immediately of the adoption of the act.

III.—If the ratepayers decide against the adoption of the act, or the majority be insufficient as aforesaid, *One Year* to elapse before it shall be lawful again to take votes in such borough, parish, or township, or part of parish or township.

IV.—Not to be lawful, from and after the time limited for the commencement of this act, for any person or persons (within any borough, parish, or township, or part of parish or township adopting this act as aforesaid,) to manufacture within the said borough, parish, or township, or part of parish or township, for sale, or directly, or indirectly, to sell, barter, exchange, or dispose of, except for such purposes as may be hereafter provided, any alcoholic or intoxicating liquor.

V.—Any person not being an agent duly authorised, who shall, within the said district, by himself or his agent, directly or indirectly sell or furnish under any pretence, any alcoholic or intoxicating liquor, except according to the provision of this act, to be liable to a fine of   on the first conviction,   on the second, and on subsequent convictions to imprisonment of not more than   nor less than   . In default of payment of fine and costs on first or second conviction, the offender to be imprisoned at the discretion of the justices.

VI.—If any   ratepayers of the said district make oath or affirmation before any justice of the peace acting for or within said district, that they believe alcoholic or intoxicating liquors to be kept or deposited for purposes of sale in any conveyance, shop, warehouse, or other place or building, within such district, the said justice to issue search warrant, and any alcoholic liquor found in pursuance thereof to be seized.

No dwelling house, however, to be searched, which is not a house of public entertainment, or in which, or part of which, a shop is not kept, unless   (at least) of the said complainants testify on oath or affirmation to some act of sale of alcoholic liquors therein or therefrom within   of the time of the complaint.

The owner or keeper of the liquor to be forthwith summoned before the justices of the district. If he fail to appear, or it is shown that the liquor was kept and intended for sale, contrary to the provisions of this act—the liquor to be forfeited and destroyed.

VII.—If the owner of the liquor be unknown,   days' notice to be given of the seizure, and if lawfully claimed, the liquor to be given up.

Any person on whose premises, or in whose building, or house, or place, any offences against this act may be committed, to be held responsible, and liable to the pains and penalties of the act, unless he can show non-participation direct or indirect.

VIII.—The justices acting for said district to appoint an agent or agents to sell within said district, at some convenient and suitable place, alcoholic liquors for purposes such as may be hereafter provided,—such agents to receive a salary not exceeding £   per annum. Not more than one such agent to be appointed for every   inhabitants.

IX.—Such agent to enter into a bond with two sureties, that he will in all respects conform to and sell only according to the provisions of this act.

Every such agent to keep a book in which he shall enter each sale made by him of alcoholic liquors, giving date, time, purchaser, quantity, and purpose for which required; this book to be open to the inspection of the justices or their officers at all times.

X.—To be the duty of any constable, &c., whenever he shall see, within said district, any person intoxicated in any public street or place, to apprehend such person, and keep him safe until sober; and thereupon to take him before a justice, who shall examine him on oath, or affirmation, for the purpose of ascertaining whether any offence has been committed against this act.

If such person refuse to answer, or to be sworn, or make affirmation, the justice to commit him during pleasure.

If on such examination it appear that an offence has been committed against this act, said justice to issue his warrant for the arrest of the offender, and the search of his premises, and convict him on sufficient evidence.

XI.—Every person who shall sell any liquor in violation of this act, to be liable for all damages which may happen or result therefrom.

XII.—Any person to have right of action against any other person who shall sell any liquor contrary to any provision of this act, to the husband, wife, parent, child, guardian, ward, apprentice, or servant of the plaintiff.

Not to be necessary to aver special damage, but jury to assess damages.

Any married woman to maintain any such action in her own name irrespective of the consent of her husband.

XIII.—No person engaged, directly or indirectly, in the sale of alcoholic liquors, to be a juror in any case arising under this act.

XIV.—Right of appeal to be given against conviction by justices under the provisions of this act.

N.B.—It must be borne in mind that the above "suggestions" aim at nothing more than an indication of general intention. Many technical deficiencies may be observed, which of course would be remedied in preparing the draft of an act of parliament.

Note also that some modification of detail will be required to render the "suggestions" legally appropriate to Scotland and Ireland. These, also, will of course be made at the proper time.

With reference to the qualifications of voters, &c., it has been thought best to adopt machinery and methods already existing, in order to avoid embarrassing the "suggestions" with extraneous debateable points. The Alliance is not committed to the advocacy of any particular plan for the voting.

On clause 6 and 7 in the "suggestions," note that in relation to gaming-houses, 8 and 9 Vict. cap. 109, declares that any dice, tables, or other instruments of gaming found in any house suspected to be a common gaming-house, shall be evidence, until the contrary be made to appear, that such house *is* used as a common gaming-house. Lord Campbell's "Sale of Obscene Books Prevention Act" gives much more summary powers than those claimed in these clauses.

Note also, on clause 10, that a recent act in relation to gaming-houses adopts the same principle. By 17 and 18 Vict. cap. 38, persons taken into custody as being present in a gaming-house, may be called as witnesses and punished if recusant. Such a provision would be more or less useful in proportion to the area of the district.

This is a Bill as proposed to be introduced into this country. It is, I believe, almost identical with that which has been adopted in some States of America, and there called the Maine Law, a title which, for brevity, I shall adopt in referring to it.

I have given you the philosophical reason for the watery character of teetotal literature, but though watery as to potency of argument, it is exceedingly hot, and fiery, and pungent, in the nature of the abuse lavished on all sellers, makers, or dealers in any kind of dietetic stimulants. This is to be accounted for, in an equally philosophical manner, as many of the writers of this abuse are men of exceedingly excitable temperament, whose instinct tells them in very plain terms, that they should be total-abstainers, as stimulants are highly injurious to them. With the obedience to this instinct, as regards their own persons, they should content themselves, and not illogically assume that all others are as unhappily constituted as themselves. The arguments of *total abstainers* are in great measure founded on the assumption that use must necessarily end in *excess;* the arguments of the Maine Law advocates are wholly and solely grounded on that same assumption. War is to be waged against all dealers, when promoted to civic dignities. One says:

"During the mayoralty of Mr. Mackie, in Manchester, . . . a spirit merchant, . . . little drink-shops had been expanded, and allowed to blossom out in full blaze, as gin-palaces, in all the poorer parts of the city. Under the beneficent reign of a spirit-merchant mayor, that had been done for which the drunkard's child . . . would curse the name of Mackie, . . . and hell herself would open her mouth and send out a mighty chorus of 'Bravo, Mackie!'"

Another states his belief that

"No man who gained a livelihood by the liquor traffic could do real justice to the people" as a magistrate. They "regard the liquor traffic and all its supporters with extreme abhorrence, and hold all law which licenses it in the utmost detestation, as that which sanctions crime." *

Abuse is showered on an unhappy vicar, who, at Newcastle, dined with the licensed victuallers (called in their tongue, "the keepers of Satan's hostelries"). His presence probably acted as a check on all excess, and he thus performed a duty, both to God and man, by the silent example, as well as the inculcated precepts of moderation.

"No man can continue to sell intoxicating drinks, without, at the same time, selling disease, insanity, and death, domestic misery, pauperism, quarrels, oaths, blasphemies, obscenities, assaults, . . . sin and crime in every shape, including suicide and murder itself."

The poor wine merchants! Again:

"The very worst that has ever been said against the devil is, that he first tempts his victim, then betrays and punishes him through time and eternity. What better are our so-called Christian government and magistrates and the liquor traffickers in regard to the trade in drink?" †

By such arguments can no one be convinced; by such denunciations, no woman even can be scared: and if such intemperance

* Alliance Weekly News, 1860. † M'Culloch, *Op. cit.*

in language be one result of total abstinence, it would be, to my mind, but a poor exchange for intemperance of another kind.

This Maine Law was first carried in Maine State in 1851, and in 1853 an Association called the "United Kingdom Alliance" was established for the purpose of securing its adoption in this country. It has been more prominently brought before the public during the past year, by its having been mentioned in terms of partial approbation by Lord Brougham at a meeting of the Social Science Congress. Subsequently at a meeting of the Maine Law Alliance itself, a very enthusiastic advocate was found in the person of the Dean of Carlisle, who is probably better known to most of you as Mr. Close, of Cheltenham. This is not the place to condemn the peculiarity of his views on certain subjects, but it is allowable to protest against the system of force and intimidation, by which he attempted to impose his opinions on others, and the anathemas launched against all who differed from him.

This "real live Dean," as he denominated himself, unable to restrain himself, in his new-born advocacy of what he miscalls the cause of temperance, lets out that he has been in the habit of taking wine, that he has had the gout, and that by medical advice, he has become a total abstainer. The fox, as in the old fable, has lost his tail, and must needs go about now most disinterestedly preaching that everybody else, who find their tails very useful, must submit to de-caudation, and because he has got the gout, must not use the bounties of God in moderation. He ought probably, to have been a total abstainer, on medical grounds, all his life; and, by his physical infirmity, he is utterly disqualified as a teacher of others, or as a judge in this matter. At a meeting last month he threw down a live-shell that I expect will prove a disagreeable exploder; he said,

"If all the drink in England were tossed into the Atlantic, he (the Dean) would be as warm an advocate for universal or manhood suffrage as the stoutest radical in the country."*

* Alliance Weekly News, 1860.

I always thought there was a slight smell of politics about all this Maine Law business, and this lively gouty Dean has perhaps let out a secret.

It is disagreeably offensive to my mind to read of meetings of "reclaimed drunkards" being considered in any way more "interesting" than so many reclaimed thieves or murderers, and it ought to be less captivating to a properly constituted mind, which rightly regards the sin of drunkenness, to hear a narrative of gross excess, and the horrors of delirium tremens, as painted by "one who has experienced it," than to listen to the details of a robbery, or the secret history of a forger.

The chief essentials of the "Suggestions for a Bill" are these, that the ratepayers should be entitled to vote on the matter, and a majority of two-thirds, not of the voters, be it observed, but *of those voting*, (see clause II), should carry it, a thorough legalisation of mob-law. The manufacturing (for sale) the selling or furnishing of any intoxicating liquors is prohibited, except for certain purposes, understood to be sacramental, medicinal, chemical, and mechanical. One salaried agent to be appointed to sell for these purposes. Fines for first offences, imprisonment for second or subsequent offences. Liquors may be seized and destroyed, and suspected persons may have their houses searched, and drunk persons are to be arrested and kept in custody—very properly—till sober, but are then,—hear this!—Clause X,—to be examined on oath (or affirmation,—they suspect even the Quakers) as to where they obtained the liquor, and if refusing to answer, to be committed to prison for any indefinite term. A little lower down—

"Any married woman to maintain any such action in her own name, irrespective of the consent of her husband."

The mental constitution of the framers of such a clause must be peculiar, this is the kindest way of putting it. It is surely enough for us men to have to pay the milliners' bills,—and not to have, in addition at this season,—"the lawyer's little account."

We may brew, distil, import wholesale,—but not buy or sell—

and the inquisitorial powers of this Bill are utterly opposed to all our ideas of freedom and liberty.

Besides this, it is inoperative where it has been adopted.

"There is hopelessly complicated contradiction as to what it has effected . . . while one party tells us that the law turned the State of Maine from a Pandemonium into a Paradise; another party, comprising Mr. Gough once the champion of the law, replies that that is all romance, and travellers from this country concur in stating that they did not find the law putting any real difficulty in the way of their drinking anything they felt inclined for."*

Travellers indeed see things as they wish to see them, in this, as in slavery, and in all other matters. An American himself states that in Portland

"There is more intemperance and more drinking there, and probably throughout the whole State of Maine, with here and there a doubtful exception, than there has been at any other time for twenty years. Young men have banded together to evade the law . . . children carry liquor about with them; and bottles are made in the shape of bibles, so as to deceive the eye."

Mr. Baxter, at a lecture in Dundee, says:

"Has the entire prohibition of the traffic in fermented drinks eradicated intemperance? I answer, without hesitation, no! Can it be enforced? In the villages and smaller country towns it can; in the cities, not at all. I have seen with my own eyes drunk men on the streets, and dozens of wines consumed in the hotels of large towns, subject to the provisions of the Maine Law. The adoption of the Maine Law, in certain cases, actually increased the consumption of ardent spirits . . . private clubs were instituted where spirits were kept in a press for the use of members, and to one of these presses alone there were 300 keys." And so on.

In Hartford, Conn., the year after the Maine Law was established, the local papers say:

"Probably there is more intoxicating liquor retailed at this time than ever before, and evidently there is more drunkenness. . . . Club-rooms have multiplied to a fearful extent; and hundreds of families, in which liquor was unknown before August last, now keep a variety, and ask their friends to drink, . . . the fashion of keeping liquors upon the family sideboard is fast coming into use, and its evils are as great as those of the rum shop."

* Scotsman Newspaper, 1860.

These so-called "family liquor bars" are next to be attacked, and it is the scarcely-veiled project of the law to prevent, under the cloak of all *selling*, all *drinking* whatever, however moderate, nay, however necessary. One thing is certain, that this Maine Law, where adopted, has led to rows and riots, injury to property and person, to the calling out of the military, and loss of life, to "vigilance committees," spies and informers, to dissensions, to quarrels, and to "all uncharitableness." Above all, proceeding, as it does, on the principle that a majority may impose an obnoxious law on a minority, it establishes a grinding tyranny, a tyranny which one can only bring home to Maine Law advocates by supposing the *converse* law to be enacted, and that all who find benefit from the use of stimulants, should combine, and insist that all *must* drink. It would be quite as reasonable, quite as legal, quite as unjustifiable.

But "there is no new thing under the sun; the thing that hath been, it is that which shall be." The Maine Law is no novelty; it was established by a false prophet, Mahomet, more than twelve centuries ago, and now exists among a people, his followers, numbering upwards of one hundred millions. The Koran says:

"Wine is an abomination, of the work of Satan." "They will ask thee concerning wine" (the word translated *wine* means all inebriating liquors) "and lots (gaming); Answer, In both there is great sin, and also some things of use unto men, but their sinfulness is greater than their use."

The stricter Mahommedans, especially if they have been to Mecca, hold it unlawful, not only to taste it, but to make it, or buy it, or sell it, or live on the produce of the sale of it. Why, this is precisely the language now reproduced. But what is the character of the Mahommedan? He has plenty of harmless unintoxicating sherbets, nay, perhaps he lives, as the Arabs, on dates and water, but he is sensual as a brute, and voluptuous as a satyr; not only in this life is he allowed four wives, besides concubines, but the pleasures of his prospective paradise are simply the grossest indulgence of the passions.

The Maine Law has not checked the spirit of secret, dark

revenge; it has ever recognised the very *principle* as well as the *practice* of slavery; and poor woman is denied almost a soul. There is indeed a paradise for her who does aright, but there can be little paradise for her here, for the Koran again says:

"Those wives whose perverseness ye shall be apprehensive of, rebuke, and remove them into separate apartments, and *chastise them*."

The conclusion from the facts concerning Mahommedanism is quite inevitable, namely that enforced abstinence from, and forbidden dealing in, intoxicating drinks, are found to be utterly wanting, even after a trial of 1200 years of successful prohibition. It illustrates the truth of my position, which I have ever held, and maintain against all comers, that temperance and moderation are—to use holy words—"fruits of the Spirit," while an enforced abstinence is, or at least may be,—grapes gathered from thorns, and figs gathered from thistles,—an unreality, a snare, a delusion,—worst of all, a possible self-deception.

The first and only real temperance society was established a little more than 1800 years ago, and by that society of Christianity we are bound to be temperate, not only in drink, but in everything. I would only add, Let us remember our responsibilities.

But what then is to be done? I have admitted with abhorrence the gross evils resulting from the abuse of drink; Is there no remedy? Are we to sit down in despair over our crimes, and our lunacy, and our diseases? I say, by no means.

And first, The Maine Law, the absolute prohibition of the sale of drink is good, nay, it is necessary, where you are dealing with men in a brute state, with Indians, with Kaffres, with the aborigines of Australia or New Zealand. Nothing less will do to keep those, who have no higher motive to influence them, from the fire water which destroys and exterminates them.

Secondly, Teetotalism, voluntary abstinence, is good for the excitable, the full-blooded, the gouty, for all those who know, either from their own experience, or from the precepts of their medical advisers, that they are the better for abstaining. If either the one class or the other indulge, they are not only foolish, but sinful. Further, teetotalism is good for all those who acknowledge their inability otherwise to practise moderation, for the debased sot and the inveterate drunkard. Lastly, it is good for anybody else who likes,—for any who feel that their influence is thereby increased among the votaries of drink, who feel their arm nerved by it in the crusade against drunkenness.

Thirdly, Temperance and moderation is not only good but *necessary* in all. But what is moderation? I cannot tell you.

"In a remote country district in Scotland, a clergyman had become notoriously intemperate, and the presbytery had to deal with the '*fama*' against him, which could no longer be concealed. One witness, supposed to be specially qualified to give the evidence, if he chose, long evaded all efforts of the court, till, at length, he seemed to be shut up to a plain answer, by the question being put thus:—'Now sir, no more equivocation; on your oath, did you ever see your minister the worse of drink?' The man's eye instantly lighted up with a twinkle of roguish intelligence, and he readily replied 'The waur o' drink! na, na, I never saw him the waur, but often a hantle the better o't!'"*

Anyone who is perceived to be "a hantle the better o't," may be safely set down as having exceeded what is good for *him*.

The definition of moderation is like the definition of health, like the definition of sanity,—one is more, another less excitable, one is more, another less mad, and no one is absolutely perfect in his organisation either of body or of mind. As a rule, all drinking except at meals, all frequent and occasional drinking, and all use of raw spirits, unless under most exceptional circumstances, cannot be classed under moderation. But each of us has had a guage, a correct and infallible guage given him by the Almighty. Our own conscience will ever and always tell us when we have contented ourselves with moderation, and still more faithfully will warn us against the earliest approach to indulgence or excess.

The real remedies for drunkenness are twofold in their character, physical and moral. The physical, the repressive measures,

* Professor James Miller in Edinburgh Medical Journal, vol. iii.

by the interference of the arm of the law, I have already said, all must agree to be justifiable and laudable. There is a parallel case which affords a very easy illustration. Playing cards are taxed 1*s*. a pack; Dice are taxed 20*s*. a pair; and the laws against gambling are most severe. The vice of gambling is surely as great as that of drinking; its power over, and its ruin of, the individual is often more complete than that of drink. Yet, though we pay taxes on dice and cards, though we punish gamblers, from the thimble-rigger at Epsom, to the titled frequenter of the fashionable "hells" in St. James', will any one say that therefore it is wrong to play backgammon with my sisters or cribbage with my grandmother? Let, therefore, as high a tax as is compatible with the successful repression of smuggling, be put on spirits, and let the consumption, in their place, of light wines and of unstupefying beers, be promoted by every legislative means, by commercial treaties, and by lowering duties. Lord Brougham, thirty-five years ago, tried to encourage the consumption of beer in place of spirits, by bringing in bills to repeal the old Beer Act, but they were all rejected, and that which was adopted in 1830, not only facilitated the trade in beer, but opened a wide door for abuse by permitting consumption on the premises,—a point which Lord Brougham contended against to the uttermost, and which he would have visited with the highest penalties. The discouragement of this licence "to be drunk on the premises" as it is worded, and too often correctly, in a second sense, is another point to which legislation may be most properly directed.

There are two small parishes in this County, Little Dalby, with 200 inhabitants, and Beeby, with 150, in neither of which is there either public house or beershop. In the former, the worthy squire, the respected Member for North Leicestershire, makes his Hall the house of entertainment for the stranger, as some members of this Society are happy to know. In the other the rector dispenses his hospitality with no niggard hand. I have been at the pains to enquire what the poor labouring class does in these two villages, and I find that the farmers supply malt in part wages, to those who can brew for themselves, and that those who do not do so, obtain their beer in small $4\frac{1}{2}$ or 9 gallon barrels from the adjoining villages, where special facilities are afforded to supply the demand. Undoubtedly these villages are two of the most respectable and moral in the County: but then, in them, the farmers are well-to-do, and care for their labourers; there is no want of work, no distress, and the blessing of a good squire and of a good rector can perhaps be best estimated by the hypothetical enquiry of what would be the state of those two villages if the good squire were a churl, and the good rector a miser. It will be said to me, This is simply the Maine Law. I say in reply, It is no Maine Law, when for dietetic purposes beer can be obtained in the next village, and neither the squire nor the parson wish to buy their claret or port in a public house. The whole scheme and object of the Maine Law is gradually to abolish entirely and everywhere the purchase or the sale of any kind of liquor for dietetic purposes; and if it be represented as not doing this, then it is but one more deceptive unreality, such as are peculiar to our day, and, as such, to be repudiated by every honest man.

Then, let us punish the transgressors. Let no mawkish sentimentality favour the drunkard, to whatever class in society he belong. Let the fines be unhesitatingly exacted, and let publicity be given to the names of the offenders. Just observe what an instantaneously beneficial effect the inflictions of a few fines, and the reporting them in the papers, has on our smoke nuisance.

Revive the stocks if you will, and after a certain number of convictions let imprisonment be the sentence with no option of a fine, just as in the case of any other crime. Do not blink the matter; it is the indulgence to excess that is the crime—the rouge et noir,—and let the backgammon and the cribbage alone. Let us have a law, as in Jersey, which deprives the habitual drunkard of the guardianship of his children; such, as in Sweden, takes away from him his political and electoral rights; such, as formerly in Spain, did not admit the evidence of any drunkard in the witness box; such, as in one German principality, refuses licences

to marry till the intemperate man has given full proofs of his reformation. It is an extraordinary fact, that in the most drunken part of Great Britain—in Scotland, there is no punishment for simple intoxication, except by an indictment at the sessions. It is an extraordinary fact, I say, and a most significant one. Then, let us have a much more stringent and strict inspection by the police, of all public houses and beer shops, and no winking, as there is, at nightly assemblages of thieves, and gamblers, and prostitutes.

The tyranny of the great brewers is another fit subject for legislation. It would be no harsher law which should prevent a brewer owning public houses than that which imposes severe penalties on doctors who send patients to asylums in which they have a pecuniary interest. They keep the licenses in the hands of men of little capital, and refuse them to the respectable dealer who would like to engage in the trade. They prevent the publican buying his supply in the cheapest market; they in some cases, almost necessitate adulteration.

Then let us have most severe laws against this crime of adulteration in all its abominable phases; let alcoholic tests be applied, and punish smartly and quickly even the adulteration with water, and as for nux vomica and grains of paradise and other poisons, let there be a sure imprisonment.

There are drunkards who are no longer responsible agents; we call them oinomaniacs or dipsomaniacs, they drink because they cannot help it; they have no longer left the self-control which denotes *sanity*, they do not drink for pleasure, they drink as often as they can, and whenever they can, whatever they can, and as much as they can.

"No regard to public opinion, or common decency, or domestic ties, or religion, or the certainty of impending ruin or degradation, or even the fear of death, can prevent their drinking till they can drink no longer."*

* Edinburgh Medical and Surgical Journal.

While reading this lecture I was attending in consultation at the deathbed of a Leicestershire farmer, whose father, mother, and three sisters, had all drunk themselves to death, and he himself, the last of his family, was sinking under disease produced by habitual intoxication.

Now, to deal with such, we want legislative interference again. When a man has lost his self-control, he has become a lunatic, and should be dealt with as such. After a certain number of convictions, such cases should be sent to an asylum for a considerable period, say a year or eighteen months. It is only the medical man who has to sign certificates of lunacy, who knows how difficult it is to lodge those labouring under this form of disease in asylums, legally, under the present law; and the detention of them there after they have recovered from their debauch is, strictly speaking, contrary to law. It is true, the commissioners in lunacy are coming more and more to wink at prolonged confinement in such instances; but only a few years ago, any one who sent a case of delirium tremens to an asylum was laughed at. I would have every case of delirium tremens from drink secluded; and for a second attack a longer period of seclusion than for a first; and I would also have them let out on parole—a "ticket of leave," and if evil ways were reverted to, seclusion should again be legal, even before a regular outbreak had taken place.

I believe that if such laws were in force, and carried out in a way to convince all that the administrators of the law were really in earnest in suppressing the abuse of drink, and thus awake the dormant moral feelings of the drinker, we should soon be very much reformed as regards drunkenness.

Lastly, there are the moral remedies, the encouragement of temperance. In place of calling publicans hard names, let the ruling and the better class, the magistrates, the clergy, the gentry, go and dine with the Licensed Victuallers, if they will, as they dine with the Agricultural Society, and thus exercise their moral influence on the habits of the class below them.

Do not taboo the honest publican, or you help to make him forget and overlook his dignity as a respectable tradesman and townsman. Let us never forget, as we sit in our comfortable drawing-rooms, bemoaning the ignorance and the self-indulgences of the poor, that they have no comfortable homes, and that the attraction of the warm, well-lighted, and sociable public-house

will often tempt a man from his slatternly home, who has no desire or intention of drinking to excess. Let us therefore apply ourselves to the bettering the condition of the working class, and improving their education, let us encourage reading-rooms, mechanics' institutes, free libraries, and museums, coffee-houses, lectures, exhibitions, public parks, recreation grounds for games, (and not sell our cricket-ground for building purposes,) above all, popular concerts, and music always attractive.

Let us keep a strict eye on our country privileges, our footroads and rights of way; if you pen people up in a town, shut up all sources of amusement, stop all the railways on Sunday, and close all the public-houses, you may make Leicester as besotted and as pharisaical as Glasgow.

It is by such festivals as are, I rejoice to say, yearly becoming more common, such village feasts and harvest homes as were held last year at Humberstone, at Wigston, and elsewhere, that the people are cheated into sobriety; by them that the publican will get rid of the sot, and the devil lose his victim. It is thus that the different classes of society may be brought together, for their mutual benefit, it is thus you may touch a man's feeling of generosity, or excite an emotion of gratitude; you establish his respect, and depend upon it, it is the man who has learned to respect his landlord and his clergyman who will soonest learn to respect himself.

I should be unpatriotic, did I omit this opportunity of a word of praise to our Volunteer Rifles. There again is a movement, noble in its origin, noble in its object, and one which I believe to be destined to be of the greatest service to us in the crusade against intemperance.

Much is also in the power of all of us who employ labour, or who have others, be they only servants, dependent on us; it is for us to lay down the strictest rules in our houses, as in our factories and our warehouses; let every drinker be assured that his indulgence will be punished by dismissal. Let there be no compromise, no encouragement given to any but the sober, and let every drunken person find in us an enemy.

Above all, let us set an example of temperance and moderation in our own persons and in our own families,—without this, all attempts, however vigorous at reform, all laws however severe against intemperance, must prove utterly futile.

In the course of my lecture I have spoken with great harshness of the habits of our forefathers. But let us never forget that though they did indulge in a grossly sensual, and wholly unjustifiable way, it was the same race of men who established on its firmest basis the name of the Englishman for integrity and uprightness: men had not then forgotten the words of Solomon, that "a poor man is better than a liar." It has been reserved for our day, for our sober day, when the drinking forms of sensual indulgence are, to say the least of it, unfashionable,—it has been reserved for our days, I say, that man should no longer dare to trust his fellow —that commercial dealings should become such that a yard is no longer a yard, a pound is no longer a pound; that "Brummagem" imitations have become a byeword in foreign countries; that a trade mark is no longer a security against fraud; that the word of an Englishman is no longer his bond; that distrust and speculation go hand in hand, the great day of deceptions and shams. And, the forger, the fraudulent dealer, the adulterator, the false-bill discounter,—these are quite as flagrant a disgrace, in our day, as was the indulger of a former day. Nay, the effects on the moral character of the individuals themselves, as well as on the public, are perhaps more ruinous than those of drinking to excess. The drunkard lowers himself to the level of the brute only; the deceiver goes further down in the scale for his prototype and claims kin to the spirits of darkness themselves.

I do not say that drinking habits and commercial integrity between man and man have anything to do with each other as cause and effect, I only assert that that epoch had its good points as well as its bad, and that in the present day, stiff formality and

heartlessness have very much taken the place of the cordial hospitality and frank dealing of former days. Display and rivalry, ostentation and insincerity, are a poor, a very poor substitute for the hearty honest welcome of our forefathers; and the vices of the nineteenth century, even if shrouded in the chill pall of a Maine Law, will encounter the same doom as the more sensual and jollier vices of the eighteenth.

> "With mirth and laughter let old wrinkles come;
> And let my liver rather heat with wine,
> Than my heart cool with mortifying groans.
> Why should a man whose blood is warm within
> Sit like his grandsire cut in alabaster?
> Sleep when he wakes? and creep into the jaundice,
> By being peevish?" *

* Merchant of Venice, Act I.

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THE

HISTORY AND PROPERTIES

OF THE

DIFFERENT VARIETIES

OF

NATURAL GUANOS.

BY

J. C. NESBIT, F.G.S., F.C.S., &c.,

PRINCIPAL OF THE CHEMICAL AND AGRICULTURAL COLLEGE, KENNINGTON, LONDON
CORRESPONDING MEMBER OF THE IMPERIAL AND CENTRAL
AGRICULTURAL SOCIETY OF FRANCE, &c., &c.

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PREFACE.

The information contained in the following pages has been derived almost wholly from my own analyses and from practical experience of the effects of various kinds of guano used in different parts of the country.

There has long been a necessity, not only for farmers, but for manure manufacturers and dealers in manure, to have some better acquaintance with the differences that exist in that class of manures known as guanos.

In the following pages will be found analyses of all the different varieties of guano, which, so far as I have been able to ascertain, have during the last eight or ten years been imported into this country.

In the present work it is intended to treat only of the nature and properties of natural guanos; we propose at a future period to give a history of the origin and progress of the artificial manures manufactured and used in this country.

J. C. NESBIT.

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THE

HISTORY AND PROPERTIES OF NATURAL GUANOS.

NATURE OF PLANTS AND MANURES.

Plants derive the elements of which they are composed, some portion from the earth, some portion from the air, and from the water or rain, which falls from the atmosphere. Soils naturally differ much in their power of furnishing the constituents of plants, and those vegetables which will grow luxuriantly in a soil which contains a large amount of available mineral and organic elements will not attain perfection in one which contains a smaller amount of these substances. Nature, however, has provided us with plants of different habits; so that, whatever the diversity of soils, we find a natural variety of plants adapted to each.

It is estimated that botanists are acquainted with at least 150,000 species of plants; some adapted to live in arctic or temperate regions, others in the torrid zone; but each one requiring certain conditions of soil and climate for its full and proper development.

The food of man is derived from a few species of plants, chiefly the grasses. All soils are not naturally adapted to the requirements of man. For instance, we hear of no district where wheat grows as a natural plant. It is not indigenous in any country, and in no climate will it arrive at perfection without the assistance of man.

Hence, the art of agriculture arises as the result of a constant struggle between the powers of Nature, which would clothe our fields with natural plants, and the necessities of man, who requires for his sustenance the growth of a few species only. A proper system of agriculture must therefore consist in a knowledge of the means of altering the ordinary condition of soils, and adapting them for the growth of certain plants required for the use of man, and of those which are necessary for the sustenance of his flocks and herds.

From remote antiquity until the present century, the ART of agriculture had made but little advancement in its mechanical or scientific operations. It had long been ascertained that certain forms of vegetable and animal matter might be used with success for the reproduction of various forms of animal and vegetable life: but the present century inaugurated the SCIENCE of agriculture; and it was reserved for the chemists of modern times to determine the nature of the elements of vegetables, and to ascertain their relative value.

It is well known that few farms have the power of producing a sufficient amount of animal and vegetable matter, as manure, to bring out their full capabilities.

In order to cultivate land profitably, therefore, extraneous substances must necessarily be imported on to the farm; and the introduction of manures, such as guanos and superphosphates of lime, has undoubtedly been of immense service to British agriculture.

By a careful examination of the component parts of those manures which in practice have been found most conducive to the luxuriant growth of vegetable life, we are now in a position to estimate their commercial and agricultural value.

Before entering fully into a description of the various Guanos, I wish to give a short account of the nature and properties of those substances which practice and science have proved to be essential elements of good manures.

SUBSTANCES FOUND IN MANURES.

The object of this work is not purely scientific; it has been written for the purpose of affording useful information for practical men. It is not intended to enter into a minute examination of every individual element, or combination of elements, to be found in manure; our observations, therefore, will be confined to the more important constituents.

The substances found in plants and in manure may be classed in two great divisions—

1. INORGANIC or MINERAL MATTERS, which are chiefly or entirely derived from the earth.

2. ORGANIC or AERIAL MATTERS, which are chiefly, and in some cases entirely, derived from the air.

1.—INORGANIC ELEMENTS.

The more important mineral elements are—

SILICA.	SODA.
LIME.	COMMON SALT.
MAGNESIA.	PHOSPHORIC ACID.
POTASH.	SULPHURIC ACID.

The inorganic elements are nearly all derived from the soil; though, in the vicinity of sea coasts, or by the action of violent winds, a very considerable amount of common salt finds its way from the sea to the land.

SILICA.

Silica exists in two forms: one very insoluble, as in common sand and quartz. The other, more easily soluble, is found in combination with various substances in different rocks and soils.

Silica is found in abundance in the stems of grasses, particularly in the straw of wheat, oats, and barley. From all the experiments hitherto tried, it appears that soils naturally furnish plants with a full supply of this substance. No benefit has attended its application in a soluble form as a manure. Its presence in quantity in guano is always a distinctive sign of adulteration or impurity.

LIME AND MAGNESIA.

Lime and magnesia are termed alkaline earths, and are both pretty generally known.

Lime, as carbonate of lime, is found in common chalk and limestones, and in gypsum as sulphate of lime. In bones it exists as phosphate of lime.

Magnesia is generally associated with lime, in a greater or less degree.

Soils generally contain a sufficient amount of lime and magnesia for the use of plants. When this is not the case, limeing or marling will supply the deficiency.

POTASH, SODA, AND COMMON SALT.

Potash and soda are termed alkalies. They are found in the ashes of all plants, but vary in amount in different species.

Common salt is chemically called chloride of sodium. The soda of commerce is prepared from common salt.

Potash is prepared by washing the ashes of plants, and boiling down the ley.

With few exceptions, soils appear generally to furnish to plants as much of these substances as they require.

Common salt, however, is very often found useful in strengthening the straw of wheat, oats, and barley, when weak and inclined to fall. It is also good for mangel-wurzel.

Phosphoric Acid.

Phosphoric acid, in combination with lime and a small portion of magnesia, constitutes the greater portion of the earthy matter of bone.

Bone ash (or burnt bone) consists principally of phosphate of lime and magnesia.

Phosphoric acid exists in most plants, united either with potash, soda, lime, or magnesia. It is absolutely essential to the life of animals, and for the production of plants, furnishing their food.

Phosphoric acid may be considered as the most valuable mineral constituent of manures.

Sulphuric Acid.

Sulphuric acid is found in most soils in the form of sulphate of lime, or gypsum. It is very useful for plants of the clover tribe. When not present in the soil, a dressing of gypsum is the readiest way of supplying it.

2.—ORGANIC ELEMENTS.

The organic elements are :—

Oxygen. Hydrogen. Carbon. Nitrogen.

Some organic compounds also contain phosphorus and sulphur.

The organic elements are derived originally in great quantity from the air by the leaves of plants; but in the practice of farming it is found exceedingly useful to place in the soil the organic as well as the inorganic compounds. As the organic matters decompose in the soil, the roots take up the liberated ingredients, which, together with similar elements absorbed by the leaves from the air, are assimilated, and there is thus insured a larger produce to the farmer of the plants he cultivates.

Oxygen, Hydrogen, and Carbon.

Oxygen, hydrogen, and carbon are the three elements

which make up the mass of plants—particularly of the woody fibre. They are almost the sole constituents of starch, gum, sugar, mucilage, and oil, which in the animal economy are the chief elements of respiration and the producers of fat.

They are originally derived by plants from the air by means of their leaves. They are usefully supplied to the soil by means of all the forms of vegetable and animal matters which constitute farm-yard dung.

Nitrogen.

Nitrogen is the most important of the organic elements. It is found in quantity in the seeds of plants, and is an essential constituent of the flesh of animals.

Nitrogen is the most valuable organic constituent in manures. It is the fertilizing principle of ammonia, and of the nitrates of potash and soda, and is found in great quantity in the best guanos. In the latter manures it is largely associated with phosphate of lime.

APPROXIMATIVE ESTIMATION OF THE VALUE OF MANURES.

In consequence of the variation in the composition of manure, and the constant adulterations practised by unprincipled dealers, it is a matter of considerable importance to the farmer to be able in an easy manner to obtain an approximative value of any manure which he may have subjected to analysis; and we subjoin a mode of valuation, the use of which will at least save him from the gross imposition to which he is occasionally subjected. The substances which analysis and practice have proved to be most efficient as manuring principles are phosphates, and nitrogen in any of its forms.

A few isolated experiments prove potash to be of some value in one or two crops, but, as this substance can readily be bought in a state of tolerable purity as sulphate or muriate of potash, and as it is not generally found in compounded manures, we shall not give this any agricultural value, further than as comprised under the term of alkaline salts.

Silica, under any of its forms, has not yet been proved to have any agricultural value; and carbonate of lime (chalk) is in most instances a serious detriment to a manure, though useful on a large scale in the form of chalk or marl.

From a careful comparison of numerous analyses of manure with the value of the substances therein contained, we have been led to adopt the following prices as giving the nearest approximative value of the several manuring matters:

	Multipliers of Value.
Nitrogen	£74 per ton.
Ammonia	60 ,,
Phosphate of lime	8 ,,
Phosphate of lime made soluble ..	24 ,,
Organic matter	1 ,,
Alkaline salts	1 ,,
Sulphate of lime (gypsum)	1 ,,
Silica	No value.
Carbonate of lime	No value.

The following mode of calculation has been used by me for many years, and is exceedingly simple, as we only require the analysis of the sample to enable us to arrive at its worth in a very few figures:—

RULE FOR CALCULATING THE VALUE OF MANURES.

Consider the analysis to represent the components of one hundred tons. Multiply the respective amounts of each ingredient by its price per ton in the preceding table, add up the several products, and the sum will represent the value of one hundred tons. Divide this amount by one hundred, and the quotient will be the price per ton.

The decimals in the analysis below 0.5 may be disregarded, and those above that amount reckoned as an additional unit. Thus, in the second example, the organic matter, instead of 21.68, may be read 22; and the phosphate of lime, instead of 44.35, may be called 44.

The values of all the guanos, the analyses of which will be found in the subsequent pages, are calculated according to the method adopted in these tables.

The following examples show how very closely the rule brings out all the actual value of the various samples. It is necessary, however, to remember that circumstances might possibly arise in the course of time which would render some alteration requisite in the amounts of our multipliers of value. At the present period, however, they are sufficiently true for every practical purpose.

EXAMPLES:

I. VALUATION OF AN AVERAGE SAMPLE OF PERUVIAN GUANO.

			Value per ton.		Total.
Moisture	15·10				
Organic matter	51·27	×	£1	=	51
Silica	2·20				
Phosphate of lime	22·13	×	£8	=	176
Phosphoric acid	3·23				
= Phosphate of lime (made soluble) 7·00		×	£24	=	168
Alkaline salts, &c.	6·07	×	£1	=	6
	100·00				
Nitrogen (*equal to*)	13·54 per cent.				
Ammonia	16·42	×	£60	=	960

1,00) £13,61
20

Value £13 12s. per ton. — 12·20

II. VALUATION OF SAMPLE OF BOLIVIAN GUANO.

			Value per ton.		Total
Moisture	13·85				
Organic matter	21·68	×	£1	=	22
Silica	2·70				
Phosphate of lime	44·35	×	£8	=	352
Phosphoric acid	3·30				
= Neutral phosphate (made soluble). 7·15		×	£24	=	168
Alkaline salts	14·12	×	£1	=	14
	100·00				
Ammonia	4·02	×	£60	=	240

1,00) £7,96
20

Value £7 19s. per ton. — 19·20

III. VALUATION OF A GOOD SAMPLE OF SUPERPHOSPHATE OF LIME.

			Value per ton.		Total.
Moisture	19·82				
Organic matter	20·72	×	£1	=	21
Silica	2·80				
Soluble phosphate	10·25				
= Neutral phosphate (made soluble) 16·00		×	£24	=	384
Insoluble phosphate	16·60	×	£8	=	136
Hydrated sulphate of lime	29·81	×	£1	=	30
	100·00				
Ammonia	2·00	×	£60	=	120

1,00) £6,91
20

Value £6 18s. per ton. — 18·20

IV. VALUATION OF A BAD SAMPLE OF SUPERPHOSPHATE OF LIME.

		Value per ton.	Total.
Moisture	17·90		
Organic matter	14.00	.. £1	= 14
Silica	29·10		
Oxide of iron, &c.	8·62		
Soluble phosphate	3·24		
= Neutral phosphate (made soluble) 5·05		× £24	= 120
Insoluble phosphate	3·85	× £8	= 32
Hydrated sulphate of lime	23·29	× £1	= 23
	100·00		
Ammonia	0·50	× £60	= 30
			1,00) £2,19
			20
Value £2 4s. per ton.			3·80

V. VALUATION OF ADULTERATED GUANO.*

		Value per ton.	Total.
Moisture	5·40		
Organic matter, &c.	20·55	× £1	= £21
Sand	49·30		
Oxide of iron and alumina	5·46		
Phosphate of lime	16·25	× £8	= £128
Carbonate of lime, &c.	3·04		
	100·00		
Nitrogen (*equal to*)	4·65		
Ammonia	5·64	× £60	= 360
Value £5 per ton.			£5·09

VI. VALUATION OF A SUBSTANCE LATELY INTRODUCED INTO COMMERCE, CALLED "MEXICAN GUANO."

		Value per ton.	Total.
Moisture	3·24		
Organic matter, &c.	13·56	× £1	= £14
Silica	0·60		
Phosphate of lime	25·60	× £8	= 208
Carbonate of lime	46·14		
Sulphate of lime, &c.	10·86	× £1	= 11
	100·00		
Nitrogen (*equal to*)	0·21		
Ammonia	0·26	× £60	= 15
			£2·48
			20
Value £2 9s. per ton.†			9·60

* Often sold as Peruvian Guano, a pound or so under the market price, to farmers who are in want of—A BARGAIN.

† This value is, however, practically lessened by the large quantity of carbonate of lime contained in the sample. Yet this substance has actually been bought by farmers as Guano, at from £8 to £9 per ton.

ON THE DIFFERENT VARIETIES OF GUANO.

The word Guano, pronounced in the Spanish "Huano," is the term now applied commercially to all fæcal deposits of birds and marine animals which on different parts of the earth's surface have been collected together in greater or less purity. The quality and value of these manures commercially depend almost wholly upon the amount of decomposition to which they have been subjected by the action of the atmosphere. The fæcal matter of these animals consists essentially of nitrogenous and phosphatic compounds. The ammoniacal portion of these deposits, with some of the phosphates, are, through the long-continued action of rain and air, made tolerably soluble in water, and are readily washed away. The phosphates of lime and magnesia are less soluble. In dry climates, where very little rain falls, as in some parts of Bolivia and Peru, on the western coast of South America, the dung deposited suffers very little from the action of the atmosphere, and retains nearly the whole of its soluble nitrogenous and phosphatic compounds. Guanos found in the regions where much rain falls lose a greater portion of their soluble ingredients. The residue is, however, often left rich in the phosphates of lime and magnesia. Many guanos are also much deteriorated by large quantities of sand being driven on to the deposits by the action of the winds. Guanos may from their composition naturally be divided into three classes:—

1st.—Those which have suffered little by atmospheric action, and which retain nearly the whole of their original constituents, such as the Angamos and Peruvian Guanos.

2nd.—Those which have lost a considerable portion of their soluble ingredients: of this class are the Ichaboe, Bolivian, and Chilian guanos. They contain a sufficient quantity of nitrogen to distinguish them from the third series.

