SECTION III.

CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS,

By W. J. RUSSELL, Ph.D., F.R.S.

PRESIDENT OF THE SECTION.

"*A Sketch of the Chemical History of the Air.*"

I REGRET that my knowledge and experience of sanitary matters does not allow me to address you on a technical subject, appropriate to this Congress, and for that reason alone, were there no other, I think your Council have not acted judiciously in asking me to preside on the present occasion; but as they have done so, you must bear with me if I confine my remarks mostly to scientific matters and leave to you their application to practical purposes. I need not dwell even for a moment on the fact that sanitary science rests to a very large extent on pure Chemistry, and that the increased power which you have at the present day of doing good, depends on the advances which pure Chemistry has made of late years. Of the subjects with which the sanitarian has to deal, air and water are probably the most important. Water, from a chemical point of view, has I find been ably dealt with by a former President of this section, Dr. Dupré, and I have consequently nothing to say to you with regard to it, but I thought possibly it might be of some interest and I hope of some slight use, if I attempted to-day, to sketch very broadly the steps by which we have attained to our present knowledge of the atmosphere. It is a subject which in detail would require a history of Chemistry even from the earliest time, but I want merely to lay before you a brief outline of the campaign to show you how the subject has been attacked, how Generals have sometimes been victorious and been able to capture and to hold important positions, at other times how they have failed in their attacks, or even if for a time victorious

their gains have been of no avail, for their army would not follow and occupy the vantage ground which they had reached. And further, how the means of warfare has of late improved, and how rapid and important have been the victories of late years.

Obviously it is not possible to imagine people living on this earth and being unacquainted with certain physical effects produced by the air, it blew upon them and upon their habitations, as it does now upon us, and they accepted this as an obvious occurrence which happened as a thing of course; but the first thing they learnt with regard to chemical properties of the air, and that from direct experiment, was, that it increased combustion. They blew their fires, first no doubt by their mouths, which did not prove that it was the air that they used; but artificial bellows were a very early invention, and it is worthy of note that the great inducement to study the composition of air has been its obvious connection with combustion. It is easy to see how it came about that the physical properties of the air were the first to attract attention. Hero of Alexander, whoever he may have been, in his treatise on pneumatics, clearly described the salient physical properties of a gas, for he demonstrates that air is matter and occupies space, and he says it is constituted "of particles minute, and light, and for the most part invisible," and that these particles are in contact but do not fit into one another, but void spaces are left between, so that when force is applied the air is compressed, and customary to its nature, falls into the vacant spaces from the pressure exerted on its particles, but when the force is withdrawn the air returns again to its former position from the elasticity of its particles. Clearly then at least some two or three hundred years before the Christian era the physical properties of the air were well known, but with regard to its chemical action the only knowledge was that it stimulated combustion, as shown by the bellows, and that bodies would not burn without it. Anaxagoras said, "air was an element," and Aristotle made it, as every one knows, one of his four elements, not that their definition of an element would exactly agree with ours of the present day. Aristotle meant a distinct quality of matter, it typified to him all bodies that approached in nature to a gas, and it is interesting to note in passing how long it took, and how much experiment it required, to convince people that there really existed different kinds of air. The dictum that air was an element, and that it had certain physical properties, satisfied the world for centuries, and until experiments became more chemical in their character, and men began to study the permanent changes of composition which bodies underwent, little or nothing further could really be learnt about the air, and all were satisfied that their knowledge of the air was sufficient and complete; for even down to the middle ages the four elements theory of Aristotle was universally accepted, and now it is hardly a century and a-half since the air was shewn to be a mixture of two gases.

As I have already indicated, it is only the principal events that I can dwell upon, the mass of smaller events, so important in their aggregate, I dare not in this sketch discuss, so I pass at once to the work and views of Van Helmont, for with him really begin the chemical history of the air. He clearly establishes what was afterwards forgotten or ignored, that there are different kinds of air, for instance, his "gas silvestre" was carbon dioxide, and he states that it is formed both by fermentation and combustion; also he describes a "gas pingue" which is given off from dung and is inflammable, but notwithstanding his clearly distinguishing these gases from ordinary air, the world in general cared not for the distinction, and it was not till long after, that such a distinction was generally admitted and believed in. Although he did not hold to the doctrine of the four elements, for earth and fire he believed to be compounds, still air and water were to him elements. His work was principally done during the reign of our King Charles I.; he was born in 1577 and died in 1644. His work, which was remarkably original and suggestive, had not long to wait in order to bear fruit, for three Englishmen quickly succeeded him, to whom the history of the air owes much—I mean Robert Hooke, Robert Boyle and John Mayou. Hooke's "Micrographia" was published in 1665 and Boyle's first treatise in 1674. His "Memoirs for a general history of the Air" are full of interest and importance, giving the views and curious experiments of an able philosopher struggling with a physico-chemical investigation, and handicapped by the fanciful theories and superstitious feelings of former ages. Bravely and cleverly he works his experiments, and large is the amount of information which he obtains from travellers and others. Naturally the author of "Boyle's law" will dwell much on the elasticity of gases, and he always comes back to the spring or durable elasticity of the air as the quality which distinguishes it really from aqueous vapours and earthy exhalations. By means of the air pump he demonstrates that air is necessary for respiration, for motion, and in fact for the existence of animals. Then he goes on to try whether air can be "produced," *i.e.*, obtained in sensible quantity from bodies wherein it did not before appear. This is suggested by older experiments on nitre, for he says that learned men believe there to be a volatile spirit of nitre in the air, but from his experiments he does not find saltpetre to be volatile at gentle heat, and at high temperature it has quite different properties. Many of our experiments of recent times are foreshadowed, for he says much in his treatise on the hidden properties of the air, and on effluvia given off by the earth; he says for instance that probably the subterranean parts of the earth send up into the air peculiar kinds of venomous exhalations, that produce new mental diseases in animals of a peculiar species, and not in others. It is interesting his dwelling on this selective power. He further treats of atmospheric dust, and gives a general method for discovering the salts in the air. He uses the blackening of silver chloride as a test to be applied to air, and then describes celestial influences and claims for celestial bodies, that they exercise definite physical action on bodies on this earth, and makes a feeble apology for astrology. He is also doubtful, but rather leans to the view, that metals grow when dug out of the earth and exposed to air, and it is a question whether tin, silver, lead and gold may not be produced in this manner. Curious and interesting as the misconceptions of the philosophers of the time may be, the real interest centres very much in this being the dawn of our knowledge of oxygen, and I cannot but repeat —for I think others have said it before me—that the simple neutral salt, nitre, has proved itself to be one of the most interesting and important chemical compounds known to history —and why? principally, I think, because 50 per cent. of its weight is oxygen. It was well known to the alchemists, and they discovered how to obtain a "most active and fiery spirit" from it, and it was really a study of this salt which led to the first discovery of oxygen in the air.

We may thank the striking fascination there is about the phenomena of combustion for leading us to a knowledge of the chemical properties of the air. That air was the "food of fire," that air "nourishes fire," and that the bellows was a practical application of these facts was known from remote antiquity, that like phenomena could be produced by nitre was also known, and hence Boyle says that learned men believe that there is a volatile nitre in the air, and, undoubtedly, this is the popular theory of the day.

Lord Bacon says that nitre contains a "volatile, crude and windy spirit." Thunder and lightning even were accounted for by the presence of this body in the air. This theory arose in a most natural and logical way, for it had been clearly demonstrated that there was a similarity of effect produced by calcining a metal in the air and by heating it with nitre or with the spirit of nitre.

Hooke, in 1665, in the *Micrographia*, appears really to have recognised oxygen in the air, and to have described its most important properties, for he says that the dissolution of sulphurous bodies, by which he means combustible bodies, is made by a substance inherent and mixed with the air, that it is like, if not the very same with that which is fixed in saltpetre, and he seems to have been fully aware that this substance formed only a part of the air, for he says that the dissolving parts of the air are but few, whereas saltpetre abounds with these particles. Considering what followed, it is curious that so clear an account of the oxygen in the air should be given 227 years ago. These views of Hooke's were fully accepted and extended by John Mayou; in fact, in the treatise which he published at Oxford in 1674, he does not distinctly draw the line between his own experiments and Hooke's, but clear it is that Mayou made a large number of capital experiments and ably extended Hooke's views. He speaks of nitre air, fire air, nitro-aerial spirit, names which in fact he gives to oxygen, and he proves that a candle burnt in a closed vessel only a portion of the air is consumed, and shows that the air only in part consists of nitre air, whereas in nitre itself it exists in a concentrated form. He also states that the acid of nitre contains all the nitre air in nitre, but in it the nitre air is surrounded by particles of water, which tend to quench the burning body. The very name of oxygen he might have given to his nitre air, for he states that all acids contain it, that oil of vitrol, for instance, is sulphur united with nitre air; that wines become sour by absorbing it from the air, and that substances covered by fat or oil do not putrify. Again, he demonstrates that the increase of weight during calcination is due to the absorption of nitre air, and that in the case of the calex of antimony an exactly similar calex is produced by heating the metal with the acid of nitre and evaporating.

I must also mention that he proves that when camphor is ignited by a burning-glass in a vessel over water, the volume of air diminishes, and the camphor cannot again, either in such residual air or in air in which a mouse had been suffocated, be ignited. Many of his experiments relate directly to respiration, and he is aware of the connection which exists between respiration and combustion. Is it not evident, then, that at this time the main features of the chemical composition and action of the air were known and demonstrated by experiment? Still the world would not accept them, neither Mayou's contemporaries nor immediate successors would adopt his views, but what happened was that these very facts had, exactly 100 years afterwards, to be re-discovered by Priestley. Again I may group together three Englishmen who were the most active in furthering our knowledge of the air—Black, Priestley, and Cavendish. Black showed in 1752 that his fixed air was a totally distinct gas from common air, that it was not any kind of modification of it, produced by impurities or otherwise, as the various gases till then had generally been believed to be. Priestley without knowing it repeated Mayou's experiment, showed that the volume of air was diminished by combustion and respiration, recognised the character of the remaining gas, and called it phlogisticated air; he went, however, further, and made as he says this important and surprising discovery, that living plants could restore to deteriorated air the power of again supporting combustion. Now the world was ready and able to understand and to be interested in his many experiments with air, and the subject rapidly developes. Not only has he learnt the composition of the air, but he has the means of analysing it and, as he believes, of determining whether it be good or bad air. He has proved that the oxygen, or as he called it dephlogisticated air, is the active spirit of the air, all actions depend upon its presence, determine then how much there is in a sample of air and you will know its goodness; the whole matter seems clear and to have fallen into his hands, for he had lately discovered nitric-oxide gas, and one of its properties was to "devour oxygen," and thus could it be removed from the air to be tested. His accounts of these experiments is worth quoting; he says: "I hardly know any experiment that is more adapted to amaze and surprise than this is, which exhibits a quantity of air which, as it devours a quantity of another kind of air half as large as itself, and yet so far from gaining any addition to its bulk that it is considerably diminished by it." He goes on also to say that "this diminution occasioned by the nitrous air is peculiar to common air, or air fit for respiration; and as far as I can judge from a great number of observations, is at least very nearly, if not exactly, in proportion to its fitness for their purpose. So that by this means the goodness of air may be distinguished much more accurately than it can be done by putting mice or any other animals to breathe it." And well may he say as he does immediately afterwards: "This was a most agreeable discovery to me, as I hope it may be a useful one to the public." He has, moreover, another reason for being pleased with it, and it shows how the air had previously been analysed. He adds: "As from this time I had no occasion for so large a stock of mice as I had been used to keep for the purpose of these experiments." I must not stop to criticize his methods of analysis; he seems to have found the amount of oxygen in air to have been about one-fifth of its bulk, which was correct, but his method as an accurate way of determining small differences in the amount of oxygen, and thus, as he thought, of determining its wholesomeness, completely failed. He makes a great number of experiments, gets the worst kinds of air he can, and compares them with the pure air of Wiltshire, where he is living. Mr. Boulton, of Birmingham, sends him a variety of specimens of air from that manufacturing town; Dr. Percival sends him specimens from Manchester, but he is able to find only very small and uncertain differences in the contraction given by pure air and the worst air from the manufactories in Birmingham and the weaving shops in Manchester. He also tries to solve the questions whether the amount of oxygen in the air varies at different times of the year and in different states of the weather, but his conclusion is that his errors of experiment are quite as great as any difference which may exist; and he quaintly and honestly says, "When I first discovered the property of nitrous air as a test of the wholesomeness of common air, I flattered myself that it might be of considerable practical use, and particularly that the air of distant places and countries might be brought and examined together with great ease and satisfaction, but I own that hitherto I have rather been disappointed in my expectations from it." Still Priestley did much good and important work in this direction, and he called attention to, and made many experiments on, the air in ill-ventilated rooms, some of his remarks are rather curious and quaint, he thinks small dining rooms are rather preferable to large ones, because on opening the door a large proportion of the total bulk of air in the room is changed, but if large rooms are to be used then there must be an opening at the top of the room to let the bad air out. He describes also how, without attracting attention, he bottled up at a dinner party a sample of the air of the room, in an empty decanter, and found appreciably less oxygen in it than in the air from a well ventilated room in the same house, but I am afraid his analyses were not quite reliable, for on re-calculating his results, the pure air must have contained 25 per cent. of oxygen, and from some other comparative experiments he concludes that had the dining-room air received a little more than twice as much phlogistic matter as it was charged with, by the breathing of these eight or ten persons, the effluvia of the victuals, &c., a candle would not have burnt in the room, and the conclusion he comes to is, that the breathing such contaminated air for so long a time, as it is now the custom to do, at and after dinner, must be very hurtful; he consequently recommends that if such large dining-rooms are built, provision be made for letting out the vitiated air at the top of them, otherwise if it were not inconvenient on other accounts, it would

be better to have the dinner in one room and the dessert in another.

When we consider that these statements were made a century and a quarter ago, and at least express clearly the necessity and scientific principles of house ventilation, I am afraid we cannot pride ourselves on the advances we have made in these matters. Architects still build large dining rooms without the hole at the top to let the vitiated air to escape, and I have known cases in which it would have been more pleasant to have had dessert in another room.

Priestley to the end of his days believed in phlogiston, he never got beyond the idea that the air was a mixture of phlogiston and oxygen, which he called dephlogisticated air, this to him was really pure air, and what remained after combustion, although he knew the gas to be lighter than oxygen, and although Rutherford had described nitrogen, still it was to Priestley, phlogiston, or rather air saturated with phlogiston.

Following Priestley, other chemists, both in this country and abroad, adopted and modified as far as apparatus went, the method of air analysis, and imagined that they had demonstrated the healthiness or unhealthiness of different places by this means. Ingenhouse, for instance, found more oxygen in the air above the sea and on the sea coast, than at other places, and this explained their acknowledged healthiness, but by far the most important series of air analysis of the time were made by Cavendish and published in the "Philosophical Transactions for 1783." He with much care investigated this method of analysis, and pointed out how the Abbé Fontana's method, which seems to have been much used at this time, could be improved, and in place of measuring he weighs the air. He says that during the last half of the year, 1781, "I tried the air of nearly sixty different days in order to find whether it was sensibly more phlogisticated at one time than another, but found no difference that I could be sure of, though the wind and weather on these days were very various," also he tried "whether the air was sensibly more dephlogisticated at one time of the day than another," and also he tried "whether there was any difference between the air of London and the country, by filling bottles of air on the same day and nearly the same hour at Marlborough Street and at Kensington, but the result in all these cases was the same, the difference was never more than might proceed from the errors of the experiment, and by taking a mean of all, there did not appear to be any difference between them."

Thus ended, for the time at all events, this method of analysis, and the brilliant and important results most naturally expected were never realised. Chemists of all countries agreed in condemning the method and sought other means for determining the oxygen in air, but within the last two years it is interesting to note that a proposal has been made to revive this old method of analysis, and Messrs. Wanklyn & Cooper state that in their hands "the method proves to be both accurate, easy in manipulation, and applicable to cases in which the other methods cannot be applied," and that they are thus able to restore this old method to its proper place.

Although this nitric oxide method was the popular one of the time still chemists were busy trying other processes; Scheele had used a potassium sulphide and a mixture of iron and sulphur for the purpose, but not with satisfactory results. Guyton de Morveau, in 1788, used a solution of liver of sulphur, also an impure potassium sulphide, and at this time phosphorus came much into use, as an absorbent of oxygen. At first it was used in the state of rapid combustion, and Reboul describes different forms of apparatus for the purpose. Seguin and Berthollet use this method, and later, the more convenient process of the slow combustion of the phosphorus comes into use. Lavoisier, even in his paper on phosphoric acid published in 1777, states that the burning of phosphorus in ordinary air causes a diminution of one-fifth of its volume. The very large differences in the amount of oxygen in the air which chemists obtained testifies how imperfect were the methods then in use. They remained however faithful to the idea, that the amount of vital air present must measure the wholesomeness of the atmosphere, and were much astonished when Davidson found that the air of Martinique, when the yellow fever was raging, contained 67 per cent. of oxygen.

Volta, it seems, as far back as 1778, used the method of adding hydrogen to air and exploding the mixture, in order to get rid of the oxygen; but although even at the present day this is by far the most accurate process known, still at first it did not yield satisfactory results, in fact the method was not properly understood and practised until Bunsen clearly defined the proportion which the explosive gases must bear to the total volume of gas, for the whole of the oxygen, and nothing more, to be removed.

Davy and Dalton, specially the latter, worked much at the analysis of air. Davy proposed a method of absorbing oxygen by means of a solution of muriate, or sulphate of iron, saturated with nitrous gas, but he soon found the process could not be relied on, and was in fact worthless. Dalton, as late as 1802, speaks favourably for the nitrous gas method, and says: "It is not only the most elegant and expeditious of all the methods hitherto used, but is as correct as any of them;" but so impressed is he with the definite and multiple character of all reactions, that he finds that in a narrow tube 100 measures of common air combine with thirty-six of pure nitrous gas, forming nitric acid, and with double this amount—seventy-two volumes—in a wide tube forming nitrous acid, the residium in each case was seventy-nine or eighty measures of pure azote gas. He also experimented with Volta's eudiometer, but does not obtain accurate results, for he finds that 100 volumes of oxygen unite with 158 volumes of hydrogen. It is, however, but fair to say that the mean of his numerous analyses come surprisingly near to the true result, for he concludes that one hundred parts of air consist of seventy-nine parts of nitrogen and twenty-one parts of oxygen.

There remains but one other method for analysing air that I need notice, that is, by means of alkaline solution of pyrogallol. Chevreul proposed the use of this substance as early as 1820. When only small amounts of oxygen have to be withdrawn from a gaseous mixture the absorption is perfect, but when the amount is large there is believed to be an evolution of a small quantity of carbon mon-oxide, but we have it now on the authority of Hempel that if the alkaline solution be not too strong this error does not arise.

A sudden change now comes over gas analysis. I have pointed out how imperfect and inaccurate a process it was, suddenly it became by far the most accurate and refined branch of chemical analysis, and this was entirely owing to the ability and ingenuity of Bunsen. In 1857 he published his work on gas analysis, and showed how gases could be measured and how absorptions could be made with wonderful accuracy, and this work remains to this day a monument to Bunsen's ingenuity and skill as an experimenter. Like other processes when the highest degree of accuracy is aimed at, Bunsen's methods require a long time to carry out, and both Regnault and Frankland have suggested forms of apparatus, which, while attempting to retain the accuracy of Bunsen's method very greatly shortened the time which each operation requires. Frankland's apparatus, modified considerably from its original form, seems to stand alone for accurate and rapid work. For many purposes the utmost accuracy is not necessary and for such purposes the ingenious apparatus of Hempel is now much used.

We naturally now turn once more to the question, what have we learnt from these new and refined methods of analysis? Clearly we have learnt that, however accurate the determination of oxygen may be, it does not tell us what the wholesomeness of the air is, but it has told us that in free air there is always very nearly the same amount of oxygen; in fact, so little is the variation, if any, of the amount of oxygen in air from the higher regions compared to that on the earth's surface, from the northern regions compared to the tropics, of winter air compared to summer air, that like Priestley and Cavendish, we may say that the errors of analysis seem as great as any differences which may possibly exist, only now our errors are only $\frac{1}{1000}$th part of what they were in their time.

Probably the most accurate determinations of the oxygen in air were the 14 analyses made by Bunsen at Marbough, one of them gave 20·97, another only 20·84 per cent. of oxygen and the mean of all the analyses gave 20·93. This exact number is singularly confirmed by the 203 analyses made by Reiset of air collected at five different places and analyzed by three different methods. Hempel has also made of late years a large number of analyses; in the air from Tromsö he found 20·92; in that from Dresden 20·90; and in that from Paris 20·89 per cent. of oxygen. We have then a tolerably well established standard for pure air, and with the exception of sea air, which is probably rather richer in oxygen but about which more knowledge is required, any departure from this amount means that it has been taking part in chemical changes and that probably new products will have found their way into such air.

At the present time probably the most interesting results to be derived from the accurate determination of the oxygen in air are in relation to this point, the using up of the oxygen, for it is difficult to suppose that two or three hundredths of a per cent. of oxygen can in itself produce any appreciable effect either on respiration or combustion, but at present we have very little information as to the effect on ourselves of air containing less than the usual quantity of oxygen and no impurities in its place.

Ozone very probably is always present in normal air, but unfortunately we have no accurate method of determining its presence. Its formation probably arises from electrical action and directly or indirectly from evaporation. It is said that the quantity present in the air is greatest in spring and gradually diminishes till the winter when it is least, and that it is more plentiful in wet than in fine weather. The characteristic properties of ozone are shared by hydrogen peroxide, which Meissner in 1863 showed was also present in air.

I feel that I must pass very rapidly over the history of the other constituents of the air. I should have willingly dwelt on the variations of the amount of carbonic acid in air, for they are indications of changes of the highest interest, but I shall only indicate a few of the principal points connected with them. MacBride certainly proved, as long ago as 1764, that quicklime after exposure to air effervesced, and so demonstrated that ordinary air contained carbonic acid. Horace de Saussure was, however, the first systematically to investigate the subject, and in his "Voyages dans les Alpes" in 1796, showed that this gas existed on the mountains of Switzerland as well as on the plains. His son Theodore published a much fuller account of these experiments in 1830. The method used in determining the amount of carbonic acid present was essentially the same as that in use at the present day, namely, shaking up a considerable volume of the air with lime water, and estimating the calcium carbonate found, and the results which were obtained were fairly accurate and comparable among themselves, although probably rather too high.

From experiments, made between 1816 and 1828, Saussure finds in a wood at Chambesy, three-quarters of a league from Geneva, that the carbonic acid varies in amount from 6·2 to 3·7 volumes in 10,000 of air and he seems very early in his investigations to have attacked the questions of whether there is a distinct variation in the amount of this gas present in the day time as compared to the night, and in summer as compared to winter. His results are that during the day the average amount is 5·04, during the night it is 5·76 per 10,000 volumes, that during December, January, and February at mid-day the quantity is as compared with that taken at the same time during June, July, and August, as 77 to 100.

He also dwells on the curious accidental variations which occur; that in an extraordinary mild January the amount was 5·1, whereas the mean of many years' observations for this month was only 4·23, and that in August, 1828, which was remarkably cold and wet, the carbonic acid was only 4·45, whereas the mean of many years gives the amount as 5·68. Further, he shows that the air over the lake of Geneva contains less carbonic acid compared with air collected over the land, in the proportion of 98·5 to 100, and that the air of Geneva contained an average amount of 4·68, while that at Chambesey contained only 4·37; so that he really attacked and obtained distinct results on all the most important and interesting questions attached to the presence of this gas in the air, and modern research has confirmed his conclusions. With regard, for instance, to the day and night variations, Schulze made upwards of 1,000 experiments, and Levy 2,500, and Reiset, Armstrong, Muntz, and others, many more, and the mean of all these results is that during the day the amount is 2·99, and during the night 3·17, and the numerous experiments of Trucot also confirm this general result. No doubt this difference arises principally from plants decomposing this gas during daylight and exhaling it during darkness. With regard to sea air Thorpe's results show that the absolute amount is about normal, and that these diurnal variations do not occur. The amount of this gas in air is so small that the absolute amount is not appreciably diminished by rain. Still, small as it is, it has been stated that the absolute amount of carbon in the air is greater than that in all plants, animals, and coal formations on the earth.

With regard to aqueous vapour, which is also always present in the air, I have only to remind you of the large increase of amounts which can exist as gas in a given space with comparative small increase of temperature, that a cubic metre at the freezing point can hold in the gaseous form only 4·871 grammes of water, but that the same space at 20° C. can hold 17·157 grammes, and I would note that the usual means of estimating the amount present in the air are physical not chemical methods.