3rd.—Those which have lost nearly all their ammonia, and contain but little more than the earthy phosphates of the animal deposit. Many of these are largely contaminated with sand.

CLASS I.

GUANOS WHICH HAVE SUFFERED BUT LITTLE FROM ATMOSPHERIC ACTION.

ANGAMOS GUANO.

This Guano is obtained from a rocky point on the Bolivian coast, called Angamos. It is the most recent deposit of the birds, and is collected by hand, with considerable danger and difficulty, from the bare surfaces of the precipitous cliffs which they frequent. When pure, it is of first-rate quality, and having suffered no decomposition, it frequently contains from 20 to 24 per cent., or even more of ammonia. The smallness of the quantity, however, that can be yearly collected, renders it of little general importance to the farmer. This guano differs altogether from the other Bolivian guano imported into this country.

ANALYSIS AND APPROXIMATIVE VALUE OF ANGAMOS GUANO.

	1852.	1854.	1856.
Moisture	10·90	7·64	11·33
Organic matter, &c.	67·36	70·21	52·92
Silica	1·04	3·55	7·08
Phosphate of lime	16·10	5·75	18·60
Phosphoric acid	Not deter.	3·48	1·08
= Phosphate of lime		(7·55)	(2·35)
Alkaline salts, &c.	4·60	9·37	8·99
	100·00	100·00	100·00
Phosphate, soluble		7·55	2·35
insoluble		5·75	18·60
Total		13·30	20·95
Nitrogen (equal to)	19·95	20·09	14·38
Ammonia	24·19	24·36	17·44
Value according to tables .. £	16 8 0	17 11 8	12 16 5

	1853.	1854.	1852.	Powder. 1852.	Lumps. 1852.	1857.*
Moisture	7·60	12·00	12·55	9·34	7·29	11·40
Organic matter, &c. ..	48·37	54·70	61·07	56·01	73·74	28·18
Silica	19·27	7·40	5·36	8·77	2·22	17·02
Phosphate of lime ..	12·84	21·50	13·76	14·08	9·84	25·00
Phosphoric acid .. = Phosphate of lime	Not deter.	Not deter	Not deter.	Not deter.	Not deter.	Not deter.
Alkaline salts, &c. ..	11·92	4·40	7·26	11·80	6·91	18·40
	100.00	100·00	100·00	100·00	100·00	100·00
Nitrogen (equal to) ..	13·47	15·35	18·24	14·80	21·64	6·42
Ammonia	16·33	18·62	22·12	17·95	26·28	7·78
Val. according to tables	£11 4 10	£13 15 0	£15 0 0	£12 12 0	£17 4 3	£7 5 3

* This guano though imported as Angamos appears to differ totally from the other specimens.

The following is a detailed analysis of a sample of—

ANGAMOS GUANO.

Moisture	22·275
Organic matter and salts of ammonia	56·025
Silica	1·465
Phosphate of iron and alumina ...	0·850
Phosphoric acid...	7·136
Lime	3.665
Magnesia	0·500
Sulphuric acid	0·385
Chloride of sodium	3·558
Soda	1·621
Potash	2·505
Other matters and loss	·015
	100·00
Nitrogen	17·413
Ammonia	21·118
Value according to tables	£15 12 10

In some cargoes of this guano a large number of hard saline lumps are found of inferior value. They contain nearly 50 per cent. of common salt. An analysis is subjoined :—

ANALYSIS OF "HARD SALINE LUMPS" IN AN ANGAMOS GUANO.

	1853.
Moisture	7·10
Organic matter, &c.	7·30
Silica	2·02
Oxide of iron and alumina	1·05
Phosphate of lime	16·73
Chloride of potassium	1·24
Chloride of sodium	49·70
Chloride of ammonium	2·20
Hydrated sulphate of lime, &c.	12·29
Loss	0·37
	100·00
Nitrogen (equal to)	1·62
Ammonia...	1·96
Value according to tables	£3 5 10

PERUVIAN GUANO.

By far the greatest deposits of guano known are those which exist within the territories of Peru. Guanos are there found not only on different islands near the coast, but also upon many parts of the coast itself. The variety known in this country as Peruvian Guano is obtained from the Chincha Islands. These islands are situated in the Pacific Ocean, off the coast of Peru, at a distance of about twelve miles.

They lie between 13 deg. and 14 deg. S. latitude; in a district within which no rain falls, where the air is dry, and the sun shines with vehement power. The waters of the surrounding ocean contain innumerable shoals of fish. Myriads of birds, after daily satisfying their voracious appetites upon the finny tenants of the deep, have for ages made the islands their resting place and nightly abode, and the receptacle of their fæcal offerings. From the arid nature of the climate, the excess of humidity has speedily evaporated from their ordure, decomposition has been arrested, and by gradual accumulation from time immemorial, these extraordinary deposits have attained the depth, in many parts, of one hundred feet.

These are the largest known deposits of guano in the world.

The Guano, as found on the islands, is subject to slight variations in composition. Towards the southwest, the deposits are more exposed to the action of the spray of the sea, brought by the prevailing winds. Some of these guanos have lost by this means a certain amount of ammonia, and have not yet been imported in quantity into this country: in others, the deterioration is trifling; and many are simply discoloured, without having suffered any other change, and are equal in value to paler samples.*

* Messrs. Antony Gibbs and Sons are the sole agents in this country for the Peruvian Government, and for the sale of Peruvian Guano.

Peruvian Guano contains in a natural form a considerable portion of soluble phosphates, which we are obliged to produce artificially in other manures, by the action of acids upon bones and other insoluble phosphates.

In fact, good guano partakes of the nature of superphosphate of lime, as it contains both soluble and insoluble phosphates. These together generally amount to the average quantity found in commercial superphosphate of lime.

This fact will be clearly seen from the subjoined table of the average of fifty analyses of different samples of guano, taken indiscriminately from the stores at present lying in the ports of London, Liverpool, and Bristol. It will also be seen by the following tables that Peruvian Guano is remarkably uniform in the per-centage of its constituents. This uniformity of composition is one of the most distinguishing characteristics of guanos from the Chincha Islands:—

TABLES OF ANALYSES

OF FIFTY PERUVIAN GUANOS

IMPORTED IN 1858.

Nos.	1.	2.	3.	4.	5.	6.
Moisture	13·60	13·00	15·40	12·40	12·40	16·00
Organic matter, &c.	53·90	53·00	57·60	54·70	53·55	58·90
Silica	1·30	1·00	0·95	1·80	1·15	0·80
Phosphate of lime	25·62	19·30	18·23	20·70	22·10	16·60
Phosphoric acid*	3·45	4·10	2·54	4·13	3·37	2·96
Alkaline salts, &c.	2·13	9·60	5·28	6·27	7·43	4·74
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	7·48	8·88	5·50	8·95	7·30	6·40
" insoluble .	25·62	19·30	18·23	20·70	22·10	16·60
Total	33·10	28·18	23·73	29·65	29·40	23·00
Nitrogen (equal to)	14·31	13·75	15·02	14·81	13·89	14·66
Ammonia	17·36	16·67	18·21	17·96	16·84	17·78
Value according to tables.. £	14 10 5	14 10 3	14 6 3	15 5 0	14 5 0	14 4 10

* The phosphoric acid is calculated as equal to neutral phosphate made soluble.

ANALYSES OF PERUVIAN GUANOS—*continued*.

Nos.	7.	8.	9.	10.	11.	12.
Moisture	15·60	14·00	14·00	12·20	17·80	16·60
Organic matter, &c.	55·70	53·60	52·65	52·85	49·60	51·95
Silica	1·40	1·35	1·50	1·20	2·00	1·15
Phosphate of lime	20·10	22·93	20·90	19·28	21·35	18·85
Phosphoric acid	2·33	3·76	3·94	4·00	3·53	3·87
Alkaline salts, &c.	4·87	4·36	7·01	10·47	5·72	7·58
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	5·05	8·15	8·53	8·68	7·65	8·38
" insoluble ..	20·10	22·93	20·90	19·28	21·35	18·85
Total	25·15	31·08	29·43	27·96	29·00	27·23
Nitrogen (equal to)	13·96	14·52	14·17	14·45	13·89	14·17
Ammonia	16·93	17·61	17·19	17·53	16·84	17·19
Value according to tables £	13 12 3	15 2 10	14 12 10	15 2 3	14 7 3	14 4 0

Nos.	13.	14.	15.	16.	17.	18.
Moisture	16·60	18·60	17·00	16·40	16·20	16·60
Organic matter, &c.	51·95	48·95	52·60	53·80	50·80	51·90
Silica	1·20	1·95	1·00	0·95	1·70	1·00
Phosphate of lime	17·65	23·15	20·82	20·70	21·85	22·65
Phosphoric acid	2·63	2·28	2·40	3·90	2·70	4·22
Alkaline salts, &c.	9·97	5·07	6·18	4·25	6·75	3·63
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	5·70	4·95	5·20	8·45	5·85	9·15
" insoluble ..	17·65	23·15	20·82	20·70	21·85	22·65
Total	23·35	28·10	26·02	29.15	27·70	31·80
Nitrogen (equal to)	13·32	13·40	14·52	15·09	13·82	14·88
Ammonia	16·16	16·25	17·61	18·30	16·76	18·04
Value according to tables £	13 2 0	13 5 10	14 5 5	14 19 8	13 19 8	15 7 3

Nos.	19.	20.	21.	22.	23.	24.
Moisture	13·20	13·60	16·40	16·40	17·40	15·80
Organic matter, &c.	54·80	52·40	53·60	57·35	53·60	49·70
Silica	1·10	1·30	0·90	1·05	1·15	0·90
Phosphate of lime	21·55	22·85	21·25	18·25	19·18	17·48
Phosphoric acid	2·94	4·00	2·93	3·47	3·04	4·20
Alkaline salts, &c.	6·41	5·85	4·92	3·48	5·63	1·92
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	6·38	8·68	6·35	7·53	6·60	9·10
" insoluble ..	21·55	22·85	21·25	18·25	19·18	17·48
Total	27·93	31·53	27·60	25·78	25·78	26·58
Nitrogen (equal to)	15·30	14·88	15·65	16·22	14·66	13·40
Ammonia	18·55	18·04	18·98	19·67	17·78	16·25
Value according to table £	15 4 3	15 7 8	15 2 0	15 19 3	14 12 0	13 12 5

ANALYSES OF PERUVIAN GUANOS—*continued*.

Nos.	25.	26.	27.	28.	29.	30.
Moisture	20·00	18·80	18·00	20·20	18·00	18·00
Organic matter, &c.	42·50	43·20	46·75	52·80	51·00	52·50
Silica	6·40	5·90	1·10	1·25	0·95	1·00
Phosphate of lime	19·58	19·20	15·50	19·90	18·90	18·48
Phosphoric acid	3·16	3·07	2·07	2·61	3·77	3·16
Alkaline salts, &c.	8·36	9·83	16·58	3·24	7·38	6·86
	100·00	100·00	100·00	100·00	100·00	100.00
Phosphate of lime, soluble ..	6·85	6·65	4·50	5·65	8·18	6·85
" insoluble ..	19·58	19·20	15·50	19·90	18·90	18·48
Total	26·43	25·85	20·00	25·55	27·08	25·33
Nitrogen (equal to)	10·36	11·28	12·55	14·81	12·69	13·75
Ammonia	12·57*	13·68*	15·22	17·96	15·39	16·67
Value according to tables £	11 11 10	12 2 8	12 2 5	14 8 0	13 0 5	13 18 5

* These examples were subsequently ascertained to be damaged Guano sent in mistake.

Nos.	31.	32.	33.	34.	35.	36.
Moisture	16·20	16·40	13·60	18·80	14·00	16·40
Organic matter, &c.	55·30	53·60	50·40	48·25	52·75	51·75
Silica	0·90	1·15	1·20	1·50	1·10	1·20
Phosphate of lime	20·45	18·20	16·40	20·65	16·20	20·90
Phosphoric acid	2·52	2·98	4·62	2·37	2·72	2·26
Alkaline salts, &c.	4·63	7·67	13·78	8·43	13.23	7·49
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	5·45	6·45	10·00	5·13	5·90	4·89
" insoluble ..	20·45	18·20	16·40	20·65	16·20	20·90
Total	25·90	24·65	26·40	25.78	22·10	25·79
Nitrogen (equal to)	15·72	15·44	12·55	13·89	15·65	14·66
Ammonia	19·07	18·72	15·22	16·84	18·98	17·78
Value according to tables £	14 16 0	14 18 0	13 6 5	13 12 10	14 15 8	14 5 5

Nos.	37.	38.	39.	40.	41.	42.
Moisture	16·00	17·00	14·80	14·40	18·60	15·20
Organic matter, &c.	49·00	49·50	54·00	54·60	52·40	54·80
Silica	2·00	1·00	1·20	1·50	0·65	0·70
Phosphate of lime	20·54	17·45	19·98	17·78	19·06	19·40
Phosphoric acid	1·75	2·45	2·75	4·25	4·51	4·95
Alkaline salts, &c.	10·71	12·60	7·27	7·47	4·78	4·95
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate of lime, soluble ..	3·80	5·32	5·95	9·20	9·78	10·73
" insoluble ..	20·54	17·45	19·98	17·78	19·06	19·40
Total	24·34	22·77	25·93	26·98	28·84	30·13
Nitrogen (equal to)	14·66	4·81	14·81	14·52	14·81	15·02
Ammonia	17·78	7·96	17·98	17·61	17·96	18·21
Value according to tables £	14 0 10	13 19 10	14 9 0	15 0 5	15 5 10	15 11 3

ANALYSES OF PERUVIAN GUANO—*continued.*

Nos.	43.	44.	45.	46.
Moisture	15·20	11·40	15·20	13·60
Organic matter, &c.	53·10	54·20	62·30	51·40
Silica	1·30	1·15	0·90	2·50
Phosphate of lime	21·75	22·44	15·17	21·15
Phosphoric acid	2·42	2·58	2·41	3·84
Alkaline salts, &c.	6·23	8·23	4·02	7·51
	100·00	100·00	100·00	100·00
Phosphate of lime, soluble	5·25	5·62	5·22	8·32
" insoluble	21·75	22·44	15·17	21·15
Total	27·00	28·06	20·39	29·47
Nitrogen (equal to)	14·81	13·68	16·14	14·59
Ammonia	17·98	16·59	19·58	17·70
Value according to tables £	14 7 0	14 0 5	15 1 5	14 19 10

Nos.	47.	48.	49.	50.
Moisture	19·20	12·80	17·80	14·20
Organic matter, &c.	51·80	51·70	52·70	52·30
Silica	0·90	1·15	1·00	1·60
Phosphate of lime	19·27	16·04	17·25	19·93
Phosphoric acid	2·68	1·42	1·73	1·96
Alkaline salts, &c.	6·15	16·89	9·52	10·01
	100·00	100·00	100·00	100·00
Phosphate of lime, soluble	5·82	3·09	3·50	4·25
" insoluble	19·27	16·04	17·25	19·93
Total	25·09	19·13	20·75	24·18
Nitrogen (equal to)	14·66	13·61	14·59	13·96
Ammonia	17·78	16·50	17·70	16·93
Value according to tables £	14 6 10	12 17 10	13 15 0	13 7 8

MEAN OF THE ANALYSES OF THE FIFTY SAMPLES OF PERUVIAN GUANO IMPORTED IN 1858.

Moisture		15·82
Organic matters, &c.		52·52
Silica		1·46
Phosphate of lime		19·52
Phosphoric acid		3·12
= Phosphate of lime	6·76	
Alkaline salts, &c.		7·56
		100·00
Neutral phosphate of lime, soluble		6·76
" " insoluble		19·52
Total		26·28
Nitrogen (equal to)		14·29
Ammonia		17·32
Value according to tables		£14 1 10

The use of Guano in Peru is of very ancient date; and for its preservation, and that of the birds by which it was deposited, the most stringent precautions were made use of by the native Incas and their Spanish successors. At one period the punishment of death was inflicted upon any one disturbing the birds in the breeding season.

The following table contains analyses of various manures, made by Boussingault and other well-known chemists, and also an analysis of an ordinary sample of Peruvian Guano.

ANALYSES OF FARM-YARD DUNG, &c.

	Farm-yard Dung.	Horse Dung.	Cow Dung.	Pig Dung.	Mixed liquid and solid excrement of man.*	Peruvian Guano.*
Moisture	79·30	76·17	86·44	82·00	94·24	18·35
Organic matter	14·03	19·70	11·20	14·29	4·72	51·25
Inorganic matter.	6·67	4·13	2·36	3·71	1·04	30·40
	100·00	100·00	100·00	100·00	100·00	100·00
Nitrogen (equal to)	0·41	0·65	0·36	0·61	0·94	13·88
Ammonia	0·49	0·78	0·43	0·74	1·14	16·85

* These analyses were made in the Laboratories of the College.

Boussingault, Payen, and many others of our leading practical Agricultural Chemists, have come to the conclusion that the value of different manures varies nearly in proportion to the amount of nitrogen they contain. There may be cases to which this rule is not exactly applicable; but in many natural manures, an increase of nitrogen is accompanied by an increase in the phosphate of lime, and every other valuable manuring element. In the above table, for instance, the 13.88 of nitrogen in the Guano is accompanied by 30.40 parts of inorganic matter, of which 23.60 parts (or more than two-thirds) is phosphate of lime.

If we take the per-centage of nitrogen, then, as a correct indication of manuring value, we shall find that one ton of ordinary Peruvian Guano is equal to

33½ tons of farm-yard dung.	22½ tons of pig dung, and
21 tons of horse dung.	14½ tons of mixed human excrements.
38½ tons of cow dung.	

Let those who farm in hilly countries, and other places where carriage is expensive, ponder well the above facts.

Though a good farmer will produce as much manure as he conveniently can, yet even farm-yard dung may be bought *too dear;* and it is certain that on numbers of farms the cartage of dung is so expensive an item of management, that the introduction of Guano, for those parts at the greatest distance from the homestead, would be productive of the same fertility, at a considerable saving of expense.

At the present price of Peruvian Guano, it is more than questionable whether the ordinary plan of increasing the available manure on a farm by the importation of oilcake and the feeding of stock is at all economical. If the oilcake owes its fertilising properties to the nitrogen and phosphate of lime it contains, it is certain, from the analyses of various chemists, that Peruvian Guano is a much cheaper source of these substances. In a lecture delivered by the author before the farmers of Dorchester, this subject was alluded to as follows :—

"It may here be necessary to notice another question of great importance, viz. :—Is the use of artificial food (such as oilcake) for stock the *cheapest* mode of introducing bone-earth and ammonia into the land? Many farmers are content if their fat stock produce as much money as will pay for the oilcake used, together with the price of the lean animals bought; thus sinking altogether the turnips, mangold, and hay, likewise consumed by the stock. It appears to be clear that, unless the oilcake affords a profit by the beef or mutton, a more expensive system of *manuring* could not well be pursued. The following table, comparing the manuring values of oil and rape cake with guano, may be of some service in determining the practice of the intelligent farmer :—

Tables of the Manuring Values of Oilcake and Rapecake, compared with Peruvian Guano, from Analyses made in the Laboratory of the Agricultural and Chemical College, Kennington.

	Oilcake from Liverpool	Oilcake from London.	Oilcake from Marseilles.	Rape-cake.	Peruvian Guano
	lbs.	lbs.	lbs.	lbs.	lbs.
Moisture	268·8	300·7	274·4	195·8	268·8
Organic matter	1739·6	1699·3	1718·3	1654·2	892·2
Nitrogen	109·1	118·5	118·2	115·4	295·0
Ammonia	(130·6)	(143·8)	(143·4)	(140·0)	(358·4)
Inorganic matter	122·5	121·5	129·1	274·6	784·0
Containing :—					
Phosphoric acid	(47·1)	(30·9)	(39·4)	(43·7)	(224·0)
Potash	(29·1)	(19·1)	(23·7)	(27·1)	(67·2)
	2240·0	2240·0	2240·0	2240·0	2240·0

"From the foregoing table, it appears that one ton, or 2,240 lbs. of Peruvian guano, containing 16 per cent. of ammonia, would introduce into the farm six times the phosphate of lime, two-and-a-quarter times the potash, and more than two and-a-half times the ammonia, than would be furnished by one ton of the best oil or rape cake. To pass oilcake through the bodies of animals, without some attendant benefit, is both expensive and wasteful; and unless you can find your profit in the increase of the beef and mutton, it is an improper expenditure of money."

These observations are amply supported by the opinion of the members of one of the most intelligent Farmers' Clubs in England. The Botley Farmers' Club have *unanimously* resolved, "That where there is not sufficient dung for the wheat crop, it is more profitable to apply concentrated manures than to purchase dung; and that an equal amount of money expended in the purchase of concentrated manures will raise more wheat than the same amount expended in the purchase of oilcake or corn, and converted into dung by feeding cattle." And the Rev. L. Vernon Harcourt, speaking of this decision of the Club, says, "All my experiments tend to corroborate the view taken by the Botley Club on this subject."

Leaving these facts and opinions for the consideration of those farmers who seek to combine good farming with economy of manuring, we shall now offer some suggestions as to the best mode, and the proper time, of applying Guano to different varieties of crops.

MODE OF APPLYING FIRST-CLASS GUANOS TO VARIOUS CROPS.

PREPARATION OF GUANO FOR SOWING OR DRILLING.

For drilling, it must first be mixed with four to six times its weight of the ashes* of wood, turf, or coal, or with the same quantity of well-sifted mould. Charcoal, in powder, either from peat or wood, is also a most excellent article to be mixed with the Guano, in the proportions indicated. Its great porosity allows it to retain the volatile ammonia, and dry weather to absorb considerable moisture from the air. This is of material benefit to plants in their early growth.

* Some varieties of wood ashes, which contain a considerable amount of free alkali, are not suitable for mixing with Guano, as they liberate the ammonia. This may easily be shown by mixing a shovel-full of the ashes with the same quantity of Guano. If a strong ammoniacal odour be immediately perceived, the ashes are not fit to be mixed with Guano. The mode of preparation here described should be used, with slight variations, according to circumstances, for all varieties of crops.—J. C. N.

Before mixing, the guano must be finely pulverized, which may easily be done with a common garden roller upon the floor of a barn or shed, or even by beating it with a common shovel. A layer of the ashes, &c., is then spread evenly upon the floor, and a quantity of the fine Guano sifted over it. This is followed by another layer of mould or ashes, and another of Guano, until the requisite quantity of both is used. The whole must then be repeatedly turned with the shovel until thoroughly mixed. If time will permit, it is now preferable to leave the mixture for eight or ten days. It must then be again sifted, when it will be ready for use.

In using Guano with the drill, care must be taken that the mixture falls below the seed, and that an inch or so of soil intervenes between them, otherwise the strength of the Guano will kill the seed. Garrett's, Hornsby's, and other modern drills, are well adapted for depositing Guano and other concentrated manures.

The above mixture is generally sufficiently damp to fall exactly where the hand directs it. When this is not the case, a small quantity of water should be added; the field must be sown with the mixture in the ordinary manner, and the manure harrowed in; the seed is then drilled as usual.

Perhaps the preferable mode would be to broadcast two-thirds of the Guano applied, and to drill one-third with the seed. The young plants would then have enough manure under the drills to serve the early stages of growth, while the Guano sown broadcast would supply the wants of the plants in a more mature state, when the roots would have spread in every direction in the soil.

Wheat, Barley, Oats, and other Cereals.

The researches of modern chemistry have in no respect proved of greater benefit to practical agriculture than in the analysis and estimation of the components of different manures, and in the careful examination of the effects of these components on different crops when applied either alone or combined. This is, in fact, the only philosophical mode of arriving at a true knowledge of the manuring substances best adapted for the development of various forms of vegetable life.

From the analyses of some thousands of samples of manure in the laboratories of the College, and from a knowledge of the effects produced by these manures on a variety of crops, the conclusion has been irresistible that NITROGEN is the cheapest substance to apply to cereals. The same conclusion has been arrived at by numerous other chemists. The results also of the experience of farmers in all parts of the country for many years is, that nitrogen in any of its ordinary combinations is the matter of all others best adapted for the growth of wheat and other cereals, and which for these crops will yield the greatest per-centage of profit.

Not that corn requires no phosphates or other materials for its development, but that the latter are generally supplied to the soil for other crops in the ordinary course of rotation, or, as in the case of Guano, are found in the manure itself. The market value of

nitrogen of course varies with the source of its supply, and with the rise and fall in price of its various combinations; but at the present comparative price of Guano, this substance appears to be nearly, if not altogether, the cheapest source of nitrogen, at least in any considerable quantity.

There can be no doubt of the vastly increased production of corn, and consequently of profit to the farmer, which would accrue if Guano were more extensively used.

Our most intelligent agriculturists, among whom we may mention Mr. Caird and Mr. Lawes, agree that the application of two cwt. per acre will give an increase of between eight and nine bushels of grain, besides one-fourth more straw than usual.

Mr. Caird has proved that without any increase of rent or taxes, an expenditure of twenty-shillings per acre produces a net profit of thirty-two shillings and sixpence. If these facts were more generally known, it is impossible to believe that farmers would not at once avail themselves of the opportunity of making a profit of more than one hundred and fifty *per cent.* upon the annual additional outlay.

Many farmers prefer using the whole of their Guano for wheat in the autumn. A portion, at all events, should be sown *broadcast* at that period. This is more especially needful if no dressing of farm-yard dung be used.

If Guano be used for wheat in lieu of farm-yard dung, a greater quantity, often the whole, ought to be applied in the autumn. Care, however, must be taken not to stimulate the plant too much, otherwise it will be liable to suffer injury from frost. One cwt. or two cwt. per acre on light lands can be applied broadcast, and harrowed in during autumn, either before or after the drilling of the wheat.

In the spring a further application of not more than one cwt. or two cwt. may be made, harrowed in with light harrows. If the wheat be drilled sufficiently apart to allow of horse-hoeing, it will be found advantageous.

Should wheat, manured with dung as usual, look unkindly in the spring, it will be greatly benefited by a dressing per acre of two cwt. of Guano and four cwt. of salt. Salt has great effect in strengthening the straw of wheat and other cereals; and where any of these crops are liable to lodge, or whenever Guano is used, four cwt. or five cwt. of salt should also be sown per acre. For barley and oats two cwt. of Guano and four cwt. of salt may be sown broadcast per acre, the seed drilled, and the whole harrowed in together.

Turnips.

For this crop Guano may be applied, either broadcast or by drill, mixed as previously shown. The quantity of Guano to be used per acre will vary with the condition of the farm. About two to three cwt. may be applied with advantage, and six cwt. have been used with safety on heavy soils. Two cwt. or three cwt. sown broadcast, and one cwt. drilléd with the seed, will probably give the best chance for a successful result.

Experiments have proved that, when a portion of Guano is applied between the drills, and well horse-hoed in after the turnips are up, large crops are obtained. It is questionable whether this is not one of the best means of applying Guano, as on light soils there is less liability to loss in the Guano, and the roots of the turnip are supplied with fresh manure at a vigorous period of their growth. Two cwt. or three cwt. broadcast before the turnips are sown, and one cwt. between the drills afterwards, will be found sufficient.

A combination of superphosphate of lime with Guano has been used with much success. For this purpose two cwt. or three cwt. of Guano is sown broadcast, and the same quantity of superphosphate of lime, mixed with ashes, drilled with the seed."*

We may here suggest to some of our intelligent, practical farmers, to try the effect upon the turnip crop of a mixture of Peruvian Guano and sulphuric acid.

Sulphuric acid is undoubtedly a manure *per se*, and it seems to exert a specific effect on the turnip. A mixture might be made of four cwt. of Guano and one cwt. of white acid, of sp. gr. 1·84. The Guano must be laid in a heap, a hollow made in the centre, and the sulphuric acid must be poured into it; the whole should then be well worked together with a spade or other instrument. Considerable chemical action will take place, but in a short time the whole will become dry and ready for the drill. If the brown acid, of sp. gr. 1·7, be employed instead of the white, one-fourth more must be used. The above quantity will be sufficient for two acres. We believe that a mixture of this kind will prove a most efficient manure.

It is of some importance to remember, in using Guano for turnips and other roots, that the whole of the nitrogenous matter is not taken out by the crop, but that a portion is left for the subsequent corn crop. Large quantities of Guano are used for heavy land by many of our best Essex farmers on mangel as a good preparation for wheat, the mangel being wholly withdrawn from the field.

Mangel Wurzel.

Guano is an excellent manure for this crop. On heavy and loamy soils the land is ploughed, and ten or twenty tons of farm-yard dung are worked into the soil—before Christmas, if possible. Two or three weeks before drilling the seed, four cwt. of Guano, with an equal weight of common salt, is sown broadcast over the field and well harrowed in. The seed is drilled in the usual way, and at thirty to forty inches apart. In thinning the plants afterwards, they should not be left too close together. Repeated horse-hoeings between the rows is of great importance, for air and nutriment are thus admitted to the roots of the plants. As in the case of the turnips, great advantage will be obtained by occasionally

* The prize for the best forty acres of swedes, in one of our most important agricultural counties, was taken by a gentleman who followed this plan.

sprinkling a little Guano between the rows previously to the hoeing. This insures continued nutriment to the plants.

When no farm-yard dung has been applied in winter, six cwt. of Guano may be used instead of four cwt. On heavy land this may be put on either in the autumn or spring, and well worked into the soil, following this up by a small dressing afterwards between the drills at the time of hoeing. The land in either case will be left in good condition for wheat.

On light chalky soils, a mixture of Guano, nitrate of soda, and common salt, at the rate of two cwt. each per acre, has been found very efficacious in the growth of mangel wurzel.

Grass.

The experiments of Kuhlman, the French agricultural chemist, upon the action of ammonia on grass lands, at once point to Guano as one of the most important manures for increasing the productive power of our pasture and meadow land. This chemist applied ammonia in different forms, alone, and combined with other simple manures, and he found that in all cases the amount of grass or hay produced was in exact proportion to the amount of nitrogen contained in the manure. Guano containing a large amount of ammonia, and being also at present its cheapest source, must, therefore, prove of great benefit in the production of grass.

For grass land, from two to four cwt. of Guano, mixed with soil, may be used per acre. Wet or damp weather should be selected for sowing it. Probably the end of March or the beginning of April is the best time. Under certain circumstances, Guano may be applied to grass land in the autumn, particularly where the under-soil is of a strong or loamy character. Thus applied, it will have the effect of bringing up the grass earlier in the spring.

Potatoes.

From the comparison of numerous series of experiments, it would appear that Guano succeeds best with this crop as a top-dressing, in conjunction with farm-yard dung. The ground is prepared in the usual manner. The farm-yard dung is deposited in the bottoms of the drills, the sets of the seed potatoes laid upon the top of the manure, and the whole earthed up. Before the plants appear, the Guano is to be sown on the top of the drills, covered over with the plough, and then rolled. If the potatoes be grown on the level, and not in drills, the guano may be sown over the field broad-cast, two or three weeks after the potatoes have been planted. The quantity of Guano to be used per acre is from three cwt. to six cwt.

Many experiments have proved the great utility of sulphate of soda, or sulphate of magnesia, in conjunction with Guano, upon this crop. As far as our own experience goes, these salts have a decided effect in diminishing the liability of potatoes to disease. We should therefore recommend, in addition to the Guano, to put per acre, at the same time,

1 cwt. of sulphate of soda, and
1 cwt. of sulphate of magnesia.

If farm-yard dung be not used for potatoes, broad-cast and harrow-in three cwt. or four cwt. of Guano, and set the potatoes as usual. Three or four weeks afterwards sow over them, and lightly harrow-in the quantity of Guano and one cwt. each of the sulphates of soda and magnesia.

The mixture of sulphuric acid and Guano mentioned under the head of "Turnips," would probably be found an excellent manure for this crop.

Near the Humber, as much as ten cwt. annually is used for potatoes, with extraordinary results.

Beans, Peas, and Leguminous Plants.

For beans or peas, two cwt. or three cwt. per acre may be used, either broadcast before sowing, or a portion afterwards between the drills at the time of horse-hoeing. The latter would probably be the better plan.

For vetches, lucerne, sainfoin, or clover, two cwt. or three cwt. per acre broadcast may be used. This should be sown in the beginning of April, on a dewy morning, or during wet weather. It is useless to sow if there be a probability of dry weather ensuing for any lengthened period.

Flax.

This crop, in olden time, had the renown of being one of the most exhausting crops which could be put into the land. We have now learned that white crops, and those in general which have the repute of "drawing the land," are those which require the largest amount of nitrogen for the formation of seed, and for which, consequently, ammoniacal manures are precisely adapted. With the aid of Guano or other ammoniacal manures, flax can no longer be considered an exhauster of the soil.

In using Guano for this crop, from two cwt. to four cwt. per acre, mixed with ashes, may be sown broadcast, and harrowed in a few days before the seed is drilled.

Cabbage, Carrots, &c.

Guano has been found of material benefit for these crops, and may be employed advantageously at the rate of from two cwt. to four cwt. per acre. It must be remembered that carrots require deep cultivation, and that both crops will be benefited by the proper stirring of the soil between the rows, and the occasional addition of a little Guano.

Hops.

To no crop does the addition of a proper amount of ammoniacal manure prove more advantageous than to the hop. The constant withdrawing of the hops, year by year, from the land necessitates the importation upon the soil of a considerable amount of both mineral and organic ingredients. Four cwt. of Guano and three cwt. of salt per acre, applied at two separate times, and well worked in between the alleys, will be found a useful application. Or the manure may be put round each hill, and covered up with the soil.

From several analyses of the hop plant, the following mixture

was recommended by the Author, some years ago, as a proper manure for the hop:—

MANURE FOR AN ACRE OF HOPS.

3 cwt. of Guano,
1 cwt. of common salt,
$1\frac{1}{2}$ cwt. of saltpetre, or nitrate of soda,
1 cwt. of gypsum.

This manure has been used with considerable success in various parts of Surrey, Kent, and Sussex.

It will not be necessary to give any further details of particular crops for which Guano is suitable, or to describe more fully the mode of its employment. The intelligent farmer will soon learn to vary its application to suit the end he may have in view.

Guano, however, is useful to others besides the farmer. To the horticulturist it is invaluable, and many specimens of the finest vegetables and fruits, and of the most beautiful flowers, have been indebted to the judicious use of Guano for the admiration they have excited, and the prizes they have obtained.

For further particulars respecting its horticultural use, we must refer the reader to the columns of the *Gardener's Chronicle*. And in concluding this part of our subject, we cannot refrain from quoting the opinion of Dr. Lindley, the learned editor of that valuable journal, that "If the experience of the last few years has taught us one thing more certainly than another, it is the unfailing excellence of Guano for every kind of crop *which requires manure*."

ON THE ADULTERATION OF PERUVIAN GUANO.

After the observations we have made on the utility of Guano to those engaged in agricultural pursuits, it would have been very gratifying to have concluded our remarks.

It is, however, our invidious duty to refer to a less pleasing, but not less important, part of the subject.

The high manuring value of Peruvian Guano, and its extensive sale, combined with the want of judgment among agriculturists as to its genuineness, and their manifest reluctance to be at the expense of a chemical analysis, have, together, induced many fraudulent dealers to adulterate this manure systematically, to a great extent. The strong desire which unfortunately exists among a large class of farmers to purchase Guano at the lowest terms per ton, without due reference to the quality or composition of the manure, has also operated most materially to their own disadvantage.

If the honest dealer offers a genuine article in the market, upon which he puts only a reasonable profit, and finds that his roguish neighbour can more readily sell an adulterated article, he has no alternative but to abandon the trade or to turn rogue himself. The man who likes *cheap* manures should be reminded that to the buyer they are always *dear*, as he has to pay the whole expense of adulteration, as well as the twenty or thirty per cent. profit of the dishonest dealer. In fact, we should recommend the lovers of cheap manures to follow, in preference, the example of Quin, who finding his milk more than half water, armed with two jugs, demanded of his milkman "to give him them *separate*, he could *mix* for himself."

It is, indeed, scarcely possible to give persons at a distance an idea of the extent to which Guano is adulterated in London and some other large towns.

The demand of the farmer for *cheap* manure, acting upon the trade through the medium of the unscrupulous dealer, has given rise to a fraudulent and hitherto successful business.

A most extensive and profitable trade is at present carried on by parties who practise the compounding of specious-looking ARTICLES, to mix with Guano; these they supply to dealers in that manure.

The materials used to sophisticate Guano are numerous. Sand, marl, clay, chalk, limestone, bricks, tiles, gypsum —ground, when necessary, to a fine powder—constitute the materials for which the farmer is destined to pay £8 or £10 per ton. These, mixed in proportions to counterfeit the colour of Guano, are sold to roguish dealers in town and country, who *introduce a little genuine Guano* to give the necessary odour. Some recent actions brought against parties who have sold adulterated Guano, in which heavy damages were obtained, have contributed some little to arrest this nefarious traffic. One remedy lies with the

farmer, who ought to prosecute vigorously those who impose upon him.

Another system of deception is often practised by men whose consciences are perhaps too *tender* to sell as first-class guanos those they know to have been manufactured in England: these parties, however, have no objection to sell as first-class guanos importations of very inferior quality. What they sell is no doubt *guano*, but it is not the guano the buyer wishes to purchase. All purchasers should therefore require the invoice to expressly declare on its face the name and quality of the guano bought, such as Peruvian, Bolivian, &c. The parties will thus render themselves liable to severe punishment in case of fraud.

Though numerous unprincipled dealers exist in the manure trade, yet there are certainly many others, honest men, upon whose fair fame there has never yet been a breath of suspicion.

We advise the farmer, therefore, to purchase his manures from men of established reputation, who have a character to lose, and who will not demand from him more than a fair and reasonable profit.

The best safeguard, however, against fraudulent dealers is never to use a manure of any kind without having a sample analyzed by a competent authority. Indeed men of real intelligence and business habits now regularly call to their assistance the science of the analytical chemist to ascertain the real agricultural value of artificial manures.

It should be also remembered that at present £12 per ton is the lowest price at which Messrs. Ant. Gibbs and Sons sell Peruvian Guano; and this only in wholesale quantities. The country dealer has, in addition, to pay wharfage, carriage, and other expenses, which must be added to the cost of the Guano. He is also entitled to a reasonable interest for his money, if he gives long credit for that manure which he himself is compelled to pay for in cash.

We leave it, therefore, to the common sense of the English farmer to judge whether a genuine Guano can possibly be purchased at the prices at which Guanos, *purporting to be genuine*, are constantly offered in the country markets.

CLASS II.

THOSE WHICH HAVE LOST A CONSIDERABLE PORTION OF THEIR SOLUBLE INGREDIENTS.

ICHABOE GUANO.

The island of Ichaboe lies on the western coast of Africa, about 400 miles north of the Cape of Good Hope; lat. 26 deg. 19 min. south, 14 deg. 50 min. east lon. It is a small rocky island, situated very near the coast, and is the abode of innumerable birds, chiefly penguins and gannets. When first discovered the guano deposits were very extensive, and were estimated to contain many hundreds of thousands of tons. The guano from this island was at first of very good quality, and nearly the whole was brought to this country; the recent importations, which consist mainly of the annual deposits of the birds, are to some extent mixed with sandy and other matters, so that they have ceased to be important either in quantity or value. Subjoined are analyses of these guanos :—

	1853.	1856.	1857.	1857.	1858.	1858.
Moisture	17·20	14·10	11·85	22·66	13·50	16·00
Organic matter, &c.	20·45	25·91	14·45	23·45	17·50	17·49
Silica	36·25	45·60	44·32	18·50	15·60	33·65
Oxide of iron & alumina	—	—	1·35	1·33	5·53	trace
Phosphate of lime	20·30	9·85	20·70	19·17	21·97	20·45
Phosphoric acid	[*]	0·72	—	—	—	—
= Phosphate of lime		(1·67)	—	—	—	—
Carbonate of lime	—	—	2·27	—	13·35	—
Lime..........................	—	—	—	—	—	1·06
Magnesia	—	—	—	—	—	2·43
Hydrated sulph. of lime	—	—	2·10	2·22	—	5·17
Alkaline salts, &c.........	5·80	3·82	2·96	7·67	12·55	3·75
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate soluble	—	1·67	—	—	—	—
Phosphate insoluble	20·30	9·85	20·70	19·17	21·97	20·45
Total	20·30	11·52	20·70	19·17	21·97	20·45
Nitrogen (equal to).......	4·93	5·99	1·90	5·50	2·89	3·07
Ammonia	5·98	7·27	2·31	6·67	3·51	3·72
Value according to tables	£5 18 10	5 15 8	3 1 5	6 2 0	4 9 5	4 5 6

[*] Not determined.

We subjoin a detailed analyses of Ichaboe guano imported immediately after its first discovery :—

Moisture		25·50
Organic matters, &c.		41·52
Silica, (sand), &c.		0·44
Oxide of iron and alumina		0·48
Phosphate of lime		20·08
„ magnesia		1·33
Phosphate of potassa		4.71
=Phosphate of lime	3·40	
Potassa		1.05
Soda		0·34
Chloride of sodium		1·61
Hydrated sulphate of lime		2·28
Other matters, &c.		0·16
		100·00
Phosphate soluble		3·40
„ insoluble		22·23
Total		25·63
Nitrogen (equal to)		7·22
Ammonia		9·60
Value according to tables		£9 1 0

BOLIVIAN GUANO.

The Bolivian guanos originally brought to this country were very nearly equal in quality to Peruvian, and in character ranked with them in the market. The recent importations have been very much lower in quality. We subjoin analyses of samples imported from 1852 to 1858, which have come under our notice :—

BOLIVIAN GUANOS.

	1852.	1852.	1852.	1852.	1852.	1852.	1852.
Moisture	13·00	8·52	10·00	10·50	20·19	7·90	11·60
Organic matter, &c. ..	23·00	33·09	12·15	27·07	32·01	13·10	33·80
Silica	7·34	9·69	4·07	14·13	6·44	3·60	10·60
Phosphate of lime ..	41·78	30·05	58·40	31·39	28·53	59·00	29·60
Phosphoric acid	3·17	[*]	[*]	[*]	[*]	[*]	[*]
=Phosphate of lime ..	(7·20)						
Alkaline salts, &c. ..	11·71	18·65	15·38	16·91	12·8	16·40	14·40
	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate soluble ..	7·20	[*]	[*]	[*]	[*]	[*]	[*]
Phosphate insoluble ..	41·78						
Total	48·98						
Nitrogen (equal to) ..	3·38	7·16	1·27	5·10	6·67	1·50	7·22
Ammonia	4·10	8·68	1·54	6·18	8·09	1·81	8·51
Value according to tables	£7 15 10	8 6 5	6 2 3	6 10 5	7 11 5	6 4 3	8 5 8

[*] Not determined

BOLIVIAN GUANOS—*continued.*

	1852.	1853.	1853.	1853.	1853.	1853.	1853.
Moisture	16·00	13·24	12·40	16·04	13·24	16·00	9·80
Organic matter, &c.	13·16	29·10	28·30	22·26	20·81	29·90	12·10
Silica *(sand)*	3·16	1·80	7·80	24·55	29·50	5·10	5·80
Phosphate of lime	60·23	37·20	36·50	28·00	27·60	33·30	57·25
Phosphoric acid	[*]	3·81	1·15	[*]	[*]	[*]	[*]
= Phosphate of lime		(8·15)	(2·50)				
Alkaline salts, &c.	7·45	14·85	13·85	9·15	8·85	15·70	15·05
	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate soluble	[*]	8·15	2·50	[*]	[*]	[*]	[*]
Phosphate insoluble		37·20	36·50				
Total		45·35	39·00				
Nitrogen (equal to)	2·11	4·00	4·02	3·59	3·38	4·41	0·91
Ammonia	2·56	4·85	5·00	4·36	4·10	5·35	1·11
Value according to tables £	6 16 0	8 6 5	7 14 0	4 19 0	4 18 10	6 2 0	5 8

	1853.	1854.	1856.	1856.	1857.	1858.
Moisture	10·20	12·50	13·85	11·70	14·80	8·65
Organic matter, &c.	21·30	10·50	21·68	21·08	25·20	20·72
Silica *(sand)*	7·80	7·00	2·70	2·77	3·15	3·92
Oxide of iron and alumina						1·23
Phosphate of lime	55·00	60·60	44·35	50·43	39·22	49·77
Phosphoric acid	[*]	[*]	3·30	2·56	2·16	5·72
= Phosphate of lime			(7·17)	(5·55)	(4·67)	(12·40)
Alkaline salts, &c.	4·00	9·40	14·12	11·46	15·47	9·99
	100·00	100·00	100·00	100·00	100·00	100·00
Phosphate soluble	[*]	[*]	7·17	5·55	4·67	12·40
Phosphate insoluble			44·35	50·43	39·22	50·98
Total			51·52	55·98	43·89	63·38
Nitrogen (equal to)	3·52	1·30	3·31	3·24	4·09	3·31
Ammonia	4·26	1·58	4·02	3·93	4·96	4·02
Value according to tables	£7 1 5	6 5 8	7 19 3	8 3 3	7 14 5	8 15 5

[*] Not determined.

A small portion of phosphate of magnesia is generally found associated with phosphate of lime.

LOBOS GUANO.

The Lobos Islands lie off Peru, and belong to the Peruvian Government. Lobos Afuera is in lat. 6 deg. 59 min. south, lon. 80 deg. 42 min. west; and Lobos de Tierra in lat. 60 deg. 34 min. south, lon. 80 deg. 45 min. west. The former is about 50 miles from the coast of Peru, and the latter about 21. Two cargoes have been imported into this country merely as samples; and it is not probable that so long as the first-rate Peruvian guanos are available, Lobos guanos will find their way to this market. We subjoin analyses of these guanos.

LOBOS ISLAND GUANOS.

	1853.	1858.
Moisture	14·08	16·80
Organic matter, &c.	22·32	46·10
Silica	7·00	2·55
Phosphate of lime	40·00	19·30
Phosphoric acid	1·85	3·71
= Phosphate of lime	(4·00)	(8·03)
Alkaline salts, &c.	14·75	11·54
	100·00	100·00
Phosphate, soluble	4·00	8·03
,, insoluble	40·00	19·30
Total	44·00	27·33
Nitrogen (equal to)	4·25	9·80
Ammonia	5·14	11·88
Value according to tables	£7 10 8	£11 4 5

PAVILLON DE PICA GUANO.

A large deposit of guano is found in lat. 21 deg. south, 70 west long., on a part of the Peruvian coast called Pavillon de Pica. This guano has not hitherto been imported in quantity into this country, but it may be so ultimately. We subjoin analyses of it:—

	1 Per Keskel. 1858.	1 Fine. Chas. Jackson. 1858.	1 Dark. Chas. Jackson 1858.
Moisture	22·00	15·50	18·00
Organic matter, &c.	38·00	33·50	30·00
Silica	2·10	5·05	7·10
Phosphate of lime	20·23	28·80	29·25
Phosphoric acid	4·66	2·70	2·68
= Phosphate of lime	(10·10)	(5·85)	(5·80)
Alkaline salts, &c.	13·01	14·45	12·97
	100·00	100·00	100·00
Phosphate, soluble	10·10	5·85	5·80
,, insoluble	20·23	28·80	29·25
Total	30·33	34·65	35·05
Nitrogen (equal to)	6·63	6·13	5·22
Ammonia	8·04	7·44	6·33
Value according to tables	£9 6 3	£8 8 10	£7 15 10

CHILIAN GUANO.

A small amount of guano is also found on the coast of Chili, deposited under the same circumstances as the preceding guano. The following analysis will indicate its general character :—

	1858.
Moisture - - - - - -	19·00
Organic matter, &c. - - - -	27·24
Silica - - - - - -	5·00
Oxide of iron and alumina - - -	a trace
Phosphate of lime - - - -	41·00
Hydrated sulphate of lime - - -	5·02
Alkaline salts - - - - -	1·50
Lime - - - - - -	0·06
Magnesia - - - - - -	1·18
	100·00
Nitrogen (equal to) - - - -	5·18
Ammonia - - - - -	6·28
Value according to tables - -	£7 4 8

CALIFORNIA GUANOS.

On some parts of the coast of California dung deposits are likewise found. They vary somewhat in character, some containing much more sand and earthy matters than others. The following table will give an idea of their general quality :—

ELIDE ISLAND GUANO.

	1858.	1858.	1858.	1858.
Moisture - - - -	19·60	28·50	25·00	6·00
Organic matter, &c. - -	22·25	34·50	33·00	27·37
Silica - - - - -	7·68	3·60	3·80	25·90
Phosphate of iron & alumina	—	—	—	13·80
Phosphate of lime - -	34·60	24·05	25·97	14·35
Phosphoric acid - -	3·65	2·19	2·05	—
= Phosphate of lime - -	(7·90)	(4·75)	(4·45)	—
Hydrated sulphate of lime -	—	—	—	9·46
Carbonate of lime - -	—	—	—	3·12
Alkaline salts, &c. - -	12·22	7·16	10·18	—
	100·00	100·00	100·00	100·00
Phosphate, soluble - -	7·90	4·75	4·45	—
,, insoluble - -	34·60	24·05	25·97	29·30
Total - - - -	42·50	28·80	30·42	—
Nitrogen (equal to) - -	3·67	6·98	5·71	1·34
Ammonia - -	4·45	8·46	6·93	1·62
Value according to tables -	£7 9 3	£8 6 10	£7 13 5	£3 17 8

PATOS ISLAND GUANO.

Patos island lies off the coast of Lower California, and has deposits of guano similar in character to those of Ichaboe. This guano has not found much favour in the market. It is similar to the Elide Island guanos.

	1858.	1858.	1858.
Moisture - - - - -	26·80	8·80	12·20
Organic matter, &c. - - - -	32·45	10·67	8·61
Silica - - - - -	2·55	21·28	14·40
Oxide of iron and alumina - - -	—	—	1·17
Phosphate of iron and alumina - -	—	4·45	1·57
,, lime - - - -	27·45	50·00	50·98
,, magnesia - - -	—	—	0·94
Phosphoric acid - - - -	3·37	—	—
= Phosphate of lime - - - -	(7·30)	—	—
Alkaline salts, &c. - - - -	7·38	0·73	0·90
Hydrated sulphate of lime, &c. - -	—	4·07	9·23
	100·00	100·00	100·00
Phosphate, soluble - - - -	7·30	—	—
,, insoluble - - - -	27·45	55·37	53·79
Total - - - - -	34·75	55·37	53·79
Nitrogen (equal to) - - - -	5·92	0·85	0·81
Ammonia - - - - -	7·18	1·03	0·98
Value according to tables - -	£8 8 8	£5 3 3	£5 2 3

CLASS III.

THOSE WHICH HAVE LOST NEARLY ALL THEIR AMMONIA, AND CONTAIN LITTLE MORE THAN EARTHY PHOSPHATES.

AFRICAN GUANOS.

As previously mentioned, the island of Ichaboe once furnished a large amount of good guanos. From many other points on the African coast guano has also been imported into this country. Some of these have been of very fair quality, as far as concerns their phosphate of lime; but others were much contaminated with earthy matters. The guano from Saldanha Bay has been found to be useful for turnips. We append analyses of these varieties of guanos :—

SALDANHA BAY GUANO.

	1852.	1852.	1852.	1854.
Moisture	17·92	32·04 (Moisture and Organic matter)	14·86	13·20
Organic matter, &c.	14·08		11·91	19·05
Silica	2·80	2·82	3·81	1·15
Phosphate of lime	59·40	59·17	63·50	57·25
Alkaline salts, &c.	5·80	5·07	5·92	9·35
	100·00	100·00	100·00	100·00
Nitrogen (equal to)	0·63	trace	1·85	1·00
Ammonia	0·76	trace	2·24	1·22
Value according to tables	£5 10 5	£4 18 5	£6 10 0	£5 8 10

SALDANHA BAY GUANO.

	1858.
Moisture	9·00
Organic matter, &c.	10·30
Silica	48·80
Oxide of iron and alumina	1·47
Phosphate of iron and alumina	6·17
" lime	13·06
" magnesia	1·41
Hydrated sulphate of lime	7·99
Alkaline salts	0·90
	100·00
Total phosphates, equal to phosphate of lime	22·31
Nitrogen (equal to)	1·69
Ammonia	2·05
Value according to tables	£3 3 0

GUANO FROM ALGOA BAY.

	1858.
Moisture	14·00
Organic matter, &c.	3·22
Silica	1·55
Phosphate of lime	10·10
Hydrated sulphate of lime	71·13
	100·00
Nitrogen (equal to)	0·42
Ammonia	0·51
Value according to tables	£2 2 10

OTHER AFRICAN GUANOS.

	1856.	1857.
Moisture	19·06	7·40
Organic matter, &c.	24·69	10·85
Silica	15·62	2·73
Oxide of iron and alumina	6·90	—
Phosphate of lime	17·63	18·50
Hydrated sulphate of lime, &c.	0·98	49·34
Alkaline salts, &c.	15·12	11·18
	100·00	100·00
Nitrogen (equal to)	1·34	0·56
Ammonia	1·62	0·68
Value according to tables	£3 1 0	£2 16 10

SOUTH AFRICAN GUANO.

	1858.
Moisture	17·50
Organic matter, &c.	4·99
Silica	1·80
Oxide of iron and alumina	a trace
Phosphate of lime	17·67
" magnesia	0·79
Hydrated sulphate of lime	56·75
Alkaline salts	0·50
	100·00
Total phosphates, equal to phosphate of lime	18·60
Nitrogen (equal to)	0·18
Ammonia	0·21
Value according to tables	£2 3 0

WEST INDIAN GUANO.

Many of the islands of the Caribbean Sea are also the resort of birds who live and breed there in the same manner as on the Chincha islands. The conditions of the atmosphere, however, are very different. While on the Chincha islands there is no rain at all, on the West India islands there is an annual rainfall of large amount, combined with tempests and other violent atmospheric disturbances. Without the rainfall, the guano in this district would undoubtedly be equal to Peruvian; but, as it is, the soluble matters are washed away, and there is left in most cases little more than the phosphates of lime and magnesia, sometimes contaminated with large quantities of sand. The analyses of the guanos from various islands of this group will give an idea of their general value.

PEDRO KEYS.

A number of islets, which are the resort of birds, exist on the coast of Cuba. In local language they are technically called "Keys." We subjoin the analysis of a sample from one called "Pedro Keys."

WEST INDIAN OR PEDRO KEYS GUANO.

		1858.
Moisture		17·40
Organic matter, &c.		6·16
Silica		0·45
Oxide of iron and alumina		1·00
Phosphate of lime		48·52
Alkaline salts		0·30
Hydrated sulphate of lime		1·92
Carbonate of lime		21·71
Lime		0·85
Magnesia		1·09
		100·00
Nitrogen (equal to)		0·28
Ammonia		0·34
Value according to tables		£4 0 3

WEST INDIAN GUANO.

		1858.
Moisture		12·85
Organic matter, &c.		13·15
Silica		0·35
Phosphate of lime		19·35
Carbonate of lime	(53·40)	54·30
		100·00
Nitrogen (equal to)		0·63
Ammonia		0·77
Value according to tables		£2 5 0

SWAN ISLAND GUANO.

	1859.
Moisture	9·00
Organic matter, &c.	11·74
Silica	22·15
Oxide of iron and alumina	16·12
Phosphate of iron and alumina	2·25
Phosphate of lime	31·70
Carbonate of lime	2·79
Hydrated sulphate of lime	1·33
Alkaline salts, &c.	2·92
	100·00
Total phosphates, equal to phosphate of lime	34·15
Nitrogen (equal to)	0·25
Ammonia	0·30
Value according to tables	£2 17 8

BAKER ISLAND GUANO.

Among many other islands of the West Indies that contain deposits of fæcal matter is Baker island. The analysis of the guano from it is annexed :—

		1858.
Moisture		7·30
Organic matter, &c.		9·40
Silica		0·60
Phosphate of lime		73·70
Phosphoric acid		2·03
=Phosphate of lime	(4·40)	
Alkaline salts, &c.		6·97
		100·00
Phosphate, soluble		4·40
" insoluble		73·70
Total phosphates		78·10
Nitrogen (equal to)		0·56
Ammonia		0·68
Value according to tables		£7 12 10

NAVASSA ISLAND GUANO.

Navassa island lies about half way between Jamaica and St. Domingo, and is between three and four miles in circumference. It is apparently thickly wooded in parts. The guano is found some little distance from the surface. It is a purely phosphatic guano, the nitrogenous compounds having been almost wholly lost by atmospheric action. The following analyses will show that this guano contains no soluble phosphate.

	1858.	1858.
Moisture	3·00	9·15
Organic matter, &c.	8·77	13·65
Silica	5·85	4·25
Oxide of iron and ammonia	9·59	14·59
Phosphate of iron and alumina	27·71	9·42
" lime	40·75	46·37
Alkaline salts, &c.	—	2·57
Carbonate of lime	2·27	—
Hydrated sulphate of lime, &c.	2·06	—
	100·00	100·00
Total phosphoric acid, equal to phosphate of lime	70·77	56·57
Nitrogen (equal to)	0·21	0·28
Ammonia	0·26	0·34
Value according to tables	£5 15 10	£4 14 8

MARACAYBO.

This most remarkable substance is found on Monk Island, near Maracaybo, in the Gulf of Venezuela. It is found in large rocky masses, containing considerable traces of organic matter, and presenting all the features of a guano changed by volcanic action. As found it would have been of no use as manure; but the deposits from this island have been almost wholly employed in the manufacture of superphosphate of lime, for which they are very well adapted. This substance is singular, from the fact of its containing an excess of phosphoric acid, compared with other known natural phosphates. The following are the analyses:—

	1859.	1859.	1859.
Moisture - - - - -	1·00	1·00	0·40
Organic matter, &c. - - - -	7·90	3·52	3·83
Silica - - - - -	0·80	1·45	0·10
Oxide of iron and alumina - - -	—	1·00	—
Bi-basic phosphate of lime - - -	78·67	80·75	76·16
Hydrated sulphate of lime &c. - -	11·28	11·33	19·01
Alkaline salts, &c. - - - -	0·35	0·95	0·50
	100·00	100·00	100·00
Phosphates (equal to) Tribasic phosphate of lime - - -	95·80	98·41	92·81
Nitrogen (equal to) - - - -	0·14	0·21	0·14
Ammonia - - - - -	0·17	0·26	0·17
Value according to tables - -	£7 17 5	£8 0 0	£7 13 8

BIRD ISLAND.

This island lies some distance to the west of St. Vincent, in the West Indies. We subjoin the analysis of its guano, which is comparatively worthless as a manure:

	1858.
Moisture - - - - -	8·00
Organic matter, &c. - - - -	6·90
Silica - - - - - -	0·85
Oxide of iron and alumina - - -	trace.
Phosphate of lime - - - -	12·80
Hydrated sulphate of lime - - -	69·61
Alkaline salts - - - - -	0·40
Lime - - - - - -	1·01
Magnesia - - - - -	0·43
	100·00
Nitrogen (equal to) - - -	0·49
Ammonia - - - - -	0·60
Value according to tables -	£2 8 3

MEXICAN GUANO.

Some manures have been introduced into this country under the name of Mexican Guanos. It will be seen from the following analyses that they are of very low character. They are hot worth importing into this country, though they have been sold to farmers at very high prices. We give two analyses.

MEXICAN GUANO.

	1856.
Moisture - - - - - -	12·34
Organic matter, &c. - - - -	17·96
Silica - - - - - -	38·38
Oxide of iron and alumina - - -	5·09
Phosphate of lime - - - -	8·01
Alkaline salts, &c. - - - -	6·89
Carbonate of lime - - - -	1·82
Hydrated sulphate of lime, &c. - - -	9·51
	100·00
Nitrogen (equal to) - - - -	3·45
Ammonia - - - - -	4·19
Value according to tables -	£3 7 8

MEXICAN GUANO.

	1846.
Moisture - - - - - -	3·24
Organic matter, &c. - - - -	13·56
Silica - - - - - -	0·60
Phosphate of lime - - - -	25·60
Carbonate of lime - - - -	46·14
Sulphate of lime, &c. - - - -	10·86
	100·00
Nitrogen (equal to) - - - -	0·21
Ammonia - - - - -	0·26
Value according to tables -	£2 9 0

KOORIA MOORIA GUANO.

The Kooria Mooria islands are five or six leagues from the coast of Arabia, lying nearly east and west from each other. They are very barren islands; Halki, the westernmost island, is small, and situated in lat. 17 deg. 29 min. north, lon. 55 deg. 40½ min. east; Sardi, the second, bears east 15 miles from Halki. Halabi, the third, in lat. 17 deg. 30 min. north, long. 56 deg. 5½ min. east, is the largest of the group. There is a fourth island called Deriabi, and an islet named Rodando. The channels between the westernmost islands and the main are safe, with soundings in them; the channels between the other islands are also considered safe; but that formed by Halabi and the easternmost island Deriabi is the best. We subjoin analyses of guanos from this district. There are many other varieties of guano obtained from the Arabian coast; their general characteristics are similar to those of the Kooria Mooria islands.

KOORIA MOORIA GUANOS.

	1857.	1857.	1857.	1858.	1858.
Moisture - - -	4·18	2·48	4·00	8·60	10·00
Organic matter, &c. - -	14·42	4·44	10·85	7·39	10·10
Silica - - - -	17·85	39·95	7·55	44·75	47·30
Oxide of iron and alumina -	—	0·23	—	6·43	6·13
Phosphate of iron and alumina -	4·70	15·29	3·05	—	—
Phosphate of lime - -	43·40	13·95	63·85	18·77	19·92
Phosphoric acid - -	1·66	0·23	trace	none	none
= Phosphate of lime - -	(3·60)	(0·50)	,,		
Alkaline salts - - -	13·79	4·17	4·50	—	4·64
Hydrated sulphate of lime, &c. -	—	19·26	6·20	14·06	1·91
	100·00	100·00	100·00	100·00	100·00
Phosphate soluble - -	3·60	0·50	trace		
,, insoluble - -	48·50	30·51	67·15		
Total phosphoric acid, equal to phosphate of lime - -	52·10	31·01	67·15	18·77	19·92
Nitrogen (equal to) - -	1·48	0·71	0·71	0·92	0·63
Ammonia - - -	1·80	0·86	0·86	1·11	0·77
Value according to tables -	£6 7 3	3 11 10	6 3 8	2 6 8	2 7 5

	1858.	1858.	1858.	1858.	1858.
Moisture - - -	10·00	3·00	8·00	7·14	12·25
Organic matter, &c. - -	10·00	9·20	10·60	7·53	5·66
Silica - - - -	39·35	35·63	43·90	27·95	20·05
Oxide of iron and alumina -	3·04	—	6·90	—	1·78
Phosphate of iron and alumina -	9·78	11·80	—	10·54	3·30
Phosphate of lime - -	11·92	14·57	22·72	23·00	45·30
Phosphoric acid - -	none	none	none	none	none
= Phosphate of lime - -					
Alkaline salts - - -	15·91	2·85	—	4·44	2·21
Hydrated sulphate of lime, &c. -	—	22·95	7·88	19·40	9·45
	100·00	100·00	100·00	100·00	100·00
Total phosphoric acid, equal to phosphate of lime - -	22·52	27·35	22·72	34·42	48·87
Nitrogen (equal to) - -	0·56	0·56	0·48	0·42	0·28
Ammonia - - -	0·68	0·68	0·64	0·51	0·34
Value according to tables £	2 14 0	3 2 3	2 12 8	3 12 10	4 2 0

JARVIS' ISLAND.

The island thus called is in lat. 0 deg. 28 min. south, lon. 159 deg. 46 min. west, and lies due south of the Sandwich Islands. It is five miles in circumference, and its surface is pretty generally covered with low shrubs; the guano is found underneath. The following is the analysis :—

JARVIS ISLAND GUANO.

	1858.
Moisture - - - - -	1·00
Organic matter, &c. - - - -	9·05
Silica - - - - - -	0·50
Phosphate of lime - - - -	36·35
Hydrated sulphate of lime, &c. - - -	53·10
	100·00
Nitrogen (equal to) - - - -	0·35
Ammonia - - - - -	0·43
Value according to tables -	£3 10 0

SOMBRERO GUANO.

An exceedingly curious phosphatic matter has been lately imported into this country, under the name of Sombrero Guano. It was at first difficult to decide the exact nature of this substance. A careful examination has, however, proved that we cannot rightly rank it as a guano, but that it must be regarded as a mineral phosphate. As it has been entered at the Custom House as guano, we feel inclined to give some account of it. The island of Sombrero is situated in Lat. 18 deg. 35 min. N., Long. 63 deg. 28 min. W. It is situated about 60 miles from St. Thomas, one of the Virgin Isles. The island is 1½ miles long, extending from N.E. to S.W., and it is of a triangular shape. The average breadth is about three-quarters of a mile.

The island is covered with boulders, said to contain fossils, and apparently different from any other rocks on the island. They vary from one ton to twenty tons in weight. The surface of the island is in most parts composed of a hard silicious rock or tufa, from two to four feet in depth, below which is found phosphatic and calcareous tufa, interspersed with irregular upright dikes and bosses of solid phosphoric matter. The whole island, as far as can be ascertained, appears to be one mass of the same material.

In different places the solid phosphatic matter protrudes to the surface to the extent of some thousands of square yards, say from one-half to three-quarters of an acre, uncovered by the tufa. This rock varies in colour from pink to grey, yellowish green and dirty white. Many silicified stumps of trees are found on the surface throughout the island. The phosphatic tufaceous deposit contains the casts of several varieties of marine shells, and many fossil bones are found embedded in the same stratum to the depth of from ten to thirty feet. The dikes of solid phosphatic rock, although generally upright in direction, are often curved and twisted from the perpendicular. In this substance we find a considerable amount of iron and alumina, and in some specimens carbonate of lime, but no soluble phosphate.

It is stated that about 40,000 tons have been already obtained from the island, and used in the United States, simply ground and put upon the land—with what exact results we are not able to state. From its composition, its evident use in this country would be a basis for superphosphate of lime.

The following are the analyses of the mineral phosphate called

SOMBRERO GUANO.

	1858.	1858.	1858.	1858.
Moisture - - - - -	4·50	2·75	5·40	8·00
Organic matter, &c. - - - -	6·90	8·35	7·26	5·50
Silica - - - - -	1·00	1·70	1·55	1·05
Phosphoric acid - - - -	36·35	36·70	33·90	32·90
Oxide of iron and alumina - - -	13·37	12·93	9·53	10·05
Lime - - - - -	32·30	34·57	34·91	37·68
Magnesia - - - - -	0·29	—	0·88	0·11
Hydrated sulphate of lime - - -	0·51	—	1·85	0·96
Alkaline salts - - - -	0·20	—	—	—
Carbonate of lime - - (2·33)	4·58	3·00	4·72	3·75
	100·00	100·00	100·00	100·00
Phosphoric acid, equal to phosphate of lime -	78·76	79·52	73·44	74·61
Nitrogen (equal to) - - - -	0·14	trace	trace	trace
Ammonia - - - - -	0·17	trace	trace	trace
Value according to tables - £	6 8 0	6 9 8	5 18 8	6 1 5

PATAGONIAN GUANO.

Some guanos have been imported into this country from Patagonia and the Falkland Islands. They are nearly all of the same character, and are very much deteriorated by the action of rain. We subjoin the analyses :—

PATAGONIAN GUANOS.

	1856.	1857.	1858.	1858.
Moisture - - - - -	17·00	30·08	16·50	12·00
Organic matter, &c. - - - -	12·73	19·93	15·10	32·45
Silica - - - - -	40·83	10.20	26.05	13·00
Oxide of iron and alumina - - -	4·50	—	—	—
Phosphate of iron and alumina - -	3·40	1·70	12·73	3·70
Phosphate of lime - - - -	16·36	29·70	5·48	11·19
Alkaline salts - - - -	5·09	3·15	—	2·20
Carbonate of lime and magnesia - -	—	4·64	—	4·51
Hydrated sulphate of lime, &c. - -	—	—	24·14	10·35
	100·00	100·00	100·00	100·00
Total phosphoric acid, equal to phosphate of lime	20·04	31·54	19·26	25·20
Nitrogen (equal to) - - - -	0·56	3·60	0·78	4·89
Ammonia - - - - -	0·68	4·36	0·94	5·93
Value according to tables - £	2 7 8	5 3 10	2 10 3	6 0 10

PATAGONIAN GUANOS.

	1853.	1853.	1856.	1857.	1858.	1858.
Moisture - - -	16·00	22·28	7·36	19·00	10·60	3·40
Organic matter, &c. - -	25·75	14·57	13·14	23·68	18·00	17·35
Silica - - -	22·55	36·20	53·63	23·93	26·60	28·65
Oxide of iron and alumina -	—	—	3·75	3·76	5·50	4·85
Phosphate of lime - -	26·00	17·50	11·00	20·28	20·12	16·61
Phosphoric acid - -	[*]	[*]	0·23	none	none	none
= Phosphate of lime -			(0·50)			
Alkaline salts - -	9·70	9·45	—	4.90	9·31	—
Hydrated sulphate of lime, &c.	—	—	9·99	4·45	9·87	29·14
	100·00	100·00	100·00	100·00	100·00	100·00
Nitrogen (equal to) - -	3·10	1·76	0·56	2·26	0·56	0 63
Ammonia - - -	3·76	2·13	0·68	2·74	0·68	0 77
Value according to tables £	4 16 10	2 17 8	2 0 8	3 14 8	2 11 5	2 8 5

[*] Not determined.

SHARKS BAY GUANO.

Some guanos have been imported from the islets and rocky coasts of Australia. They have proved of very inferior quality, and great loss has been sustained by the parties who have shipped them. The analyses appended show that the freight must frequently be more than the value of the guano.

SHARK'S BAY GUANO.

	1851.	1853.	1854.
Moisture	14·47	19·80	11·08
Organic matter, &c.	7·85	14·55	18·87
Silica	14·47	7·25	8·45
Phosphate of lime	29·54	50·75	59·05
Alkaline salts, &c.	33·06	7·65	2·55
Loss, &c.	0·61	—	—
	100·00	100·00	100·00
Nitrogen (equal to)	0·35	0·77	0·70
Ammonia	0·47	0·93	0·85
Value according to tables	£2 16 3	£4 18 3	£5 10 10

MANURES SOLD UNDER THE NAME OF GUANO.

The practical value of good guano to the agriculture of this kingdom having been thoroughly established, many manufactured manures have been introduced into the market under the name of guano. This has been done in spite of the fact that that name can only be honestly applied to the natural deposits of birds and other animals. Whenever the farmer hears of British and Italian guanos, and of other substances of the same class, his suspicions ought instantly to be aroused; it being indubitable that no guano, properly so called, has ever been deposited in the localities referred to. Some attempts have been made to improve even Peruvian guano, which has been represented by the manufacturer as "*Peruvian Guano with ammonia partially fixed, whereby its quality is much improved.*" When the Peruvian guano is not so improved it is worth £13 per ton; but it appears that when it *is improved* for the farmer its value is only £2 10s. per ton! Some other substances are equally improperly sold in this country under the name of guano, description and analyses of them will, we think, be more in place in the work we propose to publish hereafter.

NOTE.

When experiments are carried on by the agriculturist for the purpose of ascertaining the productive properties and comparative values of different manures, great care should be taken that the manures used should be fair representatives of their respective classes. This is the more necessary as it is possible that samples may be sent out for these experiments superior to the bulks, thus giving to them a fictitious value.

OBSERVATIONS ON THE USE OF GUANOS OF THE SECOND AND THIRD CLASS.

CLASS II.

THOSE WHICH HAVE LOST A CONSIDERABLE PORTION OF THEIR SOLUBLE INGREDIENTS.

Guanos of this class have lost a considerable amount of their ammonia, and in consequence require to be applied in much larger quantities than guanos of the first class.

The mode described for using first-class guanos will also apply to those of the second class; but, in general, the amount per acre ought to be nearly doubled. For ordinary root crops many of these guanos, used in proper quantities, have proved to be serviceable manures.

In purchasing these guanos the prudent farmer will always require not only a guaranteed analysis before he buys, but before using the manure he will have the bulk also analyzed. If he has bought a spurious article, he will, by taking these precautions, prevent the loss of his year's rent, tillage, and crop.

CLASS III.

THOSE WHICH HAVE LOST NEARLY ALL THEIR AMMONIA, AND CONTAIN LITTLE MORE THAN EARTHY PHOSPHATES.

If used alone, six or eight hundredweight may be applied per acre. The best guanos of this class are suitable for some species of root crops, and then only when unmixed with much sand, and containing a good amount of phosphates really derived from the rain-washed deposits of birds and other animals.

In many guanos of this class, however, the phosphates are too insoluble by ordinary atmospheric action to answer by themselves. Even the best of them are most useful when dissolved by sulphuric acid, and made into superphosphate of lime.

The precautions previously mentioned should be observed in the purchase of these manures.

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ON INFANTILE MORTALITY,

AS ILLUSTRATED BY PRIVATE PRACTICE;

WITH

SUGGESTIONS FOR FUTURE INQUIRIES.

By W. T. GAIRDNER, M.D.,

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF EDINBURGH.

REPRINTED FROM THE EDINBURGH MEDICAL JOURNAL, NOVEMBER 1860.

In the course of some inquiries in which I have lately been engaged,[1] into the rate of death of infants under one year in England and Wales, it occurred to me as being a desirable thing to obtain from the records of private practice some data bearing upon this subject. I accordingly applied to two or three friends in the medical profession, engaged in general practice, on whose faithfulness in recording facts, and willingness to communicate them, I thought I could rely with confidence. The data so obtained are not, of course, strictly comparable with those furnished by the Registrar-General, and used by me in the researches above referred to. But they are of importance, as the nucleus of an inquiry which might probably be greatly extended with advantage to the public, and which almost every practitioner largely occupied in midwifery practice might follow out within his own sphere of observation. I therefore think it right to place on record the more important of the facts furnished to me with so much care and goodwill, in the hope that, although insufficient as a foundation for general conclusions, they may hereafter be amplified and generalized so as to afford a large amount of valuable instruction.

The question which I put to the friends who so kindly undertook to assist me was this: Of the infants born alive under your immediate observation, what proportion die during the first year of life? I requested that this question might be answered, if possible, in some detail, and with reference to certain particulars pointed out as being probably attainable. I also requested that the induction might be founded upon not less than 200 cases, and that these might be taken strictly as they occurred, *i.e.*, entirely without selection; and that the doubtful cases might be stated as doubtful, rather than simply excluded from the inquiry. In this way, having regard to

[1] See a paper, read at Glasgow, Sept. 1860, to the Association for the Promotion of Social Science.

the usual large per-centage of the mortality at this period of life, I hoped to obtain results tolerably free from accidental sources of fallacy, and, at all events, to a certain extent illustrative of the broad average of infant mortality in general practice. The fear of encroaching too much on the kindness and on the time of busy men deterred me from seeking a larger basis of induction; though it is only right to mention that several of my friends spontaneously offered me the results of a search through their books, extending over several years.

I shall now proceed to give some of the results which appear to flow from the details furnished to me; avoiding, in the meantime, the publication of names, in order not to give undue prominence to a few districts in the present imperfect state of the inquiry.

A. A pastoral and rural district, mainly belonging to two great landowners, and peopled by a thriving tenantry, mostly sheep-farmers, with their shepherds, farm-servants, and labourers. The population is, on the whole, increasing since 1841, at which period it had received a considerable check ascribed to emigration, and in the lower district to the conversion of tillage farms into pasture. There is one small town frequented by summer visitors, and considered to be in a high degree favourable to health from its situation and surroundings, although there is great want of water and proper conveniences within the houses, as in most rural villages in Scotland. Besides this small town, there are hardly any aggregates of population, within the range of the inquiry, larger than small hamlets or villages. The general character of the county is that of a hilly region, gradually subsiding into an extensive plain or wide *strath*, and watered by a number of considerable streams. It has the reputation, in fact, of being eminently a healthy district, and the general appearance of the population bears out this idea.

In the district referred to, Dr M. is one of two resident legally-qualified practitioners, and holds the parochial appointments; having also a large practice among the better classes. Dr M. has been kind enough to tabulate for me the leading details, as regards this inquiry, of 277 cases taken without selection. He writes me as follows, in answer to a particular inquiry on this point:—"The list which I sent you was not from any picked class, but from all and sundry, rich and poor, well-living and dissipated. Certainly, for some time, we have not had any infantile epidemic; but when they do occur, I think very few die under one year. I know the district so well, and almost everybody in it, that I am quite sure you may take the per-centage as given in my list as pretty correct." The only qualification which this statement suggests to me is one which Dr M. may have been prevented from remarking upon by a natural delicacy of feeling. There is, at least, one irregular practitioner in the district, who is employed chiefly in midwifery, and among the more ignorant classes of the community. I think it not improbable that this man

may draw off from the two legally-qualified surgeons a certain proportion of that infantile mortality which occurs among the improvident, dissipated, and even criminal classes; but to what extent this cause modifies the averages there are no means of ascertaining.

The general results of Dr M.'s inquiry are as follows:—Among 277 infants born there were 11 deaths under 1 year of age, amounting to a little less than 4 per cent. (3·97 per cent.); in the same number there were 17 illegitimate children, inclusive of three which were subsequently made legitimate (according to the law of Scotland) by the marriage of their parents. The births out of wedlock were, therefore, a little more than 6 per cent. of the whole. Two of the deaths were among the illegitimate children, one of these being one of twins. The causes assigned for the 11 deaths are as follows:—

Bronchitis, ...	2 cases.
Inflammation of lungs, ...	1 case.
Hydrocephalus, ...	1 ,,
Measles, with head affection, ...	1 ,,
Diarrhœa, ...	1 ,,
Spina bifida, ...	1 ,,
Hereditary syphilis, ...	1 ,,
Imperfect nourishment, etc. (case of twins), .	1 ,,
Cause not stated, but parents unhealthy and dwelling bad, ...	2 cases.[1]

These results are certainly remarkable; and, as they form the lowest infantile mortality that has yet been brought under my notice in any series of cases, publicly or privately reported, I have thought it right to state the details with some fulness. It will be observed that there is only one fatal case of epidemic disease, and that diarrhœa, commonly so large an element in infantile mortality, is also represented by only one death.[2] Tubercular and scrofulous diseases, too, make small appearance in the returns, though in the case of "inflammation of the lungs" both parents are reported scrofulous. Syphilis appears to have contributed to the list of deaths in two instances. In both, the father was first affected, but in one case the disease had been communicated by him to the mother, and so appeared in the offspring; in the other, it seems to have concurred with other circumstances to cause the deaths of two very young infants in the same family.

B. A rural district of considerable extent, including a village or small town of about 1000 inhabitants. The leading industry is agriculture, though both coal and iron are worked in the neighbourhood, and there is a considerable manufacturing population within five

[1] This last (so far as I can make out) is the only instance of two deaths at this early period of infantile life in one family. It is stated that "the father had syphilis at one time, and the mother was scrofulous."

[2] Dr M. remarks on this case:—"The disease was prevailing in the house at the time of the child's birth. The mother was affected by it. The child was weakly, and imperfectly nourished."

miles' distance. An endowed school, of some celebrity, gives a special character to the village, and brought a large accession of inhabitants to it about 40 years ago; since which time the increase of population has been comparatively small.

There are three resident medical practitioners, one of whom has the parochial appointment; and there is little or no irregular practice. Dr S. writes me that "there are no births in this neighbourhood not attended by a medical man, except a very few cases of rapid delivery." The following abstract of the details furnished by Dr S. may therefore probably be regarded as pretty accurately indicating the actual infant mortality of the district referred to.

Of 288 children born under the notice of Dr S., 22 died during the first year of life, excluding two still-born children. The deaths were therefore to the total number of births in the proportion of 7·64 per cent. About 12·5 per cent. of the births (36 out of 288) were illegitimate; nevertheless, only three of the deaths occurred among this class; one other illegitimate child indeed was still-born, but as this was a case of triplets, and as the other two children survived, the illegitimacy can hardly have had anything to do with this result. In five of the deaths, the father of the child belonged to the professional and independent class; three of these cases being in one family. In almost all the rest of the 24 deaths, the parents might be said to belong to the labouring or wage-receiving class of the community, the farmers and middle class generally being almost unrepresented in the return (in so far as deaths are concerned),—a fact of some importance when it is considered that 29 of the whole number of infants born were the children of farmers, and that of these not one died within a year after birth. On the other hand, the somewhat miscellaneous class designated "labourers," furnishes by far the largest contribution to the infantile mortality, there having been six deaths among 37 children whose fathers were of this class. Among 25 children of "ploughmen" there were two deaths; showing in this class (so far as the small numbers permit an inference to be drawn) a decided advantage over the class of "labourers."

C. A practice of considerable extent in the neighbourhood of Edinburgh, in a populous rural district involving portions of several parishes, and one or two rather large villages or small towns. Dr M. holds a parochial appointment.

The population is to a large extent agricultural, but there are several mills employing both men and women in considerable numbers. There are also several collieries in the district, most of which, however, have their own medical attendants. There are numerous practitioners within a circle of five or six miles, and within a like distance there is one town of 5000 inhabitants; besides Edinburgh, which is so near as to modify the population to some extent, especially in summer.

Dr M. has given details of 363 infants born under his observation. Among these, however, it is necessary to throw aside 96, as from the movement of the population and other causes the fate of the children cannot be positively ascertained. In the remaining 267 cases, the deaths within the first year of life were 23 in number, or 8·61 per cent. More than 7 per cent. of the whole 363 births were illegitimate;[1] and of these, three (exclusive of one still-born child) are ascertained to have died within the first year; there being, however, seven of the 26 illegitimate births of which no account can be given. The proportion of deaths among the illegitimate is therefore higher than among the legitimate, in so far as the small numbers allow a conclusion to be founded upon them. The deaths were due to a great variety of causes; and it does not appear that epidemic disease contributed very largely to their sum, as there are recorded only one case of scarlet fever, one of diarrhœa after measles, two of hooping-cough, two others of diarrhœa, and one of croup (probably brought on by imperfect nursing). There were several cases of convulsions and of hydrocephalus; and in a few instances the death is recorded under circumstances leading to the belief that gross carelessness, or worse, may have been the cause of the fatal event. In one instance, the mother was insane; in two others, of drunken habits. The employment of the women in the mills may, in some of these instances, have led to neglect of the offspring, even when the children were legitimate. Thus, among 14 children of mill-workers there were two deaths, neither of which appear to have had any other assignable cause except the neglect of the mother. In like manner, in the class of female domestic servants there were 14 children born, three of whom died under one year; and in one, if not two of these cases, it seems probable that the carelessness or neglect of the mother may have hastened death; the children of this class being, of course, almost all illegitimate. Farmers and farm-servants form by far the larger proportion of the specified occupations of parents: in the former class, there were 19 children born, with two deaths; in the latter, 58 children, with three deaths (one of these being one of twins, the other of which was still-born). It is, perhaps, not always easy to separate the class of farm-servants from that of labourers; but in the latter also the mortality was extremely moderate, being only one among 13 infants born.

In correcting his data by the Registrar's books, Dr M. has found 20 other deaths, under one year of age, in the district over which his practice extends; the mothers having, in these cases, been

[1] "The illegitimate cases," Dr M. writes, "I am absolutely certain of; for I always mark them in my note-book as the case takes place." Dr M. adds, however, in a subsequent note, that the full extent of illegitimacy in the district is probably not represented by the per-centage in his practice; the mothers of illegitimate children being mostly attended by the midwife, unless there is something in the case to require more than ordinary assistance.

either without medical attendance, or, at all events, not attended by him. Several circumstances indicate that some of these mothers were among the most neglected class of the community. A much larger proportion of the deaths than in Dr M.'s cases were from epidemic causes; and one was from small-pox in an unvaccinated infant.

D. A rural district in the west of Scotland, comprising two adjacent parishes of upwards of 8000 inhabitants in all, of which number, however, upwards of 2000 reside in a seaport town much resorted to in summer by visitors, and having two medical practitioners. Dr A., who resides almost at the centre of the inland district, holds the parochial appointments in both parishes, and has a very extensive practice among all classes of the community, there being no other practitioner, whether regular or irregular, within five or six miles in any direction. The district is almost purely agricultural, except in so far as this element is modified by coal-mining, and by a little hand-loom weaving, which was formerly an occupation of some importance, but is now fast becoming obsolete. The coal-miners are considered to be the most ignorant and dissipated portion of the population, and the villages occupied by them present a marked contrast to the principal village, which is almost exclusively inhabited by artisans and by agricultural labourers, and is remarkably well kept. One of the rural villages suffered very severely from the cholera epidemic of 1854, while the others were nearly exempt. The land is mostly arable, and in high cultivation; there are numerous residences of country gentlemen, some of whom devote much of their time to agriculture and country business. The country to the north is one remarkable for mineral wealth; it is traversed by railways in every direction, and has numerous thriving towns. Within six miles is a prosperous and rapidly increasing community, which must now consist of nearly 25,000 inhabitants, and forms an excellent market for agricultural produce. The population of the strictly rural district, however, to which Dr A.'s observations apply, is not much subject to fluctuations, and his return may therefore be regarded as practically complete, nearly the whole of the inhabitants being personally known to him.

Dr A.'s return extends to 250 births attended by him personally, or only not so attended from accidental circumstances. The number of children born, however, amounts to 257, there having been 7 twin cases. Among these 257 infants there were 32 deaths (exclusive of 5 still-born children), amounting to nearly 12·5 per cent.[1] Six of these deaths were from diarrhœa, and a like number from

[1] Dr A. writes me as follows:—"I attribute much of the infant mortality here to maternal vanity and want of attention. Mothers dress up their infants and take them out in all weathers, and long distances, for the mere purpose, I believe, of exhibiting them to their friends, sometimes even within the first month after birth. Others, again, are engaged in field labour during the day, leaving their little ones in charge of mere children, who do not know how to

disease of the chest; three were from scarlet fever, the only other epidemic disease that appears among the details. There is room for the suspicion that several infants perished from want of maternal attention; for in several cases the cause of death is stated to be unknown, and in others the cause appears to have been want of proper nourishment. The illegitimate twin children of a vagrant died within two weeks after birth in a mysterious manner, and one illegitimate child of a farm-servant is recorded as having been probably smothered in the bed-clothes soon after the birth, which took place without professional assistance. The illegitimate births were 20 in number, involving two cases of twins, and being between 7 and 8 per cent. of the whole number of births. The deaths among these 20 cases were 7 in number, or more than one-third of the whole.

Among the various classes predominating in the returns, the infantile deaths took place as follows:—Among 65 labourers' children, there were 9 deaths under one year, and 2 still-born; among 28 children of farm-servants, 3 deaths, and 2 still-born; among 52 farmers' children, 5 deaths; among 14 gardeners' children, 2 deaths; among 15 miners' children, one death (premature birth), and one child died in the birth. Among 5 children of farmers' daughters (illegitimate), there were two deaths; one of the mothers dying of phthisis soon after the child. It will be observed that the mortality among the children of the miners is less than that of any other class here mentioned; a remarkable fact, although in this instance founded on too small an induction to be stated in a general form.