If any other gas has a right to claim to be a constant and appreciable constituent of the air it is ammonia, and Lawes and Gilbert state that there is about one part in one million of air.

Leaving now the purely gaseous constituents of the air, I have a few words to say with regard to the solid matter which it always contains. This solid floating matter in our atmosphere Mr. Aitken says, "is every day becoming of greater and greater interest, as we are gradually realising the important part it plays in the economy of nature, whether viewed as to the physical, physiological, or meteorological aspects." Until very recently we have only thought of gases and vapours as accumulating and taking part in atmospheric actions, but now we know what striking and important results are brought about by the particles of dust which are always present. The great Krakatoa eruptions of 1883 have shown how dust on a large scale may be ejected into our atmosphere, and how persistently it may abide there and circulate round and round our globe. Some two hundred other volcanoes add from time to time their contributions of small solid particles, the sea is continually adding finely divided sea salts, and we cannot ride, or walk, or carry on any mechanical operations without adding dust to the air, and certainly ordinary combustion must be charged with also adding much solid matter to the air.

The beam of sunlight no doubt revealed, even in the earliest times, the floating particles in the air, but no one thought much of them. It was admitted that every person in the course of a life of ordinary duration swallowed a peck of dirt, and there the matter ended. Astronomers told us that meteoric dust was showered on our earth, and that interested and surprised us, but

it really remained for Mr. Aitken to give a vital interest and importance to this subject of dust in the air. I wish I could do more than simply lay before you a few of the more important results which he had taught us. Until he demonstrated the contrary, it was a satisfactory conclusion that a simple diminution of temperature was sufficient to cause the condensation of aqueous vapour, and thus produce mist, fog or rain; but he has demonstrated that gaseous water may condense and transparency not be interfered with, and that the condensation is not a change which only occurs in a saturated atmosphere, and he says: "If there were no dust in the air there would be no fogs, no clouds, no mists and no rain." That it is these dust particles in the air which form the "free surfaces," which determine the aqueous condensation and give rise to so many meteorological phenomena. What is a haze? It may be a nearly dry dust cloud, or more likely a collection of dust particles clothed with moisture; the dust must be there, and if the air be very dry, except the dust be excessive in amount, the air remains transparent and we have no mist, but if air becomes more charged with water, each particle of dust will condense upon itself a mantle of moisture, and scattering the light, transparency ceases. Thus can a simple increase of dust particles produce a mist, also can an increase of aqueous vapour do the same. With a difference of 4° between the thermometer and only 550 particles of dust in the cubic centimetre, the air was clear; with 814 particles it was medium; but with 1,900 particles it was thick. Had the dust particles been entirely absent, no amount of increase in the humidity of the air would have interfered with its transparency.

In summer when the greatest amount of moisture is present, naturally does a haze form more readily than in winter; in July, with a temperature of 61° F., the air was thick, whereas in November, when the temperature was 50°, the air was clear, although if anything it then contained most dust; from an increasing load of moisture may a haze become a mist, a fog, or end even in a down-pour of rain. If the relative humidity of the air be small the competition among the particles of dust is great, the larger ones carrying off the lion's share of moisture, and you have a mist coarse in grain; supply more moisture, the larger particles are at least in part satisfied and the smaller ones can seize and hold their share of moisture and the constitution of the atmosphere is changed and with it the optical effects. So can mists be built up which will not only scatter light to different extents but will produce a selective action and yield most delicate and lovely colours.

I spoke just now of definite amounts of dust as present in the air and I must justify the use of such expressions. How can such determinations be accurately made, if I say it is by counting the number of dust particles in the air you may naturally consider it as a joke, and that the often suggested problem of counting the grains of sand on the sea shore is an easy task in comparison, but such is really the case. Mr. Aitken has most clearly shown how we may with ease and accuracy count the number of particles even of the finest dust which exists in air, and can even make sure that our task has been fully and accurately accomplished. I can here but indicate the principle of his method: each particle of dust he swells to a visible size by inducing it to condense on its surface a layer of moisture, it is a nucleus with a water covering, and if this be allowed to settle on a silver mirror each particle forms a drop easily visible with a magnifying glass. Take, then, a small sample of air, a known amount, say one or ten cubic centimetres, dilute it with air which is proved to be absolutely free from all dust particles, air filtered through cotton wool, saturate it with moisture, and introduce it into your flask with the mirror, so that a cubic centimetre of diluted air rests upon the mirror, then a stroke of the air pump causes condensation, every particle of dust becomes laden with its charge of moisture and falls upon the mirror. The mirror, which is one centimetre square, is crossed by fine lines dividing it into squares of one millimetre in size, and by means of the magnifying glass above, it is easy to count the number of drops in certain of the squares, and on repeating the experiment a correct average of the number in a square is obtained, further it is satisfactory to be able in the simplest way to demonstrate that all the particles of dust have been deposited. The experiment from first to last is quantitative, and a simple multiplication gives the number of dust particles in your cubic foot, or whatever measure of air you may like to use.

As a general conclusion it is found, as we should expect, that most dust exists in dry and least during wet weather. The following numbers obtained by Mr. Aitken show this, and give an idea of the absolute number of dust particles in air at Darroch, Falkirk, after a wet and stormy night: there were 119,000 dust particles in the cubic inch of air, but on an average on dry days there were 521,000, but in a room the number rose to 30,318,000 in the cubic inch. During the last two years Mr. Aitken has been indefatigable in determining the amount of dust in the air at different places, not only in Great Britain but also on the Continent; but for these results I must refer you to his papers, and content myself with only illustrating how delicate his dust test is, and how important this method of examining air must become. The air on the top of the Finouillet,

a hill 1,000 ft. high, situated in the centre of a plain near to Hyeres, one might expect to be exceptionally and continually pure, it was found, however, that never less than 57,000 particles in the cubic inch were present, and this impurity was traced to the houses of the peasantry and to villages dotted over the plain, and although the hill rises abruptly the polluted air came to the top of the hill, driven up the slopes by the wind. On the 4th of April the number of particles present was remarkably great, as many as 410,000 in the cubic inch, and this number remained fairly constant during the whole day. How at such a spot could such a result be accounted for? this is what Mr. Aitken says with regard to it: "On looking in the direction of Toulon, distant about nine miles, it was seen that the wind was blowing direct from that town, and bringing the products of combustion to the place of observation; the smoke being traced for some distance from the town, coming in a straight line towards Finouillet. At a later date Mr. Aitken, when describing his experiments at Garelochead on January 28th, 1890, says they were remarkable, as they record the smallest number of particles yet observed, and that "on this occasion there was great difficulty in getting clear of artificial pollution, the great purity of the air enabling the existence of a house at a distance of half a mile to be easily detected." These cases sufficiently prove to you the delicacy and importance of dust determinations.

As far as experiment has yet gone, even air from over the sea contains its charge of dust, and the purest air from such a source still had its 300 particles in the cubic inch; and often a dust storm mounts to the top of the Rigi Kulm, and the impure air of Paris may be found at the top of the Eiffel Tower. Continuous observations are now being made at the observatory on the summit of Ben Nevis, and here the most dust-free air has been found, for under exceptional cyclonic conditions only thirty-four particles were found in the inch. I have but indicated to you a few of the very interesting results which Mr. Aitken has obtained. His proof that dust can cause the deposition of moisture in air far from its point of saturation, and that this power varies with the nature of the dust and with its size, is of high importance; and all who study his experiments cannot but be impressed by the wonderful ingenuity and ability with which his experiments have been both conceived and executed. To collect the particles in a dusty air takes time, and the complete apparatus cannot be readily taken from place to place; we are therefore further indebted to Mr. Aitken for devising a small and portable instrument, the koniscope, for testing rapidly and easily the air in our cities and our rooms, an instrument which I doubt not the sanitary inspector will find of use. By means of it we do not attempt to determine the absolute number of dust particles in air, but we compel them to tell us by their action on a ray of light and the consequent colour produced, whether few or many particles are present. A short metal tube with glass ends, and supplied with moisture, is filled with the air to be examined; an attached air-syringe produces an exhaustion, and the accompanying decrease of temperature causes each particle of dust to become coated with deposited water; and now, on looking through the tube, there is no longer white light coming through, but the light is of a colour and intensity, which is dependent on the amount of dust present: either a series of colours may be produced, or it is easier to interpret the results by always producing a blue colour and judging by its intensity of the amount of dust present.

The succession of colours which can be produced by this instrument seem to follow the order of succession of colours in thin plates; there is, however, still much to learn with regard to the action of these different sized molecules of water on light, and we shall then know more definitely how the green and blue tints, which have from time to time been seen, are produced. (One of these instruments was exhibited.)

Mr. Aitken has roughly calibrated his koniscope by using the same air as in his larger and counting apparatus; and to make the use of this instrument clear, I would quote a few of his results. When air containing 820,000 particles in the cubic inch is experimented with, the bluish colour produced is only just visible; when 1,310,000 are present, the colour is a very pale blue; with 24,580,000 it is a fine blue; and with 41,000,000 it is a deep blue.

The following is Mr. Aitken's account of an experiment with this instrument, and it shows, as he says, how we may trace the pollution taking place in our rooms by open flames. The room is tested in every part, and the inside air gives, like the air outside, only the faintest colour. Three jets of gas are then lit in the centre of the room, which has the dimensions of 24 × 17 × 13 ft. Within 35 seconds of striking the match to light the gas, the products of combustion had extended to the end of the room, for the colours in the koniscope had become dark blue; in 4 minutes the deep blue producing air was found at a distance of 2 ft. from the ceiling, and in 10 minutes there was evidence of the pollution all through the room. It was strongly indicated near the windows, owing to the downward currents of cold air on the glass, and the impure down currents could be traced to the floor and onwards to the fireplace, while a pure current could be traced from the door to the fireplace. We can thus make impure air visible, and by this means we may be able

not only to enforce the necessity for ventilating, but may learn how ventilation can best and most surely be effected.

As briefly as I could, I have laid before you the most important steps by which we have attained to our present knowledge of the constitution of the atmosphere; we may sympathise with Priestley and with Cavendish in the percentage of vital air not proving to be the sole test of atmospheric purity and wholesomeness, but at the same time we cannot but glory in the vast increase of knowledge which has sprung up since their time, with regard both to the composition and functions of the air. I had intended to have said at least something with regard to the more purely sanitary aspect of this subject, but must now not do more than simply allude to one phase of the matter which seems necessarily to follow from what has been said with regard to dust. I mean how far micro-organisms may be looked upon as so much dust, and be expected to behave as dust. Our information on this point, I think, is still deficient; these organisms, I conceive, must have the same kind of action on aqueous vapour, as other small particles of solid matter, and form more or less active centres for its condensation, and I could have conceived of spores and organisms thus embalmed remaining in, and travelling with the atmosphere for long periods and great distances; but as far as direct experiment at present goes, Percy Frankland, and others, tell us of the strong tendency which organisms have, owing to their weight, of settling out of the air, and their existence in the lower rather than in the higher strata of the atmosphere. That at least in the city of London the numbers decrease very rapidly with elevation, for Frankland finds that 10 litres of air collected at the base of St. Paul's contains 56 micro-organisms, that the same volumes of air at the stone gallery contains only 29, and at the golden gallery only 11. That our air is largely charged with organisms, and with spores there can be no doubt; again quoting Frankland he shows that on one occasion at South Kensington, 279 were falling on a square foot of surface every minute, and that at Kensington Gardens and Primrose Hill, some 85 fell, from the Mount Souris observations it seems that the numbers increase markedly after rain, and in summer as compared to winter. I believe, however, it has been satisfactorily proved that great epidemics, such as cholera, plague, yellow fever, influenza, are not spread in their ordinary course by the air, that from numerous careful observations it has been shown that they do not travel faster than human intercourse, and we may be thankful that such is the case, for from our present imperfect knowledge it would have been readily conceivable that the causes of such pestilences might have been wafted for long distances, and have dwelt with their aqueous surroundings for long times in the air to have been precipitated at any moment on any part of the earth above which a sudden and sharp condensation arose. Actions of that kind to a small extent do occur, for the air in the immediate neighbourhood of infected spots, say a small-pox hospital, is known to be a medium by which infection can be spread to a short distance. The last century has then been productive of a vast increase of our knowledge of the air, and we may with confidence expect that in the coming century the increase will be even far greater.

Sir Charles Cameron (Dublin) said he did not think he had ever heard a more masterly exposition of the atmospheric air than that to which they had just listened. There were many persons who took no interest in the history of any subject whatever, and were inclined to look upon what was past as of no present interest at all; but that was hardly a philosophic way to look at things, and they learnt a great deal by studying the history of any subject. He had listened with great interest to the account of the early experiments with regard to the air, for there was no subject of greater importance to human beings than this, for they must remember that the weight of the air they breathed in a day was seven or eight times greater than that of the food and water they took in. He was especially interested in the latter part of the address, because there was nothing of more importance than the subject of aerial contagion, and Dr. Russell had shown how the air acted as a sort of aerial raft for disease germs. When making some experiments as to the sanitary condition of the Dublin barracks, he (the speaker) was surprised to find such different results in different parts of the building. The number of microbes in the air was fully three times greater in the dark part of the barracks than in the open squares. He moved "That the best thanks of this Section be given to the President for his lucid and interesting address."

Sir Thomas Crawford, K.C.B. (London), seconded, and expressed the opinion that the instrument for testing the air which the President had referred to was likely to be of the most important advantage to practical sanitarians, and that they were much obliged to the President for calling attention to it.

On Maps showing the Area of Chalk available for Water Supply in the London Basin. By W. Whitaker, B.A., F.R.S., F.G.S., Assoc.Inst.C.E., Assoc. Soc. Medical Officers of Health.

A good many years ago a set of maps was made, for the Metropolitan Board of Works, to show the area over which surface-water could get into the Chalk, the chief water-bearing formation of Southern England, in part of the London Basin.

Copies of these maps, and of others coloured in like fashion, were exhibited some years later (1883) to the Norwich Geological Society, when they formed the chief text of a Presidential Address.* Soon after (1884) these were again used at the Conference on Water Supply at the International Health Exhibition in London, when they were described from a different point of view.†

The meeting of the International Congress of Hygiene in London in 1891 seemed to be a fit occasion for the exhibition of a more extensive set of these maps (which had been made for the Geological Survey) and for the communication of a short note thereon. The maps were exhibited at the Museum in Jermyn Street, but the paper was not read (having been sent in too late to find its proper place in the Engineering Section), though a short verbal explanation of the maps was given in the division of Demography, at the request of the authorities thereof.‡

Since then some further work has been done, and some notes are now added to the unread paper referred to above, in the hope that this may be made acceptable to the present Congress.

On ordinary geologic maps large tracts are shown consisting of Chalk, where, as a matter of fact, it is rarely at the surface; but as on such maps, and also on the earlier Geological Survey maps, the Drift is ignored, a mistaken idea became prevalent that

* On Some Geological Conditions Affecting the Question of Water Supply from the Chalk; *Proc. Norwich Geol. Soc.*, pt. viii., pp. 285-294 (1884).

† The Area of Chalk as a Source of Water Supply; *Journ. Soc. Arts*, vol. xxxiii., pp. 847-851. Reprinted in the "Report of the Conference on Water Supply," issued by that Society, and in "Health Exhibition Literature."

‡ An abstract of the paper is printed in Section vii., Engineering, p. 144 of the Report of that Congress, 1892.

over all, or nearly all, the tracts coloured as Chalk, that rock is accessible to water from the surface, and erroneous estimates of the area of Chalk available as a gathering-ground for water have therefore been made.

That the whole area usually coloured as Chalk is available as a gathering-ground is, however, not the case; for where Glacial Drift is present in force a thick mass of Boulder Clay generally comes between the Chalk and the surface. Where, too, there is none of this Drift the higher parts of the Chalk are often covered by irregular sheets of a more or less clayey deposit. In the lower grounds, too, the loam of the River Drift is of effect.

It follows, therefore, that only in those parts where the Drift and all surface-deposits have been mapped in detail can we tell, with any approach to exactness, over what areas rain can get into the Chalk, and can become available for underground water-supply.

This is the reason for the westerly boundary of the set of maps exhibited. We are not yet in possession of the Drift-mapping further west; but as this is published the maps can be extended. As to Chalk tracts beyond the London Basin, these maps can be made for the northern tract (Lincolnshire and Yorkshire) and for the Isle of Wight, but not for the rest of the Hampshire Basin.

Though based on geologic maps, these maps are not themselves strictly geologic, with one exception at least, the part coloured as bare Chalk. Passing from this to tracts otherwise coloured on the maps, it is well firstly to note that the colours do not show the permeability, or the reverse, at the surface. There are many tracts of permeable beds which, as far as accessibility of water to the Chalk is concerned, are impermeable, the porous beds at the surface being separated underground from the Chalk by less porous, or perhaps by impervious beds. On the other hand, however, all tracts that have impermeable beds at the surface are, of course, shown as such, though not separated from other tracts where the impermeable beds are underground.

It will be seen therefore that, in constructing these maps, underground as well as surface geology has to be considered: one must take into account the underground extension of impermeable, &c., beds, a matter often of some difficulty, and sometimes involving the consideration of troublesome questions of stratigraphy.

The first description of these maps was from a geologic standpoint, the effect of the different beds being noticed in their stratigraphic order. The second account was from the standpoint of permeability, showing how the various divisions of the maps were made up. It will now be enough to describe these divisions, taking them in order of permeability, the reader being referred to the two papers in question for some matters of detail.

1. *Bare Chalk.* This division, coloured carmine, is taken direct from the Geological Survey map, on the scale of an inch to a mile, plain copies of which have been used for the set of maps exhibited. This, however, is the only case in which a geologic colour is absolutely followed, on account of the other divisions often depending on underground beds, and not only on beds at the surface.

Even in the case of the tracts coloured as Chalk there is sometimes an element of doubt, as soil often runs over the Chalk, which, though unmappable, may yet be of some effect in regard to the access of water to the Chalk. Where such soil is sandy, as is often the case, it probably makes little or no difference; but where clayey it may to some extent hinder the absorption of surface-water. It should be understood, therefore, that even over the area coloured as Chalk there may be spots where rain cannot pass at once into that rock. The basal part of the Chalk, too, is mostly somewhat clayey.

2. *Chalk covered by Permeable Beds.* Over the tracts marked by an orange colour the Chalk is covered only by beds that are practically permeable, such as gravel and sand. In other words, in these tracts nothing impermeable is known to come between the Chalk and the surface of the ground, the whole of that space being filled by permeable beds.

In many cases such tracts allow the access of surface-water to the Chalk about equally with tracts of bare Chalk; but in places where there is a fair thickness of permeable beds, some delay would occur in the water getting into the Chalk, and the supply might suffer slight loss. Moreover, there is sometimes, of course, a possibility of the presence in the permeable beds of unexpected masses of a less pervious character, which would have a like effect. On the other hand highly permeable beds often allow the downward passage of water much more rapidly than Chalk does, and for this reason a larger amount of water may sometimes get into the Chalk through a capping of permeable beds than would over bare Chalk; and this holds too where there is a sandy soil, as above-noted, on the Chalk. By sinking rapidly through some thickness of permeable earth water would be saved from evaporation.

3. *Chalk protected by Beds of Mixed or of Varying character.* In such questions as that under consideration, and indeed in most others where there cannot be absolute certainty, the spirit

of compromise should influence doubtful cases. It was soon found, in the progress of the construction of these maps, that there are beds that refuse to range themselves under the precise headings of permeable and impermeable. Some of these beds regularly take a middle place, being of such composition as to belong to neither class, but being partially permeable. Others have a varying composition: at one place all sand, at another all clay, and at yet another a mixture or an interweaving of the two. It being generally impossible to pick out these varying parts, they have to be treated together as a whole. In all cases where such beds as those described occur anywhere between the Chalk and the surface, and where no wholly impermeable beds also occupy that position, a green colour has been used.

4. *Chalk protected by Impermeable Beds.* We now come to the tracts that are unprofitable, or mostly so, as regards contributing to the store of water in the Chalk, though even here a gleam of light breaks through the darkness. In those parts coloured grey there is, somewhere above the Chalk, an impermeable bed that is enough to keep water from the surface above from sinking into the Chalk. This impermeable bed need not be at the surface, nor need it rest directly on the Chalk; it may come between permeable beds, but the effect will be the same.

It is found, however, that over tracts, sometimes of fair extent, where the direct sinking of water into the Chalk is thus barred, the rain that falls on an impermeable surface, or that sinks to this through overlying permeable beds, flows toward the outcrop of the Chalk, or to where the Chalk is covered only by beds allowing the downward passage of water. Then the small streams often sink into the Chalk, either wholly or partly, sometimes through overlying pervious beds, sometimes direct; and thus the impermeable tract contributes somewhat to the water stored in the Chalk. The swallow-holes that often mark the junction of the Chalk and the Tertiary beds are a notable case in point, and where these are frequent much water must pass down through them. Sometimes too artificial swallow-holes, made for drainage purposes, also contribute.

In consequence of this the grey areas have been sub-divided, a lighter tint being kept for parts where the drainage is toward the Chalk, a darker tint being used for the parts where the drainage is away from the Chalk, and where, therefore, no water can get into that formation. This is on much the same principle as that which gives the deepest black to the greatest heathenism, on missionary maps.

There are cases where the grey colour has been used with some doubt. In parts of Norfolk and of Suffolk, the Boulder clay is perhaps hardly to be called impermeable. It is some-

times rather sandy, more of a loam than a clay, and sometimes very chalky, being indeed mostly made up of pieces of Chalk in a chalky matrix. Here too this division of the Drift is generally of no very great thickness. In some places on the maps the partially permeable Boulder Clay has been marked by a border-line of green. The difficulty occurs only in parts that drain towards the Chalk, and where therefore the lighter tint of grey has been used.

While in many points these maps do not pretend to great accuracy, which is often indeed quite out of the question, there being so many doubtful points; yet, in all likelihood, such errors as must creep in are not great, and more or less balance one another, being sometimes one way, sometimes another. It must be clear of course that the special circumstances of various districts must be the subject of special enquiry, the maps being made for the consideration of the general question.

The making of these maps having been extended since they were described in 1884, it may be useful to give a list of those that have been done. In the following table the numbers are those of the sheets of the Geological Survey (or old one-inch Ordnance) Maps that have been used, and, as it is not always easy to make out the arrangement of the numbers, these are given so as to show the relative position of the sheets:—

			69	68	
			65	66	67
			51	50	49
		46	47	48	
34	13	7	1	2	
14	12	8	6	3	

Sheets 2, 49 and 67 (in small figures) refer wholly to tracts over which there is no access of water to the Chalk, and so are needless; they have been inserted merely to take the eastern boundary to the coast, from Norfolk to Kent. The northern boundary is the northern coast of Norfolk.

Sheets 12, 13, 14 and 34 have been done (or partly done) only lately, for the special use of the Royal Commission on Metropolitan Water Supply, use having been made of the MS. Drift work on the new Ordnance one-inch sheets; but those tracts outside the Thames Basin have been disregarded, the enquiry of the Commission not going beyond that geographic district, which is far from the same as the London Basin, a geologic district. These four maps, as well as 46, are as yet imperfect, there being still some small tracts in which the Drift survey is not done; but with these exceptions the whole of the London Basin is in hand.

As sheets of the new one-inch map are published, with Drift, by the Geological Survey, it is hoped that the work of making the set of maps now described may be continued on them, and that their accurate topography will be of advantage, as compared with the more sketchy character of the old maps.

The Chairman (Dr. Russell) said that they had heard with much interest Mr. Whitaker's remarks. The great importance of pure water had been certainly impressed upon them of late years, and it had been proved by experience that the water held in the chalk—that big sponge—was in some respects the purest and the best adapted for domestic purposes. Such being the case, they must thank Mr. Whitaker for his important survey, and the time and trouble he had given to find out where that big sponge with the chalk water was. At the present time especially the question was of great practical importance.

Mr. Rogers Field, M.Inst.C.E. (London), asked if the drift maps shown by Mr. Whitaker were similar to those recently published, and received an affirmative reply. He said that he had often to investigate the question of water supply and sewage disposal, and found that the ordinary geological maps were misleading, because it frequently happened that where chalk was shown on the maps they found stiff clay, and where clay was shown they found gravel. He should be very glad if the new maps shown by Mr. Whitaker were published for all parts of the country. Anybody who studied the question would see that the drift was of vital importance as regards water supply, for if they calculated on finding an absorbent subsoil such as chalk over a certain number of square miles and actually found it only over half of the area it entirely altered the problem. The drift maps were also very useful for questions of sewage disposal, and in several cases where he had had the opportunity of testing them, he found them remarkably accurate.