E. For purposes of comparison with the preceding statements of infantile mortality in country practice, it appeared to me desirable to obtain the results of some considerable general practice in a large town. It is by no means an easy matter, however, to obtain from town practice details equally trustworthy with those given above; because few practitioners largely engaged among all ranks of the community are able to keep notes of their cases with the requisite amount of accuracy, and still less are they able to maintain such a personal acquaintance with their *clientelle* as allows them to follow up the inquiry as to the fate of the children. Two of my medical friends in Edinburgh, however, have kindly assisted me by placing in my hands a condensed statement of their experience. Both these gentlemen are in very large general practice, and from having resided many years in Edinburgh, have been able to attain a very

feed them; and the little ones, in consequence, suffer either from being overfed or from the mother's heated milk disagreeing with them. Probably both causes contribute to swell the infant mortality. It is nothing unusual for an infant to be taken out to the hay or harvest field to get suck from its mother; and, should it afterwards be griped, toddy is prescribed to relieve it; medical aid, in many cases, being only asked afterwards, when medicine can do little good."

secure position among the more permanently resident portion of the middle class, and among the most respectable and industrious of the artisans. One of the two holds a parochial appointment in one of the worst quarters of the town; but the most of the routine work, including the midwifery, is done by an assistant, and its details are not included in the returns given to me. The summary which follows may therefore be considered as bearing upon the question of infantile mortality in the *respectable* classes of a great town—excluding almost entirely the pauper class, and also the more abandoned and destitute of the lower class, not being paupers. With these exceptions, I believe that the two fields of practice cultivated by the gentlemen referred to are as broad and as general (when taken together) as could possibly be obtained in this city; and I may further state that in this as in all the other cases, I feel entire confidence that the data have been extracted and arranged with the most scrupulous accuracy and attention to the conditions of the inquiry. The general result of the two statements is not very different, although, as might be expected, the practice which centres in the Old Town shows the greater infantile mortality of the two:

a. Old Town, 206 births—died under 1 year, 16 = 7·8 per cent.
b. New Town, 200 births—died under 1 year, 13 = 6·5 per cent.
Both together, 406 births—died under 1 year, 29 = 7·14 per cent.

It thus appears that the results of town practice among the respectable but not wealthy classes closely resemble those of country practice in healthy and tolerably thriving districts, in which all classes of the population are thrown into a general average. The slight advantage in favour of town practice shown in the following comparison, evidently depends on the exclusion of the destitute and criminal class, which, if admitted in any considerable quantity, would very quickly have turned the scale in favour of the country. It may be mentioned also, that in the town practices here referred to the illegitimate births are insignificant in amount.

F. *Comparison of Infantile Mortality among the Respectable Classes in a large town, with the Infantile Mortality of four country districts.*

Country, 1089 born—88 died under 1 year = 8·08 per cent.
Town, 406 born—29 died under 1 year = 7·14 per cent.

It is thus clearly shown that it is almost entirely to the influence of the lowest and most neglected class that the towns owe their very high rate of infantile mortality as compared with the country districts. Indeed, it is quite certain, as I showed some years ago in my lectures on Public Health to the Edinburgh Philosophical Institution, that some parts of Edinburgh have a lower death-rate, both infantile and general, than most of the rural districts in the kingdom; and, in like manner, that other parts of Edinburgh have a much higher rate of mortality, both infantile and general, than

those manufacturing towns which, taken as a whole, are considered to be lowest in the sanitary scale. Thus, in three first-class streets the annual infantile mortality under 5 years of age was 48 in 1000 living, and in five streets chiefly occupied by the respectable artisan class it was 54 in 1000; while in the closes and wynds it was found to vary between 138 and 173 in 1000. It is sufficiently evident that it is in these last frightful figures, which, however, are probably much exceeded in the worst districts of the manufacturing towns, that we are to look for the reason why Edinburgh stands lower in the sanitary scale than the surrounding rural districts.

G. *Comparison of Infantile Mortality in several important Classes of the Community.* The data for this inquiry are not, as yet, sufficiently extensive; but, such as they are, I submit them here as a nucleus for further observation.

Among 100 children of farmers mentioned in the course of the preceding investigations, there were 7 deaths under one year, giving an average mortality of 7 per cent.

Among 111 children of farm-servants (male), there were 8 deaths, or at the rate of 7·2 per cent.

Among 115 children of labourers there were 16 deaths, or at the rate of 13·9 per cent.

Among 146 children of artisans or skilled labourers, there were 9 deaths, or at the rate of 6·85 per cent. The difference between this and the preceding class is very remarkable.

I need hardly point out how desirable it would be to extend this inquiry, both by furnishing larger numbers of the classes mentioned above, and by taking in the children of large and important classes which have more or less of local importance, such as soldiers, miners, tailors, shoemakers, shopkeepers, fishermen, and various classes of the artisans inhabiting large towns. It would also be of great importance to ascertain the rate of mortality among the children of the professional classes, and of the nobility and gentry of independent means. The data for such an inquiry could, I believe, be easily enough furnished by a few of our leading accoucheurs.

H. *Comparison of Infantile Mortality among Legitimate and Illegitimate Children.*

The preceding observations yield a total result of 1086 legitimate and 99 illegitimate children in the country districts, the proportion of the latter, therefore, being upon the whole 8·35 per cent., or about 1 in 12 of the children born. But the result as regards mortality was doubtful in 89 of the legitimate and in 7 of the illegitimate cases. There remain—

997 legitimate children, of whom died within 1st year 73, = 7·32 per cent.
92 illegitimate children, of whom died within 1st year 15, = 16·30 per cent.

In other words, the proportional mortality of the illegitimate children within one year after birth was more than double that of the legitimate children. The excess in the mortality of the illegitimate children is likewise apparent in each of the four country districts; the numbers, however, being too small to give a secure result, except for the collation of the whole.

Conclusions and Desiderata.—The preceding facts and inferences, imperfect as they necessarily are, may tend to excite curiosity, and perhaps to lay the foundation of what I cannot but regard as a most important inquiry. If it be true, or indeed anything like the truth, that even in healthy rural districts, and under the observation of medical men, the mortality of very young infants varies as much as between 4 and 12·5 per cent.; if, in different classes of the community in the same districts, the difference can be shown to be as great as between 7 and 14 per cent.; and if the evidence of these differences lies so easily within reach of medical practitioners throughout the country, as appears from these returns, then there can be little doubt that we ought to have, ere long, a series of most valuable contributions to sanitary and social science from the personal experience of individual medical men. The infantile death-rate presents for this purpose an immense advantage over the general death-rate. The latter requires to rest upon such an extended basis of observations, that it is practically removed into the field of operations of the professed statist. No man can determine for himself the rate of mortality of any group of persons with whom he is specially concerned; and the death-rate of a large town, or of an extended district of country, is composed of such a vast variety of elements that, even when excessive, it cannot be easily brought home to the consciences and hearts of men. What is everybody's business is nobody's business; and very few persons can be got to take interest in, or even to comprehend, the ultimate generalizations in which the sanitary state of a whole district is supposed to be expressed. But if you could prove to a particular group of persons, that in a particular year they had lost 12 infants where they need not have lost more than 4 or 5; still more, if you can point out pretty distinctly, from comparative observations, the cause of this excessive mortality, it may well be believed that questions of sanitary, social, and even moral and religious amendment, might be made to assume a new importance in the eyes of the most dissipated and unthinking of mankind.

Now, it is a well-established conclusion of sanitary science, that infantile death-rates are among the severest and most accurate tests of the health of a community;[1] because infants are not only the most

[1] "The death-rates of young children are, in my opinion, among the most important studies in sanitary science. In the first place, their tender young lives, as compared with the more hardened and acclimatized lives of the adult population, furnish a very sensitive test of sanitary circumstances; so that differences of infantine death-rates are, under certain qualifications, the best proofs of dif-

delicate instruments, so to speak, for measuring the force of agencies opposed to the health of all; they also bear with them into the world the imprint of the evil tendencies of their parents, inheriting many of their good and bad qualities, and too often falling a sacrifice to the unthinking folly or criminal neglect of those who gave them birth. Besides, while many complex causes act on the adult life, which science can hardly hope to bring clearly into view in any particular case, the causes that lead to excessive infantile mortality are usually much simpler, and many or most of them belong to the class of removable causes of death. And this remark is more especially applicable to the case of infants under a year old, whose tender lives depend almost entirely on the care, the thoughtfulness, the affectionate instincts, and the physical health of the parents, and especially of the mother. To bring home to the hearts of the mothers of this country, with a view to a great and enduring domestic reformation, the awfully prodigal waste of infant life that is perpetually going on around their own hearths, would surely be a mission of beneficence well fitted for the medical profession. The present inquiry aims at placing in the hands of every physician and surgeon in general practice, the means of making such an appeal with the best possible effect.

To do so, however, it will be necessary to determine, upon a more extended basis of induction,—1st, What are the minimum, maximum, and average loss of infantile life during the first year, in the ordinary course of medical experience? 2d, What are the minimum, maximum, and average for each great class of the community? 3d, What is the extent of the variations produced by season, climate, and other causes which may be regarded as irremovable? When these points have been determined within certain limits of accuracy, we shall have a residuum of facts directly applicable to the case of every isolated group of persons to whom it may be conceived desirable to apply this most searching test of physical and moral health.

The Registrar-General's returns may, to a certain extent, be rendered available for determining some of these points; but as the basis and method of these returns are essentially different from those of the inquiry now proposed, it is desirable, in the first instance at least, to keep the two lines of investigation quite apart. I would therefore suggest, that practitioners willing to co-operate towards the present inquiry, should tabulate their cases in such a manner as

ferences of household condition in any number of compared districts. And, secondly, those places where infants are most apt to die, are necessarily the places where the survivors are most apt to be sickly; and where, if they struggle through a scrofulous childhood to realize an abortive puberty, they beget a still sicklier brood than themselves, even less capable of labour, and even less susceptible of education. It cannot be too distinctly recognised, that *a high local mortality of children must almost necessarily denote a high local prevalence of those causes which determine a degeneration of race.*"—*Mr Simon's Preface to Dr Headlam Greenhow's Papers on the Sanitary State of England*, p. 27.

to show at least the following facts, all of which will be of the utmost use in arriving at a general conclusion:—

1. Indication of case (corresponding with private note-book, for reference). Sex.
2. Date of birth.
3. Legitimate or not.
4. Social position and occupation of parents; *i.e.*, of the father, when the child is legitimate; of the mother, when the child is illegitimate or left chiefly dependent upon her.
5. Died or not during first year of age.
6. Remarks on cause of death, condition of dwelling, health of parents, moral condition, education, etc., as illustrating the event in cases of death. Other deaths in the same family, etc.

I have only to add further, that I shall be happy to aid in bringing before the public any information on this subject, which my medical brethren may not think it expedient to put in the form of an independent communication.

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ON

INFANTILE DEATH RATES,

IN

Their Bearing on Sanitary & Social Science.

BY

W. T. GAIRDNER, M.D.,

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF EDINBURGH.

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ON

INFANTILE DEATH RATES,

IN THEIR BEARING ON SANITARY AND SOCIAL SCIENCE.

EVERY ONE practically engaged in the study of the public health is aware of the great value justly attached to the death rates of young children, as indicating the favourable or unfavourable sanitary position of a community. Indeed, it is too obvious to require proof, that whatever may be the local circumstances surrounding the life of the adult, the ability to rear a healthy offspring in sufficiently large numbers is one of the first conditions of national existence. The community which, either from non-production, or from the production of sickly and fragile children, fails to bring its full quota to the stock of life necessary for the national well-being, is not in a satisfactory position. It has ceased to be self-sustaining, and is either declining in numbers and vigour, or it is maintaining itself at the expense of other communities more favourably placed. Nay more, a community thus degenerating is in all probability always a cause of more or less active mischief to others, and so to the nation at large. In so far as it produces diseased lives, or lives prone to disease, it tends to infect the healthy stock of the nation with corresponding diseases and liabilities. No sanitary arrangements can prevent the unhealthy members of a society or of a nation from filtering into the general community, and becoming the parents of a generation tainted with hereditary weakness. The presence, therefore, of a degenerating community among others more happily organized, is not a mere deficiency to be compensated out of the superfluities of the rest. It is a positive evil—or rather, the source of a multitude of evils to society at large.

A simple and easily applied test of the soundness or degeneracy of the race in any locality, would be of infinite value to the sanitary and social reformer. But such a test is not afforded by the mere increase in numbers of the population, for it is well known that in the great centres of commercial and manufacturing activity there is never wanting an abounding supply of new, though not always vigorous, life to fill the places of the lives prematurely destroyed. Nor is such a test to be found in the general death rates, which are far too complex in their character, and subject to too many extraneous influences, to show adequately the degree of prominence of the evils referred to. The test is only to be found, if at all, in the more careful examination than hitherto of the infantile death rates.

The importance of infantile death rates, as indicating the social and sanitary condition of a community, depends on two considerations: first, that infants are much more easily affected than the general community by most of those causes of disease and death which are common to all; and, secondly, that their dependence upon their parents for bodily organization, as well as for proper nourishment and support subsequent to birth, makes the sanitary state of very young children a most delicate test of the real health and well-being of the parents, *i. e.* of their social and moral condition at the productive period of life, and in so far as concerns the domestic relation. In other words, the proposition may be put thus:—Given a community in which the infants die with extreme rapidity, and in which the general death rate is also high, you have, in the fact of the high infantile mortality, not only a corroborative proof of defective sanitary conditions operating on the entire population, but, in proportion as the infant mortality is higher than the average of places having the same general death rate, you have proof of defective sanitary conditions operating specially on the young life, in all probability through the neglect, or vice, or ignorance of the parents, and through their failure to fulfil the necessary conditions of a sound domestic relation. If, on the other hand, it were possible to find a district where the general death rate is low, while the infantile death rate is much above the average of such places, you would have, notwithstanding the good general sanitary condition of such a population, a culminating instance of proved unfaithfulness, on the part of the parents, to their trust; proved neglect, on a large scale, of the duties of domestic life and the care of a family.

In the attempt to state some of the laws of infant mortality I have chosen the period under one year, in preference to the more usual one under five years, as representing the special death rate of the earliest period of life. I have been led to this choice by various considerations which will appear more fully in the sequel, but chiefly by the idea that the utter helplessness of infancy, and its entire dependence upon maternal care, are more fully shown forth at this period than at any subsequent one; and, further, it is evident that the high amount of this death rate, and the great extent of its variations, present facilities for working out results on a small scale, which are not to be obtained in any other way than by taking the very earliest period of life.

Keeping, in view, then, for the present, only the first year of life, as representing in the most distinct form the hazards to which infant lives are exposed, can we arrive at any secure conclusions as to the relation which the infantile bears to the general death rate? In order to solve this problem I have availed myself very fully of the laborious calculations appended by the Registrar-General for England to his Ninth Annual Report; in which we find a death rate for each sex, and for every separate age of human life in every division

and county, and in 324 districts or groups of districts in England and Wales, calculated for the years 1838-44, and for the census of 1841. It is to be regretted that no similarly minute and elaborate series of calculations has been made for any later period; but it will not be difficult for any one who wishes to make a particular application of the principles which may be arrived at in this paper to procure the necessary data for his inquiry, in the case of any localities in which he may be specially interested.*

Every one probably knows generally what is meant by a death rate, in modern statistical language. In case there should be any whose memory or knowledge may be deficient on the subject, I will simply say at the outset, that a death rate is the statement of the number of persons of a given population that die annually out of a given number living. If out of a thousand persons living, at all ages, 20 die annually, then 20 is said to be the death rate per thousand for all ages in that population. If out of a thousand infants living, below one year of age, 150 were to die annually, then 150 would be the death rate per thousand of infants in the first year of life. And so of males and females, labourers, servants, farmers, clergymen, noblemen; each class or order into which a population can by possibility be divided so as to ascertain the proportion of its mortality to the whole living members of the class, may be said to furnish forth a death rate of its own. We have to do in the present instance, however, only with two classes—viz. infants of less than one year old, and all ages; the two sexes being, for the sake of simplicity in the statement of results, not distinguished.

Now, on considering broadly the death rate of very young infants, as compared with that of the general population, it is found to be immensely different; insomuch that it is rather a moderate statement of the case to say, that where 20 represents the general death rate, 150 will be the death rate of infants less than a year old; or in other words, that the infantile is seven and a half times the general death rate. This is undoubtedly the case so frequently that it may be said to be, in one sense of the word, a normal fact.

But it is not always a normal fact for the infantile death rate to be seven and a half times the general death rate. By a further consideration of the returns of the Registrar-General, and by a calculation from them, in a great number of instances, of the proportion which the infantile bears to the general death rate, it appears, that as these death rates themselves rise or fall, their proportion to one another commonly rises or falls also. Thus, when the general death rate is so low as 16 in a thousand, it is probably normal for the infantile death rate not to exceed six and a half times the general death rate; and when the general death rate is so high as 22

* The census of 1851, though by far the most complete and elaborate that has ever been taken in any country, was, unfortunately, not published in a form to give ready access to the numbers of the population under one year of age; and a large number of important data in the mortality tables have thus been rendered comparatively useless. I have reason to believe, however, that steps have been taken to remedy this important deficiency in the census of 1861.

in a thousand, it is probably so common as to be a normal, though, of course, not a desirable result, for the infantile death rate to be eight and a half times the general death rate. Thus it appears, upon a careful and extended consideration of the details of the inquiry, that the proportion or ratio of the two death rates to one another varies with the amount of the death rates themselves. And this curious fact tells a tale of some importance, as regards the tenure (so to speak) of infant life—the conditions on which the young infant lives, moves, and has its being; for the enlargement of the ratio between the infantile and general death rate, according as the rates themselves increase, shows nothing less than this—that, generally speaking, the causes which produce a high rate of general mortality have a still greater tendency to produce a high rate of infant mortality, and operate upon the infant life to a far greater degree. In other words, the infant life is not only more largely sacrificed than the general life of a population under ordinary circumstances, but it is far more keenly sensitive to those causes of increased mortality which produce exceptionally high death rates.

The inquiry thus becomes rather complex. If the case on which I have proceeded be at all correctly stated, it will be necessary, for practical purposes, to determine not only the laws that regulate the rise or fall of the infantile and general death rates, but also the laws that regulate their relation to one another throughout that rise and fall, the limits to which they may diverge and converge, and the conditions under which they may be expected to maintain certain ratios one to the other. And this determination of laws becomes, of course, more difficult in proportion as the varieties in individual cases are more considerable; requiring, under these circumstances, the examination and comparison of a very large number of individual instances.

Suppose, for instance, that it should be discovered that in one place having a general death rate of 20 in 1000, only 120 infants in 1000 perish annually, while in another place having a like general death rate of 20 in 1000, the infantile death rate is 180 in 1000, it would very clearly follow from this discovery that in the latter place there are certain influences at work specially destructive of infant life. But supposing the general death rate to be dissimilar in the two places, it will then be impossible to compare their infantile death rate with advantage until it has been shown how far the difference of the general death rate may be expected, normally, to influence the infantile death rate of each; in other words, how far the deaths of infants in each place are caused by circumstances acting chiefly upon them, and how far they are due to the pressure of causes of death on the whole population. It is quite conceivable, for instance, that a death rate of 150 in 1000 for infants in one place might be more significant of special neglect of infants than a death rate of 160, 170, or even 180 in another. Or, to put the case in another form, it might be more significant of special forms of avoidable evil, as regards the management of infants, for the infantile death rate to be seven times the general death rate in one place of very low general mortality, than it would be in another place less favourably situated, were the in-

fantile death rate eight or even nine times the general death rate. It seems, indeed, impossible to develop the full results of the comparison of infantile and general death rates, until an investigation has been made on a very large scale, and extending over a very large surface, into the normal relations existing between the two rates, and the limits of variation of the ratio between the one and the other.

This inquiry I have endeavoured to carry out,—1st, by determining the ratio of the infantile to the general death rate in all the divisions and counties of England, and in a large number of the individual districts and groups of districts; 2nd, by placing these in series according to certain predetermined rules of general arrangement, and reducing them to mean values; 3rd, by arranging these mean values in the form of a scale or table, to be used as a guide in the rest of the inquiry before us.

This table, the result of no small labour and calculation, is a remarkable illustration of the importance of large numbers, and of the collation of many individual facts, in reducing to order a chaos of apparently random variations. It appears quite clearly indeed, from the table, that each unit, and even half-unit (within certain limits), in the scale of the general death rate of the populations of England and Wales is normally related to a certain mean infantile death rate, and a certain mean ratio of the one to the other. With the help of this table a new light is shed upon the subject of infantile death rates; and although some of the results may appear to be founded upon too narrow a basis of data, yet their regularly progressive and serial character inspires confidence in them as a whole, and shows clearly that they are in truth the expression of a general law.

Table I.

Mean Death Rates (Infantile and General) of Divisions, Counties, and Districts of England and Wales, for the Seven Years 1838-44; showing the Mean Proportion of the Infantile to the General Death Rate, as modified by Variations in the latter Rate. Showing also the very lowest and the very highest Death Rates in England and Wales, together with the very lowest and the very highest Ratios of the Infantile to the General Death Rate.

Approximate General Death Rate, for Easy Reference.		Death Rate for all Ages per 1000. (500 M.) (500 F.)	Death Rate for Infants under 1 yr. per 100. (50 M.) (50 F.)	Ratio of General to Infantile Death Rate.
				As 1 to
	Lowest death rates (infantile and general) in England and Wales (Glendale)	14·00	7·702	5·50
	Lowest ratio of infantile to general death rate (Aberystwith)	17·01	9·091	5·34
	Similar ratio, with higher death rates (St. Germans)	18·59	9·930	5·34
	Mean of 9 districts, having very low death rates	16·24	9·364	5·76
	Mean of 22 districts, having general death rates from 14 to 20 per 1000, with relatively low infantile death rates	17·34	10·364	5·97

Approximate General Death Rate, for Easy Reference.		Death Rate for all Ages per 1000. (500 M.) (500 F.)	Death Rate for Infants under 1 yr. per 100. (50 M.) (50 F.)	Ratio of General to Infantile Death Rate.
				As 1 to
	Mean of 2 healthiest counties (Westmoreland, North Wales*)	18·91	11·884	6·29
	Mean of 3 healthiest divisions (S.E., S.W., Welsh D.)	19·41	13·953	7·19
†16	Mean of all the districts having a general death rate below 17 in 1000 ...	16·22	10·604	**6·49**
17·5	Mean of all the districts having a general death rate equal to 17 to 18 in 1000	17·38	11·407	**6·86**
18	Mean of 3 counties (Surrey, Sussex, N. Wales)	18·26	12·839	**7·03**
19	Mean of 5 counties and divisions (North Riding, Dorsetshire, Devonshire, Rutlandshire, S.E.)...	19·02	13·730	**7·22**
19·5	Mean of 11 counties and divisions (Kent, Suffolk, Hants, Cornwall, South Wales, Hertfordshire, Middlesex, Lincolnshire, Westmoreland, Welsh division, S.W.) ...	19·53	14·788	**7·55**
20	Mean of 4 counties and divisions (Berks, Essex, Cumberland, E.)	20·02	15·375	**7·67**
20·5	Mean of 6 counties and divisions (Wilts, Somerset, Shropshire, Norfolk, Northumberland, N.M.)	20·49	16·240	**7·91**
21	Mean of 11 counties and divisions (Oxfordshire, Bucks, Huntingdonshire, Northamptonshire, Bedfordshire, Herefordshire, Notts, Worcestershire, Derbyshire, S.M., N.) ...	21·17	17·840	**8·44**
22	Mean of 11 counties and divisions, including England and Wales (Gloucestershire, Leicestershire, Monmouthshire, Staffordshire, Cambridgeshire, East Riding, West Riding, Durham, W.M., York division, England and Wales)	22·09	18·793	**8·51**
25	Mean of 5 counties and divisions, including London (Cheshire, Warwickshire, Lancashire, N.W., London)	24·84	21·507	**8·65**

* For purposes of registration, North and South Wales are regarded as counties, and form, along with Monmouthshire, the Welsh Division of England and Wales. In like manner, the Ridings of Yorkshire are held to be counties, and Yorkshire itself a division.

† Up to this point, the figures being deduced from selected instances, cannot be used, without due limitations, as a guide in the interpretation of particular cases. But the mean results, indicated by Egyptian figures, are probably true as approximate averages for all England and Wales (excluding London), at the particular death rate indicated: *e.g.* when the general death rate is 16, or near it, the infantile death rate is average when it is about 6½ times as great; or, when the general death rate is near 18, the infantile death rate is average when it is about 7 times as great, and so on in increasing proportion.

Approximate General Death Rate, for Easy Reference.		Death Rate for all Ages per 1000. (500 M.) (500 F.)	Death Rate for Infants under 1 yr. per 100. (50 M.) (50 F.)	Ratio of General to Infantile Death Rate.
				As 1 to
27	Mean of 21 great town and city districts (excluding London), which had a population from 50,000 upwards in 1841	26·83	24·355	**9·10**
29	Mean of 14 town and city districts, which had excessively high death rates in the 7 years 1838-44 ...	28·99	25·858	**9·20**
	Liverpool (absolutely highest general death rate)	33·66	28·005	8·32
	Ashton-under-Lyne, including Oldham (absolutely highest infantile death rate, and highest ratio)	26·74	29·641	11·08
	London (absolutely greatest aggregate of city population*)...	25·22	20·662	8·19
	England and Wales (general average, inclusive of London*)	21·87	17·975	8·22

I must now endeavour, as shortly as possible (and it must necessarily be so shortly as to amount to a mere statement of results), to bring before you one or two illustrations of the laws of infant mortality, as investigated with the aid of this table. Let me premise that the investigations to which I refer are by no means so complete as is desirable; and in selecting from the mass of notes in my hands I have been guided more by the consideration that the time allowed me is short, than by the idea of doing justice to even one subject. Still, I shall be able, I trust, to show that the method followed is one capable of yielding important truths to a careful inquirer.

First, as regards *the districts and counties having very low death rates both infantile and general, and consequently a low ratio of the one to the other.*† These privileged districts are found to be

* It will be observed that the average ratio of the infantile to the general death rate is much lower in London than is indicated in the table as corresponding to a general death rate of twenty-five: and, accordingly, the average for England and Wales, as a whole, being largely biassed by London, is likewise lower than the mean result corresponding to the same general death rate, which is deduced from the counties and divisions of England and Wales, exclusive of London.

† The following is an enumeration of these districts: 1st, Nine districts or groups of districts, having a general death rate below or little exceeding 17 per 1000, while the infantile death rate is less than 10 per 1000,—Glendale, &c., Aberystwith, Anglesea, Llanfyllin, &c., Ulverstone, Bideford, &c., Southmolton, &c., Dolgelly, &c., Tregaron, &c.; 2nd, Districts, or groups of districts, in excess of the above, but very favourably situated as compared with the country at large,—Godstone, &c., Hendon and Barnet, Morpeth, &c., Brampton, &c., Steyning, &c., Havant, &c., Williton, &c., East Grinstead, &c., Swansea, South Stoneham, &c., Totness, &c., Isle of Wight, Narberth and Pembroke, &c., Bangor, &c., Launceston, &c., Bodmin, &c., Guildford, &c., Thanet, &c., Blything, &c., Northleach, &c., Hailsham, &c., Bootle, &c., Tavistock, &c., West Hampnett, &c., Haverfordwest, Castleward, &c., Alresford, &c., Cardigan, &c., St. Germans, &c., Atcham, Newtown (Salop), &c., Amesbury, &c. From the latter series I have selected thirteen, which, with the nine in the first series, are referred to in Table I. as illustrations of a relatively small infantile mortality.

mostly rural, often to a great extent pastoral, in character; the population is commonly sparse, the towns few and small, the face of the country uneven, or perhaps mountainous; in many such districts there are valuable minerals and a considerable amount of mining industry; agriculture is also pursued in some of them to a very considerable extent; in others, there is hardly any predominating industry, but a small population supported in a variety of ways upon a soil which does not repay large advances of capital, and which is therefore cultivated by small farmers who give their own labour and that of their servants, but do not employ any considerable number of hands in out-door agricultural employment. Of the districts falling within the description of very healthy districts, the majority are in Wales, Cornwall, and Devonshire; a few of them are in Northumberland, one in Lancashire, one in Salop, one or two in Hants, Surrey, Cumberland, and Westmoreland; the island of Anglesea and the Isle of Wight belong to this order of districts. The largest town found in this connexion is Swansea, which had in 1841 a population of 24,604. It is worthy of remark, that in Swansea, by far the healthiest town of its size in England and Wales, there is a considerable seafaring, and also a considerable mining, population. In Aberystwith (North Wales), a much smaller town, but distinguished by having, next to Glendale, the lowest of all the infantile death rates in England, a very large proportion of the male population is engaged in lead mining. In Liskeard (Cornwall), and in Anglesea, copper mining is largely followed; in Ulverstone (Lancashire) iron and coal are procured in abundance; in Glendale, Bellingham, and Haltwhistle (Northumberland), coal mining is a large branch of industry. Notwithstanding the apparently unfavourable influence, therefore, which some kinds of mining (as Dr. Greenhow has conclusively shown) exert on the health of the men actually engaged in them, it would seem certain, from the experience of these places, that even lead and copper mining are capable of being so followed as not materially to increase the gross mortality of the district in which they prevail; while the death rate of infants is certainly much less unfavourably affected by mining than by many other forms of industry.

Among places which must be pronounced, on the whole, very healthy, there are some in which the infantile death rate is decidedly greater than, under the circumstances, it ought to be. Such are the districts of Hendon and Barnet, in Middlesex; Blything, Wangford, and Mutford, in Suffolk; Hailsham, Eastbourne, and Lewes, in Sussex; Thanet and Eastry, in Kent; Haverfordwest (including Milford Haven), in South Wales, as compared with Narberth and Pembroke, the adjacent district. The causes of these relatively high infantile death rates would be an inquiry of great interest; but I must not attempt it at present.

Secondly, — Among *the districts having moderately, but not extremely low death rates*, a considerable number have characters closely resembling those already narrated. Agriculture assumes a

more considerable place as a staple industry; the farms are larger, the proportion of labourers employed is greater; gardening often appears on a great scale, as in the neighbourhood of London; the population is more dense, and the towns more numerous—but still not generally above the rank of market towns of from 4000 to 10,000 inhabitants; there is altogether greater activity, and a greater variety of produce, but usually no absorbing or exclusive industry, manufacturing or other. A large proportion of the districts in the South-Eastern and South-Western counties of England are in this position; some also in the Northern counties, and in Yorkshire; together with most of the districts of Salop, Rutland, and Herefordshire, and some parts of Middlesex.

And here I must notice, in some detail, a circumstance which pertains to this part of my inquiry, and which is full of interest, though of painful interest, for the social reformer. Most of the great corn-growing districts of England belong to the class having a lower than average death rate for all ages; in other words, they have usually been ranked among the healthier parts of the country. Dr. Headlam Greenhow, indeed, threw out some ominous notes of warning about some of them, in his well-known Report on the Sanitary State of England and Wales; but as regards others, he appears to acquiesce in the general opinion (current, at all events, since the time when Virgil wrote the Georgics), that agriculture on the large scale is one of the wholesomest and happiest of all pursuits; and that a peasantry employed chiefly in the cultivation of the soil is subject to fewer causes of degeneration, moral and physical, than most other classes of men. I am not in a position to prove, and I should be very sorry to suppose, that this opinion is altogether unfounded; indeed, it is certain, from the case of Glendale and many other districts of England, that agriculture, as a leading occupation of the population, is quite consistent with very low death rates, and indeed with the best position in the sanitary scale. I think it quite clear also, from the death rate of all ages in most of the agricultural counties, that to the adult man actually engaged in field work his occupation is not without some of the bracing and tonic influence ascribed to it. But I have been greatly startled to find in the great corn-growing counties of England evidences of a flaw in the well-being of the infant population, which must necessarily exert a deleterious influence on the health of these counties, and through them on the English race in general. Not only is the infantile death rate in many of them high (absolutely higher, for instance, than that of the country at large), but in many cases where this is not so, the infantile death rate is much higher than it ought to be, considering the amount of the general death rate; and higher also than it ought to be, considering the eminently rural character of the population, the small size of the towns, and the small number of persons to each acre of surface. These facts are illustrated in Table II.

TABLE II.

Infantile and General Death Rates (1838-44) in 14 Counties, in which more than 30 per cent. of the Male Population above 20 years of age are employed as Agricultural Labourers. Showing also the Proportion of the Infantile to the General Death Rate, the Proportion of the Population living in Towns, the Density of the Population, &c., &c.

Agricultural Labourers in each 100 Males above 20 years.	Persons to One Square Mile.	Per cent. of Population in Towns.	Name of County.	Name of Division.	Death Rate for all ages per 1000. (500 M., 500 F.)	Death Rate for Infants under one year per 1000. (50 M., 50 F.)	Ratio of General to Infantile Death Rate.	Special Industrial Occupations other than Agriculture.* Principal Towns.
							As 1 to	
40·2	188	25	Huntingdonshire ...	S.M.	21·42	19·296	9·00	No special industry. Towns small.
40·2	272	30	Bedfordshire	S.M.	21·22	19·806	9·33	Lace, Strawplait, &c. Bedford, Luton.
37·7	231	29	Suffolk	E.	19·67	15·519	7·89	Silk, Strawplait, &c. Ipswich, Bury.
37·1	224	26	Essex	E.	20·19	15·611	7·73	Silk, Strawplait, Shipping. Colchester.
36·4	215	31	Cambridgeshire ...	S.M.	22·41	20·321	9·07	No special industry. Cambridge, Wisbeach.
36·1	260	25	Hertfordshire ...	S.M.	19·74	17·685	8·95	Strawplait, &c. Towns small.
36·1	198	45	Wiltshire	S.W.	20·29	14·138	6·96	Wool, Silk, &c. Salisbury, Trowbridge.
36·0	228	37	Buckinghamshire ...	S.M.	21·32	17·426	8·17	Lace, Strawplait, &c. Aylesbury.
34·8	149	25	Herefordshire ...	W.M.	21·14	14·983	7·09	Gloves. Hereford.
33·6	227	32	Oxfordshire	S.M.	20·92	16·901	8·07	Lace, Gloves, &c. Oxford, Woodstock.
32·7	226	30	Berkshire	S.E.	19·84	14·179	7·15	No special industry. Reading.
32·6	216	28	Northamptonshire...	S.M.	21·07	17·697	8·39	Lace, Boots and Shoes. Northampton, Peterborough.
31·6	213	36	Norfolk	E.	20·06	19·381	9·38	Silk, &c., Shipping. Norwich, Yarmouth, Lynn.
30·3	147	39	Lincolnshire	N.M.	19·38	18·147	9·36	No special industry. Lincoln, Boston, Great Grimsby, Grantham, Louth.
35·4	224	31	Mean of 14 Counties	...	20·66	17·213	8·32	
15·4	307	50	England and Wales	...	21·87	17·975	8·22	

* Only those industrial occupations are inserted which are so prevalent as possibly to have some appreciable influence on the death rates of the country as a whole.

I have not adopted this conclusion without carefully revolving the matter, and subjecting it to analysis from a great many different points of view. But this much is certain, that in no less than eleven of the fourteen counties of England most devoted to agricultural pursuits (*i.e.* employing the greatest number of agricultural labourers) the ratio of the infantile to the general death rate is higher than that indicated in the table as the mean ratio for their general death rate; and, further, in some of them the ratio is enormously high, exceeding, in fact, that assigned in the table to the fourteen worst town districts, and to the counties and divisions of England having absolutely the highest death rates, both of infants and of all ages. Again, in five of these fourteen counties the infantile death rate is higher than that of England and Wales, although England and Wales have 307 persons living on each square mile, while the agricultural counties have only (on a mean estimate) 224.

It is difficult to give (within reasonable limits) an idea of the precise course by which I have arrived at the conclusion that in almost all of the eminently agricultural counties the destruction of infant life is in excess of what might be expected under the circumstances. I will, therefore, only state, as the general result of my inquiries, that the evil is least (indeed, hardly apparent) in Wiltshire, Berks, and Herefordshire; that in Essex, Suffolk, Bucks, and Oxfordshire it is unequivocally present, and to a still greater degree in Hertfordshire. In Northamptonshire the high infantile rate also exists, but may be due in part to the towns of Northampton and Peterborough, which have a character quite distinct from the rural population. In Huntingdonshire, Cambridgeshire, Bedfordshire, Lincolnshire, and Norfolk the infantile death rate reaches its maximum, being considerably above that of England and Wales; and the proportion between the infantile and general death rate is more than 1 in 9—being in Norfolk 1 in 9·38, and in Lincoln 1 in 9·36. The case of Lincolnshire is peculiarly striking; for the general death rate is only 19·38 per 1000; while the infantile death rate is more than 18 per cent., instead of 14 per cent., which is the normal amount in the circumstances, according to the table. Moreover, Lincolnshire has no considerable and generally diffused industry, with the exception of agriculture; the density of its population is remarkably small, being only 147 persons in one square mile (not much greater than the density of Wales, and much less than that of Cornwall); it has few large towns to enhance the death rates, and the largest of its town districts has an average, as regards infantile mortality, considerably below that of the whole county.

These circumstances, in regard to Lincolnshire, lead me to make a remark upon the causation of the high infantile death rates in agricultural counties, or rather, upon the difficulties in the way of arriving at a just conclusion in regard to that subject. On the one hand we have, I think, distinct evidence that a large surface of soil, devoted almost exclusively to agriculture, is often associated, in England and Wales, with a too high rate of infantile mortality.

On the other hand, I think it not less evident that agriculture, *per se*, is not the determining cause of the mischief; the district of Glendale alone being enough to prove that it is possible for a large proportion of population to be engaged in agriculture without any unfavourable effect upon the death rate. What then is the solution of this two-sided difficulty—first, agriculture, an occupation apparently eminently favourable to low death rates, in the case of Glendale and other districts; secondly, agriculture, where largely diffused as an industry over the Midland counties, apparently unfavourable to infantile life?

Dr. Headlam Greenhow, in the remarkable State paper to which I have formerly alluded, has insisted strongly on the danger frequently accruing to the health of the female population, and of the children, in rural districts, from the occupations of lace making, straw-plait weaving, straw-bonnet making, &c.* The tendency of his remarks, in some parts of his inquiry, would indeed appear to be in a direction equally consistent with sound morality, and correct principles of social economy—viz. towards establishing the principle that nature intends woman to be, first of all, a mother; and in no instance, on the great scale, to be anything inconsistent with this, her first and indispensable function. That a law so clearly written in the whole physical constitution and moral nature of woman should not be largely violated with impunity, is what every thoughtful student of social science must be prepared to believe; and, so far as my inquiries have gone, I think it is plain that the influence of special industrial occupations among the women of the agricultural districts, is, to say the least, not favourable. But the reader of Dr. Greenhow's remarks, especially at page 122 of his paper, cannot fail to be struck with the uncertainty of his tone, and indeed with the discrepancies among his facts, as bearing on the relation of industrial employments of women in general to infantile mortality. I regret that I am obliged, in the meantime, to maintain a similar reserve in discussing this point, which would require a much larger and more detailed acquaintance with the localities than I possess, to enable me to do justice to it. But, whatever be the practical influence of lace making, straw-plait, or silk manufacture, in the agricultural counties, it is not the sole, nor even the principal cause of infantile mortality. For it is only, at most, in seven of the fourteen agricultural counties that these manufactures acquire any decided preponderance; and in Huntingdonshire and Lincolnshire, which are almost purely agricultural as to special employment, whether of men or women, the death rate of infants is far above the mean, even of the agricultural counties; while in Cambridgeshire, in which there is no special industry of the women, the infantile mortality is absolutely the highest of the agricultural counties, and much higher than the average of England and Wales, or even of London, or, indeed, of any part of England, with the exception of Lancashire, and the great manufacturing towns.

* Papers relating to the Sanitary State of the People of England, &c. 1858. See especially pp. 28, 55-7, 81, 121.

It is not improbable that the low level and malarious atmosphere of some parts of the agricultural counties, particularly in Lincolnshire and Cambridgeshire, may produce an unfavourable influence on the health of the offspring; but in the former county, where the general death rate is decidedly low, this influence will hardly account for the occurrence of an infant mortality so much out of proportion to the general death rate. Besides, it has yet to be proved that malarious influences, generated in connexion with the soil, have a greater power over the young children of a population than over the men, so much more decidedly and constantly exposed to these emanations in the course of their work in the fields.

On the whole, I can arrive at no other conclusion for the present than this—that the habits of the great agricultural populations of England, probably of slow formation, and transmitted down from generation to generation, are, in some way or other, apt to give rise to neglect of the family relation, or of maternal duty, or of the general sanitary laws bearing on the health of offspring; and that the extensive employment of the women in some counties in special industries is one consequence of this habitual neglect; while the imperfect rearing of children is another, and a still more widely spread consequence of it. It remains for the local social inquirer, and especially for those who are the natural guides and instructors of the agricultural population, to detect more in detail, and to remedy as far as possible, this deplorable evil.

III. *The districts having the highest death rates* present a fruitful subject for remark. I might easily enlarge, to a great extent, upon the terrible sacrifices of infant life that take place annually in the manufacturing districts, in the Potteries of Staffordshire, in many of our seaports, and, generally speaking, in all the worst parts of our great centres of population; in some of which it would appear (unless the details are incorrect) that much more than 1 in 4 of those living under one year of age perish annually. These results, however, though painful and startling, could hardly be placed in a more clear point of view than they have often been placed before. They are, moreover, well known to all sanitary reformers, and have often been brought under the notice of this Association. I pass, therefore, to other and less familiar topics.

IV. I have next a few words to say about *the infantile death rates of London*—a subject of vast extent and importance, and well deserving of much more time and attention than can here be given to it at present.

As in the case of many other town districts, the death rates for all ages are, in London, a very imperfect index to the sanitary and social state of the population. But in London there is a very special reason why it is so, particularly as regards the West-end districts. The census is taken during the height of the London "season," when vast numbers of persons, most of whom belong to the active and healthy class, come up to town for business or pleasure, bringing with them also a train of domestic servants and other dependents, who would not be brought at all if they were known to be labouring under disease, or otherwise likely to swell the death rates. By a process of what Mr. Darwin would call "natural selection," therefore, the West-end, during the season, consists, to a great extent, of picked specimens of humanity. Its denizens, moreover, are persons who frequently have their real homes elsewhere; who, if they were to fall out of the ranks through sickness or accident, would not remain in London, but would hide their heads in the country, beyond the bustle and glare of the fashionable world. Against this we may undoubtedly set a certain proportion of sick who come up to London for medical advice, and may die there. But the immensely preponderating result is found to be that London (meaning by London, the West-end) is crowded and packed with health during the "season," when it becomes the great magnet of attraction for wealth and fashion, the centre to which all the most active and vigorous of men, and the most beautiful and fascinating of women, gravitate from all parts of the kingdom. The census takes note in spring or summer of this packed but fluctuating population, the feeble and sickly members of which have been to a great extent spontaneously eliminated, and the healthy portion of which is ere long to be dispersed over Scotch moors and Swiss mountains, or sent into pleasant English country houses. Thus, the annual mortality of London, as recorded from week to week by the Registrar-General, by no means represents the mortality of the numbers included in the census; and this remark is peculiarly applicable to what is commonly called the "West-end." It is not surprising, therefore, under these circumstances, that the West-end districts of London should have a general death rate much below the average of town districts—that in St. George's, Hanover Square, only 18 in 1000 should die annually; in St. James's, Westminster, 21 in 1000; in Marylebone, under 23 in 1000; and that, even taking into account the "slums" of Westminster, and the comparatively very inferior population of St. Martin-in-the-Fields, the mean death rate of all the districts which are the great seats of business and fashionable life, in the West-end of London, should be decidedly below the average of London as a whole, and still more below the average of other great cities.

Of course there are many large populations in London by no means so favourably placed as regards their general death rates. Westminster, as already mentioned, has its teeming dens of wretchedness which raise it to a rate of nearly 26 in 1000; the crowded districts immediately surrounding the "City" have a still higher rate (the City itself, however, being comparatively healthy); and from this we reach by gradual steps the culminating death rates of 28·46 in 1000 for St. Saviour and St. Olave, 28·87 for St. George-in-the-East, and 29·03 for Whitechapel.