Mr. Henry Law, M.Inst.C.E. (London), remarked that Mr. Whitaker had told them of the circumstances which affected the entry of water into the chalk, but there was another important question which affected the water supply—its escape from the chalk. They might trace along the seashore in many parts, and in the Valley of the Thames, enormous volumes of chalk water running to

waste. In an investigation he carried on for two years in connection with the Metropolitan Board of Works (their object being to try and obtain a supply of water from the chalk), they found chalk water escaping into the bed of the river in the neighbourhood of Brentford, at the mean level with the tide. At Erith, too, they might see it escaping. The bed of the Thames from Vauxhall to Deptford was clay, which prevented the escape of the water, but at Erith they found water from the chalk which had fallen from higher levels now escaping into the river. He thought that if they sank deep wells and pumped they would lower the level of the water, and save a great deal which at present escaped.

Mr. F. Peake (Croydon) said he should like to mention a few facts relative to a supply of water from the chalk. He believed there was no doubt that water is obtainable at 100, 200, or 300 ft. down to the sea level. At about half-way between high and low tide on the beach there was fresh water. That he had often taken a drink from the beach under the cliffs of the South Downs. The owner of the estate of Blatchington, in making a pond on the Downs (about one mile from the sea) for his sheep, sank an artesian well, which now supplies the towns of Seaford and Newhaven. Brighton is nearly all supplied from a well sunk to the sea level, about one mile from the sea, which gives a constant and abundant supply. When he was at school on the hill at Brighton the well in use was he thought about 300 ft. deep down to the sea level. This was many years ago, long before waterworks and water companies were thought of.

Dr. J. Groves (Carisbroke) urged that it was very desirable that the geology of the chalk should be understood by the medical officers of sanitary authorities. The greatest mistakes were made by a want of knowledge, and he was afraid that even in that important community (Portsmouth) there were many persons who did not know the geology of the country about them. There were certain trustees of some property he knew who sank a well in the tertiary clays close to the chalk. They went down 200 ft. and found no water, and they gave up the attempt at last owing to the urgent representation of the local sanitary authorities, but they were very persistent in trying to get water from the tertiary beds for some small cottages, although it was near the surface in the chalk close by. He thought that all sanitary authorities ought to be compelled to provide themselves with these records of the valuable and important work done by Mr. Whitaker and his colleagues. The water taken for towns often prejudiced the local supply. It was thought possible in one instance he knew to supply a town of 10,000 or 12,000 inhabitants with water from a country district four miles off, and the landlord there sold his water, both surface and underground to the Corporation, who sunk a deep well and pumped from the green-sand. The result was, that they deprived all persons in the neighbourhood for a quarter of a mile round of their water supply, and those people had now been for five or six years without water. They had had private inquiries of the Local Government Board, and had been trying to persuade, urge, or cajole the landlord into doing something, but they have not been able to get anything done yet, and the law did not go far enough to help them. If a house was without water they could not under the existing law compel the owner to provide a supply if the cost exceeded about £9, or in exceptional cases, with the sanction of the Local Government Board, the cost must not exceed about £13.

Dr. A. Newsholme (Brighton) asked if Mr. Whitaker had seen certain articles that had appeared in the *British Medical Journal* dealing with the water supply of London, in which the writer stated that the water from the chalk was diminishing, the landscape was altering, the tree growth was less vigorous, while the level of the water in the wells was being reduced. Of course, if that was correct, it meant that London would have to go for a water supply to a greater distance, and there had been a question whether that supply could be obtained from the South Downs. Would there be a sufficient store there for that supply without being in any way detrimental to the towns already supplied from this source?

Mr. Washington Lyon (London) asked if it was possible to get sufficient water from the chalk under London to supply that city by sinking wells in the centre of London. A well had been sunk there and a large quantity of water obtained. It was sunk by the Commissioners of Sewers for the City of London Artisans' Dwellings. The point was an important one, as supposing they could get so much water from that source there would be no necessity to go so far away for a supply.

Mr. W. Whitaker, F.G.S. (Southampton), in reply, said there was a peculiar weakness among agents for the Drift maps, for when asked for a Geological Survey map, they would give an old one if possible. There was a Royal Commission eight to ten years ago, engaged in examining the question of the pollution of the Thames, and the points they had to consider were:—(1) Whether the Thames was polluted, and (2) Whether they could prevent it. He was requested to give evidence, and was told that the Commission was supplied with Geological maps, but on attending, he found that they were the wrong kind, and it was not until he produced the Drift maps that the Commission saw that the question of application on land ought to be inquired into. Nothing special came of that Commission, but he mentioned the circumstance as showing that the old maps were not only useless but misleading, in such a case, as the Chairman (Lord Bramwell) said. With reference to saving the escape of water mentioned by Mr. Law it was a large and difficult question, things varied so in different places that it was really a troublesome question to deal with. It was true that when they got a free margin of chalk close to the sea they nearly always found springs issuing, and they might even put their hands down into the sea there and get water tolerably fresh. There was a case at Brighton where a large quantity of water was got. When they were constructing the sewerage works they had to cut along the cliffs, and they were nearly flooded with fresh water. In some places near the sea they might sink wells and get good water, in others they could not do anything of the sort. They might sink wells in some districts a mile away from the sea and pump up salt water. There were parts of the Essex Coast where the majority of the wells gave more or less salt water, and there were cases in the neighbourhood of London, comparatively near the banks of the Thames, where wells yielded salt water, although not far off there might be fresh water springs rising from the Chalk. In one place, a little way off the Thames, fairly fresh water was obtained from the higher part of a well in the Chalk, but the deeper they went, the salter it got, and in the end it was found necessary to stop the lower part of that well and stick to the supply from the upper part. One speaker (Mr. Peake) had stated that the lowest well at Brighton was only 50 feet deep; but he had been down 150 feet. They had a good supply there and would not need to go deeper. Sinking a well in the Tertiary beds, as Dr. Groves had described, was a risky thing to do, it was not stated where that had occurred, but the best thing to do at Portsmouth was to take what the gods provided, and be supplied by the Waterworks Company rather than sink wells. As a rule he did not like Water Companies, he preferred municipalities, but he must give the devil his due, even if it were a water company.

There was a great defect in the Government organisation for the sale of maps. He believed he was the only person who had been allowed to go into the Ordnance Survey Office and get a map direct (since saying this the privilege had lapsed). The maps were prepared at Southampton, but even there they must get them through the agent appointed by the Treasury, so that the maps must go from Southampton to London and come back again, because a man in London paid £600 a year or so for the right of sale. While that sort of thing went on what could they expect? He contended that all these Government maps should be more easily obtainable, say, by being on sale in the Post Office in every large town. He should like to compel sanitary authorities to buy these maps, provided they could get them at a reasonably low rate. No matter what they cost they ought to be supplied cheaply, and if necessary be paid for out of the rates; the Government of anything but very poor nations ought to be above the notion of considering repayment by sale in such matters.

As regarded the question of supplies: if they had two pumps working and the larger pump took all the water, it was right it should do so, provided proper arrangements were made for supplying those who had been using the smaller pump. When a town-supply was being established in a district, arrangements ought to be made by the people of that district to protect their own interests. No big town should be allowed to go into a country district and take the water without giving compensation for it, say, by supplying the people with water at a reasonable rate. At Southampton they had to go beyond the municipal boundary to get a large supply from the chalk. The local authorities in the villages protested, and the Corporation of Southampton said they would put up standpipes supplied from their mains, and the people could help themselves as much as they liked, and it cost the Corporation practically nothing. Of course if they had been dealing with a larger body, they would have had to offer to supply them at a low rate. Poor people suffered sooner than anyone else in this respect, and they really wanted a central authority to deal with such matters.

With respect to the case of Ryde, mentioned by Dr. Groves, the authorities ought to have offered a supply in place of that which they took away. Mr. Law had reminded him that there was no legal right to underground water, but there were more ways than one of killing a dog. If a small local authority objected to the action of a large Corporation in acquiring water in its district, both the House of Lords and the House of Commons would consider the equity before they looked at the legal side of the proposal, and they would say that the big corporation should supply the smaller authority. He had not seen the articles in the *British Medical Journal*, but they seemed to have some truth in them. As to the alteration in the face of the country, he was not prepared to say that the taking of water from any Chalk spring did not cause a change, but the face of the earth was always changing, though they would want "a double million magnifying glass" to see it, in such infinitesimal proportions was the change being effected. As to altering the water-level there was no doubt about it. If they took water at one spot, they must necessarily pull down the water level all round unless more went in. Then as to the question of the limit of water supply to London from the Chalk being reached, he should say that the limit had not been reached or anything like it except in the central parts of municipal London. In some places no doubt the limit of supply, without causing disastrous consequences, was near, but it was hard to say when it would be reached. Then as to the question whether it would affect the supplies from the South Downs; certainly not, that track was wholly away from the London Basin, but it would probably affect the springs and local supplies in the London Basin. There was a large amount of water in the Chalk, and in places a large quantity running to waste which might be taken without disadvantage to anyone.

The well in London which had been mentioned, was only one of hundreds. Say that there were 200 altogether, and what was the result? Why, that in nearly all, the water-level had gone down greatly, and some of them had almost failed. In London itself they were very near getting as much as they could out of the Chalk, which was less water-bearing beneath the great thickness of Tertiary beds than at its outcrop. With regard to that particular well, if the Corporation of the City of London had asked him about it before they began, with reference to a *large* supply of water being obtained, he should simply have answered "No." For all practical purposes he thought the money was thrown away, and if 10 per cent. of it had been put into his pocket instead of spending it in that way, the rest would have been saved. The cost of pumping that water and supplying the buildings, according to the Corporation's reports, was some five times what they would have to pay to the Water Companies for the same thing. Being a rich Corporation they were right perhaps to try the experiment, but most folks who knew anything about it, would have guessed what the result was likely to be—that they would fail to get a large supply. If they thought that they were going to get water by simply sinking a shaft they were mistaken; to get a large supply, they must, as a rule, do large works, in the shape of driving horizontal galleries from the shaft, as had been done in various places. They had done it at Brighton, and as he should show later on, Portsmouth was unique in having a large supply without that trouble and expense. They had plenty of water at Southampton, but they had to spend money and do work for it. In nearly all large supplies they had to drive galleries as well as sink wells; they did not trust to shafts, which might or might not give a continuous supply.

On "Exhalation of Vapour from the Earth," by Hon. F. A. R. Russell.

In the course of observations on the deposition of dew and frost during 1891 and the present year, I had occasion to notice the considerable part played in dew-formation by vapour emanating from the upper stratum of earth, and especially of a sandy soil. Out of many observations I will select only a few which will typically illustrate the nature of the results obtained in a variety of circumstances. The results, as regards earth and surface temperatures, as well as the amount of condensation, refer to a locality on the south-western border of Surrey, a small level plot on an exposed ridge 630ft. above the sea. This situation favours equability rather than wide differences of temperature.

On June 10th, 1891, two tin pans, $21\frac{1}{2}$ in. in diameter and 4 in. deep, which had been exposed on the previous evening on the short grass of a lawn, were examined. One had been placed in the ordinary position and the other inverted. The inverted pan permitted a little air to enter under the spout, and also, to a less extent probably, under the rim. The first pan was only slightly dewed on the exposed surface; the inverted pan was slightly dewed on the exposed outer surface, but very heavily in the interior. The night was fine with little wind.

On June 11th, 1891, four glass tumblers were exposed about 8.30 p.m. No. 1 was placed upright on the grass; No. 2 was inverted on the grass; No. 3 was placed on the garden soil of a flower-bed which was dry to the depth of a quarter inch from the surface; No. 4 was inverted on the same soil, and the rim sunk to a depth of about a quarter inch in the soil. On examining the glasses, which were still in deep shade on June 12th, at 8 a.m., No. 1 was found to be slightly dewed on the interior at the bottom of the glass; No. 2 was very heavily dewed on the interior, the quantity of dew increasing from near the ground to the upper part of the glass. On the outside of this glass there was a moderate quantity of dew on the top. No. 3 was scarcely dewed at all; No. 4 contained a moderate quantity of dew on the upper part of the interior. It may be mentioned that the dew on the outer surfaces had been partially dried off by a northerly wind.

On June 13th, 1891, a tumbler which had been inverted on the lawn was found heavily dewed on the inside all over, and on the top outside. A brass tray, about 10 in. in diameter, which had been inverted on the grass, was found to be scarcely at all dewed on the top, but very heavily dewed with large drops on the inside. A china tray, 7 in. in diameter, was found rather heavily dewed outside; very heavily on the under surface.

On June 15th, at 8 a.m., a round earthenware cover was found to be not perceptibly dewed on the outside, but the interior surface was very heavily dewed with large drops, which ran together on disturbance. An inverted glass tumbler, which had been similarly exposed, was heavily dewed on the upper part of the outside, and also on the inner surface. A glass lying on its side was heavily dewed on the inner upper surface and on the lower outer surface, but not at all on the sides; the upper outer surface was only slightly dewed. A glass, which had been inverted on a square flat china plate, which was figured with a raised pattern so that air could pass into the tumbler rather freely, was found heavily dewed on the top outside and only slightly on the top inside, the rest of the inside being undewed. The china plate, which was very slightly raised above the ground by its edges, was slightly dewed outside but very heavily dewed on the side facing the grass. The grass was not very wet, the dew during the night not having been a heavy one.

On June 17th, 1891, a flat china plate 7 inches square, raised about half an inch above the ground by four feet, was

found at 7.40 a.m. to be heavily dewed on the top, and still more heavily underneath, yielding, on being turned edgewise, a teaspoonful of water.

On December 19th, 1891, with fine weather and hard frost, the under sides of ferns and the leaves of bushes were found lightly, the upper sides thickly, frosted. Where there was thick fern between these and the ground there was no frost on the under surfaces. Leaves of bushes on open ground had a little white frost on the upper surfaces and films of transparent ice on the under surfaces, formed probably by the freezing of deposited dew. The weather of the previous three days had been clear, bright, and frosty, with very light airs or calm.

On December 20th, 1891, a tumbler, which had been inverted and driven firmly into the hard-frozen earth, was rather thickly frosted outside, moderately inside; one on a gravel path was similarly frosted. Two tumblers placed on the lawn were heavily frosted outside, moderately inside. The ground was quite hard during night and day.

On December 21st, 1891, leaves lying on the ground were much frosted on the top, and about half as much underneath. Stones of sandy composition were not frosted on the top, but much on the under surfaces, especially where touching and about half embedded in the ground. On being taken up, many of these stones carried some of the sand or earth with them. I was unable at the time to perceive the reason for the excess of frost on the under surfaces, which seemed contrary to the theory of dew as generally stated. Sticks were less frosted on the under than on the upper side. Thick planks, about two inches thick, some raised about one foot and some a few inches above the ground, were about a third as much frosted on the under as on the upper side.

In the night of June 28-29th, 1892, thunder-showers fell, the earth at the time being very dry. On June 30th the weather was very fine, dry, cold, and still, with a slight haze. At 5 a.m. on July 1st, a plate which had been inverted on the lawn on the previous evening was found thickly dewed on the top, but much more so on the downward face, so that forty-nine drops fell from the lower surface alone. A square white china plate, raised about half an inch, and having an inverted tumbler upon it, was thickly dewed on the top, but much more on the lower surface, from which forty-two drops fell. A flat brown earthenware plate was similarly more heavily dewed on the side resting on the ground. A tumbler inverted on the grass having a plate upon it, another tumbler being inverted on this plate, was thickly dewed outside, and on the lower half of the inside. The plate was thickly and about equally dewed on the upper and lower surfaces. A plate with its edge raised and resting on the white china plate was found to be thickly dewed on both surfaces, most on the outside where most raised, and on the inside where lowest and nearest the earth.

At 7.30 a.m. the objects which had been left out since 5 a.m. were found to have notably increased their load of dew. The inverted plate had gathered so much that forty-two drops fell off it on being held edgewise, in addition to the forty-nine acquired during the night. A tumbler further exposed from 7.30 to 9 a.m. increased its deposit, became clouded, and even showed small drops inside near the grass. The shade from the hedge at this time was not deep, and the sun shone upon the grass about six feet distant. The night and morning were very fine, the minimum temperature was 39°, the temperature just above the ground at 5 a.m. was 46°, at 9 a.m. 53°, at three inches deep in the soil 51°, both at 5 and at 9 a.m.

It appeared from these last observations that in a state of soil forty-three to fifty-three hours after a thunderstorm following dry weather, the intervening days being fine and dry, a very much larger quantity of dew was deposited from emanations from the ground than from the open air, so that an exposed freely radiating surface was very much less wetted than an inclosed surface facing the ground and not radiating freely. The same conclusion holds good for the morning hours after sunrise, when the air and surface of the ground have greatly risen in temperature. The rate of evaporation from the earth seemed actually greater when the *surface* of the earth was colder than the air, than when it was warmer. Since a large quantity of dew is deposited in a tumbler raised a little above the earth, but a small quantity in a tumbler raised above a china plate, permitting equally free entrance of air, it appears that a great portion of the dew deposited on such a night is from emanations from the earth.

On July 2nd a tumbler, which had been inverted on bare dry garden earth on a slope facing west, and had been sunk one inch in the powdery soil, and banked so as to prevent ingress of air, was found to be little dewed outside, moderately inside. The earth was dry and dusty down to one inch. A plate which had been inverted on the lawn, where the earth was dry down to about half an inch, was found moderately dewed outside, but the inside was very heavily dewed, giving 62 drops. The night had been fine.

On July 3rd, at 5.30 a.m., a plate which had been inverted on the lawn gave 50 drops from the inside, and a plate which had been inverted on a sandy, dry gravel path gave 34 drops. The edges of this plate had been banked round with dusty

earth. A tumbler which had been inverted on the lawn was dry outside, moderately dewed inside; another, inverted over garden soil dry down to one inch, was slightly dewed inside; another inverted on a stake six feet above the lawn was dry. There was not much dew this night. The temperature at 5.30 a.m. was 54° on the ground, 56° at 3 in. in the soil; at 8 a.m., 64° on the ground, 58° at 3 in. deep; at 8.40 a.m., 68° on the ground, 60° at 3 in., and 63° at 12 in. deep.

On July 5th, at 7.45 a.m., a plate on grass gave 54 drops, on a dry sandy gravel path, 65 drops. This was a very surprising result, for the sand was dusty down to one inch, and only slightly moist several inches lower. At 8 a.m. the temperature on the ground was 57°, at 3 in. 55°. The night was fine and windy, the morning cloudy.

On July 9th, 1892, at 7.30 a.m., a plate on the sandy gravel walk, which had been banked round with sand and dry mould, gave 101 drops from the inner surface. This was the heaviest amount hitherto obtained. The surface of the gravel was dry down to about a quarter of an inch. A plate, of which the edges had not been banked round, gave only 73 drops in the same situation. At 9 a.m. the temperature half an inch above the ground was 64°; at 3 in. deep, 56°; at 15 in., 62°. The night had been fine and cool, with a moderate S.W. wind, and a minimum temperature of 46°.

At 10 p.m., on July 10th, a plate, which had been exposed on the lawn at 7.15 p.m. was found thickly dewed on the top, and still more thickly underneath. At 6.45 a.m. on July 11th a plate, which on the previous evening had been inverted and banked round with dry dusty earth on bare earth in a hayfield, gave 40 drops; a plate which had been on the lawn gave 98 drops. There had been a rapid fall of temperature down to a minimum of 40° at night; at 6.45 a.m. the temperature half an inch above the ground was 54°, at 13 in. below the ground 60°. This last had doubtless been practically constant during the night.

On July 28th there had been no rain since July 20th, and the surface of the ground was dry. On the previous evening, at 7.15, an arrangement of pans had been made in order largely to eliminate the condensing influence of radiation into space and of the accession of external air. A small earthenware pan about 3 in. in diameter was inverted on the grass, over this a plate, and over the plate a thick earthenware white dairy-pan of large size, 17½ in. in internal diameter. At 7.20 a.m., on July 28th, the large pan was found nearly dry outside, but heavily dewed inside, yielding half a teaspoonful of water besides what remained adhering to the surface. The plate within was not dewed outside, but heavily inside, giving 88 drops. The small pan within the plate was moderately dewed inside. But the most remarkable thing was this, that the grass inside every inclosure, even the last, was heavily dewed with drops, as on an autumn morning. The grass outside was moderately dewed where reached by the wind, thickly in sheltered places. The night had been fine on the whole, but at 7 a.m. the sky was clouded and there was a strong drying wind. The previous day, July 27th, was fine, with a hot sun and a fresh N.E. wind. The evening was fine, bright, and windy, with a little low scud and haze.

The temperature at the surface and at a little depth in the earth was as follows:

	½-inch above surface.	At ¾-inch deep.	At 3 inches deep.
	°	°	°
July 27.— 6·30 p.m.	60	66	—
" — 6.45 "	59	66	67
" — 7 "	56	64·5	66
" — 8 "	54	63	64
" — 8·55 "	52	60	62
" — 10 "	50	59	60
July 28.— 7.30 a.m.	55	58·5	57

On July 28th the min. thermometer on the grass was wet with dew underneath at 9 p.m., and its upper surface at 10 p.m. At 7 and 8 p.m., and still more at 9 and 10 p.m., stones and pebbles lying on the dusty sand of the road were wet with dew on their lower surfaces, and many pebbles, even on the warm sand near the house, were quite wet underneath, where the ground was dusty. All were quite dry on their upper surfaces. Stones which were half embedded in the sand were moist on the under side, and had evidently, by their condensing action, kept the ground moist underneath them. Black stones of close texture, and pieces of slate lying on the sand, showed their wet surfaces best, but absorbent sandstones could also be seen to be moist underneath. An arrangement of pans, similar to that employed on July 27th, gave similar results on the night of July 28-29, and two tumblers on garden soil, which was dusty down to three-quarters of an inch and one inch, were found heavily dewed inside in the morning.

Surface and earth temperatures were as follows:

	½-inch above surface.	Just under short grass, half covered.	¾-inch deep.	3-inches deep.
	°	°	°	°
July 28th.— 8 p.m.	56	60	63	64·5
" — 9 "	54	58	61	62
" — 10 "	52	56	60	61
July 29th.— 8 a.m.	52	58	58	56

On August 4th, 1892, and the morning of August 5th, when

scarcely any rain had fallen since July 20th, the temperatures of earth and grass were found to be as follows:

	Aug 4th. 7 a.m.	8 a.m.	5.50 p.m.	6.45 p.m.	7 p.m.	7.15 p.m.	8 p.m.	9.50 p.m.	10.50 p.m.	Aug. 5th. 7 a.m.	8 a.m
	°	°	°	°	°	°	°	°	°	°	°
½ in. above grass.	50	52	64	...	52	50	48·5	46	45	45	49
On grass.	51·5	54	66	54	54	50	50	47	47	48	50·5
Just under grass.	54	54	70	58	57	55	52·5	50	50	50	53
1 in. deep.	58	57	68	64	64	62	61	58	57	54	54
2½ in. deep.	58	...	70	66	65·5	64	62	60	58	...	...
4 in. deep.	58	...	...	...	...	...	...	...	...	...	...
9 in. deep.	...	57	...	...	...	...	...	...	...	56	...

A piece of glass exposed at an inch above the ground, over short grass, was found during the night and morning to be heavily dewed on the lower, not at all on the upper surface. Stones laid on sand and on grass were quite wet on the under side, dry on the top.

Since the minimum temperature on the night of August 4th and 5th was 38° over the grass, and since the temperature from one to three feet downwards may be taken without sensible error to be constant about 62° to 58° at this time of year, it follows that a difference of about 20° to 24° existed during the coldest part of the night between the air near the ground and the earth from 9 inches to 3 feet in depth; and that vapour coming from these levels towards the surface may have emerged at a temperature of about 46 or 47° at the coldest, and impinged against blades of grass at a temperature of only 38°. This difference of 8° or 9° is clearly sufficient during the night-time in the damp air close to the ground to cause copious precipitation on the grass. The difference between the temperature of emerging vapour and the air just above the surface may be quite as great in the sunset hour, but the surface may be too warm to permit so much deposition on itself, and the vapour with its contents consequently mixes with the air at some little height above the ground, becomes rapidly cooler, and often sinks into a misty stratum over low ground.