Now we might naturally expect that in these different districts the infantile mortality would bear some appreciable proportion to that of

all ages. But the fact is far otherwise, insomuch that it is absolutely impossible to extract from the death rates of London any trace of such a series of proportions as is shown in Table I. to exist in the counties of England taken as a whole. The proportion, in fact, between the infantile and the general death rate seems at first sight so purely anomalous and arbitrary as to defy interpretation. Thus, in the Strand district, with a general death rate of 24 in 1000, the infantile death rate is little more than 19 per cent., while in St. Martin-in-the-Fields it is nearly 24 per cent., and in Kensington and Chelsea upwards of 23 per cent., with nearly the same general death rate. Again, in Greenwich, with a general death rate close on 23 in 1000, the infantile death rate is as low as 16·5 per cent., while in Marylebone it is as high as 22·9 per cent. for the same general death rate. Or, to take, if possible, a more extreme instance of variation, in Hampstead the general death rate is 20 per 1000, and the infantile death rate 14·6 per cent., or about seven times the former; in St. George's, Hanover Square, the general death rate is lower than in Hampstead, being about 18 per 1000; but the infantile rate is more than 20 per cent., being no less than eleven times the general death rate, and between 5 and 6 per cent. more than the infantile death rate of Hampstead.

These facts hardly admit, as yet, of being reduced to any general form of expression. But a careful consideration of them has led me to the discovery of a phenomenon which lies, indeed, on the surface in the Registrar-General's returns, but which I do not remember to have seen stated in the distinct form in which I shall now bring it under your attention. It is this: that all the West-end districts of London, without exception, are fatal to children, in a proportion which is really enormous when we consider the favourable state of the general death rate, and the many advantages which these districts have over the others. Let us take, for example, St. George's, Hanover Square, which, with the exception of Kensington, has the lowest infantile death rate of all these districts, and which, as we have seen, has very nearly the lowest general death rate of all London. The district of St. George's, Hanover Square, with all its wealth, its splendour, and really English comfort, is only a little less fatal to infants than Shoreditch, Bermondsey, or Lambeth; it is more fatal than the Strand district, or Stepney, which have a general death rate of 24 per 1000; far more fatal than Greenwich, the general death rate of which is nearly 23; and in a still more striking proportion more fatal than Wandsworth, Camberwell, and the outlying districts in general.

St. James's, Westminster, has an infantile death rate almost precisely corresponding to that of the river district of St. George's-in-the-East, and exceeding that of Poplar, Clerkenwell, and Bethnal Green; Marylebone, tested by the infantile death rate, must submit to be ranked as less healthy than the Surrey river-side districts of St. Saviour and St. Olave, and also than St. Luke's; while St. Martin-in-the-Fields actually exceeds Whitechapel, and approaches St. George's, Southwark, in its infantile mortality.

TABLE III.

Mean Death Rates (Infantile and General) of various Groups of Registration Districts in London (1838-44). *Also, Death Rates of several Single Districts, and of all London.*

	Death Rate for all Ages, per 1000. (500 M.) (500 F.)	Death Rate for Infants under one year per 100 (50 M.) (50 F.)	Ratio of General to Infantile Death Rate.
A. Group of 3 districts adjoining the country, on the south side (Wandsworth, Camberwell, Lewisham)	18·90	15·140	As 1 to 8·01
B. Group of 4 districts adjoining the country, on the north side (Hampstead, Pancras, Islington, Hackney)	20·52	16·916	8·24
C. Group of 5 West-end districts not adjoining the country (St. George, Hanover Square; St. James, Westminster; Westminster, Marylebone, St. Martin-in-the-Fields) ...	22·40	22·086	9·96
D. Group of 4 districts, in the line from Charing Cross to Bank and Leadenhall Street (Strand, City, E. and W. London)... ...	24·09	20·806	8·65
E. Group of 3 districts adjoining the river on the north side, and including the docks, &c. (St. George-in-the-East, Stepney, Poplar)	25·70	20·339	7·94
F. Group of 3 East-end districts, adjoining (D) and (E) (Whitechapel, Shoreditch, Bethnal Green)	25·99	22·097	8·53
G. Group of 4 districts adjoining (D) on the north (St. Giles, Holborn, Clerkenwell, St. Luke)	26·31	24·166	9·18
H. Group of 4 districts adjoining the river on the south side (St. Saviour, St. Olave, Bermondsey, Rotherhithe)	27·51	21·564	7·84
I. Group of all the remaining districts of London (Greenwich; St. George, Southwark; Newington, Lambeth, Kensington, and Chelsea)	23·87	20·421	8·47
a. Lewisham (Group A)	17·26	13·930	8·07
b. Hampstead (B)	20·24	14·618	7·22
c. St. George, Hanover Square (C)	18·16	20·245	11·15
d. St. James, Westminster (C)	21·16	21·756	10·28
e. Marylebone (C)	22·72	22·937	10·09
f. St. Martin-in-the-Fields (C)	23 99	23·868	9·94
g. Strand (D)	24·17	19·353	8·01
h. Shoreditch (F)	25·07	20·990	8·37
i. Bermondsey (H)...	26·38	20·723	7·85
k. St. George-in-the-East (E)	28·87	21·721	7·52
m. Whitechapel (F)	29·03	23·575	8·12
n. St. George, Southwark (I)	26·68	24·333	9·12
o. St. Giles (G)	26·89	28·249	10·50
All London	25·22	20·662	8·19

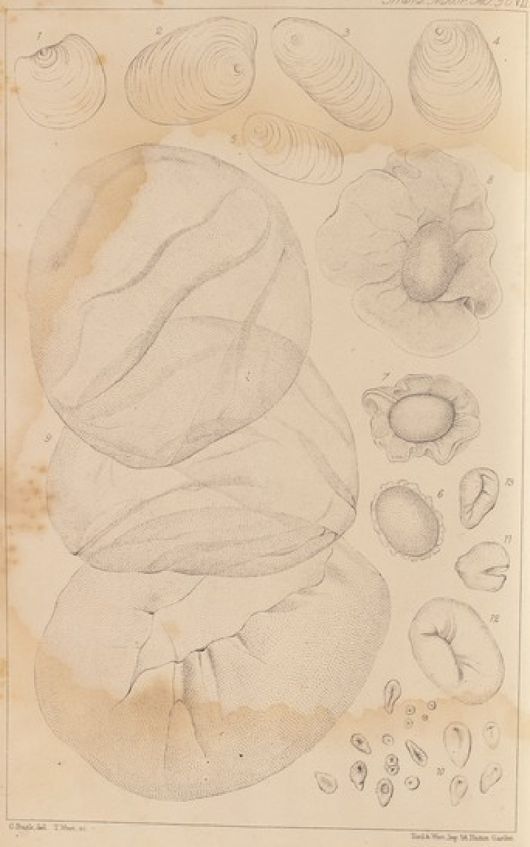
In the table of the death rates of London hereto annexed (Table III.), I have arranged the districts in groups, for each of which a mean has

been calculated. The arrangement of districts is partly geographical, and partly founded on other considerations which will be sufficiently evident on inspection. It results from this table, that the group of districts which I have marked on this map * has a position inferior to all the others except two; the two in question being simply a collection of the most crowded, and among the most neglected districts of London. In other words, the group of districts which encloses all that is best and noblest and, in one sense, healthiest and most vigorous in London, is about as murderous to infants under a year old as the districts of Shoreditch, Bethnal Green, and Whitechapel taken together; while even the sailors around the docks, and on the Surrey shore, and the tradesmen and artisans of the Strand and City districts, may boast that their contribution to the infant mortality of London is small compared with that of the rich, prosperous, and polished West-end.

I have thus brought before your notice a few illustrations of the ends to be gained by investigating infantile death rates. Some of the deductions from my inquiry are no doubt familiar enough to all who have given the least attention to the subject. Two of my conclusions—one, the influence of large agricultural populations on the infantile death rate; the other, the influence of the West-end of London—have, I confess, startled me with something like a sense of novelty. If they be facts, and not mere play of the fancy, I venture to call them stupendous facts, deserving the immediate attention of this Association, and calling for remedy with a voice far more eloquent than any words in which they could possibly be uttered. I shrink from the idea, with the imperfect data before me, of attempting to expatiate upon this subject, or to explore the whole depths of these tremendous evils. Possibly, if the Association will permit me to address them on a future occasion, the subject may be again resumed with larger knowledge and in a more decisive tone. In the meantime, it will be sufficient for my purpose if the attention of this Association, and of the numerous members of it who have personal opportunities of inquiring into the matter, shall have been fully awakened to some of the evils which afflict the most helpless age of humanity, and tend to poison the springs of health for the entire English race.

* St. George, Hanover Square; St. James, Westminster; Westminster, Marylebone, St. Martin-in-the-Fields.

Trans. Micros. Soc. Pl. VII



SOME OBSERVATIONS

ON THE

STRUCTURE OF THE STARCH-GRANULE.

By GEO. BUSK, Esq., F.R.S.

SOME OBSERVATIONS

ON THE

STRUCTURE OF THE STARCH-GRANULE.

"No substance has been more investigated, and yet of which there is less known, than starch. After the researches of ten years, in the course of which the most various views have been propounded on the nature of starch, and after all its characteristics as a proximate vegetable substance have been discussed, we are little or nothing in advance of the old point of view; and although we may, perhaps, not be wholly without some addition to our knowledge in secondary points, we are still entirely without any sound reasons to suppose that we have arrived at the truth."

This passage, from Poggendorff's Annal., 1837, vol. xxxii. is quoted by Professor Schleiden, writing eight years afterwards,* and he adds that these eight years, notwithstanding the publication of innumerable works by chemists and vegetable physiologists, had been equally thrown away in the investigation of this important vegetable element; but, strangely enough, asserting that this unsatisfactory result had arisen solely in consequence of neglect, or from superficial microscopic examinations.

If our knowledge respecting the structure of the starch-grain were thus unsatisfactory in 1844, it can scarcely be said to have been much enlarged since, notwithstanding the investigations of the learned and eminent Professor himself; and to which investigations—whatever he may be inclined to think or express with respect to the labours of others—he would not be the last to resent the imputation of superficiality.

We cannot but believe that a subject, which has thus baffled the endeavours of so many and such competent inquirers, must possess some inherent difficulty, for, in 1851, we find Dr. A. Braun,† one of the most accurate and acute of recent vegetable physiologists, still lamenting, in the same terms as Schleiden, the want of accurate knowledge on the subject of the origin, formation, and structure of starch, which he is of opinion demands a new and careful investigation, seeing that none of the views set up are sufficiently based upon direct observation.

* 'Principles of Scientific Botany.' Translated by Dr. Lankester. 1849. p. 19.

† 'Betrachtungen üb. d. Erscheinung der Verjüngung in der Natur.' 1851.

Having lately been incidentally led to the investigation of the structure of the starch-granule, I have thought the results might be interesting to the Society, although they cannot be said to be altogether novel.

In the numerous and very different modes in which it has been attempted to explain the structure of the starch-granule, only two really and essentially distinct views seem to be expressed. "These views," as Schleiden observes, "are decidedly opposed to each other, and on the assumption or rejection of them, the chemical judgment passed upon this substance must essentially depend."

1. According to the one view the starch-granule is a vesicular body, the wall of which differs, at all events in consistence, if not in chemical constitution from the contents.

2. In the other view the granule is considered as a solid body, constituted either of a homogeneous substance, or composed of concentric layers, deposited, according to one set of observers, around a *nucleus*, either differing in its chemical nature from the layers around it (Fritsche), or not essentially different in that respect (Endlicher and Unger). Schleiden, on the other hand, and many other observers, look upon the supposed nucleus as a minute cavity or indentation. Dr. A. Braun (*l. c.*), however, supposes that this cavity does not exist originally in the granule, but that it is of a secondary nature, arising in the disappearance of the nucleus.

The laminated, or supposed laminated, appearance evident in many forms of starch, and demonstrable perhaps in many others by means of polarized light, has been variously explained according to the above views of the essential constitution of the granules.

In accordance with the former of these views, Münter,* Nägeli,† and Link, suppose that the laminæ are formed by an internal or centripetal deposition of matter in the interior of the cell, and, according to the latter, this deposition is conceived to take place from without, or, as it may be expressed, centrifugally. This notion appears to be that more generally adopted. Originally propounded by Fritsche, it is followed by Schleiden, and, more recently also, though with some hesitation, by Dr. A. Braun (*l. c.*) who considers it as much more probable than that advocated by Münter and Nägeli, if the starch-grains are not themselves cells, but merely the product of secretion from the cell-contents, in the same way as the cell-

* Münter, 'Ub. das Amylon der Gloriosa superba,' &c. ('Bot. Zeit.' 1845, p. 198.)

† Nägeli, 'Zeitschrift.' 1847, p. 117.

membrane is, with which the starch is so closely allied. The same view is also adopted by Focke* and Schacht.†

The above is a very brief and imperfect summary of the views more generally entertained on the structure of starch, and, omitting all reference to what has been written respecting its mode of origin (which, in fact, amounts to little) and its use in the vegetable economy, I will now proceed to notice what may be termed a modification of the former of the above described views, or of that which assigns a cellular structure to the starch-granule, and the reception of which I am greatly inclined, from my own observations, to advocate.

Leeuwenhoeck,‡ to whom we are indebted for the earliest notice of starch-granules, enters with considerable minuteness into a description of those of several plants, such as wheat, barley, rye, oats, peas, beans, kidney beans, buckwheat, maize, and rice, and very distinctly describes experiments made by him in order to investigate the structure of the starch-granule. He placed a certain number of the grains upon a clean piece of glass, and added a minute drop of water, and, upon the grains thus separated from each other, he placed two more drops of water. The water was then dissipated by the application of heat for about a minute. He then noticed that the starch-granules had lost their rotundity and degenerated into plane figures of unequal size. From this experiment he concluded that the starch-grains of wheat, and other plants examined by him, were covered, like the wheat-grains themselves, by a cuticle. And he imagined that the incurvation of the starch-granule took place at that part only, where the cuticle, not being continuous, was joined by a sort of commissure—whence, he conceived it arose, that the granules, being heated and moistened, dehisced, and sank down into a flat form. He gives numerous figures of various sorts of starch in different stages, from partial expansion to complete evolution.

We have here apparently the basis of the cellular hypothesis of starch, afterwards more fully developed by Raspail and others. Leeuwenhoeck, however, does not appear to have regarded the contents of the starch-cell as fluid; and in this he was obviously more correct than his modern followers. But as Raspail's view, in its integrity, is no longer maintained, I believe, by any one, having been long ago given up even by his more immediate followers, and particularly by Payen and Persoz, it is needless further to advert to it. The later modification also of it advocated by Münter and Nägeli, though

* Focke, 'Die Krankheit der Kartoffeln.' Taf. ii. fig. 13, f. g. h.

† Schacht, 'Die Pflanzenzelle.' 1852, p. 41.

‡ Leeuwenhoeck, 'Epistolæ Physiologicæ,' &c. Delphis. 1719, p. 236.

with more scientific pretensions, is still so diametrically opposed to what may perhaps now be considered the correct doctrine of vegetable cell-formation, as in my opinion to be totally inadmissible.

Following in the footsteps of Leeuwenhoeck, Dr. S. Reissek* attempts to deduce the cell-nature of the amylum-granules from the phenomena presented during their decay or dissolution, when left for some time in water. He says that, "owing to the solution and exosmosis of their internal and more solid substance (in contradiction to Schleiden and Münter), they become hollow, so that of the entire starch-granule only the outermost layer remains, which, having become soft and flexible, assumes the appearance of a closed sacculus, that is, of a cell." He therefore regards the amylum-granule as a perfect cell.

M. Guibourt † says that the internal portion of the starch-grain breaks up in the form of flocculi, whilst the outer portion, the membrane, is lacerable, and occasionally exhibits the form of an empty pouch.

The expansion and alteration in form of the starch-grain, under the influence of heat and of sulphuric acid and other re-agents, is a fact recognised also by Schleiden and those who adopt the view of its solid or homogeneous nature; it is, in fact, so obvious a phenomenon that it could not possibly escape observation. They, however, and I believe nearly all who have adopted the cellular hypothesis, consider this to be owing simply to the expansion of the solid body or vesicle. Till very recently, Leeuwenhoeck only appears to have attributed this increase in size and change of form of the granule, not to a mere expansion, but to an opening out of the granule on one side, or to its evolution in other words, whence it assumes a flattened figure, and of course an increase in apparent diameter. Although not, in the precise sense, understood by Leeuwenhoeck, I believe that his notion, with some correction, represents more nearly the true doctrine of the structure of the starch-granule than that of any of his successors till a very recent period.

In the Philosophical Magazine for April last is a paper 'On the Amylum Grains of the Potato,' by A. G. C. Martin, Librarian of the Imperial Polytechnic Institute of Vienna, which appears to me to contain the germs at all events of a correct doctrine with respect to starch; and as I was led to

* Reissek, Haidinger's 'Berichten üb. d. Mittheil. von Freunden d. Naturwissen. in Wien.' Mai—Oct. 1846. Wien, 1847, p. 84.

† 'Journal de Pharmacie.' 1846, p. 191.

pretty nearly the same conclusions as himself, though from experiments of a different kind and instituted for a different purpose, I have the more confidence in his results. And as the procedure I was led, more accidentally than otherwise, to adopt is perfectly easy and simple, this paper may at all events serve to incite others to repeat the experiments, and thus we may hope that the *vexata quæstio* of the structure of starch may in some degree be set at rest. M. Martin's mode of experimenting is nearly as possible the same as that adopted by the illustrious Leeuwenhoeck, and his results are not in the main very dissimilar.

As the observed results at which M. Martin and myself have arrived in the examination of potato starch appear to coincide in every particular, it is obvious that the reasoning applied to his is equally applicable to mine. These results have in both cases been arrived at by noticing the phenomena which take place in the amylum-granule *during* its expansion, and not when it has nearly or completely terminated.* This expansion or dissection of the granule is effected by M. Martin by means of heat applied in an ingenious but still inconvenient way, while the object is under the microscope. He thus employs it:—

"Between two very thin glasses, of the same size as the stage of the microscope, a little amylum, with a sufficient quantity of water, is to be put, and the former well spread out with the finger, to prevent as much as possible the formation of bubbles. The number of amylum grains in the field of view should not exceed ten or fifteen. The glasses should lie freely on the spring-piece, which must be raised by means of two pieces of cork introduced below it, so that while the two glasses are lying right upon the object-bearer, a current of cold air will ascend from below, or permit the little flame to continue burning in the hole of or below the stage. As the glasses are wide, they protect the microscope from too great a heat or other danger. The small flame is to be obtained from a common thread, doubled and slightly waxed. This, when ignited, gives a flame quite sufficient to boil the amylum."

In the course of his experiments he discovered that the slightly iodizing of the starch-grains delayed, so to speak, the entire process of boiling, and rendered the result more certain and satisfactory, and he states that his process seems to succeed still better in a concentrated solution of alum, with as much tincture of iodine as will colour the grains of a steel blue.

* *Vide* Observations on the Structure of the Starch-granule in a paper on Valisneria spiralis, by E. J. Quekett, published in the third number of the 'London Physiological Journal' in 1844.

The same benefit arises also in my process from the addition of as much iodine as will render the starch a pale blue without destroying its transparency; and the use of iodine in either case is attended with the further advantage that it renders the starch in its subsequently changed condition much more visible than it otherwise would be.

Instead of heat I employ concentrated sulphuric acid, and in the following way:—A small quantity of the starch to be examined is placed upon a slip of glass and covered with five or six drops of water, in which it is well stirred about, and with the point of a slender glass rod the smallest possible quantity of solution of iodine is applied, which is to be quickly and well mixed with the starch and water. As much of the latter as may be must be allowed to drain off, leaving the moistened starch behind, or a portion of it is to be removed by inclination of the glass, and the starch is then to be covered with a piece of thin glass. The object must then be placed in the microscope, and the object-glass ($\frac{1}{4}$ or $\frac{1}{8}$) brought to a focus close to the upper edge of the piece of thin glass. With a slender glass rod, a small drop of *strong* sulphuric acid is to be carefully placed immediately upon, or rather above the edge of the cover; care being taken that it does not run over it. The acid of course quickly insinuates itself between the glasses, and its course may be traced by the rapid change in the appearance of the starch-granules with which it comes in contact. The course of the acid is to be followed by moving the object upwards, and when, from its diffusion, the re-agent begins to act more slowly, the peculiar changes in the starch-granules, now also less rapid, may be readily witnessed.

These changes in potato-starch are thus described by M. Martin.* "First, the amylum grain sinks in, in that place, where, according to Fritsche, the kernel (nucleus) is situated. On the surface minute fissures appear, two of which almost regularly diverge towards the thicker end of the grain. The grain continues to be depressed inwards until a cavity is formed which is surrounded by an elevated ridge. In proportion as the grain swells up, this ridge increases in circumference and decreases in breadth, that is, continues to get flatter until fissures, mostly of a stellated form, appear in the hitherto little altered thicker part of the grain. The process is not very rapidly developed, and it is very difficult for the eye to follow it. Suddenly something is torn off, the grain is extended lengthways, and in the next moment a wrinkled skin of a rounded, generally oval shape, lies on the glass.

* L. c., p. 279.

Middle sized and small grains exhibit this shape most distinctly; and they have usually only one longitudinal wrinkle, the upper and lower ends of which are pointed. The constant appearance of this wrinkle is important for the development of my theory. The appearance of this disc," he goes on to say, "demonstrates that it is *perfectly flat*, and has a slightly elevated edge which also becomes flat on pressure. The contour is rounded, but perfectly sharp. If the two glasses be violently moved from one side to the other whilst pressing the amylum, the disc is torn, and it is distinctly seen, especially in the blue-coloured ones, to consist of two layers, an upper and a lower one. Further examination shows that they are collapsed vesicular bodies, consisting of an extremely fine but strong and elastic membrane."

"The primary form, therefore, of the amylum grain," according to M. Martin, "is a spherical or ovate vesicle. If this be considered as empty, and so contracted that one-half lies in the other half, a watch-glass shaped basin is formed, which after boiling and pressure between the two glasses, appears, in consequence of the delicacy and elasticity of the membrane, as a flat, round-edged disc."

According to him, it follows, that the starch-granule, in its more usual form at least, is formed by the inrolling upon itself of this spherical or ovate vesicle. It is not very easy, at all events I do not find it so, to comprehend M. Martin's explanation of the mode in which this inrolling or involution takes place, nor have my own observations as yet enabled me to express a very decided opinion with respect to this point. The appearances exhibited in the microscope, under the action of strong sulphuric acid, convey the idea rather of an unfolding of plaits or rugæ, which have, as it were, in some kinds of starch (those with a long fissure-like or stellate hilum especially) been tucked in towards the centre of the starch grain, than of the unwinding of rolls. And I conceive that the apparent laminæ are nothing more than the indications of the edges of such plicæ or folds in the contracted state, upon which I shall say a few words presently. The starch-grain of the horse-chestnut perhaps affords as good an example as any, and one readily obtainable, of the appearances which might be supposed to arise were the constitution of the granule such as I have just described; that is, as far as the tucking in of the vesicle towards the centre is concerned, because in this grain I am not aware that the concentrically laminated appearance arising from folds of the vesicle is evident. Fig. 10, Pl. VIII., represents the usual forms and aspect of the unaltered starch of this fruit, and figs. 11, 12, 13, various granules in different stages of evolution under the use of strong sulphuric acid.

If it be allowed that the starch-vesicle, as the ultimate product of the evolution of the grain might perhaps be termed, be elastic—which, in all probability, it is—it is easy to understand, as in fact is pointed out by M. Martin, that the portions which are folded into the interior must be more or less compressed, and thence denser; in consequence of which inequality of tension the phenomena exhibited under polarised light might be explained. I have examined several varieties of starch, such, for instance, as of the Potato; the Arrow-root termed "Tous les mois," which is, I believe, afforded by a species of Canna; two other kinds of arrow-root; the starch of the Spanish Chestnut; of the Yam; of a species of *Curcuma*, which seems to be identical with East Indian arrow-root; of *Cycas circinalis*; *Zamia integrifolia*; *Arum maculatum*, and what is termed Tacca arrow-root; and find more or less distinctly in all, indications of a similar structure, differently modified, however, in some respects, in each. Upon referring, moreover, to the figures of different kinds of starch given in Schleiden's 'Botany,' before quoted, a tolerably complete series of development, as it may be termed, of different forms of starch, will, I think, be sufficiently obvious. Fig. 13 of Schleiden, representing starch-grains from the rhizome of *Anatherum iwarancusa*,* and fig. 8 those of *Iris pallida*, show, as I conceive, the simplest form of inversion or folding of the edges of the starch-vesicle. A further stage is apparent in fig. 12, the starch of *Colchicum autumnale*; and a further advance may be traced in fig. 14, the starch-granules of *Arum maculatum*, whence the transition to the form presented by the starch of the horse-chesnut is sufficiently clear, and from these more or less open forms to the complete involution seen in the potato-starch, &c.

The dissection of the starch-grain may be effected in several ways besides those I have noticed, and equally, if not more, conveniently. And as the dissection effected in any of these modes appears to yield the same result, the latter may be regarded perhaps as the more worthy of confidence.

I have usually selected for my experiments the form of arrow-root called "Tous les mois." It is a favourable subject for investigation, owing to its large size and regular conformation, as seen in figs. 1, 2, 3, 4, 5. The grains of Tous les mois are of various sizes and of different shapes,—some oval, some more expanded, with a sort of horn or shoulder on each side, or on one side only. The grains, like those of most kinds of starch, are not cylindrical, but flattened, and towards one end of each grain is a minute circular spot, the area of which appears granular; and concentric to this spot the surface of the grain—or rather one of the flat surfaces only and the sides—is marked with delicate concentric rings. It is these rings which have been described as indicating a laminated structure, and, consequently, corresponding lines or planes should be seen, under favourable circumstances, passing through the substance. This appearance has actually been described as existing by Schleiden and others, but I have looked for it in vain, and Mr. Quekett, in his Lectures on Histology, describes the markings as superficial. His expressions, moreover, would plainly imply that this accurate observer entertains an opinion with respect to the structure of the starch-grain pretty nearly if not quite identical with that advocated in this paper, and that, as I suppose, the lines indicate the rugæ or folds into which the starch-vesicle is thrown in the contracted state, and that this is the case seems to be shown by the immediate effects of re-agents. The first change, after a slight swelling of the starch-grain, consists in the appearance of minute transparent elevations around the edge of the grain, as shown in fig. 6, each of which, I conceive, represents the edge of a fold or ruga; a further stage of expansion is shown in fig. 7, and a still farther one in fig. 8; whilst the full expansion of the vesicle in Tous les mois is shown in fig. 9. I believe, also—but of this I would speak very doubtfully—that each starch-vesicle has an opening which corresponds with the central spot or hilum. With respect to the contents of the vesicle, some appearances lead me to suppose that, occasionally at all events, it contains a flocculent or grumous material—amorphous starch, which is equally coloured by iodine, as is the wall itself of the vesicle. There is sometimes also an appearance of a transparent colourless wall around these grumous contents, in a form of arrow-root I have examined; but an outline of this kind is often a very deceptive phenomenon, and I do not wish to be understood positively to assert its existence even in the case alluded to.

Two additional modes, which I have found convenient in the examination of starch, consist:—1st. In the previous roasting of the grain till it acquires a light-brown colour, and is, in fact, converted into British gum; while in this state, if it be moistened with a very weak solution of iodine, the grain gradually unfolds itself in the most beautiful manner. 2. The iodized solution of chloride of zinc, proposed by Pro-

* Münter, however, denies the existence of starch-granules like those figured by Schleiden in the rhizome of *A. iwarancusa*.

fessor Schultz, may also be very advantageously employed. This solution, if quite concentrated, does not at first colour the starch at all, but, on the addition of a little water, the blue colour is elicited, and the starch-grains gradually swell out and evolve themselves in the same way as they do under the previously described treatment. I make the iodized solution of chloride of zinc by dissolving 1 ounce of fused chloride of zinc in about half an ounce of water, and adding to the solution (which amounts to about an ounce fluid measure) 3 grains of iodine dissolved, with the aid of 6 grains of iodide of potassium, in the smallest possible quantity of water.

Since the above paper was read, I have noticed appearances in the amylaceous corpuscles which occur in the wall of the primordial utricle of *Hydrodictyon utriculatum*, which lead to the opinion that the starch—in this case at least, and probably in all the similar forms and situations in which it occurs in the lower Confervæ, &c.—is deposited around a nitrogenous nucleus. In *Hydrodictyon* the fact is very clear, that the central portion of the amylon-corpuscle is turned of a deep brown by iodine, or pink, by sulphuric acid and sugar (as was first pointed out to me by Mr. Huxley), and that at one time it exhibits no trace of starch in its composition, but that subsequently this nitrogenous nucleus becomes surrounded, not with an entire wall of starch, but apparently by a cup-shaped deposit of that substance in which the nucleus lies imbedded, or from which it projects on the external aspect. Further observation of this and analogous phenomena may perhaps in time lead to a more satisfactory explanation of the genesis of starch than can at present possibly be given. It does not, at all events, contradict the notion of the vesicular nature of the starch-grain, but rather, as it seems to me, tends to confirm it; for we have only to imagine the entire removal—as we may often witness the partial—of the central nucleus, when what remains, viz. the cup in which it was lodged, will very closely resemble some of the more open forms of starch-vesicles I have noticed in the paper.

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From the Transactions of the American Medical Associa[tion] 1850

I.

REPORT OF THE COMMITTEE ON PUBLIC HYGIENE.

THE Committee on Public Hygiene, in submitting their report, beg leave, in the first place, to express their regret that the delay in publishing the Transactions of the Association of the last year should have occasioned any impediment to the performance of the duty assigned them. The effect of the delay referred to was to deprive the committee of the opportunity of acquainting themselves, in due season, with the subjects which had engaged the attention of their predecessors. Being ignorant, for the most part, of the details of the report of the last committee on hygiene, there would have been, had the present committee entered on their labours anterior to the publication of that report, no security against the reiteration of matters already brought before the Association. The desire of avoiding a fault of this kind, and especially of discussing questions to which the attention of the Association has not heretofore been invited, will, it is hoped, be admitted as an acceptable plea, if not a satisfactory apology, for the want of variety, and limited extent of research in the present report.

In the second place, the committee would observe that the subject of hygiene is so fertile of matters demanding for their elucidation experimental research and scientific generalization, that nothing short of a plan of investigation, well digested and carefully pursued, can yield results remunerative of the labour expended in obtaining them. A committee consisting of members widely separated from one another by distance, and prevented from entering on their work at an early period after their appointment, can scarcely be expected, by any conventional action, to select from the wide domain of hygiene suitable fields of inquiry, and to proceed methodically and advantageously in exploring them. With these impressions, the chairman of the present committee deemed it proper, in communicating with his associates, in February last, to invite them to prepare monographs on such hygienic subjects as they might severally make choice of, avoiding those, however, which had been so fully and ably discussed by their predecessors. In thus adverting to the sources of their embarrassment in preparing their report, the committee deem it as not transcending their duty to suggest to the Association the propriety hereafter of assigning to the standing committee on hygiene special subjects of inquiry.

As a branch of medical science, hygiene is illimitable in the variety of its details. Its object is to discover and apply the means by which the vital powers may be so developed, regulated, and protected as to produce the greatest amount of ease, activity, and harmony of the organic and animal functions, its highest aim being to extend life without disorder to the period of its natural termination, or, in the language of Blumenbach, "to the ultimate line of physiology—to death without disease." Its scientific relations are to a great extent essentially etiological. To avoid disease it is necessary to know the disturbing causes of health. The influences which affect the vital properties are twofold. 1st. Those which, while rightly used are necessary to health, may become sources of disease. To this division belong what are denominated the *non-naturals*. 2d. Those which are never salutary, and the action of which is antagonistic to the normal vital forces. Among these are the qualities of the air which cause epidemic and some other forms of disease. From the modes in which these various morbific agents produce their effects on the human economy are deduced the principles of hygiene. As thus surveyed, it is obvious that hygiene comprehends the elements of etiology, and that, as a science, the former can never be in advance of the latter.

In regard to the general sources of disease, it is well known that some of them admit of correction by measures instituted by municipal authority, whilst others are beyond the control of legislative enactments. Of the former kind, are the emanations from filthy streets, sewers, marshes, human excretions in over-crowded habitations, and various common nuisances; and of the latter, the wide-spread influences which induce certain forms of epidemic disease. Against the assaults of these distempers, the utmost that can be done by Boards of Health is to point out their exciting causes and the means of avoiding them.

Whilst the civil, military, and naval relations of the laws or doctrines of health have long engaged the attention of governments, there is one aspect of the subject which has never been recognized as being of sufficient extent and importance to entitle it to the consideration of a separate department of study. We refer to *hygiene in relation to epidemics*. In researches strictly confined to this subject, the varieties of epidemic distempers, and their causes, characters, and laws, would be investigated and generalized; and the means, general and special, of avoiding their attacks, and preventing their recurrence, shown in a distinct and systematic order. A manual exhibiting the present state of our knowledge of these topics, so arranged in its plan that everything peculiar to particular epidemics should be brought together, and consequently made readily accessible, would be an invaluable boon to society.

As the theme of his contribution to the present report, the chairman of the committee has selected the sources of typhus fever and the means suited to their extinction. His design is to show that the disease originates from human excretions; and to investigate the kinds and quantities of these matters concerned in its production. The inquiry is divided into two parts; the first relating to the origin of typhus from the excretions of persons in health, and the second to its origin from the excretions of persons in disease.

I. The human body in health is continually undergoing the processes of composition and decomposition. The materials which enter the system for its formation, after serving that purpose for a brief period, yield their places to other matters of the same kind, and their elements entering into new combinations, are ejected as noxious to the organism. In health, except in the growing state, the supply of the nutritive and the waste of organic excretive matters are in equilibrium; and as the principles received into the body for its formation acquire the property of life, so those resulting from the metamorphosis of the tissues and eliminated as excretions, lose that property. The excretions, therefore, are dead matter; and hence being subject to the influence of chemical laws, their elements enter into new arrangements, forming various new compounds, among which there is reason to believe is *idio-miasma* or the typhus poison.

To enable the political hygienist to obtain a scientific and practical view of the extent to which the excretions of the human body may, under favourable conditions, become the source of a febrific miasm, it is necessary to estimate the quantity of effete matter expelled from the system in a given time.

Sanctorius, who for thirty years weighed daily his own body, and also his food and drink, and solid and liquid discharges, found when eight pounds of ingesta were taken, that his body returned every twenty-four hours to the same weight, and that he lost 3 pounds by urine and fæces, and 5 by transpiration. Keill makes the daily average of the fæces 5 ounces; the urine 38 ounces, and the perspiration 31 ounces, the ingesta being 75 ounces. Hartman found when the ingesta were 80 ounces, the fæces were 6 or 7 ounces, the urine 28, and perspiration 45 or 46 ounces. In Von Gorter's experiment, when the ingesta were 91 ounces, the fæces amounted to 8 ounces, the urine to 36, and the perspiration to 49 ounces. Sauvage ascertained that when the ingesta were 60 ounces, the fæces were 5 ounces, the urine 22, and the perspiration 33 ounces.* The researches of Robinson,† and Lining‡ furnish similar estimates. An exact accordance between the results obtained by different experimentalists can scarcely be expected, seeing that so many influences, such as age, temperament, condition of the atmosphere, and state of health, are continually operating to vary the quantities of the different excretions.

In estimating the amount of transpiratory matter, the above-mentioned inquirers make no distinction between the cutaneous and pulmonary exhalations. The first successful attempt to separate these excretions, and determine their relative and absolute quantities, was made by Lavoisier and Seguin. These gentlemen found from all their experiments that "the loss of weight caused by the insensible transpiration is 18 grains per minute, and that of these 18 grains 11 on the average belong to the cutaneous transpiration, and 7 to the pulmonary. Agreeably to this estimate, the quantity of matter lost through the lungs and skin in 24 hours is 54 ounces (troy). In the above estimates no notice is taken of the quantity of oxygen received into and discharged from the body by the lungs and skin.

From these statements it appears that the amount of cutaneous and pulmonary excretion exceeds the aggregate sum of the urine and fæces, being sometimes, according to Sanctorius, in the ratio of five to three.

In respect to the different excretions, it is observable that two of them, to wit, the urine and fæces, are occasionally or periodically discharged, under the direction of the will, and that the disposition usually made of them seldom admits of their becoming a source of disease. It is otherwise with the materials exhaled from the lungs and skin. These matters are constantly escaping from the organs

* See Dunglison's Physiology.

† See a Treatise of the Animal Economy, by Bryan Robinson, Dublin, 1732.

‡ See Transactions of the Royal Society of London, 1743.

which secrete them; and while the more viscid portions of them adhere to the skin and clothing of the individual, the more volatile parts assume the form of vapour, and are widely dispersed in the open atmosphere; or remain, in circumstances of confinement, suspended in the air or attached to surrounding objects.

Now, it is well known that when the effete matters evolved from the lungs and skin are accumulated and long retained in a confined place, they become highly offensive and noxious to those who are exposed to them. We are not aware that any attempt has been made to illustrate this subject, by calculating the quantities of waste matters thrown off from the cutaneous and pulmonary surfaces of individuals, isolated or congregated, during lengthened periods of time. As such calculations may aid us in forming a right apprehension of the extent of the agency of human excretions in producing disease, in dense populations, we shall endeavour to supply them. There is reason to believe that inquiries pursued in this direction will exhibit more clearly and extensively than has hitherto been done the true grounds on which, in relation to the origin and diffusion of typhus fever, a system of hygiene should mainly rest.

The lowest quantity of transpiratory matter in 24 hours, among the estimates above cited, is that quoted from Keill, namely 31 oz.; and the highest that furnished by Lavoisier and Seguin, 54 oz. The average of them all is 45 oz. Carpenter says, "The maximum loss by exhalation, cutaneous and pulmonary, in 24 hours, is 5 lbs.; the minimum, $1\frac{3}{4}$ lbs." Now we shall probably not vary far from the truth, if we assume 40 oz. as the general average.

But before entering into the proposed calculations, it is essential, to a full analysis of the subject, that we inquire what are the proximate principles which constitute the cutaneous and pulmonary excretions? The elements of the typhus poison are undoubtedly present in the excretions in question, and hence an answer to this inquiry may lead to the disclosure of the principles which pollute the atmosphere of close and crowded habitations, and which are chiefly concerned in generating that poison.

Thenard, in his analysis of the matter of perspiration, found it to consist of a large proportion of water, some saline and acid bodies, oxide of iron, and a small amount of *animal matter*. According to the analysis of Berzelius, the proximate principles are water, muriates of potassa and soda, lactic acid, and lactate of soda, and a little *animal matter*. These results are probably near approximations to truth: they accord substantially with those afforded by the qualitative analysis of Anselimo and Simon. It is to be noticed, also, that with the matters exhaled from the skin, are, according to Collard de Martigny, variable quantities of nitrogen and carbonic acid gas.

Of the proximate principles present in the pulmonary and cutaneous excretions, there is probably no one of them so directly concerned in generating *idio-miasma*, or the typhus poison, as the *animal matter;* and hence, it may be interesting to estimate the quantity of that material separately from the entire amount of matters discharged from the lungs and skin, in a given time. Happily this, we are enabled to do, by inferences deduced from the investigations of Mr. Ancell, of London.* Adopting the chemical views of Liebig, and pursuing his method of research, this gentleman has ingeniously attempted "to exhibit the various modes in which the equivalents of the component parts of the *ingesta* are eliminated from the body, and to ascertain the elementary constitution of the solid, fluid, and gaseous compounds into which they are distributed in the *egesta.*" The subject of Mr. Ancell's experiment was a healthy man, who, in twenty-four hours, took as *ingesta* 96 oz., and received, by estimate, into the system by the lungs, stomach, and skin, 32 oz. 23 dwt. 4 grs. of oxygen, making a total of matter received into the body of 129 oz. 3 dwt. 4 grs. The weight of the individual was the same at the end as at the beginning of the experiment. The egesta during the time was found to be fæces 5 oz. 10 dwt.; urine, 42 oz. and matters eliminated from the lungs and skin, consisting of water, carbonic acid, sweat, tears, animal matter, &c., 81 oz. 13 dwt. 4 grs., in all, making a quantity equal in weight to the matters introduced into the system.

The great difference in the amount of the excretions by the lungs and skin, in Mr. Ancell's estimate, and the quantities stated by former experimentalists arises from his bringing into his calculation the amount of oxygen taken into the system through the lungs, stomach, and skin, and expelled from the pulmonary and cutaneous surfaces in combination with carbon and hydrogen, forming carbonic acid and water. Subtract the oxygen in question, and the quantity of matters excreted by the lungs and skin is reduced to 48 oz. 14 dwt., a sum differing but little from the estimates given, as before noticed, by Hartman and Von Gorter.

On carefully analyzing the table in which the results of Mr. Ancell's inquiries are exhibited, it is found that of the 81 oz. 13 dwt. 4 grs. of cutaneous and pulmonary excretions, 42 oz. 13 dwt. 10 grs. consist of water, 9 dwt. of dry materials, and 38 oz. 10 dwt. 18 grs. of gaseous matters. The 9 dwt. of dry materials are found in the secretions of the skin, and consist of *animal matter* 8 dwt., and salts 1 dwt., which added to the *animal matter* exhaled with the pulmonary vapour, give, exclusive of the salts, 11 dwt. 7 grs.: that is, the amount of *animal matter* emitted with the excrementitious discharges through the lungs and skin in twenty-four hours. This amount probably exceeds the usual quantity, and consequently, to avoid exaggeration, we shall assume 10 dwt. as the normal daily average.

* See London Lancet, Feb. 4th, 1843.

Having thus ascertained, in a mode as inductive as the extent of our knowledge admits, that the quantity of pulmonary and cutaneous excretions is 40 oz. daily, and that, of this amount 10 dwt. consist of organic or animal matter, we are prepared to calculate the quantities of such excretions furnished in given times by one or any number of persons confined, or crowded in private dwellings, jails, and ships, or congregated in armies and cities; and to this task we shall now apply ourselves.

1st. The excretions of a single individual in health are seldom productive of typhus fever. The disease, however, may arise from that source, especially when there happens an extraordinary combination of circumstances favourable to the generation of *idio-miasma;* as was the case in the instance related by Dr. Harty, of a woman confined by her husband for weeks in a small, dark closet, without light or air, and without a change of clothes. The two gentlemen who liberated her were overpowered while engaged in doing so by the effluvia of the place. At the end of a week both sickened with fever; one died and the other recovered with difficulty.* In examining these interesting facts, let us suppose that the weeks of the woman's imprisonment were equal to thirty-five days, though the period may have been much longer. Now the entire quantity of matters thrown off by the lungs and skin of the woman, at the rate of 40 oz. daily, in that time, is 116 lbs. 8 oz., and of the animal matter, at the rate of 10 dwt. daily, is 1 lb. 5 oz. 10 dwt. Here, then, to say nothing of the vitiation of the air by carbonic acid gas, a febrific effluvium was generated, doubtless, from the effete and excreted animal matter.

* See an Exposition of the Nature, Treatment, and Prevention of Continued Fever, by H. M'Cormac, M. D., London, 1835.

If it be questioned, however, whether the quantity of animal matter emitted from the lungs and skin, in the time mentioned, was not sufficient to produce so concentrated and active a poison, as manifestly existed in the place, it may be supposed that the emanations from the fæces and urine which, probably, were not regularly, if at all removed from the apartment, contributed to its production. It is remarkable that the woman herself continued in health, a circumstance attributable to her system having been gradually inured to the impression of the miasm from the time of its incipient production.