On August 5th, 1892, the following temperatures were observed in the several situations mentioned, the night being fine and nearly cloudless till about 11 p.m., when the sky became somewhat clouded:

	8 p.m.	9 p.m.	10 p.m.
	°	°	°
Just under grass of lawn	54	52	50
1 inch under earth of lawn	62	60	59
In field near western hedge, about 20 ft. lower than lawn: on grass	43	38	35
Ditto under grass	51	47	45
Ditto 15 inches in earth	62	62	62

The minimum on the grass in the field was 32°, and would probably have been as low as 29° if the night had kept fine and clear. At 8 p.m. on August 5th the glass suspended an inch over the lawn was clouded with dew on the lower side only, and the stones on the dry grass and earth were very wet underneath, but dry on the surface. The above results showed a difference of temperature amounting to about 26° between the top of the grass and its roots in the coldest part of the night.

Many observations similar to the above were made during the summer, and led to the following conclusions: That a great quantity of vapour issues from the earth even in dry weather and where the surface is dry, and that the maximum emission, or at least condensation, on exposed objects, appears to take place in the hours of early morning in dry weather; that in summer about half, and at other times of year a large proportion of the dew formed is condensed vapour from the ground; that a considerable proportion is derived from the exhalations of grass and of plants generally; that soon after sunset in June, July, and August, the temperature of short grass and contiguous air may be 9 to 15 or 20° lower than that of the earth at a depth of 1 to 15 inches, and that about sunrise the temperature of the top grass of a pasture field may be 20 to 30° colder than that of the earth at depth of 9 to 15 inches and lower; that in hot weather about and after sunset, and in shady places before sunset, there is a very large emission of vapour from soil which may be dry and dusty on the surface; that in June, July, and August the temperature of the earth from 9 to 15 inches remains constant within a few degrees of 60°, but is lowest during the day and highest during the night.

It appears from observations made by Herr Singer at Munich during the twenty-nine years, 1861 to 1889, that at a depth of 4 feet 3 inches the maximum temperature of the year (59·3°) is reached on August 24th, and that at a depth of 19 feet 7 inches the maximum temperature (50·3°) is reached on November 17th.

Fodor's results gave an average maximum temperature at a depth of half to one metre in August, at a depth of two metres in August and September, and at a depth of four metres in October. Changes of temperature in the air, lasting a few days, take two or three days to reach a depth of half a metre, and then affect the earth only to a very slight degree. Liebenberg's observations show that sand is warmed throughout more rapidly than clay, and that the richer a soil is in organic matter the greater its power of absorbing heat.

As far as my observations go, the vapour emission at night through an upper layer of dry garden soil is very much less than through dry sand or dust. The vapour, with any particles which it may contain, is probably almost entirely arrested and absorbed by two inches of dry mould.

Sandy estuaries, beds of dried up torrents, and flats of sand containing organic matter, which are moist at a little depth below the surface, must emit quantities of air and vapour containing small organisms; these pass more easily through the sand than through the imperfect filters which baffled early experimenters. In hot climates, such as India and Italy, and on bare sandy ground, or in valleys, it seems probable that the differences of temperature between soil and surface air may amount at night to 30 or 40°, and in malarious places the flow of impure vapour towards the surface may be equal to the evaporation from an exposed marsh. In fact, there is reason for regarding underground beds of moist decaying organic matter, containing the organisms of malaria, diarrhœa, dysentery, or other disease, as often almost equally capable of emitting those organisms into the air through a covering of sand as if such a covering did not exist. There will be some proportion between the rate of emission and the differences of temperature, so that those places would *cæteris paribus* be most malarious where the differences of temperature between soil and surface air at night are greatest. This is I believe in accordance with experience.

Mr. Aitken states* that his experiments on cloudy condensation revealed the fact that there are enormous multitudes of particles so small that the concentrated light of the sun does not reveal them. Hundreds of these are crowded into every cloudy condensation of air. By a number of interesting experiments Mr. Aitken showed that bodies warmer than the air drive away dust from their surfaces, and create the dust-free black coat which surrounds them. He further showed that an evaporating surface has a similar influence, and that dust was driven more than twice as far from the wet part of an object as from the dry, the object being above the temperature of the air. In relation to the human body, and especially to the lungs, the evaporation in addition to the heat tends strongly to ward off dust and to keep it from coming in contact with the surfaces of the body. A temperature less than that of the human body was found very capable of preserving the surface from dust deposit. The necessary conditions for the repulsive effect to be strongly shown are, that the air be acquiring heat and acquiring moisture from the surface. Very little heat with moisture gives a thicker dark plane than double the heat would do. Mr. Aitken observes that the ease with which dust passes through small openings is surprising, indeed he has found that any opening which admits

* *Proceedings of the Royal Society*, 1877. Formation of small clear spaces in dusty air. By John Aitken.

air also allows these less than microscopic particles to pass. These observations have a bearing on the exhalation of vapour from the earth and the deposition of dew.

The layer of earth down to a depth of several feet is usually much warmer on fine nights than any objects such as grass, leaves, or stones within a few inches above the surface. In summer I have found the uppermost grass in the evening to be frequently from 8 to 12° colder, and sometimes 24° colder, than the earth at a depth of 4 inches, and generally to a depth of 12 inches or more. If the upper stratum be porous like sand, which incloses about an equal bulk of air, and if the earth below be moist, a large quantity of vapour must escape at night from the earth, bearing with it by its ascensional force many small solid particles. The surface of the earth will be giving off during the night a large quantity of air, vapour, and small particles, and these will come in contact with the cold surfaces of plants which are radiating to the sky. The conditions appear to be such as Aitken found highly conducive to the deposition of small particles. It is further probable that, in some situations, many living particles which have been carried up by the ascensional force of the vapour from the moist earth, float for a short time in the air within a few feet from the ground, and then, owing to their radiation and cooling, become weighted with moisture and fall slowly to the earth. The susceptibility to malaria at the sunset hour is thus easily understood. The warm earth or marsh is emitting great quantities of vapour and organic particles, these rise to a little height in the evening, and on their descent attach themselves to grass and other cold surfaces. After sunrise, the evaporation of dew thus pervaded with organisms, probably carries many into the air by its ascensional force, and if the morning be very still, there may be some danger from malaria after sunrise, but the general ascensional movement of the air prevents close aggregation.

A bare sandy surface enables the earth below to acquire more heat, and consequently to emit more earthy vapour at night, if the subsoil be moist, than a surface covered with grass. Moreover, the cold grass would intercept much of the rising vapour and organic matter.

It is generally assumed that evaporation or distillation of water gives rise to pure vapour and leaves behind all impurities, but this is not true with regard to minute organisms in some natural conditions. The upward movement of the air from drying ground, the bursting of countless small bubbles and films, the development of electricity in evaporation, the repulsion, as shown by Aitken, of small particles by a warming and evaporating surface, all help to carry into the lower air a large quantity

of ultra-microscopic and microscopic dust. Some of these influences probably also carry off from the lungs and air-passages of persons suffering from such diseases as scarlet-fever, diphtheria, and even consumption, the infective particles which, when sufficiently numerous, convey the disease in the air which has been breathed out. Thus walls on which the breath condenses may become culture-grounds for disease. A very small bubble of gas breaking on the surface of a glass of water is seen to scatter particles of water upward to a distance of several inches, and a similar scattering of water particles with the organisms contained in them can hardly fail to occur occasionally on mucous and earthy surfaces. The snapping force of a film of slightly soapy water about the millionth of an inch in thickness is great, sufficient to transmit an audible sound in the breaking. The impure and somewhat viscous water of drying marshes and of drying organic earth would certainly form many small films which, in breaking, would scatter their contents into the air. The blowing into the air of spray from the surf on the sea-shore in a storm, producing a driving mist of particles even to some hundreds of yards inland, is an illustration on a large scale of what occurs on drying marshes where the particles are beyond the range of visibility. In ordinary, and especially in sandy soil in a warm climate, the power of the vaporous current which passes into the air from the earth to carry with it organisms derived from a depth of less than an inch to more than two feet, can hardly be doubted. According to Parkes, some of Pettenkofer's observations show that a very large amount of air is contained even in firm soils, and that effluvia from decomposing substances may pass for a long distance through very loose soils. Soils which are permeable to water are of course still more permeable to air and vapour, and are generally permeable to small particles held in suspension in these gases. The permeable soils are sandstones, loose sands, and chalk, and are healthy unless either a clay stratum or a hard rock a few feet below the surface holds up the water, and unless the soil be contaminated by a large quantity of organic matter. Movement of subsoil water of course greatly affects the quantity of earth-vapour given off within certain periods. Some sands, such as those of the Landes in France, contain much organic matter. The dried beds of water-courses are well adapted for the evolution of malaria, for the superficial layer is often sandy and permeable, the soil contains much organic matter, and the water-level is not far from the surface. Similar conditions are found at the foot of mountains, but the upper soil may be either sandy or rich. The Terai, in India, a belt of country lying a little South of the Himalayan range, is well known as especially subject to malaria.

Dr. Ballard has stated, with regard to diarrhœa, that the essential cause resides ordinarily in the superficial layers of the earth, and that on occasion the micro-organism concerned is capable of getting abroad from its primary habitat, the earth, and of finding in food, inside as well as outside the human body, nidus and pabulum convenient for its development. Diarrhœal mortality is high upon made ground and polluted soil, especially where it is water-logged and where the superficial layer is sandy and pervious. The one condition which gives exemption is the foundation of dwellings on hard and impervious rock. In the case of gravel, the nearer it approaches to sand in fineness the greater the prevalence of diarrhœa, where other conditions are equal. While diarrhœa was prevalent at Leicester Dr. Jenkins found two to three times as many microbes in the air in certain districts as before and after that period, and in the worst affected part, he found four times as many as in that which was least attacked.

There appears to be no doubt that tetanus is caused by a microbe very widely distributed in the superficial layers of soil. It was of very frequent occurrence among soldiers who lay wounded on Indian battle-fields, when hot days were followed by cold nights, a condition leading to large exhalation from heated ground.

Dr. Vivian Poore, in his address to the Institute in 1890, stated that the vegetable mould on the surface of the earth is very rich in saprophytic bacteria, whereas the subsoil at a depth of three to six feet is barren of bacteria, and he quoted from Flügge's work on micro-organisms the observation, that "infusions made from manured fields and garden earth, even though diluted 100 times, still contain thousands of bacteria in every drop, and the ordinary soil of streets and courts also shows the presence of large numbers. Bacilli are present in much the largest numbers, but in the most superficial layers and in moist ground there are also numerous forms of micrococci." There appears to be no reason why some varieties of organisms should not exist equally well in damp soil containing organic matter covered by a pervious and loose stratum. Certain conditions, such as a high level of underground water, the presence of filth and dead bodies, and a high temperature, seem capable of evolving organisms fit to attack successfully the living body. It is after the warm days and the warm season, that is, when the earth at a little depth is at the highest temperature, that malaria and several other diseases are most prevalent. The amount of disease and mortality caused by earthy emanations

exceeds in many countries that of all other causes combined. In India, and even in Italy, there are many places where the whole population is afflicted with life-long weakness and ill-health. In some of these a removal of the pestilent condition of the soil appears possible, in others a removal of the population to healthier situations may be the only practicable remedy.

In conclusion, I may be allowed to point out the bearing of the above observations on the importance of securing an impervious flooring and ventilation under houses and in tents, of paving in towns, of avoiding "made soils," and the vicinity of graveyards; of drainage of damp and organically-polluted soils, of widely separating cesspools from wells, and of preventing the exposure of articles of food and drink to night air near the ground.

Mr. G. J. Symons, F.R.S. (London), regretted the absence of Professor Lane Notter, who had presided in Section I. The parallelism between his remarks, respecting the generation of cholera in Northern India, and those of Mr. Russell was a curious instance of the universality of truth which cropped up now and then in such a way as to almost startle them.

The Chairman (Dr. W. J. Russell) remarked that Mr. Symons had mentioned a circumstance which did not appear in the paper just read—that Mr. Russell's interesting experiments were similar to those previously made by Mr. Aitken, and it was very satisfactory to know that the results obtained by both agreed. It showed that the theory of wells, although so firmly believed in up to the present time, did not embrace the whole question, but that the aqueous vapours which formed the dew came in larger proportions from the ground than from the air. Mr. Russell applied this and made his point very clearly, pointing out the importance which must arise from the great difference in temperature between the earth and the air above. This statement of his was very striking, as it showed what a very great amount of projective force might arise from this cause.

Local Geology from a Sanitary Standpoint, by W. WHITAKER, B.A., F.R.S., F.G.S., Assoc.Inst.C.E., Assoc.Soc.Med.Off. Health.

BY permission of the Director-General of the Geological Survey the new MS. six-inch maps of that Survey were exhibited, and these formed the text of the discourse. The work on these maps has been reduced on to the new one-inch map, sheet 331, the engraving of which is in hand and may be finished this year (1892).

A short account of the geology of the neighbourhood of Portsmouth was given, from the Drift beds to the Chalk, and it was pointed out that the former, though thin, occurred over a large area and had a marked effect on the shape of the country, forming flat ground at a low level.

The choice of sites for building on was discussed, and it was noted that one of the newest of the geologic deposits, the Alluvium, or marshland of streams and creeks, was a bad site, both from its extreme lowness and from its otherwise damp character. Nevertheless, in part of Southsea some houses had been built on such a soil, partly perhaps masked by made earth, and it was strongly suggested that the Corporation should not allow further building thereon, but should have such sites kept as open ground, houses so placed being likely to favour rheumatism as well as consumption. Satisfaction was expressed that some of the houses in question showed strong signs of giving way, from insecurity of foundation, and at the news that the Corporation were considering the matter.

The rest of the town, as well as the neighbouring town of Gosport, is built on the Drift, and chiefly on gravel. This deposit forms good building-sites, except when very thin and water-logged, giving both a firm and a dry foundation. The loam that often overlies the gravel may be somewhat less advantageous, but here it is both thin and rather sandy; moreover it is commonly worked off for brickmaking before building is begun, and the houses then rest on the gravel beneath.

The great question, however, in which the geology of the district has a practical bearing, from a sanitary point of view, is that of water-supply, and the sources of water around Portsmouth may be discussed under three heads:—The Gravel, various more or less permeable beds in the great series of Tertiary formations, and the Chalk.

The large sheet of gravel is a very permeable bed, and being mostly underlaid by clays, must hold a great quantity of water. In the open country this water would naturally be of good quality, unless contaminated artificially; but where buildings are common the risk of contamination increases vastly and soon becomes a certainty. In parts that are well populated this source of water should be avoided, and any supply from it in the town should be closed.

The thick mass of Tertiary beds that underlies the Drift of Portsmouth and Gosport, and rises up from beneath the Drift northward, is for the most part clayey and therefore impermeable; but there are in it various beds of a more sandy character, which allow of the passage of water, more or less freely, the chief of them probably being the Bagshot Sand, some 30 feet thick. It is from such sources that sundry deep wells in the two towns get their supply.

The Gosport Water Works are a very notable case of a large supply being got from Tertiary sands. The wells and borings of these works, at Bury Cross, are of various depths, and they secure the water from the different sand-beds passed through, beginning at no great depth from the surface and going down to nearly 750 feet.*

Though Gosport gets a good supply in this way, the like could not be done at Portsmouth, the demands of which are far larger: moreover, should the population of Gosport increase very much, it may become a question whether the works there can be increased in proportion. Should this turn out to be the case, it is consoling to feel that Portsmouth can, of its plenty, spare enough for its near neighbour.

It is to the Chalk only that Portsmouth can look for its supply, and lucky, indeed, is the town in getting a bountiful supply of good water as easily as it does. In other cases the supplies of towns of less size have to be got by digging wells and by driving galleries far and wide; but here, in the first place, little more has to be done than to take what a kindly Nature provides. In the low ground near Havant the surface of the Chalk is in places a little below the level of saturation, or the level of underground flow of water. As a result, there are springs at such places; the water that was flowing underground on the north appears at the surface, and, from the plane of saturation rising northward, under the higher ground

* Since the above abstract was in print (December, 1892), the author has heard that a boring at the Gosport Water Works has been carried down to the depth of 786 feet, the Chalk being reached at 777 feet, a greater depth than he expected, the Reading Beds being 127 feet thick, which is in excess of anything found before in the neighbourhood. No water was got in the Chalk.

in that direction, there is a constant flow of water underground to the sites of the springs. All that has to be done to get the water in great quantity is to open out the springs, and to keep the pools thus made clear of vegetation.

The amount of water yielded by the various springs at Havant and Bedhampton is undoubtedly very great; but it has often been vastly over-estimated, as much as 200 million gallons a day having been given as the yield. This, however, seems to be a romance, and it is doubtful whether a quarter of that amount is reached: as even this latter figure is nearly ten times as much as Portsmouth wants; the town may therefore be well content with sober reality.

Whether the whole of the water comes (directly, at all events) from the Chalk is a little doubtful; the hardness of the water is less than is usual with Chalk-water, and it seems possible that there may be communication with sands that occur in places near the base of the Tertiary Series. In this there is no harm, the lessening of the hardness indeed being an advantage.

There is, however, another chance of the mixture of other water with that from the Chalk. Around Havant there is a good deal of gravel, and the water falling on this would tend to flow toward some of the springs. As noticed above, water from such a gravel-tract, where there is a good number of houses, is likely to be contaminated, and it is essential that such water should be kept out of the works. It is satisfactory to know that this had not escaped the attention of the Company, and that the purity of their water had been ensured by puddled walls having been made well down into the Chalk, so as to cut off the access of surface-waters.

Having so good a supply, which is used not only for the town itself, but also for parts of the surroundings (including Havant), it behoved the authorities of Portsmouth to religiously preserve its purity.

Mr. J. H. Ball (Southsea) opened the discussion by asking for some information as to the springs which were to be seen near Havant. He lived close to Havant and had had the opportunity of seeing the great care that the officials of the Portsmouth Water Works took to exclude some of the water, at all events, which might be deleterious to the water supply. As architects they could not lay too closely to heart what Mr. Whitaker had said about unsuitable sites for building, and he would specially like to hear something as to the insecurity of foundations in water-logged soils, caused by subsequent drainage. It was a point often seriously neglected, and one or two such cases had occurred at Portsmouth. It would be

very useful if they could get any data about the amount of foul water which a given soil would absorb, and over what area a given amount should be distributed.

Dr. J. Ward Cousins (Southsea) warmly protested against any insinuation that the water supplied to Portsmouth was in any way contaminated.

Dr. J. Groves (Carisbroke) said the hint thrown out with reference to the Portsmouth Water Works was very important. People absorbed ideas slowly in the South, and though there might not be much said about it now, the possibility of contamination would be much talked of a week hence. He thought that if the protecting wall were not deep enough the chalk-water might be contaminated by that from the gravel, into which Havant had been drained. It was, he feared, very common in this part of the world, in places where they did not care to go to the expense of getting water from the chalk, to draw the supply for drinking purposes from the gravel into which the filth was discharged; leaking cesspits were sunk in the gravel from which the water was drawn. There was another point that was important and must not be lost sight of. In a place like Portsmouth, for generations past, the sewage had been discharged into the gravel, and if wells were left, the water of which was not objectionable to the taste, and looked nice, there was great protest against closing them. He did not know whether there were any wells left in Portsmouth, but it was so in other parts of England. In London, during the cholera epidemic of 1866, the Privy Council gave the medical men in charge of the districts instructions to close the wells, and he was astonished to find so many wells in use in the Strand district. They had to close what was known as the "holy well," in Holywell Street, and there was a great fight over that. The inhabitants continued to pump from the well until the pipe was taken up. After the lead pipes had been removed he went down and examined this well and actually found a drain emptying into it which he cut off. Subsequently he discovered that this drain communicated with a closet into which cholera stools were thrown. Cholera poison would have found its way into the "holy well" if they had not cut the drain off when they did, and if the well had not been closed cholera would have been distributed far and wide, for people sent long distances to the "holy well" for their drinking water.

Mr. H. R. Smith (Engineer to the Portsmouth Water Works Co.), referring to Mr. Whitaker's remarks anent the Company's springs at Havant, said that as there might be a suspicion that some reflection had been cast on the water supply he would state that the possible danger referred to had been anticipated by the Directors, and it was impossible that there could be contamination in the way suggested. There had been a sentiment outside that it might be possible for water from the Tertiary beds to get into the chalk springs, and two or three years ago the Directors spent many thousands of pounds in building a puddle-wall, which in some places reached to a depth of thirty feet, being everywhere continued into the chalk and not merely to a uniform depth of six feet as had been stated. During the excavations for this wall there was very little water indeed seen passing through the Tertiary beds, and that proved how small a quantity came into the springs. The subsequent report of Sir Robert Rawlinson on the subject after the puddle-wall had been completed, stated that it was impossible now or in the future for any water to come from the upper strata into the springs. As a matter of fact the water came from a very deep seat and was the same in temperature all the year round—it was about 50° or 51°, winter and summer, night and day. The Company had spent thousands of pounds in acquiring land and protecting their works, and there was not the slightest ground for any suspicion whatever of the entrance of any impurity.

Mr. W. Whitaker (Southampton) replying, said with reference to the Havant springs that they were only a like occurrence, in another place, to the springs from which the Water Company got its supply, but they were at a higher level, in the valleys of the Chalk hills. The underground water-level of the Chalk springs rose inland, and varied roughly according to the level of the ground. The high Chalk country was intersected with valleys, and here the Havant springs, which were known by a host of names, occurred when the level of saturation rose above the levels of the valley-bottoms. He asked Mr. Ball, or any others interested, to record the times of outbreak, where they occurred, and all about these springs, because records of them were very interesting. The water-levels of the wells near the Havant spring agreed exactly with them. Mr. Baldwin Latham, a member of the Institute, had taken such careful observation of similar springs that he was able to predict on what day and where they would break out.

The settlement of buildings he could readily understand. If a big sewer was made it might bring half the houses down because it drained all the water out of the gravel, and in buildings near, the result would soon be disastrous; many years ago he had seen that in making a sewer near Victoria Park (London) a small water-pipe was broken in the gravel, and if the outflow had been allowed to go on a little while longer the result would have been a subsidence of the neighbouring houses.

The question, how much water the soil would absorb, wanted a great deal of investigation. When firm rocks were concerned it depended largely upon the form of rock and its position; with loose soil it was hard to form an opinion. Sometimes such a soil would absorb nearly as much as one liked to put into it.

Of course there was a possibility of the contamination of Portsmouth water, as there was the possibility of contamination of every water under the sun; and there must be in Portsmouth lots of out-of-the-way places where cesspits had not yet been discovered, and which would do harm to any water obtained, except from the Water Company, and except, perhaps, from the wells in big works and breweries, whose water was as well protected as that of the Water Company. In the area in the Strand, where the Law Courts stand, were found wells such as Dr. Groves had described, and under one was discovered a coffin! There was a good deal of body in the water of that well. He had noticed in many country places, too, that there were "Holy Wells" in which the water was supposed to be particularly sanctified, close to the churchyards. He did not cast any reflections on the Portsmouth water; he only said that having got a good supply they must take care to keep it good. As to Mr. Smith's arguments, he (the speaker) only wished to point out that a small amount of water might come in from the older Tertiary sands. Chalk-water came up into the Tertiary sands sometimes. In London, in the Chalk wells, it was sometimes found, by chemical analysis, that the water was not all Chalk water, but that it was mixed with water from sand. Of course the line of junction between the gravel and the Chalk would be irregular, and naturally the reservoirs at the Portsmouth Water Works would vary in depth accordingly. The temperature of the water was a good test as to when the water was from a good spring and not simply one trickling into the Chalk from some other overlying deposit.

What he meant to say about the Gosport Water Works was that they were a good example of catching water from Tertiary sands; of the two he should prefer the Portsmouth well. As regarded the Portsmouth supply he did not wish it to go forth that he had spoken the least ill of it: he only thought they were lucky to get it so easily, and he believed that the Water Company would look well after the interests of the consumers. He was glad to find the Company supplied places outside the Municipal district.

The President of the Section (Dr. W. J. Russell), in conveying the thanks of the meeting to Mr. Whitaker, said that even those who had no personal connection with Portsmouth had, he was sure, listened with much interest to this paper, and those who had a local interest in the town must have been particularly interested in what Mr. Whitaker had told them.

On "Entomology as a Sanitary Science," by THOS. B. GOODALL, F.R.C.V.S.

I AM not aware that the study of Entomology has been deemed of sufficient practical importance to give it a place in sanitary science, though we shall be able to show that the services of the engineer and of the chemist are brought into requisition only because man has of necessity been compelled to dispense with the services of Nature's proper scavengers and purifiers, the larvæ of many dipterous and coleopterous insects.

We have many excellent works on injurious insects; and in the study of Entomology it is of common occurrence to read of the larvæ of certain insects being found in dung, in decomposing vegetable or animal matters, or in drains or ditches or stagnant water; but I do not know of any work having been written to connect these with the great question of sanitation, or on those Diptera which are eminently beneficial to the health of mankind.

It will be my object on the present occasion, by giving a brief resumé of the life-history of two of the Diptera, or Flies (though there are hundreds that are concerned in scavenging work), to draw the attention of sanitary scientists to a study, a knowledge of which will be serviceable on some occasions.

In approaching this subject, we must be reminded that man has elected to oppose his will to all the laws and forces of Nature; and that civilization induces a condition in which the primary laws of Nature are set at defiance and disorganised. Man says that these violations are all necessary for his well-being and comfort.

In venturing on such a step, how little does he consider that Nature's laws cannot be violated with impunity; that if one small link in the vast chain of the cycle of life is destroyed, or its functions materially interfered with, it necessarily leads to the disarrangement of other links. If one is destroyed we must immediately wage war with its compensating balance.

Let us bear in mind the fundamental principle that every form of life is created for a purpose, and is absolutely necessary to effect the changes that are for ever taking place in the infinitude of particles, that together make up "matter."

In Nature, stagnation is impossible, but there is a constant, ever recurring growth and decay.

Nature provides a vast army of workers whose office it is to disintegrate all particles that have formed part of an organised being.

Inorganic matter is for ever being converted into organic, by the infinitude of forms of life of the vegetable kingdom; this is

taken to a higher grade through the vegetable to the animal kingdom, and all this same "matter" has to be as constantly re-converted to the inorganic world again, that it may be renewed; this is done by the action of the most minute forms of known life.

This we might designate a rough outline of the "main stream of life." But just as a great river has thousands of uses and functions, besides just running its course, these being, in fact, the purpose of its existence, so has this "main stream of life" thousands upon thousands of functions to perform, and the well-being of every form of life, from man to monad, is dependent upon its rhythmic course.

If any form of life threatens to become superabundant, Nature's laws make ample provision for checking excess, or the balance to be interfered with.

It is at this point where the sanitarian might take a useful lesson from the laws of Nature. All his ingenuity and skill is taxed to prevent excess in the numbers of the bacteria and the micrococci, &c., or the microbes, ferments, and moulds, because he knows that they are his deadliest foes in the struggle for existence.

Nature does not allow these disease germs, or putrefactive germs, or death germs, to run rampant; we must bear in mind that from Her standpoint they are, within certain limits, as necessary for the rhythmical flowing of "the stream of life," as are any of the other forms of organisms, animal or vegetable; and Nature has made ample provision for checking their superabundant increase. This is, without doubt, due to the action of the myriads of larvæ of hundreds of forms of dipterous and coleopterous insects; but civilized man, with his closed sewers and drains, prevents these insects depositing their ova in his sewerage and refuse; the microbes are protected, and increase *ad infinitum*. Man shuts away their natural enemies, and, by breaking the cycle of "the stream of life," places himself in antagonism to Nature's laws; and having as it were refused the aid of Nature's forces, he must exert his utmost vigilance by an unceasing constant use of disinfectants, &c., to keep the numbers of his minute foes in check.

When we spread manure over the land it teems with microbes, but we find insects innumerable depositing their ova in it, so that their larvæ feed on the microbes; we cannot walk abroad in any rural district, with our eyes given to search, without realising this truth. Wherever there is decomposing organic matter, there shall we find swarms of those insects, whose larvæ live, not on the matter itself only, but also on the microbes which cause its disintegration.

And now, gentlemen, if your patience is not utterly exhausted, I must defend the propositions I have laid down by demonstration. This I shall do by taking you briefly through the life-history of two most useful scavengering diptera, and explaining to you what I have myself observed of the methods of their larvæ in procuring their food.

One of the most useful is the *Eristalis tenax*, or Drone fly. In its perfect state it has some resemblance to the hive bee, and the female is to be seen frequenting the margins of vessels containing putrefactive organic matters in solution; about stagnant ditches, sewers, drains, or manure yards; here she deposits her ova into crevices above the water-line. The larvæ on leaving the egg pass into the dirty water or mud, and they can live in either. Specimens may be found in any drain, cess-pit, or in any place where there is decomposing organic matter in a state of solution.

When the larva is mature it leaves the water, buries itself in the earth, the outer skin forms the puparium, and in this the pupa is transformed to the perfect insect or imago again.

It is the larvæ to which I particularly wish to draw your attention, and I submit to you one or two drawings I have made from life to exhibit the points of most importance.

The mouth proper is retractile, being enveloped by a series of folds of the anterior segments of the body, that we might designate lips; these folds are studded by numbers of re-curved hooklets, which appear to be protruded and retracted with the movement of the folds, like the claws of the cat. These folds have a two-fold function: when the creature is feeding among solid matters they are used in drawing the food to the mouth proper; when it is suspended in the water, they, with the assistance of other organs which I shall refer to presently, act as cilia, inducing a current of the filth-impregnated water to flow towards the mouth, which enables it to select its food.

Proceeding from the centre of the inner part of the membranous folds are two bifid claws, which can be turned back towards the mouth; these may be organs of prehension when necessary; they are also used in locomotion, being protruded, they lay hold of the ground surface, and the body is drawn along. Surrounding the oral orifice are a number of fibrillæ, and on each side of it is an organ having much the appearance of the gill of a fish.

The oral orifice is very small indeed, and it is probable that all food has first to pass these fibrillæ and gills; following the mouth is a hard-looking organ, the gizzard; it is hard, rounded, and in two lobes, a passage being seen down its centre—this is in one piece with the mouth, being drawn forward with that organ as the folds and prehensile organs retract.

Proceeding from the gizzard are two indistinct tubes communicating with a large gland on each side of the body, secreting glands of some kind, and the stomach proper follows, of a saccular shape across the body; then follow two other glands and the large intestinal convolutions leading to the anal opening. This is surrounded by a large fan-like organ, which is only protruded when the creature is undisturbed, and of which there is no visible sign under the microscope. When the animal is feeding this is in constant motion like the opening and shutting of a hand, and there is generally a string of fœcal matter seen protruding from the anal orifice at its centre.

It has six pairs of membranous feet, and each of these has on it a number of sharp-looking claws.

The breathing apparatus is also very remarkable, and fits it admirably for its mode of life, being, as it must be, enveloped in filth.

The posterior abdominal segments are protruded in the form of a tail and can be extended to several inches, the extreme end of this is hard and chitonous, and at its extremity are two hair-like pieces. Proceeding up this elongation are the two air tubes, opening at the extremity and passing down to a large air-sac on each side of the body. In a large larva these are nearly as long as the body, but in a very young one, as the one from which my sketch is taken, they are relatively much smaller. From these air-sacs tubes proceed to the anterior segments of the body, and one is always noticed in the folds at each side of the mouth. These become the spiracles in the pupa. When the creature is feeding in a fluid medium it hangs with the end of the tail protruding through the surface of the water, the folds of the segments surrounding the air tubes are extended and contracted by muscles which can be seen. The fan at the posterior part of the body is in constant motion directing a current towards the mouth, and the make of the pedal appendages assists this action. The folds surrounding the mouth are in a constant state of opening and closing, drawing minute particles suspended in the water towards the oral orifice. As the folds dilate the mouth and gizzard retract; as they close in again this is protruded, and this action is almost continuous.

The creature will also take particles of semi-solid food, but *not until* it is in a state of putrefaction.

To test this I placed a dead larva with a living one in a clean vial of water. It took no notice of its presence for 36 hours, when it suspended itself in the usual attitude for feeding, and by a patient use of its prehensile organs, and the hooks of the folds surrounding the mouth, it made a way through the external skin, and splitting it open as it went on, it devoured all the soft internal structures and left the hard skin. I contend that it did not attempt to do this until its dead companion was disintegrated by putrefactive organisms, and then it demolished these.

Can we doubt then that this is in nature one of our best and most useful scavengers. Its breathing apparatus adapts it to keep itself supplied with a large quantity of air when enveloped in filth, from which it is ingesting those organisms, which would otherwise be multiplied to excess, and make the locality uninhabitable for man and the higher forms of life.

Another very useful little creature in its larval stages, to man, is the *Culex pipiens*, the common gnat. Anyone not conversant with the life-history of this fly is likely to exclaim at this assertion; in fact, by the generality of people it is looked upon as an unmitigated nuisance, and we hear people saying that it has no use in nature but to torment man and beast! But in what a different light do we regard it when we know all about its life history.

The eggs are deposited by the female on the surface of stagnant water, and, for choice, she prefers water containing decomposing organic matters. I have kept two tubs of water side by side, freely exposed to the air; in one of them the water was teeming with organic matter, and in the other it was kept clean, the gnats deposited their ova only on the water containing the filth, the other was left untouched. The eggs, 500 in number, are agglutinated together by the female into a boat-shaped little black mass, which floats freely over the surface. After about twenty-four hours the ends resting on the water open, after the manner of the operculi of mosses, and the little creatures immediately commence their lively aquatic life.

These rough drawings show how beautifully they are adapted for the performance of their function as scavengers. I would have you notice that they cannot ingest solid matters as such, but they can freely partake of the microbes swarming in the situations in which they are found.

As the creature hangs suspended with the point of the "tail" protruding through the surface, it is breathing, for the spiracles, two in number, pass through this, and the large air reservoirs are seen passing from this through the length of the body, plentiful small branches of the air tubes going close to the mouth and its appendages.

The mouth parts are most beautifully ciliated—my drawing can convey only an imperfect idea of this—but as it hangs suspended, or when it is feeding at the bottom of the vessel, these

cilia are seen to be in constant motion, creating quite a current of water towards the small oral opening; and from this it selects all those smallest of creatures on which it feeds. It seems to be partial to the microscopical algæ, but it will thrive in any water containing putrefactive organisms.

The oral opening seems to be guarded by a kind of sieve, and then we see a hard-looking gizzard, and then the stomach proper, followed by a large digestive tract well marked; and this by smaller convolutions, which are rather indistinct, and terminating through the anal opening, which is situated at the extremity of a second prolongation of the posterior abdominal segments, quite independent of the one through which the spiracles pass. I need not weary you by taking you through the other stages of these insects, my object being only to show those facts which seem to indicate that a knowledge of Entomology might be useful to the Sanitarian.

Another gnat, the *Chironomus plumosus*, deposits her eggs as a spiral mass held together by a glutinous secretion, after the manner of a frog. These may be seen on the edge of a vessel containing stagnant water, being generally fixed to the side and hanging in the water, being very easily mistaken for annelids, or worms.

The larvæ of these are known as blood worms; they are also quite as useful as the others I have named.

Then, too, a study of the larvæ of the common "blow-fly" (the *Calliphora vomitoria*) and its allies would repay the Sanitarian.

There are hundreds of other dipterous insects, amongst which might be mentioned the common house-fly, *Musca domestica*, the Stinger, *Stomoxys calcitrans*, the small Phoridæ, &c. A study of the life history of each of which would be equally as interesting and instructive as the one or two I have been dwelling on more particularly; and as their larvæ are also found in decomposing organic matters, if we admit that the function of the myriads of these dipterous larvæ is to keep in check the numbers of the putrefactive organisms, we shall be bound to acknowledge that the magnitude of their operations in the economy of life is stupendous.

In the great rush of life we seldom pause to consider how great are the works being accomplished by these small scavengers of Nature, but some idea of their numbers, and the consequent vastness of the work of their larvæ may be formed, when I tell you that on a warm summer's evening I have driven nine miles and have been passing through swarms of gnats the whole of the way.

I have but touched the fringe of a vast and important subject, but if I have said sufficient to arouse the interest of such an important body as The Sanitary Institute I shall be satisfied.

But surely the brief facts I have laid before you point a lesson to the rural sanitarian at least, that he should not be so ready with his closed drains and sewers, to hide all refuse out of sight, and then make the public and himself believe that they are safe. The putrefactive and disease inducing organisms are not by this means shut off from the organic matters which it is their function to restore to the elements; but being thus protected from their natural enemies, they multiply inordinately, and when they escape from their pent-up drain pipes, as they must do periodically, man and his domestic animals pay the penalty of his folly in disturbing Nature's equilibrium.

What appears to be the most rational method of sanitation, and the one most conformable to the rules of "the great stream of life" is that all fœcal and organic matters, in rural districts, be removed as far as practicable from dwelling houses and wells, and spread over the land. If offensive, they should be covered with a light coating of earth, and then Nature's myriads of workers would be enabled to perform their allotted tasks, and we should be saved the sufferings of many evils, and much expense.

I was at a gentleman's mansion a few days ago, where the sewage was run into open ditches. I was taking notes for this paper. The ditches were low, ducks and fowls were feeding on the very larvæ I have been describing, the *Eristalis tenax*. Here the cycle of life was being completed. Putrefactive organisms disintegrating the sewage matters, the larvæ of the Diptera had been thriving and growing on them. The ducks and fowls were growing fat on these larvæ, and would in their turn be consumed by man.

I only lay these notes before you as being applicable for the disposal of ordinary normal sewage. The bodies of all animals having died of an infectious disease should be either cremated or destroyed chemically, and all fœcal matters from diseased man or animals should be treated in the same way.

Dr. J. Groves (Carisbroke) remarked, that their great object was to keep the water supply pure, but in order to do so he thought they could not trust altogether to the little scavengers Mr. Goodall had described. He had very much to do with such matters in rural districts, and found that frequently the people drained into leaky cesspits, because they would not be at the trouble of emptying them; the cesspits practically drained into the drinking well, and he would like to know how to introduce those little things into the water so that the germ of typhoid fever might be eaten up. That would be a practical application of the lesson to him as a Health Officer.

Dr. W. G. Black (Edinburgh) pointed out that they could see the sanitary work done by the insect world every day. The ordinary dung beetles (*Geotrupes Stivenarius*) did good scavenging work, and there were also the carrion insects, *Necrophorus* and *Staphylinus*, which were constantly found on carcases, and one of which was the burying beetle. He thought the common house fly, however, was a great disseminator of diseases, such as Ophthalmia in Egypt, and the mosquito and bug maliciously disturbed hygienic repose.

Mr. T. B. Goodall (Christchurch), in reply to the question concerning drinking water, said that if the dipterous larvæ he had been describing were found in a sample of drinking water, it would be fair evidence that it contained putrefactive organisms, for the female flies deposit their ova *only* on such water; and if water was so contaminated by sewage, it would be the duty of the Sanitary Officer to keep the sewage out. He simply wished to enforce the lesson of what was being done by the little creatures he had described. In country districts the most rational way of getting rid of the sewage was frequently neglected; they wanted to destroy it in an elaborate manner, but by so doing they were impoverishing the land. He could have mentioned many other insects that were doing good sanitary work; there were hundreds that were so employed, but in his curtailed paper he had simply touched the fringe of the subject to raise an interest in it. He mentioned that he had watched a pair of Sexton beetles bury the body of a dead mole, in a sandy soil in less than four hours; and he alluded to the manner in which the common Dung beetles carry into the earth excrementitious matters. The house fly had been described as a disseminator of disease, by biting and innoculating, but it was not so, for the mouth of this fly was so constituted that it could not pierce the skin. There was a fly very much like this (the *Stomoxys*) though it was not the same—the mouths of the two were very different—the *Stomoxys* could pierce the skin, whereas the house fly could only suck up moisture from the outside of the skin. When people blamed the house fly in that way it showed that they had not studied the anatomy of its mouth. Whatever little harm might be done by this adult insect, was compensated a thousand-fold by the beneficent sanitary work of its larvæ.

The President of the Section (Dr. W. J. Russell) said he thought that Mr. Goodall had accomplished what he desired in trying to raise an interest on a subject which was of considerable importance. They were not in the habit of realising how great was the amount of work carried on by these insects, but were inclined to attribute the changes to purely chemical decomposition. At the same time Mr. Goodall did not advocate their giving up precipitation and other means of purifying sewage, and introducing these animals instead. People in general began to tremble and wonder that they lived at all when they heard so much about microbes, but it was reassuring to know that there was so much good fighting being done on their behalf. He tendered the thanks of the meeting to Mr. Goodall for his paper.

"*The Determination of Dissolved Organic Matter in Water*," by W. C. Young, F.I.C., F.C.S., &c.

In making an examination of water for sanitary purposes, one of the most important things to be determined is the quantity of organic matter in solution. Until recently there has been no reliable process available which would give the required information with any degree of accuracy.

The processes relied upon by analysts for ascertaining the organic purity of water are the following:—

1. Loss on ignition of the solid residue.
2. Frankland and Armstrong's combustion and other similar methods.
3. Wanklyn and Chapman's Ammonia method.
4. Oxygen absorbed from potassium permanganate.
5. Wanklyn's moist combustion method.

The "loss on ignition" method (the only direct process of the five) has been almost entirely abandoned on account of its untrustworthiness, but as it is even now used by several chemists, I have included it with the others. The figures obtained by it, when every precaution is taken, are always very excessive, the reason being that a portion of the loss sustained by the mineral constituents of the residue through the high temperature employed is included in the results.

The following figures show how great the error is:—

	Grains per Gallon.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
Total organic matter in solution	·105	·245	·140	·210	·300	·308	·350	·560	·750
Loss on ignition of solid residue	0·8	2·6	1·6	5·6	1·4	9·4	2·4	3·6	6·8

The organic matter in solution was obtained by myself by a process to be described later on, and the "loss on ignition" by another chemist from duplicate samples.

Frankland and Armstrong's "Combustion" method is not in general use, probably on account of the complicated character of the apparatus required, and length of time taken by it, and possibly because of the variable results obtained upon the same waters by different chemists.

Frankland claims that this process accurately determines the quantity of two of the constituents, carbon and nitrogen, of the organic matter in water. He claims further that the proportion of carbon to nitrogen shown by the results obtained indicates the nature of the organic matter, as the proportion of carbon to nitrogen is much higher in vegetable than in animal organic matter.

If these claims could be substantiated the process would undoubtedly be very valuable, and, short of giving the exact amount of organic matter present, nearly all that could be desired.

The process is used by Dr. Frankland and the Companies' analysts for ascertaining the organic purity of the water supplied by the London Water Companies, and the results are published in monthly official Reports, both of which are embodied in the monthly Reports of the Metropolitan Water Examiner.

If the process possessed the accuracy claimed for it, the results obtained by Dr. Frankland should differ little from those obtained by the Companies' analysts, and although the samples of any one of the Companies' water analysed by either may possibly have contained a little more or less of organic matter, the organic matter must have had a constant composition, therefore the proportion of carbon to nitrogen should be practically the same in each case.

In the following Table I have placed side by side the proportion of carbon to nitrogen shown by Dr. Frankland and the Companies' analysts in their monthly Reports on the London Water Companies' water during the year 1889. This year was not selected for any particular reason, but simply because, at the time the Table was prepared, it was the only year of which I possessed a complete set of the Returns. I have since compared the Returns for the subsequent years and find a similar result.

TABLE showing the proportion of Organic Carbon to Organic Nitrogen in the results of Analyses of Water supplied by the Metropolitan Water Companies, by Dr. Frankland and the Companies' Analysts for the year 1889, taken from the Monthly Official Returns of the Metropolitan Water Examiner.

Name of Water Company.	January.		February.		March.		April.		May.		June.	
	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.
	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N
New River	4·3 : 1	3·4 : 1	3·9 : 1	4 : 1	4·4 : 1	2·9 : 1	4 : 1	4 : 1	3·7 : 1	7·6 : 1	4 : 1	3·1 : 1
East London	3·3 : 1	5·8 : 1	3·2 : 1	5·7 : 1	3 : 1	5·1 : 1	3·1 : 1	4·6 : 1	3·1 : 1	6·3 : 1	3·3 : 1	5·1 : 1
Chelsea	3·4 : 1	5·7 : 1	3·4 : 1	6·9 : 1	3·3 : 1	5·1 : 1	3·1 : 1	4·8 : 1	3·2 : 1	7·2 : 1	3·1 : 1	5 : 1
West Middl'sex	3·4 : 1	6·1 : 1	3·3 : 1	5 : 1	3·4 : 1	5·6 : 1	3·3 : 1	4·1 : 1	3·1 : 1	6·2 : 1	3·2 : 1	4·1 : 1
Lambeth	3·3 : 1	4·3 : 1	3·5 : 1	4·4 : 1	3·4 : 1	4·4 : 1	3·2 : 1	4·7 : 1	3 : 1	7 : 1	3·3 : 1	3·3 : 1
Grand Junction	3·5 : 1	4·6 : 1	3·3 : 1	3·6 : 1	3·3 : 1	2·6 : 1	3·3 : 1	3·3 : 1	3 : 1	5·1 : 1	3 : 1	3 : 1
S'uthw'rk and Vauxhall	3·4 : 1	4·7 : 1	3·4 : 1	6 : 1	3·3 : 1	4·1 : 1	3 : 1	4·6 : 1	3 : 1	5·2 : 1	3 : 1	2·7 : 1
Kent	3·9 : 1	3·4 : 1	4·6 : 1	2·2 : 1	4·3 : 1	2·4 : 1	3·1 : 1	2 : 1	1·7 : 1	4·5 : 5	4·7 : 1	9 : 1

Name of Water Company.	July.		August.		September.		October.		November.		December.	
	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.	Company's Analysts.	Frankland.
	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N	C : N
New River	3·6 : 1	2·8 : 1	3·8 : 1	3·7 : 1	3·4 : 1	2·3 : 1	4·1 : 1	5·3 : 1	4·5 : 1	4·5 : 1	2·6 : 1	3·5 : 1
East London	3·3 : 1	5·8 : 1	3 : 1	3 : 1	3·1 : 1	4 : 1	3·2 : 1	6·3 : 1	3·5 : 1	4·9 : 1	3·4 : 1	3·8 : 1
Chelsea	3 : 1	3·6 : 1	3·1 : 1	4·5 : 1	3 : 1	4·4 : 1	3·1 : 1	7·7 : 1	3 : 1	4 : 1	4·1 : 1	4·2 : 1
West Middl'sex	3·3 : 1	5 : 1	3 : 1	4·3 : 1	3 : 1	4·9 : 1	3·1 : 1	6·6 : 1	3·4 : 1	5·4 : 1	4 : 1	4·7 : 1
Lambeth	3·1 : 1	4·6 : 1	3 : 1	5·1 : 1	3·1 : 1	4·5 : 1	3·1 : 1	6·3 : 1	3·4 : 1	4·5 : 1	4 : 1	4·8 : 1
Grand Junction	3·2 : 1	4·5 : 1	3·3 : 1	3·6 : 1	3·1 : 1	4·8 : 1	3·1 : 1	6·5 : 1	3·3 : 1	5·4 : 1	3·5 : 1	4·8 : 1
S'uthw'rk and Vauxhall	3·3 : 1	3·8 : 1	3 : 1	4·8 : 1	3·1 : 1	3·6 : 1	3·1 : 1	9·9 : 1	3·3 : 1	5·9 : 1	3·5 : 1	5·2 : 1
Kent	4.5 : 1	4·2 : 1	5·5 : 1	3·3 : 1	11·3 : 1	3·1 : 1	9·5 : 1	4·9 : 1	3·6 : 1	4·7 : 1	3·4 : 1	2·2 : 1

It will be seen from this Table that with very few exceptions Dr. Frankland's results differ greatly from the other, and show a much higher proportion of carbon to nitrogen. It will also be observed that Frankland's results are much less uniform than those of the Companies' analysts, the proportion of carbon to nitrogen varying from 2·3 to 7·6 to 1 in the New River; from 3 to 6·3 to 1 in the East London; from 3·6 to 7·2 to 1 in the Chelsea; from 4·1 to 6·6 to 1 in the West Middlesex; from 3·3 to 7 to 1 in the Lambeth; from 2·6 to 6·5 to 1 in the Grand Junction; and from 2·7 to 9·9 to 1 in the Southwark and Vauxhall Company's water.

According to these figures, the organic matter in the samples examined by the Companies' analysts was almost invariably of a totally different character from that in the samples examined by Dr. Frankland. It seems also that the organic matter in Frankland's samples was of a much more variable composition than that in the samples examined by the Companies' analysts. The actual analytical results show many striking differences. In the New River Company's water the Company's analysts found more than twice as much organic nitrogen as Dr. Frankland in July, November and December, and nearly twice as much in May. The organic carbon was also three times as much in July, and more than twice in November.

In the East London Company's samples the Company's analysts' organic nitrogen results were nearly three times higher than Frankland's in October, more than twice in May and August, and nearly twice in January, February, June and September.

In the Chelsea Company's water the Company's analysts' organic nitrogen results were more than twice those of Frankland in May, July, August and October, and nearly twice in September. Their organic carbon was also nearly twice that of Frankland in July.

In the West Middlesex Company's water the Company's analysts' results were more than twice those of Frankland in May and August, and nearly twice in June, July, September and October.