2d. Among the more common sources of typhus fever are the effete matters of the human body, accumulated and long retained in private dwellings. The facility and promptness with which such accumulations take place in the close and crowded hovels of the poor may be readily explained by calculating the amount of materials excreted from the lungs and skin of a definite number of individuals living in the same habitation. Let us suppose a family, one, of which there are hundreds of examples, consisting of ten adult persons, dwelling in a small, ill-ventilated house, and negligent of personal and domestic cleanliness; and, further, that the time severally passed within doors by the ten individuals, some of whom are constantly at home, while others are temporarily absent, amount in the aggregate to twelve hours out of every twenty-four. The mass of effete matters thrown out by the lungs and skin, by such a family within their dwelling, in one month, is 500 lbs., in six months, 3033 lbs. 4 oz., and in one year 6083 lbs. 4 oz.* Though by far the greater part of these excretions consist of carbonic acid, water and salts, yet the quantity of ejected animal matter is not inconsiderable. It amounts in one month to 6 lb. 3 oz.; in six months to 37 lb. 11 oz.; and in one year to 76 lbs. 0 oz. 10 dwt. In such circumstances it is, and especially in seasons in which the prevalence of typhus is favoured by an epidemic influence, that the disease often spontaneously originates in the squalid homes of the poor.

If we extend this mode of investigation to a number of families, each consisting of ten members, residing in contiguous tenements, we shall obtain results which may forcibly impress the mind of the public hygienist. Instead of a hypothetical example, let us select one which is reported as actually existing. "In one of the *cul-de-sacs* in the town of Leeds, there are thirty-four houses (described as impure and ill-ventilated), and in ordinary times there dwell in these houses 340 persons, or ten to every house; but as these houses are many of them receiving-houses for itinerant labourers, during the period of haytime and harvests and the fairs, at least twice that number are then here congregated." It is probable that of the 340 persons who ordinarily occupy the thirty-four houses some are children; yet, though this may be true, the occasional itinerant lodgers doubtless make the number residing in each house throughout the year equivalent to ten adult persons. Now, if the cutaneous and pulmonary excretions of one adult be 40 oz. daily, then the 340 adults discharge by the lungs and skin, within their dwellings, in the half of one day or twelve hours (assuming this to be the average of the time passed severally by the whole number in their houses), 566 lbs. 8 oz., and in the same proportions, in one month 17,000 lbs.; in six months, 103,133 lbs. 4 oz.; and in one year, 206,833 lbs. 4 oz. It is said that there were removed from the place in which the houses in question are situated, during the days of the cholera, 75 cart loads of manure—a quantity, allowing each cart load to weigh 1200 lbs., not equal to half the amount of the materials eliminated from the lungs and skin of the 340 persons, within the thirty-four houses, in one year. If we now calculate the amount of animal matter cast out from the 340 persons, it will be found, at the daily rate of 10 dwt. for each person, in the half of one day, to be 7 lbs. 1 oz., and, in corresponding proportions for each day, in one month, 212 lbs. 6 oz.; in six months, 1289 lbs. 2 oz.; and in one year 2585 lbs. 5 oz.: this last amount being more than two cart loads, each of the weight above mentioned.

We would here, for a moment, arrest our inquiry, in order to remark, what, indeed, is so well known that it needs scarcely to be stated, that the entire amount of effete materials evolved from the lungs and skin of persons living together, is not retained within their dwellings. In every human habitation there are openings or passages which admit of more or less ventilation, or, in other words, through which there is constantly a more or less free interchange of the air within with the air without. Now of the various proximate principles present in the cutaneous and pulmonary excretions, viz., carbonic acid gas, water, salts, and animal matter, the first, agreeably to the law of the diffusion of gases, rapidly escapes through the apertures mentioned, and is widely dispersed in the general atmosphere; and by virtue of the same law, the water, assuming the form

* In these and the subsequent calculations a month is reckoned as 30 days; six months as 182 days; and one year as 365 days.

of vapour, and holding the salts in solution, and suspending a fraction of the organic matter, also readily finds its way into the open air. But with the residue of the animal matter it is otherwise. The organized atoms, exhaled from the human body, have not, according to Professor Graham, "the diffusive force inherent in gases and vapours;" and consequently are slow in dispersing themselves. In confined habitations, where there is no perflation, they long remain floating in the air, or become attached to the persons, clothing, bedding, and furniture of the inmates. It is owing, therefore, to the difference between the diffusive property of the molecules of *animal matter*, and that of the *carbonic acid gas*, exhaled from the skin and lungs, that the former is, in ordinary, much more liable, though vastly less in quantity than the latter, to impart to the air of human dwellings a morbific quality.

3. Pursuing the same method of investigation, we may next estimate the amount of material excreted from the lungs and skin of persons confined in jails. The history of prisons abounds with examples of the origin of typhus from human filth accumulated in them. "The most pernicious infection, *next the plague*," says Lord Bacon, "is the smell of the jail, where prisoners have been long, and close, and nastily kept." There are few things which more strikingly illustrate the later advances in civilization than the improvements in the hygienic condition and discipline of prisons. Indeed, so great have been the reforms in the sanitary police of these institutions, since the time of Howard, that jail fever is now comparatively of rare occurrence. The disease, however, is still occasionally induced from excessive over-crowding. Take, for example, the prison at Rheims, which, it is said, is calculated to receive one hundred prisoners, that is, to accommodate this number without endangering their health. In general, it contains from 130 to 150. But, as M. Landouzy informs us, in 1839, the number rose to 180 and 190; and that fever broke out in the most crowded apartments.* It is evident, therefore, that if the prison is fitted to receive but 100 persons, any addition to this number must render its inmates liable to generate the cause of fever. According to the daily average of 40 oz. from one individual, the amount of cutaneous and pulmonary excretions from 100 persons in one month is 10,000 lbs., in six months, 60,666 lbs. 8 oz., and in one year 121,666 lbs. 8 oz. The quantity of animal matter exhaled in one month is 125 lbs., in six months 750

* See Archives Générales de Médecine, Janvier, 1842.

lbs. 4 oz., and in one year 1520 lbs. 10 oz. Now it appears that in the prison at Rheims ample provision is made to prevent the occurrence of disease from the transpiratory matters of 100 prisoners. But how different was it when the number of prisoners was nearly doubled; and when, of course, the quantity of effete matters thrown out from the lungs and skin was proportionally augmented? Then it was that the mass of excretions, over and above the amount which the space and means of ventilation are sufficient to render innocuous, became the source of a miasmatic poison; and then it was that typhus broke out.

4. In like manner may be determined the quantity of pulmonary and cutaneous excretions of passengers in ships, sailing on long voyages. No human habitation is so liable to suffer from disease, by overcrowding, as a vessel that navigates the ocean. The annals of jail fever afford no examples of the mortality of that disease more appalling than those of the ravages of ship fever within the last few years. Of the emigrants, near 100,000, who left the British Isles for Canada, in 1847, over 5000 perished on the passage; and the deaths in the passenger ships bound to the United States, in the same year, were scarcely less numerous. From some ships upwards of 100 were buried at sea. Nor can this immense mortality be surprising when we contemplate the hygienic condition of the ships at the time of their arrival. A writer, in a Boston paper, who accompanied the port physician of Boston to a sickly emigrant ship, in describing the scene that the steerage of the ship presented, says: "As we descended by the light of a lantern between decks, and inhaled the fever-generating air, the concentration of 150 foul and infectious breaths, and beheld the ghastly victims of want and disease, and the filth in which they were literally imbedded, we could think of nothing but the black hole, or the middle passage." The condition of this ship affords a fair specimen of that of almost every vessel in which fever extensively appeared, while crossing the Atlantic, in 1847. The causes to which the occurrence of typhus in passenger ships are chiefly due, are not always under human control. The time occupied by ships in crossing the ocean varies greatly in length; and the health and good condition of the passengers mainly depend upon the opportunities they enjoy for spending a portion of each day in the open air, and on the cleanliness of their person, and the purity and aeration of the steerage. Whilst fine weather allows them to visit the deck, tempest and other atmospheric inclemencies compel them to keep below.

Now the quantity of matters eliminated from the lungs and skin in the steerage varies of course with the number of passengers, the length of the voyage, and the number of hours passed in the steerage. If 300 adult passengers spend twelve hours daily between decks, the matter there emitted from the lungs and skin during a voyage of thirty days will amount to 15,000 lbs.; and in the course of a voyage extended to forty-five days, to 22,500 lbs. The quantity of animal matter, calculated, as in former examples, will amount in thirty days to 187 lbs. 6 oz., and in forty-five days to 281 lbs. 3 oz. The construction and interior arrangements of the vessels, usually employed in transporting emigrants, are peculiarly unfavourable to the rapid diffusion of these large amounts of excrementitious transpirations. The main and direct openings into the steerage are generally too contracted to admit of free ventilation; and are occasionally from necessity closed; offensive accumulations consequently take place; the retained carbonic acid renders the air unfit for respiration, and the atoms of animal matter, having but little or no diffusive force, transform themselves into a pestiferous miasm.

Now, is it conceivable, in the true spirit of philosophy, that when there is such an amount of human exhalations, more or less of which is retained, in the circumstances mentioned, it is necessary to resort to the hypothesis of a specific contagion to account for the ravages of fever among those who lodge in the midst of them? When typhus appears in a foul and crowded emigrant or transport ship, the inference naturally deducible from a common sense view of the case is, that the disease originates from a poison generated from the detrita of the passengers, and especially from those emitted from the lungs and skin, to which, in many instances, are added the emanations from the fecal and urinary discharges and the matters ejected from the stomach in cases of sea sickness. The theory that typhus is produced exclusively by a specific contagion, analogous to that of small-pox, introduced on board at the port of departure is invalidated, if not overthrown, by the fact that the disease never prevails among the passengers of a ship, unless the condition arising from filth and deficient ventilation, already described, exists. If typhus be produced by a specific contagion, the disease would prevail in clean as well as in foul ships, a circumstance which never happens; and, besides, if the fever depends upon contagion, it would most probably show itself among the passengers within a few days after their embarkation, whereas the truth is, typhus rarely occurs in a ship until she has been several weeks at sea, and the steerage has become polluted with vitiated human effluvia.

5. In further attempting to illustrate the extent to which human exhalations sometimes become the source of an active fever poison, let us estimate the quantity of the pulmonary and cutaneous excretions of a definite multitude of persons, congregated in circumstances different from those above mentioned; for example, a large body of troops.

The condition of a common soldier, in respect to personal cleanliness, is extremely different in different circumstances. In times of peace, and while under a system of regular and rigid inspection of his person, apparel and quarters, there is usually nothing about him from which the typhus poison can originate. But it is otherwise when in active service in the field; he perspires freely, neglects ablution, and is long without a change of clothing. In such circumstances, whether in bivouac, or on the march, his garments become excessively filthy, and his person besmeared with the excrements of the skin. In such a condition, according to Foderé, were the French troops on their return from Italy in 1799; their clothes were in rags, their shirts glued to their bodies for several months, and their skin covered with filth. Such impurities long attached to a soldier, render him an object scarcely less dangerous to approach in a friendly interview than to meet in a hostile rencontre. "The same matter," says an American writer, "which renders shirts, drawers and stockings *disagreeable* to the wearer after two or three days will render them pestilential after five or six weeks close and incessant application to the skin."*

In order to form some idea of the magnitude of this source of disease in armies, let us compute the quantity of waste material discharged from the lungs and skin by a given number of troops, say 20,000, in definite periods of time. Basing the estimate on the daily average of 40 oz. from one individual, it appears that a corps of that number, eliminate in one day, 66,666 lbs. 8 oz; in one month, 2,000,000 lbs.; in six months, 12,133,333 lbs. 4 oz.; and in one year, 24,333,333 lbs. 4 oz. But, as by far the greater part of this amount of effete matter consists of water, carbonic acid and salts, which probably take no part in the generation of the typhus miasm, it is necessary, to a just view of the subject, to estimate the quantity of animal matter evolved from the cutaneous and pulmonary organs. If 10 dwt. be the daily quantity from one individual, then 20,000 men emit in one day 833 lbs. 4 oz.; in one month, 25,000

* New York Med. Repository, vol. v. p. 70.

lbs.; in six months, 151,666 lbs. 8 oz.; and in one year, 304,166 lbs. 8 oz.

It will be observed that the above estimates comprise the exhalations from both the lungs and skin. Now, it is obvious that so long as troops are serving in a campaign, or moving in the open air, the pulmonary excretions are wholly innocuous, being dispersed in the atmosphere, whilst those of the skin, or, rather a part of them attaching themselves to the body and clothing, furnish the elements from which are generated the *materies morbi* of typhus. It is only when troops are in barracks or in close tents that the pulmonary exhalations unite with the cutaneous, in producing a fever poison.

The quantity of sordid material adhering to a soldier in the circumstances now described, it is not easy, nor is it important, to determine. The rank odor, proceeding from his person, manifests, what in truth is apparent to the eye, that the quantity is not inconsiderable; and, at the same time, evinces that the substance in question has undergone a chemical transformation.* It is also to be noticed, that, though freely exposed to the air, the mass of filth on his person and raiment suffers no diminution by evaporation, the loss, sustained in this way, being constantly replaced, with additions, by the incessant discharges from the skin. A soldier in this condition may not inaptly be said to be clothed in a suit of fomites; and an army composed of such men, and moving in a body, may be likened to a morass, the emanations from which produce fever in those who come within the circle of their influence. It was in this manner, we are told, that the ragged and filthy French troops, above alluded to, disseminated the germs of typhus fever in the towns and villages that lay along their route from Italy; and it is remarkable that it was not until after halting at places beyond the reach of pursuit, and being concentrated in confined situations, they themselves succumbed to the influence of the noxious effluvia emanating from their own persons. There is reason to believe that a very large proportion of the ravages of fever, which have occurred at different epidemic

* Winterbottom, in discoursing on the odor emitted from the human body, cites the following curious remarks from a prize essay by Ritter. "The want of ablution occasions that insupportable and specific smell which the soldier, when in mass, spreads around him, and which differs in different nations. The smell of Hungarians, and Croats, differs from that of German soldiers; and an English regiment smells extremely different from a Spanish, Bohemian or Dutch one. The specific smell of different classes of men may be attributed to their mode of life and employment, as well as to their domestic and national customs."—*Thoughts on Contagion. Monthly Journal of Foreign Medicine*, vol. iii. Philadelphia, 1829, from the *Edinburgh Medical and Surgical Journal.*

periods, in the armies of Europe, was caused by *idio-miasma*, generated, under a favoring epidemic influence, from the personal filth of soldiers, and by the union of this poison with common malaria, forming the compound poison *idio-koino-miasma*. Dr. Rush, in speaking of the fever produced by "*excreted matters*," says that "it has been but little known in the United States since the Revolutionary war, at which time it prevailed with great mortality in the hospitals and camps of the American army."*

6. If any interest have been awakened by the results afforded by the mode here adopted of studying the etiology of typhus fever, it will not, perhaps, be lessened by proceeding to estimate the quantity of matters transpired from the skin and lungs of a city population, in various periods of time.

The inhabitants of a densely populated town may be regarded as a single family, living in contiguous or narrowly separated apartments, any number or the whole of which may as certainly be rendered infectious by over-crowding as the cells of a prison. In no mode perhaps can the danger from this source of disease be so distinctly impressed on the mind as by estimating the quantity of waste matters eliminated from the bodies of the people of a city in given times. If we assume as a numeral basis a population equal to 200,000 adults, it will be found, if calculated as in former examples, that the entire pulmonary and cutaneous egesta amount in one month to 20,000,000 lbs. in six months to 121,333,333 lbs. 4 oz; and in one year to 243,333,333 lbs. 4 oz.; and that the exhaled animal matter alone amounts in the first of these periods to 250,000 lbs., in the second to 1,516,666 lbs. 8oz., and in the third to 3,041,666 lbs. 8oz.

The health of a city depends, in no small degree, upon the distribution of the inhabitants over an area of sufficient extent to admit of the free ventilation of every dwelling. When such a distribution obtains, and attention is given to personal and domestic cleanliness, a population of 200,000, or any greater number, will be as secure against the invasion of typhus as are the inmates of a commodious, cleanly and well-aired private dwelling. But populate a town as densely as are the alleys and courts of many cities, and the consequence will be that the whole population will feel the influence of an *idio-miasmatic* atmosphere, and disease be co-extensively produced. Though such instances are extremely rare, yet history furnishes us with a notable example. We allude to the plague at Athens, which,

* New York Med. Repository, vol. vi. p. 155.

occurred in the time of Pericles, and the terrors of which are so thrillingly sketched by Thucydides. We are told that the people of Attica, during their warfare with the Peloponnesians and their confederates, took refuge within the walls of Athens; and that so great was the multitude assembled in the city, that every spot was excessively crowded. The ordinary population of Athens, at the time in question, cannot be satisfactorily determined. Xenophon reports that there were 10,000 houses; and a modern writer, founding his calculation on this statement, and assuming 12 inmates to each house, makes the number 120,000. Dr. E. H. Smith, in his admirable essay on the Athenian pestilence, states that the ordinary number of citizens was about 50,000, and that it was increased by the new comers from the country to more than 400,000. The plague broke out in the spring of 430, A. C. one year after the commencement of the removal from the country, and extended into the following summer. In its greater severity, it prevailed probably at least six months, and its ravages were renewed in several subsequent years.

With these data, we may compute the quantity of effete matter eliminated by the lungs and skin of the people in the space of six months. Supposing the usual population, taking the average of the above hypothetical estimates, to have been 85,000, and these to be equivalent to 50,000 adults, then, if each furnished daily 40 oz., the total quantity in six months amounts to 30,333,333 lb. 4 oz., of which the portion of animal matter, at the rate 10 dwt. daily, amounts to 379,166 lb. 8 oz. If we now assume that, to the stated population, there were added 350,000 fugitives from the country, making a total of 435,000, and that this number, including all ages, was equal to 300,000 adults, it will be found that the material excreted by transpiration was in six months 182,600,000, and that of this 2,275,000 lb. consisted of animal matter. And, lastly, if we subtract the quantity of exhaled excretions furnished by the ordinary population of Athens from that evolved by the augmented multitude, there will remain of the total exhalations 151,666,666, lb. 8 oz.; and of the animal matter 1,895,833 lb. 4 oz. These latter numbers, then, express the amount of exhaled matter, over and above the quantity emanating from the stated population of the city, in the course of the six months in which the plague raged with the greatest violence; and though there is good reason to believe that other causes, such as the miasm from accumulated fæces, and masses of decaying organic substances strewed on the earth, exerted a powerful agency, under the influence of a peculiar epidemic meteoration, in causing the distemper, yet there can be no hesitation in ascribing to the *idio-miasma*, produced from the immense volume of molecules of exhaled animal matter, suspended in the air, the effect of exasperating its malignity, and swelling its mortality. Thucydides says that "the general removal from the country into the city was a heavy grievance, more particularly to those who had been necessitated to come hither; for as they had no houses, but dwelt all the summer season in booths, where there was scarce room to breathe, the pestilence destroyed with the utmost disorder, so that they lay together in heaps, the dying upon the dead, and the dead upon the dying." Plutarch tells us that the Athenians raved against Pericles for causing the plague, and attempted his ruin, "being persuaded by his enemies that the sickness was occasioned by the multitude of out-dwellers flocking into the city, and huddled together in the height of summer, in small huts and close cabins, where they were forced to live a lazy inactive life, instead of breathing the pure and open air to which they had been accustomed. Of all this (they affirmed) he was the cause, who at the commencement of the war admitted within the walls such crowds of people from the country, and yet found no employment for them; but let them continue pent up like cattle to infect and destroy each other without affording them the least relief or refreshment." That such an epidemic should have sprung mainly, if not exclusively, from human exhalations cannot be doubtful or surprising, especially when the amount of these are rightly estimated, and their proclivity to generate a pestilential miasma is recognized. The sentiments of De Pauw, in relation to the Athenian plague, fully accord with the view here taken of the etiology of the disease. "To seek," he says "in Ethiopia the origin of the disorder, so evidently arising from a multitude of men heaped and pressed together, would be absurd, especially as its influence did not extend beyond the walls of Athens, and was totally unknown in every other part of Greece. Similar effects would be now produced in any town where the particles of the atmosphere are entirely changed by being charged with different noxious effluvia, as frequently happens in fleets or among armies encamped in too close order."

II. Having in the foregoing inquiries confined our attention to the excrementitious exhalations of persons in health, as the primary and chief source of the typhus poison, we now propose to examine the relations of that poison to the excretions of persons in disease, and especially of those affected with typhus.

Many distinguished pathologists regard typhus as springing exclusively from a specific *contagion*. That the disorder is communicable, under certain circumstances, there is no question. The communication, however, is effected by the transmission of a principle which, in its nature and mode of origin, has no analogy with the poisons of small-pox, measles, and scarlet fever. The poisons of these diseases are the products of specific morbid secretions, or vital processes which are respectively *sui generis*, whilst the poison of typhus consists of the ordinary excreted matters chemically altered in their properties. As, then, the excrementitious emanations from a typhus patient may be transmitted to a person in health, and in him produce typhus, the disease of course may be said to be communicable. But as the poisonous material communicated is totally unlike a specific contagious virus, the disease in question cannot with propriety be considered *contagious*. The disorder is strictly the effect of a chemical aeriform poison, and as this originates from human excretions, the poison is correctly denominated *idio-miasma*.

The excretions of patients affected with any form of disease may produce typhus fever; only, however, when they are accumulated and long pent up in confined apartments, or when they are highly vitiated or putrescent, at the moment of their elimination from the body, which is generally their condition in the more malignant forms of typhus. But even when in this form they are rarely the cause of fever, if the persons, clothing, and bedding of patients be preserved clean, and pure air be freely admitted to their apartments.

From inquiries, instituted to determine from which of the special excretions of persons in disease *idio-miasma* mostly originates, it has been found that the cutaneous and pulmonary transpirations generally furnish the elements of the poison. It is true, these excretions are variable in quantity, especially in febrile disorders, being sometimes greatly diminished, and at other times excessive. At no time, however, are they entirely suppressed. Febrile heat, though usually attended with a decrease of exhalation, promotes evaporation, and hence in part the dryness of the skin. When not apparent to the eye or touch, the cutaneous emanations are often manifest to the sense of smell. Edwards, in his work on the Influence of Physical Agents on Life, expresses the opinion that the perspiration can never be entirely suppressed; and Dr. Southwood Smith, in speaking of the odour which belongs to a typhus fever patient, that "it is so characteristic, that a person familiar with the disease might in many cases be able to pronounce, merely from the odour of the effluvia that arises from the body, whether the disease were fever."

With respect to the urine and fæces of the sick, they are, as we have said of those of persons in health, discharged occasionally, and are commonly removed from the apartment immediately or shortly after they are voided; and hence they are in general comparatively innocuous. It is only, or, for the most part, when these evacuations occur involuntarily, or are allowed to remain in the room of the sick that they are sources of a fever poison.

It is then to the excrementitious matters thrown off from the lungs and skin of diseased persons that the poison of typhus is mostly traceable. Such matters, transformed into a febrific principle and diffused in the air, constitute what Dr. Miller denominates *atmosphera idio-miasmatica*. Every patient affected with typhus in its graver form, in a close apartment, is surrounded by such an atmosphere, and it is by the attendants and others coming within the circle of its influence that the disease is propagated. When many typhus patients are assembled together in a close and narrow space, the miasmatic atmospheres of the sick gradually widen their circles of activity, until meeting and blending together the whole place becomes pestiferous. The liability of nurses and physicians of contracting fever in an infirmary, is generally proportionate to the number of typhus cases admitted into the wards. Dr. Christison says that, "it has been invariably remarked that the admission of a few cases into a general ward is attended with little or no risk of the fever passing to the other inmates of their wards. But so soon as the cases exceed considerably a third of the whole, then the fever begins to show itself among the domestic attendants, and to appear among the other patients." Similar observations have been made in the New York Hospital. It is remarked by an English writer, in reference to the admission of fever patients into general hospitals, that "it has been found safer and better to have them scattered as single cases through different wards instead of congregating them together into one;" and he adds that "this plan has been adopted in more than one of the London hospitals; and we believe that there has been, on the whole, no cause to regret having followed it."*

The fact is here deserving of special notice, that the matters eliminated from the lungs and skin of a *solitary typhus patient* in an ill-aired room, acquire a febrific property in a period of time much short of that in which a fever poison is generated from the combined

* Med.-Chirurg. Review, No. 105, p. 229.

excretions of several healthy individuals shut up in a close apartment. This is so for the reason that the exhalations in typhus are highly vitiated from the time the disease is sufficiently developed to be recognized, and, having a strong putrescent tendency as the disease advances in its downward course, are rapidly transformed into idio-miasma.

In regard to the quantity of excrementitious matters discharged from the body during the course of an ordinary attack of fever, we have no definite knowledge. Among the changes which take place in a typhus patient, there are few more striking than the emaciation. The weight of the body is sometimes greatly reduced. A part of the waste matters escape by the bladder and rectum; but the loss which the body sustains by discharges through these emunctories is, in a measure, replaced by the ingesta, and consequently a large portion of the transformed blood and tissues passes off by the lungs and skin.

It would be interesting to inquire what the average quantity is of the pulmonary and cutaneous excretions in cases of fever of a definite duration; and what proportion these bear to the alvine and urinary egesta. We have seen that an adult in health loses daily by the lungs and skin on an average 40 oz. Whether more or less than this quantity is lost by a patient ill with fever, we have not the means of determining. The amount probably does not, if at all, fall much below the quantity lost in health. In some cases, and especially in some conditions of fevers, there are copious sweats, which compensating for deficiency of perspiration in other cases and other conditions of the disease, bring up the total amount to the average quantity in health. In some febrile epidemics, the transpirations probably exceed the normal amount.

The excretions of a starving man exceed the half of those of one who is duly nourished. Currie mentions the case of an individual who was unable to swallow, and whose body lost 100 lbs. in weight during a month."* This is exactly the average amount transpired from the lungs and skin of a healthy man in 30 days, and it is probable that, in the case here referred to, the greater part of the matters eliminated escaped through these organs. Now the equilibrium between the waste and supply of the system, in an attack of fever, is broken up, the former exceeding the latter, and consequently emaciation follows. The difference of weight of the body at the

* Liebig's Animal Chemistry, p. 25.

accession and termination of the disease in a case of ordinary duration, cannot be less than 30 or 40 lbs. Though a diarrhœa and the alvine discharges produced by cathartic medicines may alter the relative normal proportions of the different excretions, yet there is reason to believe that a considerable if not the greater part of the transformed tissues, together with much of the drink and food introduced into the system during the disease, is eliminated from the lungs and skin. If the daily transpirations of a typhus fever patient be equal to 36 oz., that is 4 oz. less than the quantity in health, the amount in 20 days will be 60 lb., a quantity which, if there be any impediment to its diffusion, cannot fail to contaminate the air of a small apartment. It is from such transpirations retained in the narrow and close hovels of the poor that typhus is propagated, in seasons favourable to the epidemic prevalence of the disease.

But though private typhus patients may communicate the disease by their exhalations to their attendants and visitors, and thus spread the malady from house to house in towns and country districts, it is chiefly in hospitals that the cutaneous and pulmonary emanations display their power of reproducing the disease. Ten typhus patients, in a ward, discharge by the lungs and skin 600 lbs. of effete matter in 20 days. Now supposing this to be the average time which patients remain in a ward, and that the number mentioned be preserved by the admission of new patients to fill the places of those discharged, for 100 days, the quantity of exhalations in that period will amount to 3000 lbs. With such facts before us, and considering the noxious quality of the exhalations in question, it is plain that nothing short of ventilation, the most efficient, and of cleanliness, the most thorough, can prevent the occurrence of the disease among the nurses and other hospital attendants.

In respect to the principles which compose the exhaled matters from typhus patients, there is reason to believe that, however they may differ in their quantities, they are the same in kind as those from persons in health, namely water, carbonic acid, salts, and animal matter. But whether the proportions of these are relatively the same is problematical. As to the animal matter, we have no means of estimating its quantity. The fœtor of the breath, and the offensive odour of the sweats, in the graver forms of the disease, indicate that the amount does not fall short, if it do not exceed the quantity discharged in health. In some forms of abnormal excretions

* See Christison on Continued Fever, in Tweedie's Library of Medicine, Phil. edit. pp. 202, 203.

there is a large increase of organic material; and according to Stark albumen exists in the sweat in putrid and some other diseases on the approach of death.* Admitting this to be true in respect to the morbid perspiration and pulmonary excretion in typhus, the cause of the ready diffusion of the disease may be easily explained.

But in tracing the typhus poison to the matters emitted from the lungs and skin, it must not be forgotten that, though the fæces and urine of typhus patients supply nothing essential to its production, they are probably not unfrequently its source, especially when they are discharged involuntarily, and consequently pollute the bedding and clothing of the sick.

In conclusion: from these etiological, let us turn to the hygienic views of our subject.

It is a law of the human economy, which impressively illustrates the wisdom and benevolence of the Creator in respect to the social and domestic relations of men, that the effete materials which are so abundantly and continuously exhaled from their lungs and skin, in health, are never hurtful or offensive to them so long as they live in a space sufficiently ample to allow them to breath a free and pure atmosphere, and their bodies are preserved clean. It is in reference, therefore, to the transpirations of the body that ventilation and personal cleanliness are so clearly demanded by the cardinal laws of hygiene; and as these laws have their foundation in the normal physical relations of man to the external world, the violation of them by crowding individuals into spaces or situations in which the air becomes surcharged with carbonic acid and the other matters of exhalation, is no less productive of disease than is the infraction of any other natural laws on the undisturbed operations of which health depends. It is by the failure to observe these salutary principles that densely populated localities engender the evils of which we have treated.

Though the mode in which we have endeavoured to discuss this subject is more especially interesting to the practical hygienist, yet it brings into view questions relating to organic nature which challenge the notice of the chemical philosopher. We have seen that the quantity of pulmonary and cutaneous excretions from a population of 200,000 adult persons, in one month, is 20,000,000 lbs.

This amount, of course, increases proportionately as greater numbers are made the basis of the calculation; such, for example, as the population of the city of New York, Paris, or London. Now,

* Simon's Animal Chemistry, vol. ii. p. 109.

the principles which constitute the effete matters of transpiration of a city population are derived, for the most part, as they are elsewhere, excepting the water, from animal and vegetable substances, the products of rural districts. These organic substances gathered by human industry, and transported to cities on rivers, railroads, and other highways, and distributed to the inhabitants, serve the purpose of human sustenance. Having answered this end, they are evolved as effete materials from the body, and mostly returned to the country; the gaseous portion finding its way thither by virtue of its diffusive property, and the remaining volatile parts on the wings of the wind. Now, the interests of agriculture in common with those of private and public hygiene, demand that to such a return there should be no hindrance. Allowed to take their natural course, their elements enter into new arrangements, and the resulting compounds, descending to the earth with the dews and rain, and serving as the pabulum of plants, reappear in vegetable forms, fitted as nutriments for man and brute. If this order of nature, so beneficiently contrived, and so happily elucidated by Dumas, Boussingault, Liebig, and Fownes, be disturbed, or rather, if but a comparatively small part of the organic matter evolved from the lungs and skin be retained and accumulated in the stagnant air of human habitations, or become attached to garments, bedding, furniture, &c., it may be metamorphosed into an agent destructive to life; and, consequently, so much be withdrawn of the materials designed for the nutriment and growth of plants. In thus adverting to the mutual physical dependencies existing between man and the lowest orders of organic nature, we arrive at the conviction that it rests with the people or rulers of a city to decide the question, whether the matters transpired from their bodies shall be dispersed over agricultural districts, and, in their circle of mutations, be again measurably returned to them as wholesome food, or be retained in their dwellings and transformed into a principle productive of disease.

In perhaps no other mode of investigation than that pursued in the preceding inquiry are we enabled to form a just estimate of the value of personal and domestic cleanliness, and so fully to perceive the importance of making ample provisions in plotting the streets and courts of cities, and in constructing dwellings, workshops, factories, and public edifices, as prisons and almshouses, for securing the advantages of ventilation. If it be ascertained what extent of space, and what degree of perflation, or change of air in a habitation are requisite for the health of a single individual, it will not be difficult to calculate what extent of area, and what arrangements for supplying fresh air are necessary to preserve any number of persons or families in a neighbourhood or city from suffering from their own exhalations. It is said by the register general, of England, that "the space allotted to the sleeping rooms of many public institutions in towns is too small." And he remarks that, "it should in no case be less than eight feet cube (= 512 cubic feet) to each person, with proper apertures for the removal of the breath. If the air were removed twice as fast, a room of 500 cubic feet would afford the same advantages with regard to health as a room of 1000 feet; but it is a difficult matter to remove air from a room with double velocity—more difficult and expensive than to make the rooms at least on hand of sufficient extent in the first instance. The mortality in crowded rooms, if carefully investigated, would no doubt be found to be in a certain inverse ratio to the space, a death marking every degree of concentration of the expired atmosphere."

It is demonstrated, in the Parliamentary Reports on the sanitary condition of the lower classes in England, that among the causes of disease in cities, there is none more extensive and active than a deterioration of the air produced by the poor, overcrowded in ill-ventilated dwellings, and by operatives and trades-people, congregated in small and confined apartments. As in such situations, typhus and other forms of disease unquestionably originate, it follows that the means of preventing the evil is to limit the number of inmates in apartments of given dimensions; and to provide dwellings and factories with suitable apertures and sufficient space around them for free ventilation. Such sanitary measures, with attention to personal cleanliness, carried into effect by an efficient police, would put a period to the prevalence of the disorders referred to; and at the same time minister a wholesome rebuke to the mercenary spirit of proprietors and landlords. As there are legislative enactments prohibiting the overcrowding of emigrant ships, why should not legal provision be made to prevent the overcrowding of habitations in cities? For such a law there are precedents. In 1563, Queen Elizabeth commanded that in London, "one dwelling house should not be converted into more;" and, in 1580, she "published a proclamation forbidding any dwellings to be erected on new foundations within three miles of the city gates; and that only one family should inhabit each house."*

JOSEPH M. SMITH, *Chairman.*

* Brewster's Edinburgh Encyclopedia, Article, London.

[From the Medical and Physical Society's Transactions.]

To Dr. Parkes,
with the author's compliments,
— India. 1861. —

GENERAL TOPOGRAPHICAL AND MEDICAL ACCOUNT OF MOUNT ABOO.

BY

ASSISTANT SURGEON J. OGILVY, M.D.,

IN MEDICAL CHARGE ABOO SANITARIUM.

GENERAL TOPOGRAPHICAL AND MEDICAL ACCOUNT OF MOUNT ABOO.

BY ASSISTANT SURGEON J. OGILVY, M.D., 33RD FOOT,
In Medical Charge Aboo Sanitarium.

Presented September 1860.

Geographical.—Mount Aboo is a large isolated mountain, in the territory of the Rao of Serohi; 45 miles N.E. from the military cantonment of Deesa, and to the S.W. of the Aravelli range, from which it appears to be distinct. It is situated in latitude 24° 40′ West, and in longitude 72° 56′ East.

Historical.—Its fame is of great antiquity, and pilgrims appear to have been attracted to its sacred temples since A. D. 1031. No notice was taken of it in our maps of India before the year 1806. Hindoo temples are said to have existed here in remote ages, dedicated to Siva and Vishnu; but all traces of them have disappeared. On their traditional site at Dilwarra, the famous Jain temples now stand built by Bimul Sah, a rich Jain merchant, and others; and the two principal temples are dedicated, respectively, to Richabdeo and Neminath. They are built almost entirely of marble, which must have been brought up the hill with much labour and expense from a quarry in the plains, on the Eastern aspect of Aboo. They are said to have cost 19 millions sterling. The internal carving and decorations are of the most elaborate, varied, and gorgeous description. A dirty half-ruined village is built all round, and approaches close to the outer walls of the temples. Other parts of the hill, and more especially the peak of Achilghur, have their peculiar history and traditionary legends. Remains of the rocky fastnesses of the Achilghur Chief of the olden time still exist, and the story of several Mussulmani inroads is still told to the curious traveller. The latter may still see the traces of the icono-

clastic fury of the followers of Mohammed. Aboo was formerly governed by the Chiefs of Chandrávati,—an extraordinary city about 10 miles from the base of Aboo, and the ruins of which are said to extend to an almost fabulous length, to this day. From this rule, Aboo passed into the hands of the chief of Meda, and from him it finally became transferred to the Raj of Serohi.

Discovery; Ascent.—Colonel Tod, the Governor General's Agent for the Western Provinces, was the first European who made the ascent of Aboo. He reached its highest summit in 1822, with considerable difficulty, and his grandiloquent remarks on what he saw are embodied in his large book called "Travels in Western India." Between 1824 and 1832 very few Europeans visited Aboo regularly, except the Political Superintendent of Serohi; but when the Joudhpoor Legion was formed, and the invigorating effect of the Aboo climate came to be known, houses began to be built, and the hill regularly visited by Europeans in the hot months.

Invalids sent up.—About 1840, the experiment was tried of sending up invalid soldiers from Deesa, for the sake of their health, during the hot months. They were generally encamped on the banks of the Aboo Lake. In 1843, a piece of ground was apportioned by the Rao for the hutting of the men. A hospital building, convalescent room, and two barrack huts were erected, partly at the recommendation of Colonel Sutherland, in 1847, who was strongly of opinion that Aboo should be made use of as a sanitarium throughout the whole year.

Descriptive.—The base of Mount Aboo is about 13 miles long, 11 broad, and 50 in circumference. It rises abruptly from the sandy plains, and the ascent is consequently steep and winding. The slopes of the hill are, generally speaking, covered with trees and shurbs; the intervening herbage affording pasturage during most parts of the year to the adventurous village cattle. The summit of the hill is very irregular; consisting of peaks, ridges, and valleys, sloping plateaux, and extensive basins.

Height.—The highest point is called Guru Sicker, and is 5,700 feet above the level of the sea. The average height of the station is 4,000 feet.

Landscape.—The general effect of the hill landscape is romantic and pleasing; the vigorous shrubs and herbage, blending agreeably with the bold and grotesquely shaped granite rocks. Streams of water flow along the low grounds and valleys; and here and there a small lake is left after the monsoon fall,—only dry during the hot months.

Ghauts.—There are many ghaut descents on different aspects of the hill; and here and there a deep gorge gives exit to the converging streamlets.

The Aboo Lake.—Some pains have been taken to embank and keep full one reservoir of water close to the station. This lake is called the Nukhee Talao. Originally scooped out, of modest dimensions, by supernatural hands (!), it has been enlarged to its present size, by the creation of a substantial bund. It is now about 1,000 yards long, and about half as broad. Its greatest depth under 40 feet. It is always filled up by the rains, and by the end of the hot weather falls 6 or 7 feet. The recession of the water, and the effect of a strong breeze, generally leaves on the leaward shore a belt of scum and offensive *débris*, which, to those living in the immediate vicinity, is anything but pleasant or sweet smelling. A little embanking at the shallow parts, so as at no season to leave any part of the bottom exposed, would probably remedy this evil. The weeds in the lake keep the water tolerably pure; and if the *Mahseer* or Indian Salmon was introduced, the result would probably be satisfactory.

Roads.—The station and its vicinity are supplied with roads, kept in repair for the most part at the expense of the residents. The Government provides the road up the hill, and those in the neighbourhood of the men's barracks. They are usually only gravelled paths. There are many cattle-tracks, bridle-paths, and narrow rocky walks all over the hill.

Game, &c.—The chief sport on Aboo is afforded by the Sambur deer, which abounds all over the hill. Cheetas and bears are also common enough, and the villagers are every now and then alarmed by the depredations of prowling tigers. On the lakes and swamps, in the cold weather, duck and teal are to be found; and in the hot months the beautiful jungle fowl and the spur fowl abound. The note of the cuckoo is first heard in the month of May. Different kinds of snakes are always to be found. The lake contains several kinds of fish, some of which are tolerably good eating. The fresh-water crab abounds in some of the larger streams. Oxen, buffaloes, and goats are the only live stock generally kept by the villagers.

Geological.—Aboo is almost entirely composed of granite. Distinct veins of quartz are common, and trap, greenstone, and other rocks are occasionally met with. Fine specimens of rock crystal are sometimes picked up. The amygdaloidal structure may be observed in some of the rocks. The various stages of decay of the granite rocks is easily traceable. The marble of which the temples are made was brought up from the foot of the hill by an ancient and still partially existing road on the south-eastern aspect of the hill.

Villages.—There are twelve villages in Aboo, exclusive of the collections of houses which have sprung up in the vicinity of the station. Two villages are now deserted.

Aborigines.—The aborigines of the hill appear to have been a sort of Bheels. They seem at some time or other to have become mixed with marauding Rajpoots from the plains, and with the workmen who were so long engaged in building the Dilwarra temples. This mixed race call themselves Loke, and are now in possession of almost all the land under cultivation.

Population.—The Hindoo population probably exceeds 1,000, exclusive of the followers of Political Agents and Vakeels. The castes are chiefly Jains, Rajpoots, Coolies, Bheels, and Lokes. The Mussulmans met with on Aboo are followers of the Rajpootana Agency or pensioners.

Cultivation.—Cultivation is naturally limited, and is confined generally to the low strips of valley land in the vicinity of the villages and streams.

Irrigation.—Irrigation is carried on by means of the *Aret* or Egyptian wheel.

Crops.—The only crops are wheat and barley in the cold weather, and in the rains, maize and a few species of cucumbers and gourds.

Vegetables.—Potatoes and European vegetables generally thrive well on the hill.

Tea.—The tea plant some years ago was, for a time, cultivated with success, but unfortunately the Rao transferred the plants to his own garden in Serohi, where they naturally perished.

Fruit, &c.—Mangoes are plentiful, but of an inferior quality. From the branches of the mango tree is often seen hanging the *Ambatri*, an elegant flowering parasite. Plantains thrive, but the fruit does not come to perfection. The karoonda plant (the *Carissa carandas*) grows wild and is plentiful and vigorous. An excellent and wholesome jelly is made from the berries.

Different plants.—The jessamine, the oleander, the willow, and the dog rose are abundantly met with. The apricot and nectarine, the grape, the pomegranate, and citron are claimed as indigenous in Aboo. The sacred golden champa tree grows at Dilwarra and other parts of the hill to a considerable size. The delightful fragrance and umbrageous beauty of this magnificent tree are very striking. English flowers grow well in the gardens.

Soil.—The soil is porous in the higher grounds; but the black soil of the lower parts is very tenacious of moisture. It is composed chiefly of the different kinds of clay and gravel, mixed with decayed vegetable matter. In some parts of the hill two crops are raised yearly. Wild flowers are abundant, and honey is a favourite food among the villagers. There is a small trade carried on in bees' wax, the honey being drained off in small earthern pots.

Grass.—The grass is not of very good quality for fattening cattle or horses. A sort of strong high grass called *mooyah*, and used for chuppering houses, springs up in tufts most luxuriantly wherever there is dampness or moisture, and its presence is a pretty sure sign of the necessity of draining the ground on which it grows.

The Seasons.—The seasons are divided, as in the plains, into the cold, the hot, and the rains. The hot season commences about the middle of April, and terminates with the rains some time in June. The rains begin and end with slight thunderstorms, and cease about the middle of September. A short season of warm weather, with occasional showers, fills up the

interval between the wet and cold seasons. Towards the middle or the end of November, the cold weather begins, and continues until April.