In the Lambeth Company's samples their analysts' figures for organic nitrogen were more than twice those of Frankland in May, July and August, twice in March and April, and nearly twice in June and October. Their organic carbon was also nearly twice Frankland's in June.

In the case of the Grand Junction Company's water, their analysts obtained more than twice the quantity of organic nitrogen than Frankland in May, June and July, twice the quantity in April, and nearly twice in February, August, September, October, and November. Their carbon results also were more than twice as much as Frankland's in June, and twice in April.

In the Southwark and Vauxhall Company's water the Company's analysts found more than twice as much organic nitrogen as Frankland in February, May, July, August and October, and nearly twice as much in September, November and December. They also found nearly twice as much organic carbon as Frankland in July.

The analysts for the seven Companies alluded to were Mr. Crookes, Dr. Odling, and the late Dr. Tidy, and great as are the differences shown between their results and Dr. Frankland's, they are small compared with the discrepancies in the analyses of the Kent Company's water; the Company's analyst in this case being the late Dr. Bernays.

Dr. Bernays found more than three times as much organic nitrogen as Frankland in July, more than twice as much in March, June and December, twice as much in January, February and April, and nearly twice as much in May and November. On the other hand, Dr. Frankland found five times as much as Bernays in September, and twice as much in October. Dr. Bernays also found four times as much organic carbon as Frankland in February and March, more than three times as much in July and December, three times as much in April, and more than twice as much in January.

It will be seen also, by the table, that the proportion of carbon to nitrogen varies enormously in both Dr. Frankland's and Dr. Bernays' analysis of the Kent Company's water, ranging in the former's from 2 to 9 to 1, and in the latter's from 1·7 to 11·3 to 1.

The enormous differences in the actual results obtained with this process by eminent chemists having extensive experience of it, upon the same waters show that the claim of accuracy is not sustained, and as the proportion of carbon to nitrogen in the organic matter differs so frequently the process is seriously misleading in its indications as to the quality of the organic matter.

I cannot, within the limits of this paper, discuss the cause of these discrepancies, but must point out that even if the process were perfect in every respect it would only account for the non-volatile organic matter, as the volatile (which is present in water in considerable quantity, as I have shown in my paper on the subject, read before the Society of Chemical Industry in November, 1891) is lost in the evaporation.

Wanklyn and Chapman's "Ammonia" method of analysis is

most extensively used by chemists. It professes to distinguish between vegetable and animal organic matter by the relative proportions of "free," and "albumenoid" ammonia obtained by the process. The results may be absolutely relied upon to give certain indications of the presence of *fresh* sewage pollution, and of the degree of contamination, but when the pollution is not recent it fails to distinguish between animal and vegetable organic matter. In such cases it is necessary to supplement the process by determining the quantity of chlorides and nitrates present, when, if the results are abnormally high, there need be no hesitation in coming to a definite conclusion that the water has been subject to sewage pollution at some previous date. The following analyses illustrate the application of the process:—

No. of Sample.	Grains per Gallon.			
	Free Ammonia.	Albumenoid Ammonia.	Chlorine as Chlorides.	Nitrogen as Nitrates.
1.	None.	·00035	1·12	·437
2.	None.	·0014	·77	·437
3.	·0007	·0014	1·68	·875
4.	·0056	·0028	4·34	3·06
5.	·0322	·007	3·34	1.1

All the above samples were from wells in the same locality. Nos. 1 & 2 represent the normal condition of the water in the neighbourhood, and are unpolluted. No. 3, although safe organically, gives evidence by the increase in the chlorine and nitrogen as nitrates, of having at some previous date been polluted by sewage. No. 4 is of first-class quality, judged by the small quantity of "albumenoid" ammonia obtained from it, but as it is associated with a larger proportion of "free" ammonia there appears to be a slight recent contamination by organic matter of sewage origin, and the large quantity of chlorides and nitrates further indicate that there has been a considerable sewage pollution in the past. No. 5 shows, by the comparatively large quantity of "albumenoid," the still larger quantity of "free" ammonia, and the high results for chlorides and nitrates, that the water is contaminated by recent sewage pollution of considerable extent, and also that the pollution has been in existence for some time.

The process has been found exceedingly useful by innumerable chemists, and gives fairly concordant results with duplicate samples of water in the hands of different operators, but as the albumenoid ammonia bears no definite relation to the quantity of organic matter present it affords no means of estimating the proportion of the latter.

The "oxygen absorbed from potassium permanganate" process was originally suggested by Forchammer, and subsequently modified and improved by Miller, Tidy, and Dupré respectively. The process, in the improved forms suggested by Tidy and Dupré, is largely used as a confirmative test, but its indications cannot be relied upon as in any sense a measure of the organic matter present, therefore it is of very little use. The following examples show how contradictory its results are:—

No. of Sample.	GRAINS PER GALLON.	
	"Oxygen absorbed" (Tidy's Method).	Total organic matter in solution.
1.	·006	·140
2.	·016	·300
3.	·018	·308
4.	·073	·350
5.	·012	·750

Wanklyn's "Moist Combustion" method is not very much used, probably because it was patented by its author when first introduced. It is really a modification of the last-mentioned process, the difference being that the permanganate is used in the presence of an alkali instead of an acid, the oxidation is carried on at boiling temperature, the water is concentrated, by distillation, to a tenth of its bulk during the process, and a much larger quantity of the water is employed.

The process appears to me to be very promising, and its author claims that the results are roughly proportionate to the quantity of organic matter present. Whether this is so or not I am unable to say, as there are no experimental results available upon the point.

Having dealt with the several processes in common use, showing how little they can be relied upon for estimating the exact quantity of organic matter in water, I now direct your attention to a process, which has been in constant use in my laboratory for more than two years, giving perfect satisfaction, by which the volatile and non-volatile organic matter in water can be determined, together or separately. I may here remark that volatile organic matter in water has been entirely overlooked hitherto, and I need hardly point out that it must be of equal importance, at least, with the non-volatile.

The process was first introduced in my paper on the subject, read before the Society of Chemical Industry in November, 1891, and for full details I refer you to the Journal of the Society, Vol. X. p. 883.

Shortly described, the process is as follows:—

To determine the Total Organic Matter.—1 litre of water, to which 0·5 gramme of dried and ignited sodium carbonate is added, is distilled in a conical iron still of about 2 litres capacity, attached by means of a gun-metal "swan's neck," with screw connections, to a tin worm condenser. The distillate is received in a graduated measure, and when 970 c.c. has been collected, the heat is removed, the still disconnected, the contents and washings placed in a platinum basin and evaporated to dryness on a water bath. The residue is then dissolved in a little pure distilled water, filtered through an asbestos plug into a platinum basin, dried on a water bath, and subsequently heated for an hour in an air-bath, at 150° C. After cooling in a good desiccator, the basin and contents are weighed in a quick balance. The residue is then ignited at a low temperature (below red heat), cooled and weighed, and the loss noted. The ignited residue is then dissolved in water, excess of dilute sulphuric acid added, and standard solution of potassium permanganate (1 c.c.=·0001 gramme oxygen) added, until the colour is permanent after five minutes. The weight of oxygen lost by the reduction of nitrates in the residue thus ascertained is deducted from the loss on ignition, and the difference is the organic matter.

To determine the fixed or non-volatile organic matter the same course is followed, except that the sodium carbonate is not added until the concentrated water is transferred from the iron still to a platinum basin.

To determine the volatile organic matter the distillate from the last-mentioned process is placed in the still together with 0·5 gramme of sodium carbonate, and distilled until about 25 c.c. remains in the still, afterwards proceeding as before, except that it is unnecessary to ascertain the quantity of oxygen lost on ignition. The result represents about two-thirds of the total volatile organic matter present; further small quantities can be recovered from the distillate by repeating the process.

The process gives only the *quantity* of the organic matter in water, and does not afford any direct evidence of its *quality;* still, when there is a large quantity present the odour given on heating enables a fair opinion to be formed as to whether it is of animal or of vegetable origin, but I am bound to say that I find it quite impossible to decide in this way when only small quantities are present.

The depth of colour of the concentrated water appears to be roughly proportionate to the organic matter present. By making up the bulk of the liquid, before the last evaporation, to, say, 10 c.c., and comparing the colour, as seen in a small flat-bottomed glass cylinder, with a standard, a good idea may be formed of the quantity of organic matter present. A good standard colour may be prepared with weak ammoniacal solutions and Nessler's reagent, which when once ascertained can readily be reproduced.

The process is extremely simple in practice, requires little personal attention and can be completed within four hours.

In conclusion I give a few illustrations of its application to different classes of water, together with results obtained by other processes, for comparison.

Description of Sample.	Grains per Gallon.						
	Fixed Organic Matter.	Volatile Organic Matter.	Total Organic Matter.	Free Ammonia.	Albumenoid Ammonia.	Oxygen Absorbed. (Tidy's Method.)	Chlorine as Chlorides.
Moorland Water	·385	·315	·700	·0028	·0021	·070	0·63
Do.	·420	·280	·700	·0021	·0028	·073	0·70
Water from the New Red Sandstone	·105	·280	·385	None.	·0014	·003	1·05
Chalk Well (deep)	...	...	·350	·0014	·0007	·047	1·15
Do. do.	...	...	·490	None.	·0007	·021	1·54
Do. do.	...	...	·130	·012	·0042	·013	1·82
Source of River Lee...........	...	...	·511	·0007	·0042	·040	0·98
Do. do.	...	...	·560	·0007	·0035	·0167	1·05
Source of the New River ...	...	...	·693	·0021	·0035	·040	1·26
Do. do. ...	...	...	·420	·0007	·0028	·0177	1·40
River Lee. Intake of New River	...	...	·441	·0014	·0035	·0268	1·05
Do. do.	...	...	·308	·0014	·0049	·0232	1·26
River Lee. Intake of East London Water Co.	...	...	·483	·0056	·0056	·0484	1·40
Do. do.	...	...	·385	·0042	·0063	·0490	1·40
Kent Water Co..................	·273	·140	·413	...	...	...	...
New River Water Co.	·175	·280	·455	...	...	...	...
East London Water Co.	·322	·210	·532	...	...	...	...
West Middlesex Water Co....	·420	·140	·560	...	...	...	...

Dr. H. W. A. Sandell (Leighton Buzzard), referring to the differences in analysis, said that it was mentioned at the Conference of Medical Officers on the previous Tuesday by more than one speaker that different results had been obtained in analyses of water taken from different levels in the same well.

Dr. J. Groves (Carisbroke) corroborated this remark, adding that it was a point that had not occurred to men generally, but which was of the greatest interest. Dr. Thresh stated at that meeting that he had noticed a similar difference in analysis of water taken from a tube well.

Mr. J. H. Ball (Southsea) asked whether there was any simple but reliable way of testing the purity of water.

Dr. J. Groves (Carisbroke) said that unfortunately while a chemical analysis would prove the presence of contamination, it would not prove its absence. The poisons which would be potent in producing disease may be present in drinking water, but chemical analysis may not detect the presence of impurity. The source of supply and its surroundings were the true tests of the wholesomeness of water.

Dr. F. Pearse (Southsea), in answer to a question, remarked that without a chemical analysis it was impossible to say whether the organic matter present was of a vegetable and comparatively harmless nature, or whether it was animal matter.

Dr. J. Ward Cousins (Southsea) said that the very best common test of the purity of water was to find its source and its temperature. An analysis of water required great skill, and elaborate chemical apparatus, and it was impossible to have a common test such as Mr. Ball had suggested, though taste might sometimes be a guide.

Mr. J. H. Ball (Southsea): If Dr. Cousins had seen some of the water I have, he would not have ventured to taste it.

Dr. J. Ward Cousins (Southsea): Then there could not be much doubt of what the result of analysis would be in such cases.

The President of the Section (Dr. W. J. Russell) admitted that one of the great necessities of the times was some simple test to decide whether water was wholesome and fit to drink or not. It was a very natural request, and one that was often made to chemists. His own impression was that no such thing existed or was likely to exist. As long as people ate high game they could drink water that contained a good deal of decomposing organic matter. The chemist could not answer the question whether it was a wholesome water or not, but he could say whether the water was likely to become dangerous, and whether it was contaminated by sewage matter or not. It would be a great advantage were there a simple test, but there was not. He hoped that the method described by Mr. Young might be thoroughly relied upon, because it would give them a great deal of additional information as to the character of a water. It was simply a refinement of the old test of burning off the organic matter and reweighing. He regretted Mr. Young's absence, but thanked him for his paper.

On "A method of determining the purity of stable air by a comparison of the temperature within and without the building," by Veterinary Captain F. Smith, M.R.C.V.S., F.I.C., Professor in the Army Veterinary School, Aldershot.

ABSTRACT.

The examination of the air of a large number of stables, has shewn that the sense of smell carefully employed gives a fair idea of the amount of impurity present, as was demonstrated by the late Dr. de Chaumont to be the case in barrack rooms.

The carbonic acid of two or three hundred specimens of stable air was determined, and during the course of these experiments some observations were made as to the difference between the temperature of the external air and that of the stable.

I found that, as a rule, the greater the impurity of the air, the greater the difference between the temperature of the air of the stable and the air outside, so that by observing the thermometer, a fairly correct estimate could be obtained of the air purity of the building. A difference in temperature of from 3° to 5° Fahr. always accompanied air pollution; in the best ventilated stable the temperature of the building was only ·5° to 1° Fahr. higher than the outside temperature.

The above observations were all made during the winter, and at night time to ensure the stable being full.

When we remember that the warming of stable air is derived from the bodies of the animals which live in it, we can understand the *rationale* of the observation.

CONFERENCE OF NAVAL AND MILITARY HYGIENISTS.

ADDRESS

BY

INS.-GEN. J. D. MACDONALD, R.N., F.R.S.

PRESIDENT OF THE CONFERENCE.

Having been requested by the Council of "The Sanitary Institute" to act as President of the Conference of Naval and Military Hygienists, it devolves upon me to open the business of the Conference with an address on Hygienic matters. But, as the subject is wide and far reaching I must be satisfied with the consideration of some few important particulars, which I am led to hope will be of interest to those who may not have had precisely the same opportunities of investigating them. I always feel both proud and thankful to have been the friend and colleague of the late Professor Parkes at Netley, up to the date of his lamented death. One of the last things I submitted to him was a paper on the microscopic organisms detected in samples of ground air obtained on the spot. Up to that time the chemical constitution of the ground air had been investigated to a certain extent, particularly the increase of carbonic acid in proportion to the depth, but, no results of microscopical examination had been recorded. He gave me the sage advice not to make any public statement of the matter until I had amply supported my position by further experiment and proof. In passing I might say that the additional proof has been obtained, opening up quite a new field of research.

The ground air, like the ground water, is a subject of great importance, and has very largely claimed the attention of hygienists during the last few years. It is subject to its currents, storms, and calms, like the atmosphere above it, and though always more or less impure, it may be poisoned or infected with the products of specific organisms, as well as with the organisms themselves. Passing from this to the question of drinking-water, I desire especially to call your attention to a persistent cause of its contamination in the play of the vital functions of the *Protophyta* and *Protoza*. But, for the more satisfactory comprehension of this interesting subject, it will be necessary to premise some general principles and then show their application in the particular cases adduced. In the first place, we know that gases, liquids, and solids tend, or may be made to intermix homogeneously by the exercise of attractive and cohesive forces, which are ever restless until an equilibrium is established. Simple as this statement is, it forms the basis of at least three important laws, viz.:—(1st) The diffusion of gases; (2nd) the osmosis of fluids; and (3rd) the dialysis of crystalloidal substances, the same affinities being exercised with or without the interposition of a medium. The first law manifests itself most strikingly, in the preservation of the same formula of composition in the atmosphere all over the globe. The second is perhaps best seen in the circulation of the sap of plants, and the third in the processes of deposition, and absorption in animals. The three great laws are each brought into activity under special conditions, and pressed into the service of Nature to fulfil by physical agency certain offices in the organic world, which were formerly supposed to be of a purely vital character.

Time would fail us in the attempt to give even a very cursory sketch of the numerous purposes subserved by these laws, but the subject of *Osmosis*, and of *Dialysis* in particular, as applied to the physiology of nutrition in the lower orders of plants and animals, may profitably engage our attention for a short time.

1. The materials of which organised bodies are composed are capable of either crystallization or are non-crystallizable, named respectively crystalloidal and colloidal substances, by Dr. Richardson, whose simple and intelligent view of the subject will answer our purpose admirably.

2. Crystalloidal substances are usually found in the fluid state, scarcely ever assuming the crystalline form, except under morbific conditions, and they will exhibit this tendency in the inverse ratio of their solubility. Thus, we find crystals of cholesterine in atheromatous deposits, carbonate of lime in the coats of the minute cerebral arteries and lithate of soda in gouty concretions, which owe their segregation and subsequent persistency to the absorption of the water with which they were originally thrown out from the capillary vessels. Besides the *Raphides* in plants, crystals also as such are to be found in some animal bodies, as in the *Thalassicollidæ* for example.

3. Colloidal substances, on the other hand, are found either in the liquid or plastic state for the growth and repair of the tissues, Albumen, Fibrine and Gelatine in the muscles,

Albumen particularly in the nerves and brain, and Gelatine in connective tissue, ligament and bone.

4. In the vital fluid, blood, both crystalloidal and colloidal bodies are homogeneously blended together in watery solution. The latter components take up water from the former and so continually yield it up again by transpiration, that a regulated supply of water is necessary to keep up this cycle of actions and preserve the fluidity of the circulating mass.

5. The late Professor Graham first demonstrated that crystalloidal substances will pass through a colloidal membrane floating on water and diffuse themselves through the latter, while colloidal substances also present are left behind on the dialysing membrane. In this way the poisonous alkaloids are usually isolated from the other contents of the stomach, and identified by their appropriate tests in medico-legal investigations. Now the walls of the blood-vessels are literally dialysing membranes, and the facts to which we have alluded shed much light on the physiology of absorption, deposition, nutrition, and secretion. It will be part of my purpose to-day to show that the extraordinary pseudo-volitional movements of certain minute algals, more particularly *Bacterians*, *Oscillatorians*, *Diatoms*, and *Desmids*, are due to the play of the same forces. In my work on the "Microscopical Examination of Drinking Water," I have endeavoured to show that a similar explanation will apply even to the pseudopodial extensions of the *Rhizopoda* and the gliding movements of the *Gregarainæ*, which are destitute of cilia.

The law of intermittency observable in the phenomena connected with assimilation and decay is most interesting, and quite in the same category as that which we notice in the circulatory, respiratory and digestive functions of animals in general. The first appearance of the germinal vesicle and spot in the ovum, its final dissolution, and the substitution of two new cells in its stead, afford us the earliest evidence of that intermittency of action or interchange of building up and breaking down which is to all living things an essential condition of existence. In further illustration of the principle I am advocating, I wish to refer you to the anatomy of the lower division of animals. In the naked eyed *medusa* for example, four great vessels radiate from the central somatic cavity to the corresponding generative organs nearer the margin of the disc, to and from which parts the current of blood intermittingly flows. Thus, the materials of growth and development are conveyed to the ovaries one moment, while the products of decay are carried back by the same vessels the moment following. The circulation in the Brachiopod (*e.g.*, *Lingula*) is even more remarkable, for, although it also is effected by ciliary motion as in the *Polyzoa*, the out-going and returning currents course along the opposite sides of the same vascular channels.

The first unequivocal heart occurring in that well-marked series of beings which culminates in the true *Mollusca*, is found in the *Tunicata*. But here, as the circulatory system is in effect single, without any valvular mechanism, the whole round of the circulation sweeps alternately in opposite directions. Thus, the vessels conveying blood to a particular part one moment carry it back the next, when the course of the circulation is reversed. It is obvious therefore, that each vessel must play the part of artery and vein successively, affording another good instance of intermittency in those functions connected with the supply of new, and the removing of old material.

A perfect heart, with a receptive and a propulsive chamber, so arranged as to determine an irreversible path to the circulation, and the persistent distinctiveness of arteries and veins, distinguishes the *Mollusca proper* from the *Molluscoida* and *Cœlenterata*, to whose blood vascular systen allusion has been made. Organic cells, whether they appertain to plant or animal, are nourished in the same way, practically speaking, and while the singular movements exhibited by *Bacteria* and *Diatoms* are clearly due to invisible *Dialytic* or *Osmotic* currents, their obvious remittency bears out the views expressed in the foregoing remarks.

For many years after the publication of the great work of Ehrenberg on the INFUSORIA, while numerous unequivocal plants were eliminated from that *omnium gatherum* of organic forms, the *Diatoms* and *Desmids*, perhaps solely on account of their apparently volitional movements, remained in a doubtful position. They were constantly adduced in evidence of that neutral ground in which the animal and vegetable kingdoms were supposed to blend with each other or take a common origin. Indeed, the same may be said of the *Bacteria;* even the name of the putrefactive *Bacterium termo* was chosen to express the ultimate limit of animal life. At the present time, however, no doubt on the one hand can be entertained as to the vegetable nature of these forms or the absence of true volition in their movements on the other. Though these latter have not been hitherto satisfactorily accounted for, one remarkable fact has been observed in relation to them, namely, that when the energy by which the organisms move in a given direction is exhausted they forthwith pursue an opposite course, and this intermittency is continued indefinitely. Thus the normal movement of a *Diatom*, a *Navicula*, for example, is either zig-zag or backwards and forwards on the same line, as we shall presently see. But the kind of movement unquestionably depends upon the shape of the frustule, a fact which does not appear to be recognised by writers, who deal with the subject in a general way. Thus, if the form is elongated or boat-shaped, as in *Navicula*, the movement will be in the line of the longitudinal axis, but if the form is short or irregular a wabbling movement will be observed. The movement of a true *Bacterium* is excursive, while that of a *Micrococcus* is a jostling dance, due to the special form and the interchange of actions in the minute parts of the protoplasm. In Flügge's great work, translated by Mr. Watson Cheyne, page 159, he states that "some vegetative forms and species of *Bacteria* are always at rest; thus the spherical cells and all those species which occur only in the form of *Micrococci* exhibit only a trembling movement, with very slight alteration of position, which may be referred to unavoidable agitation and currents," which latter remark appears to show that he did not apprehend the true cause of the movement itself or of its peculiar character. Indeed, on page 558 he remarks that "The movements of *Fission Fungi* are swimming movements in fluid media, and are generally or always produced by cilia," a very doubtful position. But, to return, it is now well known that if *Diatomaceous* frustule in its onward movement meets with an obstruction, it will naturally appear to contend with the difficulty, and in due time of course recede. Thus, the very fact which was at one time best calculated to support the volitional theory is shown to be deceptive. If we divide a frustule of *Navicula* into two parts by an imaginary line through its short diameter, each half will probably contain a considerable mass of endochrome and a highly refracting globule, much resembling that which we observe in the *Thalassicollidæ*, and which probably discharges a similar office. Now, to understand how movement takes place, say to the right, we have only to suppose that the right half of the frustule is taking up endosmotic currents, while exosmosis is going on in the left half. The former would, as it were, draw it to the right, while the latter would impel it in the same direction, but when these conditions are reversed the frustule will move to the left, or, in other words, the little ship will take an opposite course in the trackless field of the microscope. *Bascillariæ* executing their fantastic compound movements, and even *Oscillatorians* waving like cilia on a magnificent scale, fall into the same category.

When we come to study the numerous minute forms of *algæ*, both marine and aquatic, we find either that, the individual cells or definite groups of them are enveloped in a more or less consistent gelatinous substance which acts as a dialyser or medium through which the materials of their nutrition are absorbed on the one hand, and the waste or effete matters of the organism are thrown off on the other. The gelatinous envelope in many cases takes so characteristic or definite a shape as to have obtained for it the name of a frond. It is sometimes beautifully laminated or dichotomously branched, globular or simply expanded floating or encrusting. The ordinary *Bacterium termo* and its allies which are individually surrounded with gelatinous matter either free, or clustered in the Zooglœa form, carry on their vital functions in a similar way; and it is incontestable that not only the matters which form their pabulum, but those effete compounds resulting from the waste of their substance, are in perfect solution in the surrounding water. Now, if we suppose only the waste materials or any part of them to be gaseous, they would first be held in solution up to the point of saturation, and then overflow or pass off into the surrounding air. There is great reason to believe that the subtle principles which may be assumed to be the cause of the most serious forms of specific disease are quite inodorous. In this light the more offensive gases have been regarded as the heralds of warning, either forbidding our approach, or demanding their own extinction, that in like manner more dangerous emanations may be either avoided altogether or divested of their power by the means employed in the first instance to correct a disagreeable odour.

The gelatinous coat of *Bacteria* and *Micrococci* varies much in its consistency under different circumstances and may even undergo complete solution.