Temperature.—The temperature in the hot months in the shade, seldom exceeds 90° but has been known to rise to 98°. The lowest point to which the thermometer has fallen is 28°, but in most cold seasons it rarely falls below 40°. Taking the usual extremes of 40° and 90°, the table below will show the range and the comparison with the Deesa readings. During April, May, and June, the weather is most delightful and healthy; and the temperature in the middle of the day in the shade is never what can be called oppressive. The nights are cool and well suited for refreshing sleep. Kuskus tatties are unknown, and punkahs are seldom employed. The average summer temperature is 77°; the corresponding Deesa average being 90°, as will be seen by the accompanying table:—

	Usual extreme of Summer heat in shade.	Usual extreme of Winter cold in shade.	Average daily Temperature throughout the year in shade.	Maximum Temperature in Sun's rays.	Usual range of Thermometer.
Deesa	110°	40°	74·1°	147·7°	70°
Aboo	90	40	69·9	112·9	50

The Monsoon.—Generally speaking, hill stations in the wet months are disagreeable to live in, but Aboo appears to me to be an exception to this rule. The rain-fall in the plains round about is so scanty, and the heat so close, damp, and unhealthy, that Aboo is, in the monsoon, a most valuable and desirable retreat from the trying climate below. It cannot be said to be an agreeable season for the soldiers, because their out-door exercises and amusements are interrupted; and because, as will be fully afterwards stated, their barracks are badly situated and unfitted by their temporary and leaky construction for a monsoon residence. Yet, notwithstanding these drawbacks, the men are always healthy during the rainy weather. It will easily be understood how, in this respect, the

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Aboo hill climate differs from the Deccan and Himalayan Sanitaria, to which there is much less necessity in the rains for drafting sick troops than exists in Guzerat. This remark especially applies to the Deccan, in which the monsoon season is mild, genial, and healthy. Again, the rain-fall at most other sanitaria is excessive ; while, by a reference to the following table, it will be seen that at Aboo it is extremely moderate :—

	Average annual Rain fall.
Aboo	55·0 inches.
Deesa	25·0 ,,
Bombay	75·0 ,,
Mahableshwar	254·0 ,,
Poorundhur	72·2 ,,

The average monsoon temperature at Deesa is 89°, while the mercury averages a height of only 70° at Aboo. The climate here during the monsoon is soft and pleasant ; but there are the drawbacks, of course, of fog, drizzle, and wet walking. There is almost always great humidity in the air ; and exposed furniture and other articles become rapidly covered with mould. From 55 to 60 inches of rain is the usual annual fall, although, for the last 5 years, the unusually high average of 69 inches 29 cents has been attained. The penetrating, driving, drizzle which sometimes occurs, requires a particular construction of building to resist and exclude. There are occasionally fine days throughout the wet weather, which seldom remains without interruption for more than five days at a time.

Drying-up period.—After the rains, the usual season of autumnal heat succeeds, and the drying-up of the wet ground begins. The high ground and hilly tracts are soon drained of their moisture; but the valleys, and low grounds, receiving the drainage of the higher ground on all sides, remain moist up to about the end of the year. They are also covered up to a late period of the year with constant morning mists. The soldiers live in such a valley, and suffer at this season in consequence from malarious diseases.

Cold Season.—The cold weather after December is very healthy and bracing; the temperature averaging about 60°. Hoar-frost often covers the grass in the morning before sunrise; and some years ago ice used to be made and stored. From the 1st of January downwards, this season appears to be healthier than any other.

Selection of Station.—In the selection of an European station at Aboo, the present site was naturally fixed on, on account of its romantic position on the banks of the lake; the adaptability of the undulating ground to the purposes of building, and for gardens; and its convenient nearness to the Deesa road and to the chief objects of interest on the hill. It would certainly be fixed on as one of *two* positions to be found on Aboo, which appear to be well adapted for the purposes of a station.

Site of Ooria.—The other tract of ground appears to be in many respects still more advantageous than the presently occupied site. It is a large piece of table-land called *Ooria*, and it is situated on the Western aspect, and at the foot of the high peak of Gurusicker. It is nearly five miles distant in an Easterly direction from the station; and 500 feet higher than the latter. It would probably afford scope for the hutting and exercising of two or three thousand men. The ascent to it, at present, is steep and difficult, but it would not be a very laborious task to make a good road. The ancient road from the marble quarry at the bottom of the hill might be repaired and made use of as an immediate method of access from the plains to Ooria. Undulating bungalow and garden ground is plentiful at this part of the hill. On its south side, a certain amount of drainage would be necessary. In a few years, when it comes to be seen, more than it seems to be at present, that hill stations of a particular altitude and favourable climatic qualities are the natural and providential residences, when practicable, of Europeans in this country (with a few exceptions), and more especially for the young and weakly, I can imagine that motives, both of humanity and financial economy, may induce the Government to form an extensive Depôt or Depôt Brigade of Troops, and especially of young and recently arrived soldiers at Aboo, for the supply of surrounding stations. In that case, the plateau or table-land of

Ooria might be employed with advantage, and the position more minutely studied. With a line of railway to Deesa, Ahmedabad, Nusseerabad, and Neemuch, it would be possible and desirable to concentrate the European troops at Aboo, leaving the smallest possible number of European soldiers at these stations. To adduce no higher considerations, the expense of the invaliding and discharge of broken-down soldiers from Guzerat and Rajpootana, now so great, would, I conceive, be most materially lessened by such an arrangement.

Road from Deesa.—The present road from Deesa to Aboo is little more than a cart tract over the sand, dusty and heavy in dry weather, and intersected by numerous streams and difficult of passage in the rains. Travelling by stages, of which there are four intermediate ones on the road, it is a dreary journey, but in dry weather, with good means of conveyance, it may be hurried over in a single night. A railway at the Indian rate of speed, would draft invalids from Deesa to Aboo in 2½ hours. About two miles from the foot of the hill, is the little village of Anadra, where troops and visitors usually halt to procure cooly carriage and chairs for the ascent. The road, from the foot of the hill upwards, is a steep zigzag path, on which two men can walk abreast. The Engineer of Aboo states that there are no engineering difficulties in the way of making a good carriage road up the hill. The top of the hill is reached at what is called the *Aboo Gates*, which are merely two prominent perpendicular rocks, between which the road passes. Proceeding along this road 200 or 300 yards further, the first glimpse of the Aboo Lake is afforded, and shortly afterwards, the road winds through the station.

The Station.—The station of Mount Aboo is situated in a sort of basin formed by the Northern and Western ridges of the hill on two sides, and by the smaller peaks and detached ridges on the South and East. The station is about 4,000 feet above the sea, and the ridges round about rise to a height of from 400 to 1,000 feet higher. The basin may be said to be about 3½ miles long, and 2 miles broad, irregular in outline, and communicating by several gorges and ghaut paths with the plains below.

Bungalows.—There are about 20 bungalows in the station belonging to residents, or rented by visitors. They are generally built on rising ground, and there is perhaps a difference of 150 feet in the height of the highest and lowest bungalow. The depressions and valleys are usually avoided for building purposes, as they are damp and unwholesome to live in, but they have hitherto been thought good enough for the soldiers' barracks.

The Church, &c.—A small, airy, strongly-built iron-roofed Church stands near the centre of the station, and a few yards from it the extensive buildings of the Aboo Lawrence School are placed. The Deesa Chaplain makes a visit about once a month when the roads are practicable.

Bazars.—There is a large bazar near the Church on low ground, which presents few features of interest; and there is a smaller one attached to the Sanitarium and within the military limits. The means and supervision for insuring cleanliness in both the bazars appear, from the results, to be inadequate. Almost all supplies come from below on the heads of coolies, and on the backs of donkeys, and are retailed in the bazars at considerably advanced prices.

Cemetery.—There is a prettily situated cemetery within a mile of the Church, in a westerly direction.

Number of Europeans.—There are generally from 200 to 300 Europeans on the hill, including the Lawrence School children and soldiers.

Objects of Interest.—The chief objects of interest or excursion in Aboo, are the Cannibal's cave; the Dilwarra temples; the Achilghur hill, lake, and temple; the shrine of Achileshwar; the plateau of Ooria; the high pinnacle of Guru Sicker; the ancient road from the marble quarries; the Gaimuck descent, well, and temple; with the various surrounding peaks and hill-tops.

Political, &c.—The hill of Aboo, is owned by the Rao of Serohi, who, at first with some difficulty, was induced to approve of the sacred ground of Aboo being used as a station for European residents and soldiers. The strictness of the Rajpootana treaties has hitherto prevented the slaughter of oxen at Aboo, there being no military cantonment there, properly so called. Since the time of Sir Henry Lawrence, Aboo has been the head quarters of the Governor General's Agent for Rajpootana; who, with his staff and numerous followers, remain at Aboo during the hot months and part of the rains. The Political Superintendent of Serohi is the Magistrate of Aboo, and remains for most part of the year on the hill. A few of the foot soldiers of the Erinpoorah Irregular Force remain on the hill as a guard for the prisoners, who are made useful on the roads and in the gardens.

Schools, Aboo Lawrence School.—There is no native school at Aboo. There is a very flourishing establishment for the education of the children of European soldiers, and others; founded and endowed by the late Sir Henry Lawrence. It is called the Aboo Lawrence School. It has already proved an incalculable blessing to many children, who would otherwise have been exposed to the deadly influence of a residence in the plains and the baneful example of a barrack-life. It is now chiefly supported by voluntary subscription, with a small monthly allowance from Government. The number of children varies from 40 to 70. Their happy and healthy appearance is the subject of remark of all visitors. The boys are provided with situations in the Civil, Staff, and subordinate Medical Departments; and the girls are trained to be useful wives and members of society. In the difficult problem of the colonization and civilization of India, it is surely impossible to overrate the importance of an institution like this. The constant influx into the middle ranks of the European society in India, of well brought up and educated youths whose expectations and hopes do not reach beyond the limits of the country, is an element of strength, which it would be well to develope and employ.

Hill Stations.—It appears in this age of advanced sanitary ideas, that hill stations are beginning to occupy a larger share of attention than formerly. Till within the last 3 or 4 years, India has been in a certain sense little known in England. Especially has very little information been collected and made public on the subject of European soldiers in the East, nor has much interest been taken apparently in such questions of vital interest as their diet, dress, barrack and hospital accommodation, their exercises and

amusements. Statistics, the accuracy of which cannot be questioned, show that every 13½ years the European Army in India disappears entirely from the country; and also, no less surely, that more than two-thirds of this mortality arise from preventible disease; nay, almost altogether from the effects direct or indirect of malarious poisoning. Such an enormous mortality appears to call for an explanation with a view to arriving at rational modes of prevention. Sir R. Martin, has brought forward several excellent suggestions on this subject, and among others has directed particular attention to the hill climates of India, which he says remove the European above the range of the malarious fevers of India; he is more particularly of opinion that the solitary hills have advantages over the more extensive mountain-ranges, peculiar to themselves. In adapting the benefits of hill sanitaria to invalids, it appears certain that considerable judgment is necessary. For men not suffering from organic disease, they seem, under proper sanitary conditions, to be extremely suitable and advantageous. It is quite clear that, to a certain extent, and in particular places, sources of malaria exist on the hills as well as in the plains; and if men arrive at a hill station possessing the malarious taint, and consequent proclivity to periodic fevers and organic congestions, these latter forms of disease will assuredly be stirred into activity by a fresh exposure to even a small amount of malaria at the hill sanitaria to which they are sent. It is therefore of infinite importance that thorough sanitary measures should be adopted at hill stations as well as in the plains, that their benefits may not be neutralized. If such a thing as acclimatization exists, it will certainly be found to be secured by a year or two's residence on a hill climate, very soon after arrival in India. As far as our limited experience as yet extends, it seems undesirable to remove *en masse* a service-worn European Regiment, which has been several years in India, to the hills. Visceral congestions are likely to occur in a proportion of the men. It is in the freshly arrived drafts and regiments, with special reference to young recruits, that benefit is to be looked for. The hill stations, without doubt, are admirably adapted for the acclimatization of newly arrived Europeans, especially for young soldiers under the age of 22; for the complete restoration of convalescents from many forms of disease; and in a striking degree for the rearing of European children. Financially speaking, there would certainly result a great money gain to the Government in the diminution of invaliding, transport, and recruiting expenses.

The Climate, &c.—Aboo occupies a favourable position among Indian hill sanitaria. It is central among the sultry and unhealthy stations of Guzerat and Rajpootana; its climate is agreeable and salubrious; there are no hot winds; there are no violent storms; there have never been accidents from lightning; the rain-fall is moderate, for it does not equal that of the island of Bombay; the place is not blocked up with snow, as in some other sanitaria in the cold weather; there are facilities for making good roads up and on the hill; the soil is, except in the very low grounds, porous and easily drained; the water is pretty good when filtered, and abundant; English fruits and vegetables grow vigorously, and there are facilities for boating, shooting, cricketing, and other amusements seldom combined in one station. The Aboo climate appears well adapted to the European constitution. Children especially thrive most vigorously, and have an English colour and firmness of muscle. Recruits and young soldiers sent up drooping and weakly from the debilitating effects of the Deesa heat, soon put on flesh and colour. The effect of the heat on young soldiers especially, is well-marked on the Guzerat plains. Deesa statistics of health appear favourable on paper, but the men, though not actually suffering from disease, after some time, become pale and dried-up looking, fall out often on parade, and become faint from exertion of any kind; and, moreover, become predisposed to the effects of exposure, sun-stroke, drink, and epidemics. If the troops, instead of at once settling down under these enervating conditions, were collected at Aboo, and kept there for a year or two after their arrival, they might be paraded and drilled morning and night, without fear of overworking or distressing them. As comparatively strong and drilled soldiers, they could then be sent to do duty at those stations in the plains, where it was considered an absolute necessity for European soldiers to be. The constitution of the soldiers would thus be preserved from the malarious taint, which a large number of them acquire during their first two or three years residence, and which afterwards very slight causes are sufficient to stir into activity.

Aboo for Invalids.—As a Sanitarium for Invalids, the Aboo climate during most part of the year is well adapted for a selection of cases. The most beneficial season for a change to Aboo is the hot weather. The monsoon weather at Aboo being cool and mild, is also adapted to many cases that droop and sink in the hot monsoon of the plains. The winter months from December to March are very healthy to most men, but should be avoided by those suffering from any organic visceral disease, lung affections, syphilitic or rheumatic weakness.

Sanitary defects, &c.—In the present sanitary state of Aboo, no men should be sent up from the plains in October, November, or December. With a disregard of the first principles of health, the barracks have been built in a low valley with all the elements of malarious generation rife at hand. Until the drying-up process begins towards the middle of October the paludal poison does not appear to be called into activity, and the miasm appears to have cleared away by the time of the new year.

Cases that do not benefit.—The following forms of disease, with occasional exceptions, do not appear to receive benefit from a change to Aboo:—

1st. Idiopathic rheumatism; acute and chronic. Patients suffering from this complaint, may receive a slight benefit in April, May, and June; but during the other months they ought not to be sent up the hill.

2nd. The same remarks apply in a still stronger degree to the different forms of secondary syphilis.

3rd. Hepatic complaints. Patients quite convalescent from this disease will probably gain strength by a fortnight or a month's change during the very warm months; but by no means should patients actually suffering from hepatic disease be sent to Aboo during any part of the year, or kept on the hill after it has broken out.

4th. Heart diseases.

5th. Pulmonary complaints.

Patients under the 4th and 5th classes receive benefit only in their general health at certain stages of their malady. The rarity of the air appears to give the lungs more work to do in a given time; and most assuredly phthisical cases in the later stages are hurried on to their end.

Cases that are benefitted.—On the other hand, benefit is to be derived from the change, in the following diseases:—

1st. Intermittent fever. Here the effect is striking. The paroxysms abate in frequency and strength, and the debilitated patient almost invariably puts on flesh and colour. But so long as the sanitary conditions of an Aboo residence are disregarded as at present, I would strongly advise that, during the months of October, November, and December, no fever cases should be sent to Aboo. Indeed as many men as possible should, during this season, be sent back to the plains.

2nd. Dyspepsia (idiopathic) receives much benefit.

3rd. Chronic and obstinate ophthalmia the same.

4th. Ulcers and discharges will receive marked benefit.

5th. Diarrhœa. Patients will almost always be cured by the change. There is no such thing as *hill diarrhœa*, as met with in some of the Sub-Himalayan hill stations.

6th. Dysentery. Patients so affected will receive a moderate amount of benefit, especially during the hot months and in the monsoon, and after slow and lingering convalescence.

Exercise.—There is at Aboo a tendency to biliousness and headache amongst a good many of the residents and soldiers, and the habit of constant brisk daily exercise is very necessary to keep the skin and liver in good working order.

Epidemics.—Now and then an epidemic of small-pox passes over the hill, but no case of cholera has been ever known, except in individuals lately arrived from the plains where it has been raging. The natives of Aboo are not a very strong or muscular race, and suffer a good deal in the wet and cold seasons from periodic fever, rheumatism, and other diseases. There are not very many old people to be seen. It is difficult to introduce vaccination amongst them, and the late small-pox epidemic was very severe on the village children. The anæsthetic leprosy is not unfrequent

amongst them, and affections of the eyes, perhaps a good deal from dirt and inattention, are common enough.

The Barracks, &c.—There are two barrack-huts at Aboo, intended to accommodate 60 men each, but certainly not fitted for more than 40 men each; and there is a patcherry, temporarily occupied as a hospital, and fitted to contain about 40 patients. The two first-named barrack-huts are built in a valley near the west end of the lake. This valley is about one-third of a mile long and runs in a direction from W. to E. nearly. It is the channel by which, in the monsoon, a large quantity of the rain that falls on the surrounding hills finds its way to the lake. It is flanked on both sides by hills, some of which rise to a height of 150 feet. The lake is 350 yards distant from the barracks, and at the point where the valley meets the lake, the banks are shallow and marshy. The aspects of the two barrack buildings are respectively S. S. E. and N. The original intention, which was that the soldiers might be well out of sight, and out of the way of visitors and residents when the latter went out to walk or ride, appears to have been well fulfilled. There is not much breeze over the barracks, except what comes up—sometimes not very savoury—from the direction of the lake. The barracks are, what is called by some wise old authorities, nicely sheltered and defended against the bleak and cutting winds of this cold region. I believe, generally speaking, that this sheltering from bleak winds, is just another name for deficient external ventilation, which is of much more consequence to secure than any imaginary immunity from draughts. The soil of the valley is soft and marshy, and requires a good deal of drainage to keep it tolerably dry. In digging and deepening the drain-trenches in the comparatively dry weather, I have particularly remarked the soil thrown up to be wet and heavy. It would make a very good place to grow vegetables. In the cool months, the valley air feels cold and raw, while the feeling on the higher ground round about, which is warmed and ventilated by the early rays of the sun, is fresh and exhilarating. This site has been occupied by soldiers since 1843; and so lately as 1858, two new barrack buildings were actually built in the same place to replace two old condemned ones. There have been committees without number; and though every one and Government also appear to be agreed on the necessity of a removal to a new site, there seems little prospect of an early change. I should be afraid to speculate on the amount of benefit to European invalid soldiers which has been thrown away or rendered nugatory by about the worst position in Aboo being occupied as their residence. About the same distance from the church as the present barrack site, the moderately-sized plateau of Gundermuck offers almost every advantage as a site, except extensive exercising ground, and that is to be had in but very few places on the hill. There is an immediate fall from it on all sides, which secures dryness and successful carrying off of drainage water. There is facility for well-sinking all about the place. There is no hill or intervening object to shut out the breeze. At one end there is an excellent airy position for a hospital, and lower sloping ground to leeward for cook-houses, latrines, bazars, and followers. Like every other position chosen for a site, it would require a certain amount of drainage. This site was recommended some years back, and has been approved of by Government.

The two barrack huts before alluded to are situated in the centre or broadest part of the above-described valley, are 183 yards apart, and both have aspects nearly N. and S. They are long-tiled huts of wattle and dab, with a broad verandah on each side. The barrack-room runs the whole length of the building without interval or partition. The ends of the verandahs are walled up into little rooms, used as non-commissioned officers' and married people's quarters, canteen, and store-room. The barrack is 18 feet high in the centre ridge, 103 feet long, and 21½ feet broad. The verandah gives an additional breadth of 11½ feet on each side. There are 14 windows and 4 doors. There are three ventilators of clumsy impracticable construction on the roof of one barrack, and none at all on the other. The barracks are built on a somewhat raised foundation. Each barrack contains 33,790 cubic feet of space, and I think should not accommodate more than 34 men. They are built by the engineer to hold 60 men. If the engineer's allotment was carried out, each

occupant would have only 563 cubic feet of air. Under the same arrangement each man would have a surface space of only 36½ square feet. Certainly, considering the porous construction of the walls and roof, and the number of windows and doors that can be opened, amounting to one-tenth of the whole wall superficies, it must be admitted that the apparent allowance of cubic space shows more unfavourably than is actually the case, the breathing space allotted to each man. The floors are of beaten earth, cowdunged four times a month. What with this damp and dirty floor, and the porous wattle and dab walls, it may be conceived how difficult it is for the men to keep their clothes and bedding dry in the monsoon. Within two or three yards from each barrack is a chuppered grass bath-room, where a cask of fresh water is always kept for drinking and washing purposes, and a tub lies filled for bathers. At the other end of this chupper house is a chunam ledge used as a urinal. There are good necessaries and cook-rooms all pucka built, and one of each to each barrack. A work-shop has also lately been built, but is too small to be of much use. There is a guard-room, cell, and soldiers' library,—all of the most dwarfed construction. Under two temporary sheds the Commissariat casks, provisions, and office are sheltered. They are much too close to one of the barrack huts. There is no regular hospital at present, the old one having been pronounced unsafe in July 1859. A patchery, which had just been finished for married soldiers' quarters, was then taken into use as a hospital, and has so remained up to this time. It is 425 yards distant from the barracks, and 70 or 80 feet higher than the latter. Considerable inconvenience has been occasioned by this temporary occupation of an unsuitable building. There was originally no necessary, no quarters for the apothecary, hospital serjeant, surgery, medicines, stores, or anything else. The patchery is a long tiled building something like the barracks. It is surrounded with a verandah 8 feet wide. The building itself is 150 feet long, 20 feet high at the centre ridge, and 39½ feet wide, including the verandahs, aspect N. and S. It was found necessary to partition off at each end small rooms for the use of the medical subordinate, surgery, medical stores, hospital serjeant, hospital guard, and dead-room.

The hospital-room proper was thus curtailed to a length of 98 feet. This gives a cubic space of 34,545 cubic feet, or ample room for 30 patients, who would each have over 1,100 feet of breathing space. Each would also at this rate enjoy a territory of 76½ square feet. The verandah roof does not run down flush with the roof of the building, but comes off about 2 feet below the eaves of the latter. This intervening space of the side wall is devoted to ventilation. Instead of being walled up, it is filled in with bamboo lattice-work. In wet weather this is an objectionable mode of ventilation, as the rain drives freely through the interstices. So it has been closed up at that time of the year when there is, perhaps, more necessity for roof ventilation than in the fine weather, when the doors and windows are always open. There are five small bath-rooms outside the building under one roof, and a good cook-house. There is a temporary necessary made of grass tatties, 10 yards to leeward of the hospital, and approached by a covered way. There is a well 300 yards from the barracks, of pretty good water, which, however, at some seasons becomes thick and muddy, and requires to be passed through a chatty-filter arrangement before it is palatable. There is also a well near the hospital.

Aboo water.—The water at Aboo is, I believe, chiefly supplied to the different wells by percolation from the lake, except in the wet weather, when the drainage of surrounding high ground finds its way into these reservoirs. Some of the wells are much better than others, but in none of them is the water of *very* excellent quality, although by filtration it can be made tolerably good and pure. I believe its usual contamination to be vegetable matters. Natives who come up from the plains complain of it as the "heavy hill water." I think it has something to do with the bad health which the majority of them more or less experience shortly after their arrival from below.

Garrison.—Aboo, up to the time of the mutiny, in 1857, was used for sick and convalescents only, but since that time, in addition to these, a detachment of 80 men has been stationed there. The invalids, when discharged from the convalescent list, have always taken their share of the regular duties. It is much to be regretted that the sick of the detachment have always been treated in the Sanitarium hospital, and included without distinction in the same returns as the arrivals for change of air. This has been lately obviated by a very proper order from the chief medical authority of the division. The number of invalids generally present at Aboo for change of air, varies from 30 to 100, and is chiefly composed of men sent from Deesa and Nusseerabad. It seems desirable that the Neemuch and Ahmedabad troops should also enjoy the advantage of a change to Aboo; but from the distance, or some other cause, none have as yet arrived.

Aboo Staff.—The Aboo Sanitarium is commanded by a Captain, who usually belongs to the European Regiment at Deesa, and who holds his appointment for two years, except in the event of his Regiment being removed from the Bombay Presidency. The medical charge of the Sanitarium is held by an Assistant Surgeon of the Home Army, on the same conditions as the Commandant.* The Non-Commissioned staff comprehends a Serjeant Major, a Hospital Serjeant, a Canteen Serjeant, and Writer. Invalids not belonging to the same regiment as the garrisoning company, are, when unaccompanied by an officer, paid and looked after by the commandant.

Duty.—The duties are light. There are three guards—barrack, hospital, and ammunition; putting twelve privates and four non-commissioned officers on guard daily. The men have thus from five to eight nights in bed generally speaking. During the monsoon, the hospital guard is sometimes discontinued.

Diet.—The diet of the men, such as it is, is generally good:—the daily ration to each man is 1 lb. of fresh mutton. The strict treaties on the subject of killing oxen and cows do not admit of a change in the meat ration; but I am informed by the Governor General's Agent for Rajpootana, that he is about to make an attempt to prevail upon the native authorities to allow oxen to be slaughtered on the hill. This would be a great boon, not only as a change of diet, but for Hospital purposes. The mutton ration is generally good, and this also, as well as the other rations, is inspected daily by an officer. Now and then a

* These arrangements are not now in force.—*Ed.* 1861.

ration of salt beef or pork is substituted for the mutton. The men have their meat cooked according to their own liking. Each man has 1 lb. of good bread, 4 ozs. rice, and 1 lb. of vegetables, of which $\frac{1}{3}$ is generally onions, and the other $\frac{2}{3}$ potatoes, sweet potatoes, or pumpkins, as the season of the year permits. Salt, tea, and sugar, are provided in usual and sufficient quantity.

Liquor.—Above one half the men drink their daily quart of porter, and one third of the men have been arrack drinkers. Many of the men who drink the arrack, I feel sure would confine themselves to the malt liquor, had they not acquired the habit of spirit drinking on the different lines of march; where a half compulsory system of arrack issue is adopted. Afterwards when in quarters, they do not care to struggle against the habit. They have not much difficulty at Aboo in procuring also the poisonous native liquor; but I am certain that not nearly so much drinking takes place among the men at Aboo, as if they were in the plains with their Head Quarters.

Number treated.—During the year ending 31st March 1860, 159 weakly men have been sent up to Aboo for change of air. Of these, 5 have died; 12 have received little or no benefit, and have been sent back to their regiments to be invalided or otherwise disposed off; and 53, having quite recovered, have rejoined their respective head quarters. During the year there have been in addition present at Aboo 80 duty men, and the sick of both classes have been treated indiscriminately in one hospital. This, as before remarked, is to be regretted, as the returns do not consequently show with accuracy the effects of the climate on the weakly. 284 cases of disease, exclusive of officers, have been treated in hospital during the twelve months; of which number, 7 have died, 12 have been transferred not benefitted, 265 have been cured, and 8 remain in hospital under treatment.

Out of this total of 284 cases treated, no fewer than 236 come under the head of zymotic disease. Of the 7 deaths, 3 were from zymotic complaints. Need I add that the diseases of the zymotic class were almost all of the miasmatic order, and the vast majority of them of periodic fever and its sequelæ. Mortality per-centages and other particulars will be best considered in the tabular form which is annexed.

That invalids and convalescents from disease may reap the full benefit of the change to Aboo, it is necessary that the following particulars should be attended to:—

1st.—The selection of the invalids or the weakly men to be sent up should be carefully made by the medical officers of their corps; and no man suffering from advanced lung affection or asthma, liver or heart disease, chronic or syphilitic rheumatism, or the syphilitic cachexy, should be sent up, except under very particular circumstances, in the hot months.

2nd.—No soldier, sick or well, as long as the barracks are situated where they are, should be sent up to Aboo during October, November, or December; but every opportunity should be taken of returning the men to the plains for this period.

3rd.—As a general rule, there should be frequent relays and exchanges of weakly and recovered men. The advantage of the change to Aboo is seldom increased after a residence of six months on the hill, and a stay of two or three months will generally suffice to restore the strength. It cannot, however, be too much kept in mind, that, in the present condition of the barrack accommodation, the full benefit of the Aboo climate cannot be derived by our weakly soldiers. I venture to conclude this report with a few suggestions, which naturally occur to my mind in looking back at the sanitary defects which, during my experience on the hill, I have had ample opportunity to deplore; but I shall only remark on a few points. Gundermuck having been selected as the site for the new buildings, it is unnecessary to say much with respect to eligibility of position. That site is in my opinion an advantageous one. The whole surface of Gundermuck should be thoroughly intersected with drains, at once to carry off the rainfall, and to ensure complete dryness soon after the monsoon. Each barrack building should be raised at least 4 feet above the highest point of the ground it covers, and be built on a dry solid foundation of concrete. The floors should be laid with slabs, or glazed diamond shaped tiles. Each building should be one storied, and be made to contain not more than 40 men. Each man should be allowed a surface area of 100 square feet, and at least 1,000 cubic feet of space. The barrack room should be not less than 18 feet high, and not more than 30 feet broad. The side walls should be pierced with doors and windows in abundance, to admit light and air. Each window should reach to within a foot of the ceiling. A window to every two beds would be a proper allowance. The system of over-lapping roof ventilation should be adopted. A high and spacious verandah should surround the whole barrack room, and be fitted with both glass and Venetian windows. There should be two open brick fire-places in each barrack, if possible, in the middle of the room, and not in the walls, for warmth, dryness, and complete ventilation: these fire-places are essential at Aboo. There should be a capacious, well-aired, and properly heated reading-room, in which the men could, with comfort, read, write, or otherwise rationally amuse and improve themselves. Such a room is generally provided for the men at large stations; and here, from the nature of the climate, it is particularly wanted for the convalescent soldiers. There should be provided, in the close vicinity of the barracks, a drying-room, fitted with fire-places or stoves, and have bamboo rails or ropes fixed all round to hang the men's clothes and bedding on in the monsoon. I recommend that there should be accommodation of the above description for 200 weakly men, and that the advantages of the climate should be extended to the troops at other stations besides Deesa and Nusseerabad. There should be, within easy walk of the barracks, soldiers' gardens, where the men might work when so inclined, and from which a constant and ample supply of vegetables might be procured. Soldier-gardeners, however, are seldom sufficiently steady and persevering to ensure successful crops, and it would be necessary to entertain a proportion of mallies and bheesties to carry on the work. After a time, the gardens might be made to pay their own expenses; but at first, considering the amount of amusement, as well as the supply of vegetables the soldiers would derive from the gardens, a small expenditure of Canteen-fund money, in payment of the native workmen, would, I think, be justifiable. There should be a substantial brick-built oven in the corner of each cook-house. This would enable the men to have an excellent change in the way of cooking their mutton ration. Very indif-

ferent roasting and baking is done with the make-shift cook-room furniture at present in use. There should be a large and very commodious chunamed bath-house to every 40 men. Chunam baths or tubs should be supplied in ample quantity. Perhaps a large tub to every 10 men would prove to be a sufficient allowance. The removal of sewerage water and other matters, would have to be considered with reference to the position of the ground and buildings, and conducted on sanitary principles. I would suggest that a monthly return for invalids and weakly men, sent up for change to Aboo, should be made out in a different manner from the present one, or be supplementary to it. In this return, the time of arrival, the cause for which sent up, the condition on arrival, the progress of the convalescence, any new attack of disease, any noticeable effect good or bad on the man's health during the month, perhaps his improvement in weight, opinion as to sending back each particular case after a stated period, and an analysis for the month, with averages, &c. might all be succinctly included, and prove a most valuable guide for the future, as well as a record of the past.

Meteorological and Medico-Statistical Table, Mount Aboo Sanitarium, 1st April 1859 to 31st March 1860.

Season	Month	Temperature. Maximum.	Temperature. Mean.	Temperature. Minimum.	Rain fall. Inches. (In. cts.)	Rain fall. No. of Rainy Days.	Average daily strength of Men.	Admissions.	Discharges.	Deaths.	Average No. of Cases completely treated in each Month.	Average daily Sick in Hospital.	Average duration of each case days	Admissions to Strength per cent. per annum.	Mortality Ratios. Per cent. per annum. Deaths to Strength.	Mortality Ratios. Per cent. per annum. Deaths to Average daily Sick.	Mortality Ratios. Per cent. Deaths to Cases treated.	Zymotic Diseases. Per cent. Zymotic Adms. to total Adms.	Zymotic Diseases. Per cent. Zymotic Deaths to total Deaths.
	1859.																		
Hot Season.	April	91°	76°	62°	0 11	1	162	14	10	..	18	14	23	103	..	..	..	92·1	..
	May	90	77	65	0 20	1	175	22	20	1	29	16	17	150	6·8	71·8	2·6	77·7	..
	June......	92	80	68	8 31	9	171	20	18	.	27	19	20	147	..	..	..	90·0	..
Wet Season.	July	87	77	67	24 6	10	160	11	15	..	22	15	20	82	..	..	..	90·9	..
	August	77	71	65	16 14	9	161	7	9	..	15	13	26	52	..	..	..	71·4	..
	September.	76	70	65	6 36	11	157	30	17	..	30	15	15	229	..	..	..	96·7	..
Drying up Season.	October ..	76	69	63	..	..	157	36	48	1	55	23	12	271	7·6	52·1	1·6	88·8	..
	November.	74	64	54	..	..	152	56	52	1	61	18	8	442	7·8	66·6	1 4	100·0	..
	December .	66	53	41	..	..	148	32	32	1	40	15	11	259	8·1	77·4	2·1	84·4	..
	1860.																		
Cold Season.	January ..	67	49	31	0 55	1	140	19	23	2	29	13	13	162	17·1	184·6	5·9	52·6	..
	February ..	74	58	42	0 14	1	172	14	10	1	17	8	13	97	6·9	150·0	4·3	57·8	..
	March ..	86	72	58	..	..	171	13	17	..	21	11	16	91	..	..	..	61·5	..

Quarterly Meeting, October 16th, 1860.

Dr. R. Angus Smith, Vice-President, in the Chair.

The Chairman gave a short account of his examination of coal pyrites for arsenic. He stated that although the knowledge of the existence of arsenic in the iron pyrites found in coal may not be considered perfectly novel, it certainly does not seem to be known that arsenic is so widely disseminated as to form an ordinary constituent of the coals burnt in our towns, and chemists of celebrity have held it—and now hold it—to be absent there. He had examined fifteen specimens of coals in Lancashire, and found arsenic in thirteen. He had also found it in a few others; but Mr. Binney having promised a collection, properly arranged, the examination will then be made more complete. Mr. Dugald Campbell had also lately found arsenic in coal pyrites. The Chairman added, that this had a very direct bearing on our sanitary knowledge, as we must now be obliged to add arsenic to the number of impurities in the atmosphere of our large towns. It is true that he had not actually obtained it from the atmosphere, but when the pyrites is burnt the arsenic burns and is carried off along with the sulphur. One or two coal brasses (as they are called) contained copper, a metal that is also to some extent volatilized, as may be readily observed wherever copper soldering takes place. Although an extremely small amount of copper is carried up from furnaces, it is not well entirely to ignore it. The amount of arsenic, however, is probably not without considerable influence, and we may probably learn the reason why some towns seem less affected than others by the burning of coals, by examining the amount of arsenic burnt as well as sulphur.

Mr. Spence said that he could confirm the remarks concerning the existence of arsenic in coals, as he had burnt coal pyrites for many years, and had always found a very decided amount of arsenic in the sulphuric acid made from it.

Mr. Ransome called attention to the peculiar symptoms described by Berzelius, as produced by selenium; and he considered that some similar symptoms were produced in a manner which might be explained if selenium were found in coals.

A Paper was read by William Roberts, M.D., entitled, "On the Estimation of Sugar in Diabetic Urine by the Loss of Density after Fermentation." When a diabetic urine is fermented with yeast, its specific gravity previously ranging from 1030 to 1050 falls to 1009 or 1002, or even below 1000. This result is mostly due to the destruction of the sugar it contained, but partly also to the generation of alcohol and its presence in the fermented product.

As the diminution of density must be proportional to the quantity of sugar broken up by the ferment, the amount of loss evidently supplies a means of calculating how much sugar any urine contains—always provided that the remaining ingredients of the urine continue unchanged, or become changed in some uniform ratio.

To ascertain the relation between the density lost on fermentation, and the sugar destroyed, experiments were made on the urine of diabetic patients on the following plan:—

1. The amount of sugar per 100 parts was ascertained by the volumetrical method, with Fehling's test solution.
2. The density of the urine was taken.
3. Three or four ounces were then placed in a 12oz. phial, with a drachm or two of German yeast, and having lightly covered the bottle it was set aside to ferment.
4. In about twenty-four hours the fermentation was finished and the froth dissipated. The density was then taken a second time, and the loss calculated.

Operating in this way on a specimen of diabetic urine sp. gr. 1038·60, the following results were obtained:—

Sugar, per 100 parts, by the volumetrical method, 7·69.

Density before fermentation at 60° or $D = 1038{\cdot}60$.
Density after fermentation at 60° or $D' = 1005{\cdot}92$.
Density lost, or $D - D' = 32{\cdot}68$.

The relation, therefore, between the density lost and the percentage of sugar, in this instance, was as 32·68 to 7·69, or as 1 to 0·235. By numerous trials with diabetic urines, of different strength, it was found that the most correct proportion was as 1 to 0·230. The corresponding formula, therefore, was:—

Sugar, per 100 parts, or $S = (D - D') \times 0{\cdot}23$.

The accuracy of this method was further tested by operating on diabetic urine diluted with known volumes of water or non-saccharine urine, and on solutions of loaf sugar in water and in healthy urine.

This method of estimating sugar is especially applicable to medical practice, and the following simple and most convenient rule expresses the result of the analysis:—

Each degree of 'density lost' indicates one grain of sugar per fluid ounce of urine.

PHYSICAL AND MATHEMATICAL SECTION.

October 11th, 1860.

Some conversation took place respecting recent storms, and the bearing of the new weather tables, given in the *Times*, on their theory, as Mr. Baxendell remarked that according to these observations the wind did not blow from the areas of greater pressure.

Mr. BAXENDELL called attention to certain phenomena of solar spots recently observed by him, and stated that in cases in which projections of the penumbra into the nucleus occurred, the penumbra is generally increased in breadth in that part of its circumference, and it often happens that striations observed in the penumbra are curved, and terminate in the points of projection into the nucleus.

A Paper was read by THOMAS CARRICK, "On the Atomic Constitution of Water and Ice."

After briefly alluding to the nature of his own views on the ultimate atomic constitution of terrestrial matter, and its relations to cosmical force, the Author—guided by considerations derived therefrom—proceeded to discuss the question of the relative specific gravities of water and ice, and arrived at a specific gravity for ice differing by only 1/[illegible]th part, from the most recent and correct results of experiments.

The prominent characteristics of water and ice were also shown to be the natural result of the disposition and relations of the ultimate atoms.

MICROSCOPICAL SECTION.

September 17th, 1860.

A specimen of envelopes was exhibited by the SECRETARY, such as were proposed to be sent to captains of vessels, in which to preserve soundings they obtain in different parts of the world, for this Section. The envelopes were much approved of, and were thought likely to be productive of future interest to the Section, and to microscopists in general.

Mr. LATHAM referred to Mr. Hepworth's method of mounting insects in Canada balsam, and described his own experience of the same. Mr. Latham spoke in very favourable terms of the facility with which slides can be washed off and finished. He found that the balsam should be as thick as possible, almost even to dryness; then dissolved in chloroform, to a consistence only thin enough to flow easily under the thin glass; the object having previously been mounted by Mr. Hepworth's process, under thin glass tied on with thread, exhausted of air, and saturated with turpentine. After heating over a spirit-lamp the balsam sets hard almost as soon as cool, when the slide, after cleaning with alcohol, is ready for the cabinet. Mr. Latham exhibited several slides thus mounted, with specimens of the gizard of a cricket, saw fly, entire system of the silk-worm trachea, ichneumon fly, spiracle of the silk-worm, goldfish scale, leaf of wheat showing spiral vessels.

Mr. LYNDE exhibited a fine plumatella living on the shell of a large lymnea or water-snail.

Mr. MOSLEY exhibited specimens of hydra and other aquatic objects.

October 15th, 1860.

A Circular was read, addressed to captains of vessels, with a request that they will preserve the produce of the soundings they make when abroad, in the envelopes sent therewith.—A Letter was read from Mr. Hayman, of Liverpool, to the effect that circulars and envelopes have been supplied to the captains of eight steamers belonging to Messrs. John Bibby and Sons, in the Mediterranean trade; three of Messrs. Mac Iver's steamers, plying between Liverpool and New

York; to the steamer "Armenian;" for Madeira, Sierra Leone, Calabar, &c.; to the "Marco Polo," and two other vessels to Melbourne; as well as to vessels which have gone to Woosung in China, Bombay, Alexandria, &c., &c.

The CHAIRMAN made some observations in praise of the plan, which he had no doubt would be productive of advantage and add to the interest of the meetings of the Section.

It was suggested by Mr. BROTHERS that a special subject, previously fixed upon, should be discussed at each meeting: the suggestion was at once adopted. The subject for discussion at the next meeting will be, "Upon the Best Method of Preparing and Mounting Diatoms, &c., obtained from Soundings and other Sources." It is requested that the Members of the Section will meanwhile obtain and communicate all the information they can on the subject

Mr. LYNDE exhibited a specimen of a small insect allied to the Podura, which he found leaping about on the surface of the water in his aquarium. Mr. Lynde had never seen a description of such an insect, nor was it known to any of the Members of the Section present.

Mr. BROTHERS exhibited the hydra viridis, &c.

A few specimens and parts of flowers obtained at the Botanical Gardens, were exhibited by the SECRETARY. In the tank of the Victoria Regia, little minute animal life could be discovered during a short visit. A specimen of Cetochilus was shown which was found there, as also a few diatoms not fully examined.

XV. — *On the Production and Prevention of Malaria.*

By DR. R. ANGUS SMITH, F.R.S.

Read February 19th, 1861.

1. *On the Production of Malaria.*

BY malaria I mean simply bad air rising from land or water not contaminated with impure substances from the habitations of man. In this short paper I by no means propose to myself to enter upon the whole question of the production or prevention of malaria. The subject would require not only more time than can be given to it on this occasion, but much more information than I possess. It has been my intention to examine the matter thoroughly, but I have not had the necessary opportunities, and I give here only some ideas towards an elucidation of the subject, founded on a few simple observations. It has been shown by numberless writers that malaria is a very frequent evil; that large portions of Europe are more or less subject to it, and considerable districts rendered by it quite uninhabitable. But besides those dreaded evils, such as almost instantaneous illness or slow and lingering death, Dr. Macculloch has shown that large portions of very healthy countries, such as England itself, are subject to emanations which diminish their healthiness to an extent which careful observation can detect, although the sufferers themselves are unable to account for the loss of strength, or look on it only as one of the inevitable evils incident to humanity. Macculloch says: "I trust to prove in this essay, that the causes of malaria exist under numerous circumstances not at all suspected in our country, and in thousands, tens of thousands of places, even at our very doors" (p. 11, ed. 1827). Again: "Malaria produces in itself a far wider mass of human misery than any other cause of disease; as, for the world at large, it is also the cause of far more than half the mortality of mankind" (p. 31).

In the examination of different districts for organic matter in the air, I have invariably found that low grounds well cultivated have shown more than high grounds or hills, and more than the open sea. I cannot, therefore, doubt that the remarks of Dr. Macculloch are correct as to the very general occurrence of unwholesome influences caused by the state of the ground. I am inclined to go further, and to say that even in places where we cannot find that health is in any way injured, emanations arise. But it is not sufficient that health should be injured, or at least the average age reduced below the standard of the country, in order that a place may be called insalubrious. It may be that the impulse given to life may be diminished in some districts by substances rising from the ground, whilst in other districts an entire or greater freedom from all noxious exhalations may allow the supply of the purest air, with all its highest quickening effects.

The cause of malaria has been with great certainty traced to the soil. I shall not revert in this place to the arguments and observations which have led to this conclusion. It is true that some places are exposed to emanations of gases from subterranean reservoirs, but gases such as can be prepared by the chemist, combinations of inorganic bodies, are not known to be able to produce the agues and peculiar fevers which we connect with the true malarious district. Atmospheric phenomena, the condition

of electricity for example, affect the health, and so does the amount of water, of cloud and of light; but all these causes seem to be different from that insidious poison arising from those organised bodies found neither deep in the earth nor high in the air, but only on the surface of the ground.

It is now many years since I first began to study these subjects; and one or two of the facts which I allude to, and which I consider important, were published fourteen years ago; but their significance has not till lately been sufficiently clear. I observed that the water of soils is sometimes acid and sometimes alkaline; that on the surface generally of our soils it is acid to a small extent, whilst below, when the inorganic salts overpower it, it becomes alkaline. We may say as a rule that all inorganic soils give off their drainage water in an alkaline state. The tendency of plants is to render the soil acid, and if they render it very acid the soil is said to be sour. Drainage will draw off the excess of vegetable juices, and lime will also remove them, as well as other free alkalies. In hot-houses and where rich manures are used, the soil is not always acid, but frequently very alkaline. I have not examined a great many, but where forcing is resorted to with strong manures the result must be and is an alkaline condition. This condition depends on temperature. Having observed some very alkaline soils, I went a few days afterwards for a specimen of water flowing from the surface, without allowing it to pass deep into the strata which would have filtered out its organic matter, and given it alkaline earths. Meantime the weather had changed, and the alkaline water had disappeared, having given place to one that was acid. This was in a peaty district.

If the soil of our fields were not kept acid, but were kept alkaline and warm, there would arise from it a greater amount of exhalations. "If the soil is very alkaline and moist, the conversion of the organic matter into ammoniacal compounds is very rapid. I put some soil not very rich in organic matter into this condition by the assistance of a little ammonia, so as to make it alkaline, and the consequence was the rapid occurrence of a very intense putrefactive decomposition, not in any way differing, as far as could be perceived, from that of ordinary putrefaction of animal and vegetable matter. These nauseous and unwholesome odours are therefore possible from the ordinary soil of our fields; but any occurrence such as this on a large scale would be disastrous, and the ground is protected from it by an almost constant acidity, which sometimes increases so as to be injurious, forming what is called sour land. This very acid state generally occurs in wet land, where it is probable that alkalinity would be most injurious, but the soil may be found alkaline in a well-manured garden, and where the ground is dry, without apparent injury." —Author's *Report on Air and Water of Towns*, *British Association* 1851, p. 69.

In this experiment I produced in fact *artificial malaria*. The conditions were exactly such as the best observers have in most cases described, with the addition of the alkaline state, which will probably be found to play a very important part, but which as far as I know has not been attended to. Not that I say that it is impossible to have malaria without ammonia, but ammonia is the wing on which some of the products of decomposition seem to delight to fly. This experiment, which brings the usual condition of warmth and moisture, shows that there may be many modes by which the organic matter in land may pass from the soil besides the transformation into plants, and besides simple oxidation. The decomposition spoken of shows that from soil numerous products may arise. If we allow that putrefaction begins we know no end to the

number of substances produced. These products will vary according to the nature of the substances in the soil, according to the season when one or other substance predominates, and when one or other substance acts as a ferment.

It is not necessary to go further than this experiment in order to show that there may arise from soil under certain conditions substances producing the most desolating diseases. I suppose this artificial state to be the extreme, such as probably has never happened in an extensive district. All other conditions of insalubrity are probably stages of this. It may be said that it was well known that soil retained organic matter, and that organic matter could putrefy, but this state of actual decomposition had never before, as far as I know, been observed. By the sense of smell we have found reason to believe that volatile products arise; disease has also led to this indication, and minute quantities have even by careful experiment been observed; but in the experiment I speak of, the amount rising was gross and unquestionable. I will scarcely venture to speak of the quality of these products. To me they strongly resembled those of putrid flesh or blood, and in that case their composition would probably ally itself to that of protein; indeed I find that after removing the purely gaseous bodies arising from such decomposition there is left a substance whose carbon and nitrogen bear a relation almost identical with that in protein. But the variety of substances found will probably prove to be extremely great. We can imagine some washed down by the rain, and some removed by the plant. In the same way some classes of malarious diseases may be removed by rain, some caused by more and some by less moisture and heat, and others better removed by the agency of plants and the processes of agriculture.

The soil is an extremely complex machine; the balance of forces in it has not been studied. The surface is acid, the lower part is alkaline; it is a filter, with a power of retention and selection. The flow of air and water is from the surface downwards. The surface therefore becomes first oxidised, and is made acid. This acidity is itself a preventative of great putrefaction, and this oxidation is a destruction of those substances which may have resulted from the rotting masses. When land is well drained these processes will go on with greater rapidity; it is as if the lungs were enlarged. But notwithstanding this oxidation and prevention of decomposition we must not forget that it is useful to counteract another agency of great importance, that by which the plant rots. This rotting is accompanied by grubs, insects, animalcules, and vapours and gases; it closely resembles, and no doubt in part is a suppressed putrefaction. The soil has the power of retaining the products to a great extent and until it has destroyed them, when they are not excessive.

If the passage of air through a soil is not sufficient the products of decomposition are not destroyed. If the passage of water through a soil be not sufficient the soluble products are not removed into the soil, but left, and assisted to putrefy.

It is certainly an object of great interest to be able to know by the examination of a soil if it could or would produce malaria, or if it were really in the act of producing it. By the view taken most soils, indeed all containing putrescent organic matter, will be subject to malaria when the oxidising influence of the air and the balance of vegetable and chemical life are disturbed. The soils most productive of malaria are low grounds, and moist ones with abundant vegetation. At the same time there are others not described as such, and not very thoroughly investigated. If we examine the surface water flowing from such grounds in this country we shall find it to contain animal

or animalcular life in immense variety, and we shall also find that if we allow it to stand vegetable life will show itself in great abundance. The hilly districts of our own island do not contain water of this kind. I was extremely surprised, on taking my microscope to the north-west of Scotland, to find that the ditches were so meagre of living creatures. A green pool was scarce, and when found it was small, whilst on examination it was vivified by very few living forms. The whole hills in fact were either void of matter capable of putrefaction, or they were so rapidly washed that the putrefying matter was passed at once into the soil. The moisture, too, produces no corruption; it is water in rapid motion filled with air, and rapidly traversing the soil, oxidising all the small portions of putrid matter that may be forming in the soil, and fixing the products in the earth. The animal life is repressed, *i.e.* the life of such living things as arise from decomposed plants or animals. But why should this be? Let us push the argument further. If grass grows in such places there must be food for plants, and elements for the production of infusoria. It is true that grass grows, but not in great vigour, and as the rain passes very rapidly through the soil there must be very little matter kept soluble at one time. The plants must be fed by small although by very frequent meals. Besides, the soil is not deep; the power of retaining soluble matter is therefore small; the stock of food laid up over the whole district, in other words the material from which such animal life must spring, is extremely scanty. Now I am not prepared to say that all unhealthy districts actually contain a large amount of matter either putrefying or forming into animalcular life, but it certainly is the characteristic of what seems to me to be the soil most blamed; there may be some, as already stated, where other causes arise. This state of soil is that of all our lower lands; the ditch water swarms with life;

muddy wet lands present it in every drop of water; whilst in our high hills, purified by barrenness and disinfecting peat, we have hunger and health. I do not say that there is a necessary connection between malaria and animalcules, but as there is a connection between them and the state of the air in our own county, it is probable that the inquiry may be extended profitably to malarious districts. Infusoria and even larger animals indicate the presence of matter which may putrefy, but it is even probable that they may prevent its injurious action on the atmosphere.

The microscope then may very soon be brought forward as an instrument for ascertaining the sanitary condition of a country. It is extremely probable that the quality of the decompositions will be known by the microscope to a large extent, and the nature of the disease and its extent be indicated. It was not my intention to have brought forward these views until I had examined in detail this part of the subject, but I fear I shall not soon have an opportunity of doing so, although I have more materials ready than I can find room for in this paper, which is chiefly a practical one. I may readily be misunderstood. I do not say that where most animalcules are there is most disease. Water may exist too putrid for them, and some states of decomposition destroy them.

It may be said that it was well known that places containing less organic matter were less liable to disease, and that the sea coast and barren hills have long on that account been frequented; but to me at least the reasoning generally and the mode of observing is new, and I feel as if new eyes were given us for observing the soil more minutely. To some extent we can at once tell the quality of waters by the use of the microscope, and have even a clue to the gases and vapours rising. If these waters are taken from the surface of land we have a clue at once to the condition of the land.

2. *Prevention of Malaria.*

If we can imitate the production of malaria, can we not also imitate the mode by which it is destroyed or prevented? When the products of decomposition are formed in a soil they are removed by natural processes. Mere mixture with the soil will remove or render decomposing matter innocent. The soil will act as a porous body. But the soil may be overburdened. It may be shallow, and its machinery may be of small force; or it may be inefficient from the excess of organic matter over the amount of air passed through it. The first act of disinfection is the action of the soil as a porous body. The next seems to be the act of oxidation by which the soil at the surface is rendered acid. By these means decompositions are confined within the soil itself.

We may consider the atmosphere to be in a constant struggle with the vegetable matter of the soil. Substances containing nitrogen are constantly tending to give out ammonia, the ground is constantly tending to convert this into nitric acid, whilst it converts other portions into carbonic and organic acids. By manuring we assist the tendency to become alkaline, taking the side of vegetation, and we resist the oxidising tendency of the air. A large portion of our manuring is simply the addition of alkalies, a struggle against the acidifying influence of the air. No wonder it requires so much lime for the fertilizing of acid peat lands. From lands of this kind it is probable that no miasma arises.

Moisture lying on rich lands becomes filled with animal and vegetable life, a sure sign of rapid decomposition. Allow this moisture to pass through the soil and this animal life disappears. This is an act of purification by drainage. It may not at all times be possible to obtain the requisite amount of drainage, and there are even cases where the land produces malaria, without, according to the greatest authorities, showing need of drainage. We can readily imagine one condition which will produce this result, viz. excessive dew, which will evaporate and carry a large amount of organic matter;* others may depend on the plants and animals present. The oxidation in the soil may also be aided by the artificial opening of its structure, but this may not always be convenient, and the demand for it may be too laborious. Are we not able to imitate some of the other methods taken by nature to prevent infection?

If we add any acid to the putrid soil of which I spoke, that peculiar mode of decomposition ceases; if we add any other disinfectants or antiseptics we put a stop to decomposition. If we add antiseptics to the water over soil containing a great variety of animalcules, and giving every evidence of decomposition, we find these instantly dying; the same, of course, results with grubs, larvæ, &c. Animal life is arrested, and chemical action is staid or impeded according to the amount used; but a very large amount must be taken in order to show an injurious effect on vegetation. In this experiment we do in reality prevent malaria; we arrest the decomposition of substances in the soil. We cannot call this a theory or a speculation; it may be considered simply as a fact. The use of antiseptics will arrest all animal and vegetable decomposition. and where there is neither of these malaria will not arise. The chemical action which goes on in a vessel containing a few cubic inches will not differ if extended over a surface of miles. I look on the results, therefore, as certain, viz: that by the use of disinfectants malaria will be destroyed.

The idea of the disinfection of whole districts rose out of a proposal made long ago to disinfect whole cities by beginning at the root of the evil, the sewers. That was

* Since writing this an Italian friend informs me that this opinion is prevalent amongst the scientific men of his country.

intended for this country, the land of great cities. This plan for the disinfection of districts is intended chiefly to apply to other countries. I may, however, be allowed to give one illustration from this country. Mr. McDougall has used sewage over one hundred acres of land; sheep and cattle have fed on it without any case of disease. The growth of vegetation was great, the moisture was constant; there was also the constant presence of decomposed matter, but there was no disease. There was, on the contrary, a large production of healthy vegetable and animal life. This experiment suggests many questions, but I do not intend to enter on any except so far as to show it as a proof that putrefactive decomposition may be arrested without any fear of destroying the life of plants, and that rich water meadows may be used for feeding cattle without fear of rot, even if treated with sewage. The disinfectant used was crude carbolic acid with lime water.* The arrest of decomposition was thus caused by a process which at the same time diminished the acidity. I think the amount required will be small enough to render the process possible over large districts. At the same time also I expect that the idea will lead to other and perhaps even to cheaper modes of producing a like result. As it is to be hoped that an opportunity of using it will occur, it is well not to attempt to speak of details.

I may add also at the same time that the extinction of insects obnoxious to a country, — gnats, mosquitoes, and those dreadful enemies of cattle the zimb and the tsetse, — will probably follow the destruction of the obnoxious decompositions in the soil. Nor do I suppose that only one disinfectant will do the work, although the one I

* The value of carbolic acid has elsewhere been shewn by Mr. Mc Dougall and myself; the preparation here used was that patented by Mr. McDougall in 1859. He will be able soon to make public many other experiments relating to rot and the destruction of insects.

have mentioned is, as far as I know, the most powerful, and can be made in all countries and climates where coal lies or where trees grow.

It is desired to make Rome the capital of Italy. From all I hear it is badly fitted for such from its sanitary condition. By the method proposed I believe objection on the plea of health would be removed, and it would rapidly be made fit for habitation.

I wish in this paper chiefly to show that decomposition, to a most pernicious extent, is possible in soils; that it is not a mere opinion, but a fact readily demonstrated. Next, to show that decomposition may be arrested artificially to the preservation of health without the destruction of vegetation; and that in these facts we have not only a surer basis in our reasonings on the origin of malaria, but an almost certain process for its ultimate and total destruction.*

* Since writing the above I have formed artificial malaria in soil by the use of water only, an exactly analogous case to that of marshes. I call it artificial malaria, although, of course, I have not produced fever or ague with it. Similar soil, when disinfected, evidently resists animal and chemical decomposition longer, yielding at once to the wants of vegetation. It is said that cultivation will cure malaria, but malarious ground is dangerous to touch; our engineers are dying rapidly whilst making the railways in India. The soil and the jungle could both readily be treated before turning them up, or as soon as turned up. I may add that the road to and from India might be made more wholesome by the destruction of the corruption in the bilge water of ships; nothing can be easier, and yet men die on account of this corruption, and people have inquests and commissions upon them instead of commanding its cure.

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ON THE INFLUENCE OF IMPURE WATER IN THE PRODUCTION OF DISEASE.

BY ROBERT DUNDAS THOMSON, M.D., F.R.S.S., L. & E., &c.

Member of the Royal College of Physicians, Physician to the Scottish Hospital, Medical Officer of Health and Analyst for St. Marylebone, President of the Metropolitan Association of Medical Officers of Health.

The importance of a supply of pure water for domestic use appears to have been thoroughly recognised by the Romans. For although the river Tiber flowed through the city of Rome, and the Romans at a very early period had made use of its waters and likewise that of wells, it is now two thousand one hundred and seventy-three years since they discovered the unwholesome characters of such waters, yellow with mud and mingled with sewage as they were. These ancient people were aware of the importance of collecting the waters of rivers near their source, before they had been contaminated with drainage, and hence they brought the supplies to their fountains from the sources of the Anio and Tiber by twenty different aqueducts, at various distances up to sixty-two miles, at an enormous expense. Nothing is more surprising than that although moderns have devoted so much time to the study of the Roman classics, they should have entirely lost sight of the sanitary knowledge acquired above two thousand years ago, and that we should find ourselves in the middle of the nineteenth century persisting in the metropolis of England in perpetrating experiments upon human health and life, which a little knowledge of history would have served to obviate.

It must be obvious to every one that rivers passing through inhabited districts are an improper source for domestic water supply, as they act as the sewers of the country through which they run, and hence they are now superseded as sources of supply by mountain streams or hill drainage. Wells situated in towns have long been known to contain nitric acid as an altered form of sewage (Margyraf, 1751), and ammonia (Heberden, 1767) as a still more recent product of animal refuse, while these substances are either entirely absent from country wells, or their presence is dependent on unsanitary arrangements in the neighbourhood of human dwellings. But all these facts seem to have been forgotten, and to have required re-discovery, since sanitary science has begun to occupy a conspicuous position in the art of remedying disease. So late even as 1851 we find three chemists appointed to analyse the London waters, stating that "the shallow wells of London have never been pronounced unwholesome," yet in 1847 much public discussion resulted from a report which I made to the magistrates of Glasgow, in which it was demonstrated that sewage was present in greater or less quantities in all the wells of that city, and which I therefore pronounced to be unwholesome.

In 1850, at the request of the magistrates of Liverpool, I reported on the wells of that city, and gave a similar opinion of their unsanitary character. In the case of Glasgow, a proposition had been made to the magistrates to expend a large sum of money in sinking new wells, but the unfavorable report of their impurity led to the project being abandoned. Companies were subsequently formed for the supply of water to Glasgow from streams in the neighbourhood of which I had the chemical examination, and the result proved that the purest water which could be obtained was that of Loch Katrine, a noble Lake, containing the drainage of a mountain range. When the water was first introduced into the main pipes the total impurity amounted to as much as 3·3 grs. or degrees per gallon, although when I first examined the water in the lake the impurity was 2·3 grs. in the gallon. It was obvious that some impurer springs had mingled with it in its passage to the city, which has now been remedied, as in March last the impurity was 2·35 degrees, of which ·605 was organic.

The authorities of Glasgow have expended on this scheme somewhere about three quarters of a million, and probably before the plan is complete the expenditure may not be less than nearly a million sterling. Allowing for the difference of population this would be equivalent to between seven and eight millions for the inhabitants of London. For this sum it is believed a pure mountain drainage water might be made to supersede the present supply from the Thames which acts as a sewer to the whole of the populous country which it traverses. Manchester and Liverpool, which like Glasgow suffered intensely from cholera, and where well water was much used, have now obtained pure supplies of water from mountain or pastoral

drainage. The importance of these improvements has been fully borne out by the facts which have come under the cognizance of those who have made sanitary science their peculiar study.

The inhabitants of India have long connected the occurrence of cholera and other diseases with the use of impure water, and during my service in the East I had frequent opportunities of observing the influence of impure water in such cases. On arriving at Bombay on the 12th May, it was reported that no cases of cholera existed in the town; the temperature was then at 80 degrees, and the wind westerly, with a clear sky. On the 15th the disease was stated to be in the town. Cases of diarrhœa were frequent on board ship in the harbour about the 24th. The first case of cholera occurred on the 7th June, on board, and terminated fatally. The wind was now south-westerly, blowing therefore from the ship to the land. The monsoon being about to set in, which it did on the 14th, with rain on the 8th, two cases of cholera were reported; on the 15th there was another case of cholera, and on the 16th a fatal case. These men had been working in the hold, and using Bombay water taken from one of the filthy tanks in the town. In the hold the heat and closeness were very great, and the odour of shark's fins, part of the cargo, was very annoying. The portion of the hold where the men had been stowing cotton I found extinguished a Davy lamp. From this period no Europeans were allowed to stow, and on the 18th they were replaced by Seedies, powerful Muscat men. Cholera disappeared from the ship. The Seedies worked for some days, and then left for shore, and were reported to have died of cholera. These men likewise used Bombay water. This water I found to contain much organic matter.

A large tank used by the natives may be described as being dug in the earth or cut out of the solid rock, containing water which is usually turbid, produced by the agitation caused by the natives entering for the purpose of carrying the water, and for bathing; the taste is warm and earthy, and the temperature at this season from 80 to 85 degrees. One large tank, I recollect, which was used for the supply of water, had located on its banks several faquirs, who had resided there for years; one of these who had made a vow to allow his nails to grow for twelve years attracted my attention particularly by the remarkable appearance of his nails which resembled ram's horns in being twisted and indurated to the extent of six inches. I was desirous of getting a specimen of his cast off nails for my museum, but he replied that it was part of his vow to throw them into the tank, where also all excretions were deposited, and where his ablutions were performed, according to his own statement. These waters contained much organic matter in solution, a considerable amount in suspension, and some common salt, sulphate, and carbonate of lime.

During my service in China I recommended the commanding officer to pay particular attention to the supply of water. The usual mode of supplying water was to take it direct from the Canton river. I volunteered to go with the boat's crew and select the water myself. Accordingly we proceeded up creeks into the interior and there remained until ebb tide. I took my tests with me, and gave the order when the water was to be filled in. It was in these days rather a precarious matter to leave the ships at any considerable distance, because the inhabitants were in the habit of attacking us, and we were obliged to go armed; but still we pursued that plan, and we had not a case of cholera on board, although in other ships the disease did exist, and we were afraid of its being communicated to us. I had no distinct faith at that time in water alone being the cause of disease, but, at the same time, I thought it was necessary to take this precaution.

The occurrence of cholera at Bombay, as previously described, it appears to me, can best be explained by the concurring causes of the use of Bombay water, and the immersion of the subjects of the disease in an impure atmosphere. The water alone is scarcely calculated to produce cholera, neither would the noxious air, judging from experience, produce similar results; but it is when two such influences (personal and atmospheric) are united that a disease possessing a regular type such as that of Asiatic cholera appears to be generated.

During the prevalence of cholera in 1854 I visited, at the request of the General Board of Health, many of the houses where cholera had proved fatal in various parts of the metropolis. I saw many of the unfortunate victims dying and dead, and took specimens of the water from the cisterns and butts used by the inhabitants. I was much struck with the peculiarity of one water, in certain houses in the Soho district, supplied by the New River Company. Having found the quantity of impurity in this water very large, I sent my assistant from the St. James's district on the same day to the New River reservoir at Sadler's Wells, to obtain a sample of water. I found the water there to possess a totally different composition from the water taken from some of the houses in Soho. I repeated the experiment frequently with similar results. The mean gave 28·64 degrees or grains as the amount of impurity in the gallon, of which 2·02 grains were organic impurity, while the composition of the water from the reser-

voir was 17·22 degrees or grs., total impurity, and the organic impurity was 1·46 grs. When this statement was first published in a short *resumé* of the proceedings of the Board of Health, the officials of the New River Company denied the accuracy of my analyses. I repeated my examination with analogous results, and after much expenditure of printing on the part of the company, the sanitary police established by the Board of Health proved too powerful, and it was at last admitted that the water which I had detected was actually derived from a well belonging to the company, which was pumped not into the reservoir at the New River head, but into a pipe which gained access to the New River pipes by a lateral communication, so that every day as I found the composition of the water in the cholera houses varied. It was in this district that the Broad-street pump water proved so injurious in the propagation of cholera. This water was exceedingly impure, being full of sewage. I have recently examined it, and found it to be in free communication with sewage, of the products of which it contains a large amount, the total impurity being 89·70 grains or degrees per gallon, of which 6·08 grains are organic matter derived from organic *débris*.

A remarkable instance of the influence of this water in connexion with cholera is well established. A lady who had previously resided in the Broad-street district, and used the pump water, had been for some time resident at West-end, Hampstead. During the prevalence of cholera she expressed a desire to have some of her favourite beverage, and had some Broad-street pump water brought for her use. She was soon after attacked with cholera, although no case of that disease had previously appeared at Hampstead.

A striking instance of the effect of water in inducing cholera occurred to me in 1857. A report was brought to a meeting of the Medical Officers of Health that cholera had broken out at West Ham, and a committee of the association was nominated to examine into the circumstances. We found there a block of dwellings, in almost every house of which cholera had appeared, and we could not trace it to any greater distance. Although not within the metropolitan boundary, a medical officer of health (Dr. Elliott) had been appointed some time before, and he had the good sense to examine the only source of water supply—a pump in the road—and to cause the removal of the pump handle. After that water ceased to be used, we could not ascertain that any new case of cholera occurred. When I examined the water, I found it loaded with sewage, both in solution and in suspension, the total impurity being 56·16, and the organic impurity

4·40. On inspecting the neighbourhood, it was found that the source of the water supply was derived by soakage from a creek communicating with the river. Our attention was subsequently directed to the Registrar General's Report, which noticed the death of a boy from cholera at Poplar, within the metropolitan boundary, and on carefully investigating the case, we found that the boy, on the Sunday I think it was, preceding his death, had passed West Ham with his father, and after getting beyond this block of houses his father missed him, and looking back saw him drinking at the fatal pump.

But, perhaps, the most horrible example on record of the fatal effects of impure water occurred in 1854. I found that the Southwark Company's water was of a different composition from the water of the Lambeth Company. When I applied a piece of muslin over the supply pipe of the Southwark Company to the cistern in my laboratory at St. Thomas's Hospital, a large quantity of human excrement was detained, and the impurity in solution was much greater in the Southwark Company than in the Lambeth water, which contained little or no matter in mechanical suspension. The Lambeth water was obtained from Hampton, while that of the Southwark Company was pumped up from the river near Vauxhall-bridge. These two companies possessed mains in the same streets, and supplied the houses indiscriminately. Analysis alone enabled me to detect the two waters, as the inhabitants, without consulting their water receipts, were unable to state the source of their supply. And although the population supplied by the two companies was precisely in the same condition, except as to water, the cholera deaths in the houses supplied by the Lambeth Company were 37 to every 10,000, and in those by the Southwark Company 130 to 10,000, or as one to three and a half. I conclude from the data supplied that 2,500 persons were destroyed by the Southwark water, who would have been saved if they could have obtained the Lambeth water. It is a remarkable fact that the Lambeth water, in the epidemic of 1848-49, was more fatal in its effects than the Southwark, the Lambeth Company taking their water lower down the river at that time. The mortality in houses supplied by the Lambeth water was 125 in 10,000, while the deaths in houses supplied by the Southwark water were 118 in 10,000.

Such are a few examples, among many derived from my own experience, of the prejudicial influence to health of impure water. The water now supplied to London by the Water Companies is of a much purer description than formerly, although it is much inferior to that which is supplied to Manchester, Liverpool, Glasgow, Edinburgh, and many other towns.

To the Committee of Justices for the County of Surrey appointed to provide a new Pauper Lunatic Asylum.

GENTLEMEN,—Having had the honour to be consulted by you respecting your proposed new pauper lunatic asylum, I take leave to submit to your consideration the accompanying plan and description for an asylum on the separate-block system, calculated to accommodate 650 patients.

The advantages derivable from the separate-block system of asylum architecture, from simplicity of construction, facility of natural ventilation, and diminished risk from fire, great as they may be, are yet but small advantages in comparison with that afforded by avoiding the evil of concentrating vast numbers of insane persons within a limited space, so that each patient, to his great detriment, becomes, as it were, surrounded by a thick atmosphere of insanity.

The separate-block system diminishes this main evil of asylum architecture to the greatest practicable extent; while, if the decentralization of the buildings be kept within due limits, the advantage of economical management dependent upon the provision of easy communication between the separate blocks and the use of one set of offices may still be preserved.

I believe that in the plan submitted, the decentralization of the buildings is effected in the manner most consistent with simplicity of construction and facility of communication; and although it may be said that the difference between the ground plan and that of some other asylums is merely due to retiring the middle third of each wing, the result of this simple change is to give an arrangement entirely distinct and different from that of any asylum in existence.

The removal of the residence of the medical superintendent from the centre of the asylum has the sanction of experience at the Gloucester County Asylum and elsewhere. A new residence for the medical superintendent is at the present time being built at some distance from the large Edinburgh asylum; and the same arrangement has been made at Broadmoor and at Inverness. By distributing the residences of the officers, their influence will be at least as much felt throughout the asylum as if, in the more usual manner, they were all placed in the centre of the buildings.

The arrangement of the blocks will give to all the patients the immense moral and sanitary advantages of a front view and a southern aspect.

In the construction of an asylum on this plan, it may be thought that the great length of covered ways will be a costly item; and to some extent this would be true. But those covered ways at the back of the blocks, and those at right angles to the front, would add little to the cost, since the walls of the buildings and of the airing courts would be made use of in their construction, and a wooden roof, which would last twenty years, might be added to these walls for 12*s*. the foot run. They would also prevent the need of erecting exercising sheds and sun-shades. The covered ways facing to the front would be more expensive, but their length is not great.

By avoiding all waste of room, the construction of the block buildings themselves would be exceedingly economical. The avoidance of internal passages rendered possible by the use of the external covered ways, would be one cause of this economy of room. The use of large rooms for the day accommodation of the patients would be another cause of it. Daily observation assures me that a number of patients will not distribute themselves over the long galleries in use in asylums, as they readily do over large day-rooms. The result is that half the space in long galleries is wasted space, and wasted space is the greatest and most common architectural extravagance. Let any one of our most costly public buildings, asylums, hospitals, or even prisons, be looked at with the desire to ascertain in what manner the money it has cost has been sunk, and it will probably be found that there is little enough to shew for it in ornamental extravagance: but this one thing will be apparent almost everywhere, namely, that there is abundance of wasted space, wide galleries only used as passages, wide well-staircases, and intervals of space used for nothing. It is by avoiding all waste of space that the buildings of the plan submitted would, as it is hoped, be equally economical and efficient.

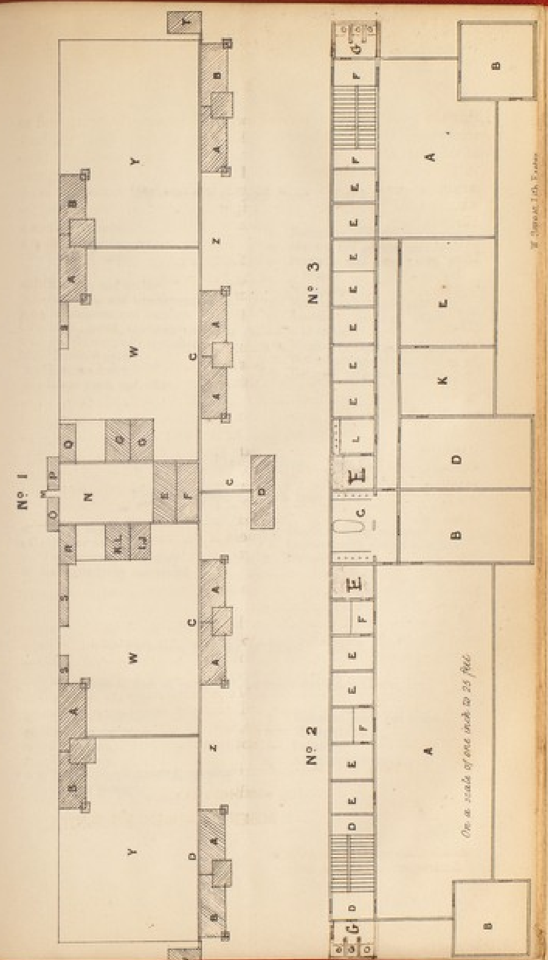
I estimate the cost of the asylum buildings, without fittings, according to the plan submitted, to be not more than £55 for each patient accommodated, which is about half the average cost of these structures. I should, however, recommend a fair margin to be left in the estimate for fittings, since the internal finish of an asylum has a large influence upon the well-being of the inmates, thereby promoting the cure of the curable, and the tranquillity and facility of management of those who are not curable.

I have, Gentlemen, the honour to remain

Your very obedient servant,

JOHN CHARLES BUCKNILL.

DEVON COUNTY LUNATIC ASYLUM,
EXMINSTER; *Nov.* 18*th*, 1861.



PLAN OF A PROPOSED COUNTY LUNATIC ASYLUM FOR 650 PATIENTS.

Reference to Ground Plan. No. 1.

A A. Large wards.
B B. Small wards.
C C. Covered ways.
D. Chapel.
E. Kitchen and scullery.
F. Refectory and amusement room.
G G. Washhouse and laundry.
I J. Meat, bread, and cellar stores.
K L. Bakehouse and brewhouse.
M. Entrance gate.
N. Kitchen court.
O. Board room and office.
P. Reception and visiting rooms.
Q. Matron and general servants.
R. Steward and clerk with store-rooms.
S. Workshops.
T. Medical superintendent.
V. Assistant medical officer and chaplain.
W W. Workshop—yards, and courts.
Y Y. Walled airing courts.
Z Z. Patients' pleasure grounds.

Reference to Plan of Block. No. 2.

First or day-room floor of a large ward.

A. Large day-room.
B B. Smaller day-rooms.
C. Bath-room and lavatory.
D. Entrance lobby and stairs.
E E. Single sleeping rooms.
F F. Lobbies, with closets in recess.
G. Water-closet.

Reference to Plan of Block. No. 3.

Ground floor of small ward for acute and infirm Cases.

A. Large day-room.
B. Smaller day-room.
E. Dormitory.
D. Dormitory.
E E E. Single sleeping-rooms, opening into passage.
F. Entrance lobby and stairs.
G. Water-closet.
L. Lavatory.
K. Attendants' room.

DESCRIPTION

OF A

PROPOSED NEW LUNATIC ASYLUM

FOR 650 PATIENTS,

ON

THE SEPARATE BLOCK SYSTEM.

In the plans here set forth it is designed to describe a County Lunatic Asylum so constructed as to distribute the patients over the widest area which may be consistent with economical management and due supervision; and for this purpose to break up the buildings used for patients into blocks sufficiently separated to ensure the advantages of isolation and yet to provide ready means of communication with the kitchen and other central offices.

It is further intended so to place these separate blocks that the patients residing in them may enjoy the whole benefits of a southern aspect, of a front view, both from the buildings, and the courts and pleasure-ground devoted to their use.

It is further intended to make the internal arrangements of these separate blocks in such a manner as to avoid internal galleries and passages, and to provide for the day residence of the great majority of the inmates on the ground floor in spacious and well-proportioned rooms, and to provide for their sleeping accommodation on the upper floors; certain exceptions to these arrangements being made in favour of acute and infirm cases for whom large wards and the use of stairs would be objectionable.

Ground Plan of the Buildings.

The buildings consists of six separate blocks, three for men, and three for women, four of the blocks are in aligument in the front; the second and fifth blocks are in retirement from the front to a distance of about sixty yards; they however face the front, so that the whole line of block buildings with the chapel occupying the central position between the men's and women's sides, forms one frontage, affording scope for architectural effect.

In the centre of the buildings and behind the chapel are the refectory, kitchen, and other domestic offices, constructions of one story, for which ample space is afforded.

The entrance of the asylum is from the back, and from the north, and on each side of the entrance are the board room and the visiting and reception rooms; and in immediate proximity the residences of the steward and of the matron. In the matron's house, and under her control, the cooks and laundresses will reside.

The residence of the medical superintendent is a distinct building to the east of the front, and in connexion with the acute and infirmary wards for women.

The residence of the assistant medical officer and of the chaplain is to the west of the front, and in connexion with the acute and infirmary wards for men.

The different blocks are brought into connexion with each other, and with the chapel and domestic offices, by means of covered galleries; these galleries are intended to be open on the side facing the airing courts, so that they may serve as sun-shades and as covered ways for exercise; they will also form the boundaries of the courts to prevent escape.

The inclination of the ground is supposed to be from the north to the south so that the lower windows of the blocks retired from the front will look over the covered ways connecting the front blocks.

The chapel is intended to be the only part of the building upon which architectural ornament will be displayed and should perhaps be of light-coloured stone in contrast to the plain brick of the asylum buildings. The spire or tower will contain the bell or clock, and the chapel itself will mask from the front the low roofs of the domestic offices.

The stables and farm buildings will be placed at a convenient distance from the asylum, sufficiently remote to prevent the effluvia from a large piggery reaching the wards.

The gas works must be on the lower level. If facilities should be afforded it will be advisable to make a wharf and yard in connexion with a creek of the neighbouring canal on the asylum property; and in this yard to place the gas works, the pump for raising water, sheds for coal and other bulky stores, a smith's forge, and the residence for the engineer. The water, for which a supply of not less than 25,000 gallons daily must be provided, should be pumped into cisterns placed in the central tower of each block. If the main water supply should be derived from the canal, two or three shallow wells with common hand pumps will be useful to supply water for drinking.

Construction of Blocks and Internal Arrangements.

The main building of each block is of two stories, but there are in connexion with each block three towers of three stories, the third story in each tower being used exclusively for small dormitories. These towers have high-pitch roofs and while they provide valuable accommodation, they will break the monotony of the line of building, and give an agreeable and effective outline to the structure. The towers at the end of each block are fifteen feet square within the walls; the central tower in each block is thirty feet by twenty-four feet and a half.

The blocks have single roofs, the span of which is thirty-three feet within the walls.

The span of the floors from the front wall to the walls of the single sleeping rooms is twenty-three feet within the walls.

The several blocks will not be of exactly the same length.

The blocks for the women should be longer than those for the men, to accommodate the larger number of female pauper lunatics which accumulate in all county asylums; but no block will exceed 180 feet from end to end of the main roof.

Each block has a partition wall in the centre which divides it into two or into three wards; the blocks nearest the centre are divided into two wards only; the four blocks furthest from the centre are divided into three wards each, namely, one large ward marked A, and two small wards one on each story, marked B. Thus there are four large wards and four small wards on each side, sixteen in all. In each block the front or south side is occupied by living rooms and dormitories, and the back or north side is occupied by a range of small rooms, the front or south wall of which will support on that side the floors of the larger rooms. The corridor of communication will run at the back of each block, the windows of the lower range of single rooms being placed above its roof. Means of ingress and egress are provided at the extremity of each block. In the large wards there is only one internal wall running longitudinally, but in the small wards there is a second wall running rather more than half the length of the ward and dividing off a passage leading to the dormitories and single sleeping rooms. This is a passage of communication only, and is lighted by windows in the inner walls of the dormitories and by a glass door opposite to an end window. With the exception of these passages fifty feet in length in the small wards, there are no internal passages or corridors or galleries in the whole of the building.

Tranquil and healthy patients will be placed in the large wards which are nearest to the centre, in order that they may more readily dine together in the refectory, and that the women may be near to the laundry and kitchen, and the men to the workshops. Patients suffering from bodily disease and from acute mental disease will be placed in the smaller wards; the wards especially devoted to the use of the sick will be those which are close to the residences of the medical officers; the excited and dangerous will be placed in the small wards in the retired blocks.

Accommodation in the large wards will consist of one large day-room from fifty-five to sixty-five feet long within the towers, according to the size of the several blocks. The width is twenty-three feet, the height is fourteen feet.

In addition to this spacious living room, there are two smaller sitting-rooms in the towers. Behind one of the sitting-rooms in the central tower is a bath-room common to the block; and the smaller sitting-room in front of this bath-room is to be used as an ante-room in connexion with it, when numbers of patients are being bathed.

Only four of the small rooms on the ground-floor of the large wards are to be used as single sleeping rooms by patients who would at night be liable to disturb the quietude of the dormitories in the second story. Three of these single sleeping-rooms do not open directly into the large day-room, but into a small lobby between each pair of them; the lower part of which lobbies is utilised as store-closets. There is a double water closet with its entrance lobby at the end of the ward nearest the centre of the block. The bath-rooms and water-closets are all brought near to the centre of each block, and in proximity to the cistern in each central tower; the supply pipes and drains are thus made as short as possible.

The second-floor in each large ward, twelve feet high, is devoted entirely to dormitories and single sleeping-rooms. All the single sleeping-rooms open direct into the room which is placed over the large living room in the floor below; a passage, however, five feet wide, into which these single sleeping-rooms open, is divided off from the large dormitory by a partition, only four feet six in height, however, so that any person on entering this floor, would from the passage have an uninterrupted view of the dormitory. The dormitory inside this partition is eighteen feet wide, so that two rows of beds placed opposite to each other would leave a passage of six feet; if the two rows of beds were placed facing the windows there would be a passage at the foot of each row of beds three feet wide, and each patient would have the sanitary advantage of facing the light, and no patient's head would be placed in the downward draught caused by a window. Between each two beds a seat or locker should be

placed, and by this arrangement without any second partition, the two rows of beds would be conveniently separated from each other.

The rooms in the towers at each end will form small dormitories of four beds, and the rooms in the central tower will form dormitories of seven beds; parts of these rooms must necessarily be occupied by stairs for access to the third stories of the towers, which will contain dormitories for the same number of beds. The upper stories of the towers in the whole asylum are thus good for the sleeping accommodation of 132 patients, namely twenty-two in each block.

Between the dormitory in the central tower and the large dormitory in the body of the block, an attendants room is partitioned off fourteen feet by eighteen feet. This attendants' room communicates with the two dormitories between which it is placed, by means of doors whose upper panels are made of perforated zinc, so that the attendants may be able to hear any unusual noise that may take place in either of the dormitories. The large dormitory between the attendants' room and the projection of the end tower is fifty feet long, and allowing five feet for each bed and its interval, will give room to place twenty beds; an additional bed might be placed in the inner line, but it is better to keep this place free for washing-stands. No wall or partition is placed between the dormitories and this end of the building, in order that the light from the end windows may not be interrupted, the light of an end window having always great effect in promoting the cheerful appearance of the room. A water-closet and a lavatory are placed on this floor above those in the floor below.

The following sleeping accommodation is thus formed in one of these large wards—Large dormitory twenty beds, two dormitories in the central tower seven beds each, two dormitories in the end tower four beds each; four separate sleeping rooms in the first floor, seven separate sleeping rooms in the second floor, = 53.

Arrangement of the smaller wards.—The half of the two blocks furthest from the centre on each side, is arranged in quite a different manner from the large wards, so as to provide a ward on each floor. In these wards such patients will be placed as are suffering from acute mental disease or from bodily disease, or from the infirmities of old age, or who are suicidal or dangerous to others and cannot be associated in the large wards; all patients, in fact, who need special care and supervision. These wards in the front blocks will be generally devoted to the infirm, and those in the retired blocks to the dangerous classes. The wards on the ground floor of the former will be used generally for that class of infirm patients whose condition will not prevent them from taking exercise in the open air. Aged and infirm people whose condition will prevent their taking open air exercise will be placed in the small wards of the second floor; the complement for these wards being made up by patients in better health to whom the use of the stairs will not be an objection.

The small wards in the retired blocks will contain what may be called the dangerous classes of the asylum community, and their classification in these wards will depend greatly upon their mental condition; practically it has been found advantageous to separate the merely noisy and excitable patients from those patients who are apt to indulge in acts of violence, the refractory class properly so called. Epileptics will, as a rule, be placed on the ground-floor and distributed according to their state of mental tranquillity between the small wards in the front and the retired blocks. Idiots and demented patients of good health will be placed in the large wards of the retired blocks.

The small wards on the ground-floor and those on the upper floor resemble each other in their arrangements, except that those on the upper floor have the additional sleeping accommodation for eleven beds which is afforded in the third stories of the towers.

The construction of the building in the small wards differs from that in the large wards by the addition of a second internal wall running longitudinally, and extending to half the distance between the corner of the central large tower and the end of the block, and cutting off a dormitory and an attendants' room to the front of the block, and a passage of communication of five feet in width between these rooms and the single sleeping rooms. This passage used only for communication will be lighted through windows in the wall of the passage by light transmitted through the dormitory and through the attendants' room. The dormitory twenty-two feet by seventeen feet will contain eight beds. The room in the central tower twenty-four feet and a half, by fourteen feet and a half, will also contain eight beds. The attendants' room placed between these two dormitories is arranged in a manner similar to that of the attendants' room in the dormitories of the large wards, affording an additional security to that of the night watch against nocturnal accidents. At the end of the block furthest removed from the centre of the building, is the day room, thirty-six feet by twenty-three feet, but encroached upon in one corner by the angle of the end tower. The room in this tower fifteen feet by fifteen feet is a second and smaller day-room for the separation or retirement of a few patients. There are seven single sleeping-rooms, five of which open direct into the passage of communication, and two of which open into the day-room The water-closet and lavatory are placed at the end of the ward nearest the centre of the block.

The accommodation of these small wards is, on the ground-floor two dormitories of eight beds each, and seven single sleeping-rooms = twenty-three beds. On the upper floor the same accommodation − one bed in the central dormitory and + eleven beds in the upper story of the towers = thirty-three beds.

The whole sleeping accommodation provided therefore, according to the proposed arrangement of beds, is in each of the eight large wards 53 beds × 8 = 424. Small wards on ground floor 23 beds × 4 = 92. Small wards on the upper floor 33 beds × 4 = 132. Total 648.

Four additional beds might be conveniently gained in each block by extending the central towers four feet forwards.

PAR

3

PAMPHLETS

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