It is apparently precipitated by chloride of lime, cupralum and some other disinfectants, including also the *Bacteria*. I can not be very certain, but it seems to me to disappear under the action of carbolic acid so far as to liberate the *Bacteria* and give them a more equable distribution over the field of the microscope. Now, it must be remembered that although colloidal substances in a concentrated state will not dialyse, they will do so when largely diluted, just as they would commonly occur in drinking water admitting for a moment their solubility. I mention this merely as another possible source of water contamination, that may not hitherto have been taken into account by Hygienists.

On "*The Prevention of Common Diseases at Home and Abroad,*" *by* RICHARD DOMENICHETTI, M.D., Deputy Inspector General, H.P.

ABSTRACT.

IN regard to the prevention of diseases at home, the means at our disposal, although for the most part of a satisfactory character, are in some instances permissive and not obligatory, which is much to be desired. The powers of the Sanitary Authority, for instance, in dealing with the isolation of infectious disease require to be better defined.

Too much of the routine to be followed out by Medical Officers of Health is hampered with "red tape," and more latitude should be given to them in combatting epidemic disease. It is a mistake to expect that all Local Authorities will be guided by the experience and advice of those who should be in a position to enforce what is good for the interests of the community. Much may be said about the method of dealing with diphtheria and cholera, which have been discussed at some length in this paper.

Then as regards the prevention of disease abroad the author deals with the subject as presented to him during a long service in India and at Gibraltar, especially urging attention to the water supply and sanitation generally as being the only safeguard against attacks of epidemics unhappily still met with at the present time, though statistics and recent experience show how much has been done to disarm epidemic disease of its terrors. Allusion has been made to the diminution of the death-rate at Louth, Lincolnshire, where for 20 years the author has been Medical Officer of Health; the urban population, 10,000, has now a death-rate of 16 per 1,000.

"*On some sources of Danger to the Public Health in Indian methods of Conservancy: especially with reference to the prevalence of Zymotic Disease in that country.*" By Surgeon-Captain R. H. FIRTH, A.M.S., Assist. Professor of Military Hygiene, at Netley.

ABSTRACT.

INDIA is one of the few places which affords practical sanitarians an opportunity of seeing, on a large scale, the working of a dry earth system of sewage disposal. In that country practically

no other system is in use, and on the whole it is found to work satisfactorily. Notwithstanding this there are dangers in its too perfunctory employment. These dangers seem to exist in the fact that much of the soil in India, especially during the hotter and dry months, is impotent for producing those real and necessary changes in the excreta, which are the very essence and *rationale* of the earth method of sewage disposal. The author, in the course of a long series of experimental observations upon the nitrifying powers of various samples of Indian soil—taken not only from fields, but also from the earth supplied for use in barrack and hospital latrines—found that 14 per cent. of the soils failed to show any nitrifying power. Sandy soils, and the peculiar sandy and very dry soils of Upper India, appeared to be peculiarly defective and unsuitable for the conversion of excreta into harmless matter.

Another source of danger to public health exists in India in the absence of sufficient care being exercised in the manner of burying excreta. This carelessness is not the result of any want of special instructions on the point, but is the outcome of inadequate supervision and inspection. It is no infrequent occurrence to find that the excreta, instead of being buried in trenches at least one foot deep, are barely buried at all, or perhaps only just covered by a few inches of light, porous, sandy soil. This state of affairs is aggravated by the foraging propensities of pariah dogs and jackals after garbage and filth of all kinds—to say nothing of the denudation which follows the churning up of superficial soil by the dust storms so prevalent.

Complementary to this aspect of the subject is the seasonal prevalence of enteric fever in Upper India, which prevails chiefly in the hot dry months before the rains, and again in the drying up months after the rainy season. While desirous of not being thought to consider that all or one-half the cases of this disease in India are due to defects in the disposal of excreta, the author is yet of opinion that an appreciable number owe their origin to the diffusion, in the form of atmospheric dust, of spores and bacilli of that disease derived from imperfectly buried typhoid dejecta.

A further source of danger lies in the fact that it is no infrequent occurrence to find that the very cart which carried excreta out of cantonments for burial, is employed on the return journey to bring in dry earth for use in the latrines: while this very earth so brought in is often collected from spots where excreta have only recently been cast or superficially buried. Knowing as we do that Eberth's bacillus retains its vitality in soil for many months, such procedure is eminently calculated to keep up a constant supply of the specific virus of typhoid fever in cantonments and elsewhere.

To remedy this condition of laxity in sanitary supervision and methods, the whole Sanitary System of India needs to be overhauled: with the establishment of definite Sanitary circles. These circles need to be judiciously limited in area, so as to be efficiently worked by a competent Sanitary officer. This officer should be a medical man endowed with full control over the subordinate Sanitary officials, and himself alone directly responsible to the executive government for the sanitation of the circle under his care. Further, those tracts or areas devoted to the reception of excreta need to be systematically cultivated and irrigated, so as to secure the necessary changes in the buried dejecta as well as a chemico-mechanical fixation of all hurtful elements within the deeper soil layers. The burning of all excreta should be encouraged as much as possible, as fire is the only agent on which we can rely for the destruction of disease germs contained in dejecta.

CONFERENCE OF MEDICAL OFFICERS OF HEALTH.

ADDRESS

BY

PROF. C. KELLY, M.D.

PRESIDENT OF THE CONFERENCE.

THE census returns of 1891 show some remarkable results. The population of England and Wales, as estimated to April, 1891, amounted to 29,704,068, while, as enumerated, the actual numbers were 29,001,018, a difference of 703,350 persons.

The decennial rate of increase was 11·65 per cent., against 14·36 in the previous decade, and it was lower than in any previous intercensal period.

The natural increase of population amounted to only 3,630,761, whereas it would have been 3,919,543 had the increase been in the same proportion as it was in the preceding decennium. This was due to a steady fall in the birth-rate which has been going on continuously since 1876, when it was at its maximum. It was lower in 1890 than in any year during the last half-century, and it was 5·8 per 1,000 less than in 1876. This decline cannot be accounted for by a decrease in the marriage rate, and it will probably be found that in a considerable section of the population large families are not so often met with as in former periods. It is a fact well worthy of notice that whereas the death-rate for 1881-90 was lower than in any previous decennium, yet the diminution in the birth-rate was much greater, so that the loss in numbers due to the falling off in the births amounted to 288,782.

A second cause of the decline was due to an increase in the number of emigrants over immigrants. Had the balance of emigrants been in the same proportion in the last as in the previous decade the decrease would have been only 189,614, whereas it actually amounted to 604,182, or an access of 414,568. These two deficiencies account for the error of 703,350 in the estimated as compared with the enumerated population. Of the emigrants 410,648 were males and 193,534 were females; and although the ages of these people cannot yet be given, there can be little doubt that they include a large number of young adults at the active and productive period of life. The excess of males over females who leave the country

causes a large increase in the proportion of females to males at home: this increase has steadily gone on since 1851, and now there are 106·4 females to every 100 males.

There are in this country 900,000 more females than males, a fact of much importance when the competition for existence is so keen.

This excess of females is confined to urban districts; in rural districts the males are slightly in excess of the females, while in the urban districts there is an immense difference.

The erroneous estimates of population affect urban much more than rural districts. The twenty-eight large towns with a population of 9,405,108 had an estimated excess of 605,318; while in the rest of the country, with a population of 19,595,910, the estimated excess was only 98,032.

The estimates of the population are based upon the hypothesis that the rate of increase prevailing during the period 1871-80 had been maintained during the last decade. This method is untrustworthy, for in the case of the twenty-eight large towns the rate has varied from 28·3 per cent. to 11·2 per cent. during the last ninety years; and since the estimates have been wrong, it follows that the recorded birth-rates and death-rates have in most cases been given in error. In London the population was over-estimated by 271,255 persons; in Liverpool, by 103,327; in Salford, by 52,307; and in Nottingham, by 39,555. On the other hand, Newcastle was under-estimated by 22,486, and Portsmouth, by 15,457.

In the first or second year after a census the error is not great, but it increases rapidly towards the end of the decade; and during the last five years of an intercensal period the estimates for large towns are in most cases very misleading.

Mr. Noel Humphreys has shown that in Liverpool, on the old estimates, the death-rate had declined from 26·7 in 1881 to 23·6 in 1890, whereas the actual figures show it had risen from 26·8 to 27·8; in Salford the error was still greater; on the old estimates the death-rate was 22·6 in 1881, and 22·4 in 1890, whereas the actual figures show that it had risen from 22·7 to 27·6 per 1,000.

These are the most extreme examples, but it is very important for us to consider what can be done to prevent such errors in future. It is useless to prepare annual reports and to spend much time and labour in working out birth-rates and death-rates when the estimates on which we rely are so misleading.

We talk of lives saved when we really mean deaths postponed.

A low death-rate is not the only thing for which we should strive. A high wage-rate is just as important as a low death-rate.

In rural districts the population increases very slowly, and in many counties it shows a decline. There is the same exodus towards the large towns as there was when Arthur Young wrote his surveys, and when Cobbett bewailed the growth of the Great Wen. The figures for each parish are not yet published, and there seems to be no reason for the delay. In 1881 the results were known a few weeks after the census was taken, but last year an instruction was given that no information should be granted to the public by those engaged in the census taking.

In rural districts the superintendent-registrar is very often the clerk to the sanitary authority, so that the medical officer may be giving his authority for erroneous birth-rates and death-rates for his district, while the clerk has in his pocket the correct figures, which he cannot disclose. There seems to be no good reason for this secrecy, for the corrected returns differ very slightly from the results sent in by the registrars, and as the public pay for the census-taking, they ought to know the main facts as soon as possible. If every superintendent-registrar sent in to each sanitary authority the summarised results for each parish at the same time that they were sent in to the census office the chief facts would be known within a month instead of having to wait for a period of two years. Any corrections hereafter to be made would hardly affect the birth-rates or death-rates.

The general public believe in a low death-rate as a sign of a healthy district, but this belief will be shaken unless more nearly correct information can be given. The errors at the next census-taking may be greater than those recently recorded, because emigration appears to be on the increase, and the returns on this subject are very imperfect. If young adults leave the rural districts for large towns or for other countries, there must be an accumulation of older people in our villages, and this raises the death-rate, while it is made slightly higher by the presence of so many males in the population. The age and sex distribution of a rural district may raise the death-rate 2 per 1,000, as compared with a standard population.

On the other hand the excessive proportion of females in large towns and the smaller proportion of aged persons tends to lower the death-rate, so that as compared with a standard population a recorded urban death-rate may be 3 per 1,000 below the corrected death-rate.

No one can view with satisfaction the results of the last census. We can speak of a lowered death-rate, but a declining birth-rate has had the effect of more than neutralising any increase in numbers from that cause. The increasing numbers of the young and active who emigrate, the excessive proportion

of females in our large towns, and the admission of pauper aliens are not elements which add to our prosperity.

The care which is taken of the idiot, the pauper, the lunatic, and the criminal may do credit to our humanity, but it does not add to the strength of a nation. To a great extent we are cultivating the weeds in our garden. In the great social questions which lie before us these facts must be taken into account.

It has often been urged that a quinquennial census should be taken, and this is now done in France and Germany, and in some of our colonies. There is a great need of a simple population enumeration every five years, which will give the correct numbers of males and females in each sanitary district, and the ages at which they live. The results should be published as early as possible after the census taking, while every ten years, as at present, more elaborate results could be obtained, which would be useful for actuarial purposes.

The returns of emigration and immigration should be more accurately given, and the age and sex of each person should be recorded.

There should be a statistical department established at the Local Government Board, so that men trained to the use of statistics may each year give nearer estimates of the growth or the decline of towns and country districts than we can at present obtain.

This Conference might aid in pressing upon the Government these much needed reforms.

On "*Isolation Hospitals*," by J. Groves, M.D.

Any person who is able to look back a quarter of a century to a time when he was intelligently observant, can scarcely fail to note, when he compares the present with the past, that a great change in public opinion has taken place, and is still going on, with reference to the views held as to what may be described as the relation of the individual to the community, and more particularly as regards matters appertaining to the interests of the public health. Sometime since, I was walking down Parliament Street, and observing a structure in the middle of the roadway not far from the offices of the Local Government Board, curiosity prompted me to ascertain its object. Descending a flight of steps from the road-level I found myself in a spacious apartment lined with white glazed tiles, and having a tessellated pavement, on one side of which was a row of water closets, on the other side a row of white enamelled earthenware urinals, and at the end a lavatory with marble fittings. There was absolutely no smell, and the apartment was such a one as would be found only in hotels of the very highest class. A notice set forth that this arrangement for the convenience and comfort of the public had been provided by the Vestry of St. Martin's parish. I fairly rubbed my eyes. On ascending to the road I found there was another flight of steps leading, presumably, to a similar apartment for the accommodation of ladies. Subsequently I discovered that such places had been constructed by the vestries of other parishes, and as the land beneath the roadway has been vested by Parliament in the vestries for this purpose, and as no ground landlord's agent can now bar such a public benefit, the provision of like conveniences to the whole of the metropolis will only be a question of time. These arrangements made by the community for the benefit of the community as a whole, although many of the individual contributary ratepayers may never participate in the advantages they afford, will serve to illustrate the change in opinion I have indicated.

A quarter of a century ago, when, endowed with almost autocratic powers by the Privy Council, I had the honour to hold a sanitary appointment during the cholera epidemic of 1866 in one of the large districts of the Metropolitan Board of Works, which included, if I remember rightly, a part of this very Parish of St. Martin's, a Metropolitan Vestry would scarcely have conceived it possible that twenty-five years later it would be considered seemly and right that the money of the ratepayers should be used in making the best possible arrangements for the comfort of the community, that the individual interest would cease to be prominent and would become merged in the general interest of the community. Not that there was any supineness in the presence of cholera. Much was done: wells were closed, there was a general clearing up of insanitary conditions, and there was no stint of expenditure whatever; the poor among the cholera patients were treated at the public expense. Great commiseration was felt for the unfortunate sufferers, and disinfectants flowed in streams along the streets and down the sewers. But whatever the views of the Privy Council may have been, public attention was concentrated upon the victims of the disease, and public feeling was benevolent to a degree with reference to them. But public opinion was not prepared to sanction the removal and the lodging elsewhere at the public expense of the inhabitants of crowded houses which had become infected, because there was a poison abroad, threatening the public safety, which had been caught or imprisoned; or the provision out of public funds of trained nurses for the sick, in order that they might be more perfectly isolated, and not that they might be better nursed. There were no hospitals of the Metropolitan Asylum's Board in those days, and had it not been possible to send many of the cholera patients to hospitals supported by voluntary contributions, the result of the invasion would have been disastrous. The great hospitals saved London in 1866, when cholera poison was regularly turned on by the turncocks to houses supplied by the East London Waterwork's Company.

The almost universal acceptance of the popular Notification of Infectious Diseases' Act, notwithstanding its interference with the liberty of the individual and with the privacy of his home, and notwithstanding that the notification fee is paid out of the public purse, is alone sufficient evidence of the adoption by a large body of intelligent opinion of the principle that in matters appertaining to the public health, at least, the well-being of the community at large dominates every other consideration. And if this principle applies to notification, it must necessarily apply to the corollary of notification—the isolation hospital. The principle underlying the isolation hospital is that of the maintenance of the general well-being at the expense of the individual, that is to say, of those who in the aggregate make up the community, which is, indeed, the principle, and the only principle, upon which sanitary legislation should be founded, and which is the principle, and the only principle, upon which sanitary law should be administered. If this be universally recognized as the guiding principle in sanitary matters, there should be no difficulty in deciding the course either of legislation or of administration. If it were so universally acknowledged the legislature would not permit matters so vital as notification and isolation to be permissive, and sanitary authorities would not endeavour to throw the whole of the burden of sanitary improvements upon those obviously and directly benefited only.

The public health cannot be secured in any community if the poison of infectious disease is disseminated through it. Notification points out the spot at which the poison is being generated, disinfection destroys it after it has been produced, isolation alone will render its production harmless. The person producing the poison may be isolated on the spot, either by removal of the other inmates of the dwelling or by appropriating one or more rooms, with certain precautions, to his exclusive use; but, as a rule, efficient isolation can be obtained with certainty only by taking him out from among the community, and if this be so, a place must be provided to which to take him, and the provision of that place must necessarily be made by each individual ratepayer contributing his share of the cost of it. Equally certain is it that the removal of the person who is poisonous and his maintenance while he continues so, must be provided for in the same manner. From a humanitarian point of view it is satisfactory that he will benefit; but the provision of an isolation hospital and his removal to it is not done for his benefit, but for the protection of the community of which he forms part. In an economic sense the expenditure necessary to the establishing and maintenance of an isolation hospital is, doubtless, a wise investment having regard to the money cost of sickness; but this is quite a secondary consideration, altogether subordinate to the main object of its existence, which is that it affords an additional and powerful safeguard to the community against disease and death.

Of the 1,510 provincial sanitary authorities in England and Wales, rather more than one fourth have made provision for isolating cases of infectious disease. Dr. Thorne Thorne is my authority for this statement. It would appear, therefore, that in nearly three fourths of the provincial sanitary districts the principle to which I have referred is not observed as regards the isolation of the poison of infectious disease. Among these are districts which actually include watering places and health resorts, which are especially liable to the introduction of zymotic disease because convalescents are removed to them while still poisonous. The authorities who administer the sanitary law in such places would appear to be particularly culpable, for they not only leave the normal population without such protection as isolation may afford, but their visitors—who are to them what a manufacturing industry is to another community, their source of wealth, and many of whom are, possibly, invalids—are also left without this form of protection. In places so visited all must agree that sec. 131, P.H.A., 1875, should read, "authority *shall* provide" instead of "authority *may* provide."

The principles which govern the construction of an isolation hospital are embodied in the memorandum as to Isolation Hospitals issued by the Medical Officer of the Local Government Board, and it is unnecessary to consider the details now. Some who are present had the opportunity of inspecting, a few weeks back, a large hospital so constructed, at Nottingham, and very perfect it seemed to be, and worthy such an important community as it is intended to protect. A similar hospital exists here, and it is, doubtless, of enormous assistance to my friend Dr. Mumby, who so efficiently safeguards the interests of the public health of the great community we are visiting. In passing, I may say that the Mayor of Portsmouth has told me this hospital is of the greatest service and most popular, and the worthy Alderman, who is the Chairman of the Health Committee of the Corporation of Nottingham, remarked that notwithstanding the large outlay which the provision of the hospital involved, the ratepayers of Nottingham would only be too thankful if there was no necessity to make use of it.

Although in several districts in which Notification is in force the old estimate of one bed per 1,000 of the inhabitants has been found too low, it is probable that when it becomes universal this estimate will be too high; but much will always depend upon the character of the population, and upon other circumstances. It is impossible to say now what the mean proportion will in the end prove to be, so vitiated at present are the notification returns by the presence of non-protected districts. A district in which scarlet fever is permitted to burn itself out, occupying two years, perhaps, in the process, must materially affect the notification returns in surrounding districts. Less difficult is it to determine the amount of space each bed will occupy, and to ascertain, therefore, the size of ward or pavilion. It is pretty generally agreed that in a well-ventilated ward the smallest allowance of air-space per bed should be 2,000 cubic feet. Dr. Thorne Thorne has proposed that each bed should be allotted a floor space of 12 ft. × 13 ft., the bed standing 1 ft. from the wall, which does not seem too generous an allowance.

The infectious diseases which with us call for isolation in hospital are in the order of their importance: scarlatina, typhus, small-pox, diphtheria, enteric fever, and cholera. Those less frequently isolated in hospital are erysipelas, measles, whooping cough, and puerperal fever.

When they possess an isolation hospital it is for the welfare of the community that each case of infectious disease which occurs in their midst should be isolated there. Every inducement to use the hospital, therefore, should be offered. The best nursing, the best attendance, the best cooking should be provided. What are known as the better classes should be especially encouraged to send their sick there if only to remove the suspicion of pauperism which the mechanic and labouring classes may have. The medical man who has been treating the case should continue to attend it; mothers or near relatives should be allowed to enter the hospital with a child and remain there if they wish; and the freest access compatible with the public safety should be permitted at all times, more particularly in serious cases, every precaution in the way of disinfection being taken before a visitor leaves. No payment should be accepted even if it be offered by the rich, for in doing so the principle for which I contend would be destroyed, and the stigma of pauperism would attach to those who did not pay. The 132nd sec. P.H.A., 1875, which recognises the system of payment, and something more, should be repealed. It would be better, in my opinion, to offer premiums to those who are willing to secure the public safety by entering the hospital, than to put this clause into operation.

We, as Medical Officers of Health, have it in our power to mould public opinion in our several localities upon this as well as upon other questions; and having determined in our own minds the principles which should guide us, the more fearless we are in giving expression to our opinions the more quickly—for public opinion is paramount—will be attained the great object we all have in view, the security of the public health throughout the land.

On the "*Condemnation of the Meat of Tuberculous Animals*," *by* Arthur Newsholme, M.D., Medical Officer of Health for Brighton.

ABSTRACT.

1. It is generally admitted that tuberculosis is an infective disease, capable of being produced by specifically infected ingesta.

2. Everyone will also admit that the flesh of tuberculous animals, to which diseased pleura or glands are still connected, is a source of real danger. Cooking cannot be allowed to enter into consideration, as much meat is eaten underdone or raw.

3. It is universally agreed that the flesh of tuberculous animals in which general wasting has occurred, whether the disease be local or general, should be condemned.

There remain, therefore, in dispute only the cases in which more or less tuberculosis exists, without at the time of slaughtering having impaired the apparent nutrition of the animal. In these cases the internal organs may be studded with caseous masses, or all the serous membrane may be extensively implicated.

Are emaciation and bad condition of the tissues to be the sole test in condemning the flesh of tuberculous animals?

If tuberculosis is an infective disease, spreading by the lymphatic or vascular circulations, its infectivity is probably greater in the early stage of a tuberculous growth than at a later period, when the bacillus has been killed by the caseating products of tubercle.

It cannot be expected that we should have much evidence of tuberculous disease traceable to infected food, the conditions of life being so complex. There is, however, experimental evidence of this in lower animals.

The following resolution is submitted:—

That where tuberculosis of a single organ of the body impairs the nutrition of the flesh, the whole animal should be condemned; and that where tuberculosis affects more than one organ, or where more than one serous surface is extensively implicated, the whole animal should likewise be condemned.

"*The Purification of River Water by Agitation and Metallic Iron, as conducted with the water of the River Severn at Worcester,*" *by* Horace Swete, M.D.

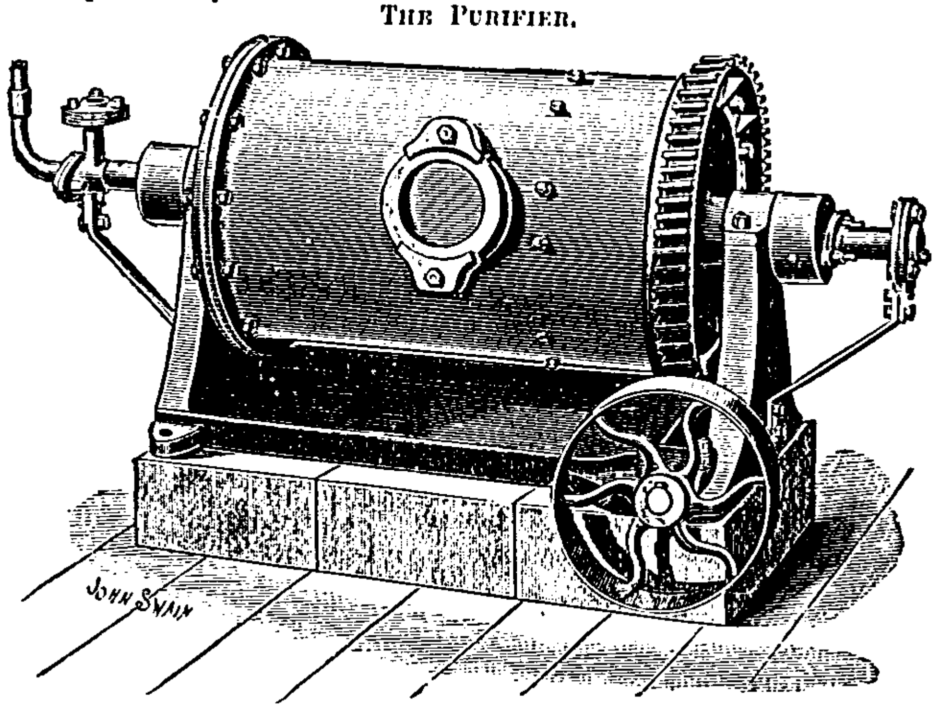
ABSTRACT.

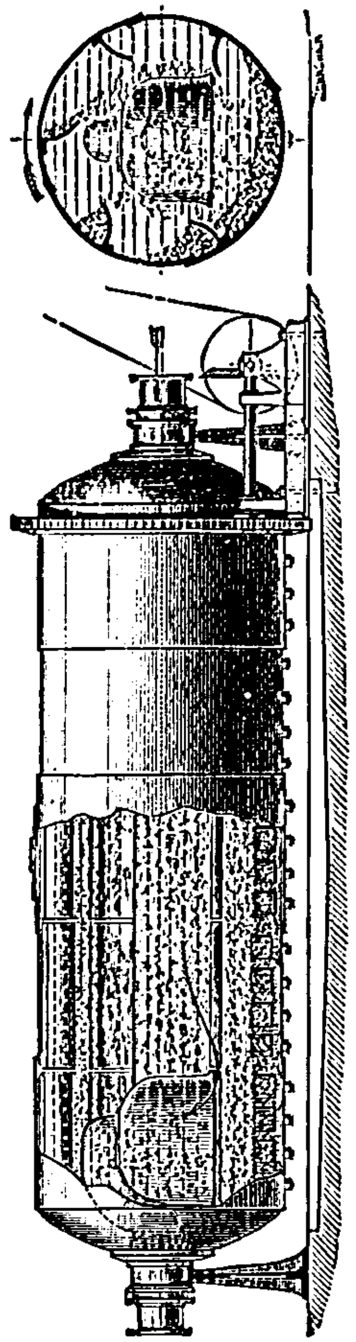
There are few subjects of greater importance and interest to us, as Medical Officers of Health, than that of obtaining a wholesome and sufficient supply of water.

It is a sanitary axiom, that a water that has never been polluted is far better than a polluted water rendered pure by filtration or other means, however successful the purification may be; but there are many districts in this country where pure deep well water cannot be obtained, and if it can there is not a sufficient supply. Our large towns, as Liverpool, Manchester, Birmingham, and others, are giving up their deep wells and are seeking an inexhaustible supply from Lakes, or the upper waters of rivers, above the pollution of towns. This is, however, too costly a process for our smaller towns and villages, whilst frequently a river or brook, if only it could be sufficiently purified, would afford an ample supply for the population. In the City of Worcester we are in that position with the ordinary surface wells grossly polluted; a deep well supply of very doubtful quantity; and a river with an inexhaustible supply, but of polluted water. For many years the river has been the source of our town supply, filtered through sand filters, but these have been unable to cope with the impurities, especially the peat and kaolin, which the Severn contains in large quantities. Recently the City has undertaken an experiment on a large scale to purify the water by means of Anderson's Revolving Purifiers. These have been at work since June 7th, 1892, and as I have made daily analyses of the river and of the purified water, I am able to place facts before you that you may consider whether such a method may not be equally applicable to other places.

There is nothing new in the principle; it is the old plan of shaking up the water with some pieces of iron in it, allowing it to settle, and filtering off the thick matter, when the water is rendered bright and clear. Years ago it was a common custom in the West of England to put a few rusty nails in a bottle of bad water and shake them up, by which the water was greatly improved. The wooden barrels for water on board ship are now exchanged for iron tanks, the motion of the ship enabling the iron tank to keep the water sweet for a lengthened voyage. For many years there have been processes in use for purifying water with iron, more or less successful. The most important filter for domestic filtration is that in which Bischoff's "Spongy Iron" is made use of as a filtering medium, which can be from time to time renewed, and this has held a deservedly high place amongst filters for home use. On the large scale, however, it has not been so successful. At Antwerp, where the water supply is derived from the tidal river Nethe, a river largely polluted with organic matter and peat, spongy iron was at a great expense used as the filtering medium, 900 tons being mixed with three times its bulk of fine gravel in the filters; for two years this gave excellent results and then gradually the filters became choked, and the spongy iron converted into a hard and concrete mass; in 1884 the system was abandoned, the cakes of spongy iron being broken up with a pick with considerably difficulty, and Sir Frederick Abel suggested to Dr. Anderson, that if the spongy iron could be kept in motion in the water to be filtered it might be more successful; Dr. Anderson therefore designed the Revolving Purifier, and found that pieces of iron and preferably the burrs made in punching iron plates, were even more effective than the spongy iron previously used.

THE PURIFIER.





These illustrations shew the plan of the Purifiers, the smaller size being that designed for Village supply. The larger cut shews the interior arrangement of shelves for the cascade of Iron and the dependant Funnel through which the water is discharged from the Purifiers.

This apparatus is extremely simple. A large iron cylinder, capable of revolving on hollow trunnions, through which the water passes in and out is constructed; this cylinder is fitted with four or five rows of shelves in echelon, so that as the cylinder revolves, the iron burrs are taken up by the shelves and discharged through the water, the cylinder giving thirty cascades of iron in each revolution. To retard the water from passing straight through too quickly, the outlet trunnion is fitted with an inverted funnel, the open mouth always facing the bottom of the cylinder, and a few inches from it. These cylinders are made of various dimensions according to the amount of water to be purified, but for large works one or more of about twenty feet long by five feet in diameter, with twelve inch openings are mostly used, and are capable, if working for twenty-four hours, of purifying about one million gallons of water. The rate of contact is generally three-and-a-half minutes, the time however is regulated by the character of the water to be purified, and if the nature of the impurities require it air is at the same time pumped through the cylinder. To enable the water in the purifiers to be maintained at various heights during their revolution, which may be required to be altered according to the nature of the water to be purified, the tank into which the purifiers discharge their contents is fitted with sluice boards so that the level of the water in the tank and consequently the depth of water in the purifiers can be altered by removing one or more sluice boards.

After passing through the cylinder, the water flows along a trough of some length, falling in a cascade into a settling tank; during this passage it is aerated by air being pumped through the water as it flows along the trough; the water is then allowed to remain in the settling tank about six hours, when it is drawn off by a suction pipe, floating three inches underneath the surface, into an ordinary sand filter bed, from the bottom of which it is delivered at the rate of four to six inches an hour into a pure water tank, and from thence it is distributed over the town.

Such is a brief description of the most general form of working this apparatus. I have purposely refrained from giving any engineering data, as the object of interest to us as Medical Officers of Health is the method by which the water is purified and the amount of purification.

The Rationale of the Process.

The numerous analyses I have made of the water in the different stages of the process, as well as the sand and deposits in the filter beds, enables me to offer for your consideration a theory of the nature of the work done in the purifiers and filter beds, which appears to me to be, in the main, borne out by analytical facts.

The process consists of three parts:

(a) The work effected in the purifiers.
(b) The result of aeration and subsidence.
(c) The work done by the filter beds.

(a) The work done by the purifiers.

The water of the river going into the purifier contains about 9·4 millegrammes of dissolved oxygen per litre, on passing out this is reduced to about six millegrames, the water has therefore lost oxygen, which has oxidised some of the iron to form ferrous oxide, and this is dissolved in the water to the amount of 0·3 grains to the gallon.

The free or saline ammonia is unaltered.

The organic matter, which would be estimated as albumenoid ammonia, is unaltered.

The organic matter principally carbonaceous, which is estimated by the amount of oxygen required to oxidise it, is diminished to the amount of about 40 per cent., it is possible that some of this may have been converted into carbonic acid, as Professor Crace Calvert has shewn, that iron does not oxidise in water, except in the presence of carbonic acid.

The number of colonies of microbes is not diminished.

The work of the purifier is therefore to reduce the amount of dissolved oxygen, to reduce the amount of carbonaceous matter, and to form ferrous oxide.

(b) The result of aeration and subsidence.

The water, which is now of a greenish brown colour, from the ferrous oxide, passes along the trough, where air is blown into it through the false floor of the trough; this changes the green ferrous oxide into the red ferric oxide, or ordinary iron rust. As the water passes along the trough and falls into a cascade, into the settling tank, it is further aerated, so that when it reaches the filter bed it contains more dissolved oxygen than was originally present in the water of the river.

During the oxidation of the ferrous oxide, a gelatinous cloud is formed, which entangles into itself saline ammonia, organic matter, and some of the microbes.

The aeration and settling tanks therefore oxidise ferrous oxide into ferric, add oxygen to the water, and entangle saline ammonia, organic matter, and microbes in the gelatinous coagulum formed by the oxide of iron.

To show that this is the case I collected some of the deposit precipitated after aeration, and found it to contain besides the ferric oxide, of free ammonia 5·3 parts per 100,000, and of albumoid ammonia thirty parts per 100,000 the nitrites being nil and nitrates a trace.

It is evident that it is here, as well as in the sand of the filters, that the saline ammonia and the organic matter is arrested, not being chemically decomposed, but mechanically caught in the coagulum of the oxide of iron.

(c) The work done by filter beds.

In Worcester the settling tanks and filters are insufficient to allow the water to be retained in the settling tanks for more than three hours, so that much of the precipitate, which ought to have been retained in the settling tank, passes over to the filters, giving them extra work to do. Had the settling tanks and filter beds been specially designed for the system, the water passing to the filter beds would have been almost clear, so that some of the free and albumenoid ammonia found here must really belong to the settling tank.

An analysis of the sand of the filters gives 2·6 of free ammonia and 2·7 of albumenoid in 100,000 parts.

Oxygen is also taken up in passing through the filters, the filtered water having rather less oxygen than the river water, a freshly-made filter taking up nearly 50 per cent., which is gradually lessened as the filter gets in working order to 6 per cent. At Antwerp, where the filters have been working for six years, this action has ceased, and the filtered water contains more dissolved oxygen than the river water, as shown by Dr. Tidy's analysis.

As the water passes through the filters generally at the rate of six inches per hour, the surface sand collects the film of precipitated oxide of iron and organic matter, and the sand grains become gradually coated with ferric oxide; this will not wash off when the surface sand is cleansed. The coating of oxide gradually extends throughout the filters, absorbing oxygen from the water to complete the oxidation of the iron; by this means the interstices of the filter get gradually smaller and enables organic matter and microbes to be more completely trained out. From time to time half an inch of the surface sand is taken off and washed; this, when the filter is too thin, is replaced again. Now the most perfect filter is the "Chamberland," which is merely a piece of baked porcelain, unglazed, through the minute pores of which organic matter and microbes will not pass, so that it completely mechanically sterilizes the water, so much so that this filter is used by bacteriologists for the collection of microbes for microscopic examination. Now what the process does is to convert the sand filter into as near a resemblance to a "Chamberland" filter as possible. The "Berkefeld" filter, made of fossil earth, "Kieselguhr," also acts in a similar manner. This view is carried out by my cultivations of microbes in the water of each individual filter. During the experimental stage, No. 5 filter was remade from the bottom with three feet of fresh sand. A cultivation made a few days after it was put into action gave over 500 colonies per cubic centimetre, the river giving about 9,000; this has

been gradually reduced to a little over the 100; filters No. 2, 3, and 4 give 91, 50, and 95 colonies, whilst No. 1 filter, which is very thin and requires remaking up to the usual depth of sand, is gradually giving more and more colonies. A more recent cultivation of the water of the separate filters gives—

No. 1	100 colonies.
" 2	90 "
" 3	40 "
" 4	None.
" 5	40 "

being a mean quantity of 54 in a cubic centimetre.

Prof. Roux gives the following table:—

Water excessively pure	5 to	10 colonies per centimetre cube.	
Water very pure ...	10 to	100	" "
Water pure ...	100 to	1,000	" "

It is clear, therefore, that the sterilization of the water is mechanical, and is more or less nearly perfect, as the pores of the filter are contracted by the aggregation of the oxide on the particles of sand. This shows the importance of not disturbing the crust of the filter, and that this process cannot be allowed after it has once started, as is too often the case, to go on, in a happy-go-lucky manner, but must have continuous and intelligent supervision.

To sum up the rationale of the process, it is *chemical* so far as the formation of the oxides of iron are concerned and the reduction of some of the carbonaceous organic matter; it is after that *mechanical*, reducing the pores of the filter and enabling them to undertake what they could not perform before, especially with peaty and clayey waters.

I think that when a supply of deep well water cannot be obtained, the result of the experiment at Worcester shows that there is a process that may render a river or brook water sufficiently good to come within the category of potable waters, and must therefore be a subject of interest and importance to Medical Officers of Health.

On "The Interpretation of Results in Water Analysis," by
JOHN C. THRESH, D.Sc., M.B.

ABSTRACT.

IN face of the probable introduction of Cholera, a disease spread largely by specifically polluted water, this subject is of special importance at the present time. All Medical Officers of Health who have studied this subject will I think agree that it is much more easy to make an analysis of a sample of water than to interpret correctly the results. Unfortunately, the popular opinion is that any man who can make such an analysis is competent to speak with authority as to its quality and suitability for domestic purposes and to give an opinion as to whether it has produced, or is likely to produce, disease. Still more unfortunately this is the view taken by nearly every Chemist, whatever his qualifications or lack of qualifications, and the readiness of most analysts to give such an opinion upon any sample of water, whether anything of its source and history be known or not, is probably the cause of the public holding so tenaciously to this error. It is too much to expect that a person desiring to know the quality of his water supply will first submit it to a Chemist for analysis and then submit the analysis to a medical expert for an opinion. The opinion should be given by the person who makes the analysis, and, to make the opinion of any weight, it should be given by a person who has had a medical training and who has made the subject a special study, therefore the Analyst should be a Medical Officer of Health, or, at least, possess the qualifications necessary for becoming one. I regret that a contrary opinion is held by those in high places, and that a very slight acquaintance indeed with practical water analysis is necessary for obtaining a diploma in Public Health. The result is, that on the one hand we have Chemists giving opinions which ought only to be given by Medical men, and on the other hand we have Medical men (M.O.H.) giving opinions based often on most inadequate and unreliable data. No wonder, therefore, that diametrically opposed opinions are sometimes given with reference to samples of water from the same source.

The writer holds that the Analyst, even supposing him to be a M.O.H., is rarely justified in expressing an opinion as to the fitness or unfitness of a water for domestic purposes unless he knows something of the history and source of the sample.

The more important points to be ascertained were indicated, and attention was drawn to the fact that in many wells, especially shallow wells, the water often varies considerably from time to time and at different depths, being especially liable to change after heavy rains.

The relative importance of the various constituents in waters from different geological formations was discussed, and the various methods of measuring the amount of organic impurity briefly alluded to. It was shown that none of these gave any reliable indication of the nature of the organic constituents, and even when supplemented by both a Microscopical and Bacteriological examination there was often room for doubt. To condemn one water which yields a little more alb. ammonia than another or because it contains a few more organisms than another when we know nothing of the nature of the substance yielding the ammonia and nothing of the character of the organisms is obviously so illogical as to be absurd, and yet this is what is almost invariably done. In very many cases the results even of the most careful and complete analysis must be supplemented by a Microscopical and Bacteriological examination and by a thorough investigation of the source of the water and of the possibility of its being contaminated before an opinion can be given, and even then there is the possibility of the opinion being erroneous.

NOTE.—The Resolutions passed at this Conference are referred to on page 345.

CONFERENCE OF MUNICIPAL AND COUNTY ENGINEERS.

ADDRESS

BY

H. PERCY BOULNOIS, M.Inst.C.E., City Engineer, Liverpool.

PRESIDENT OF THE CONFERENCE.

It is scarcely necessary for me to tell you the great pleasure it gives me to be present to-day in the position I have the honour to hold as President of this Conference of Municipal and County Engineers. The pleasure, as you may suppose, is greatly enhanced by the fact, that so many years of my private and professional life were spent in this important and prosperous Borough, and that my recollections of those years are full of pleasant memories of my work and of the friends and acquaintances that I made. It is also a very great honour to me that I should have been invited to occupy this position as your President, as there are so many men who are more capable of fulfilling the duties, but no doubt my former connection here as Borough Engineer guided those who are responsible for the selection, and it will be my endeavour, with your kind assistance, to make this Conference a success. It is the first time in the history of The Sanitary Institute that such a Conference has been held, and I trust that this new departure in the programme may be fraught with good results to The Sanitary Institute as well as to those of us who are taking part in this Conference, and that the success of the experiment may justify a repetition in coming years.

The growth in the importance of Municipal and County government within recent times is one of the remarkable episodes in the present remarkable era. During the reign of Her Most Gracious Majesty Queen Victoria, each successive Parliament seems to have vied with its predecessor in passing

Acts to confer extended and broader powers on the local governing bodies of this country, with a view to meet the sanitary and other requirements of the nation. This increase in the powers and responsibilities of local governing authorities has undoubtedly necessitated the educational advancement of the executive officers of those authorities, and I venture to believe that amongst those officers the advancement of the Municipal and of the County Engineer in professional knowledge and skill has fully kept pace with the times. His evolution has been rapid, and the "fustian jacketted plodding man of highways and bye-ways," as described by Sir Henry Acland, has developed into the skilled and scientific Municipal or County Engineers of to-day, some of whom hold a world-wide as well as a local reputation. Nor can this be surprising when we consider the cosmopolitan nature of their duties, which I have attempted to describe on a graphic diagram (facing page 320). It will be noticed that I have divided the duties of such officers into six chief branches, viz., *Engineering*, *Architecture*, *Surveying*, *Law*, *Administration*, and *Miscellaneous*. These I have sub-divided under their different heads, which have again been further sub-divided into their different ramifications, and which can only be explained with the assistance of the diagram, for it would be almost impossible to do so in writing, as you will at once understand if you count the number of subjects I have enumerated, which amount to 98.

I gave a short descriptive paper and exhibited this diagram last year at the International Congress of Hygiene and Demography, and in the discussion which followed no one could gainsay that I had faithfully represented the duties and work of Municipal Engineers, and thus it may fairly be conceded that the diagram is a faithful record of some, if not all, of the work we may at any time be called upon to perform.

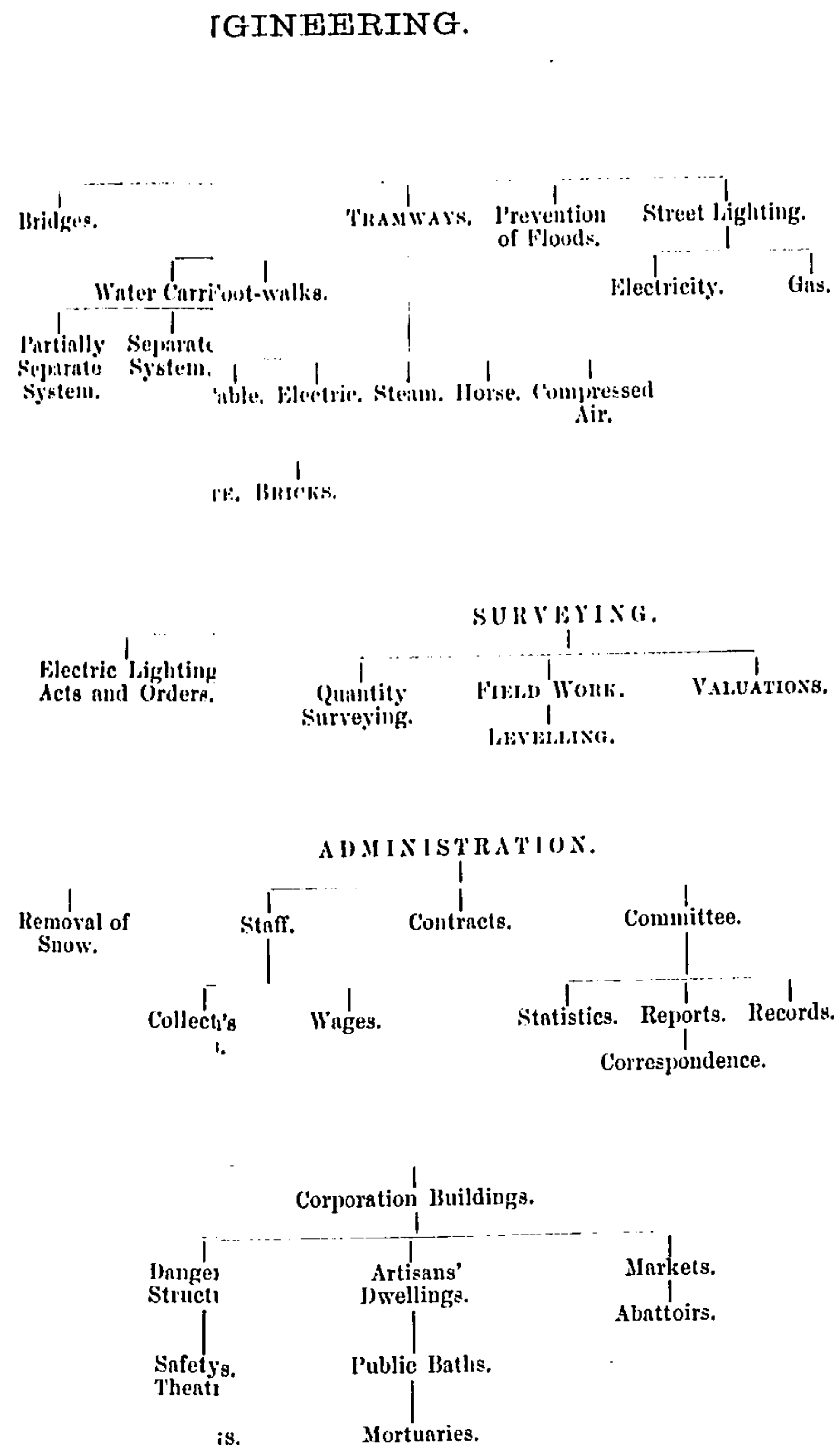
Having, then, referred to the diagram, it becomes a question as to what has been the result of this growth of local powers and responsibilities, and of the evolution of the officers of Local Authorities. The majority of the villages, towns, and cities of this country are now well and efficiently drained and sewered. They are supplied with an abundance of wholesome pure water; their streets and roads are well paved and lighted; their houses are built under supervision, which prevents grave abuses during construction; the house refuse is systematically removed to unobjectionable localities, or burnt; and the streets and roads are cleansed and sprinkled. Parks and recreation grounds afford free and wholesome amusement to the citizens, whilst public baths and washhouses give them opportunities of cleanliness and health; and in many localities—

notably in this town where we are now assembled—trees planted at the verge of the roadways, give shelter from the sun and a charming appearance to the vicinity. The recent visit of that terrible scourge, the Cholera, to our shores has shown us the value of such works, and of the vigilance, skill, and unwearying zeal of our brother officials, the Medical Officer of Health and the Sanitary Inspector. Although the cholera has been brought amongst us it could not take root; good water, efficient sewerage, proper scavenging, plenty of air and light have been too much for it. Such a disease can never be epidemic in this country, thanks to sanitary works and sanitary precautions.

Let me for a moment compare our present surroundings with those of only sixty years ago to give some idea of the advance in sanitation that has been made. Sewers for the conveyance of fœcal matter were almost unknown: sewage disposal was an unknown term; the streets and roads were shockingly ill-paved, if paved at all; the water supply was insufficient and often impure, and the condition of the dwelling houses can scarcely be conceived. What do we find as to the condition of London in 1840. One of the early pioneers of sanitation, the late Mr. Roe, the Surveyor to the City Commissioners of Sewers, says in a report of that date:—

"The whole evaporating surface of stagnant and pestilential matter beneath the houses and streets of the metropolis has been estimated to be equal to a canal 10 miles long, 50 feet wide, and 6 feet deep, and if spread out 6 inches in thickness would form a pestilential swamp 800 acres in extent, being nearly three times as large a surface as the whole population of London could lie down upon." He does not attempt to estimate how many "colonies" of bacteria it would accommodate. In a more detailed report, amongst other equally impressive cases, he states with reference to a certain dwelling house in London that "the basement is flooded to a height of 3 feet, with excrement, ashes, and dead animals and other offal saturated with filthy water." It is not surprising to hear in the same report that out of 877 patients then in the London Fever Hospital, 211 cases came from this locality! One can scarcely believe that such a condition of things could have existed so recently, and that in a short sixty years such a remarkable change could have been effected.

The scientific construction of drains and sewers is now an accomplished fact, improvements in house drainage and fittings are making almost daily strides, the supply of potable water from shallow impure wells is almost a thing of the past, as is also its storage in improper receptacles. The economical, and



own where we are now assembled—trees planted
the roadways, give shelter from the sun and
earance to the vicinity. The recent visit of
urge, the Cholera, to our shores has shown us
uch works, and of the vigilance, skill, and
of our brother officials, the Medical Officer
he Sanitary Inspector. Although the cholera
ht amongst us it could not take root; good
sewerage, proper scavenging, plenty of air and
too much for it. Such a disease can never
this country, thanks to sanitary works and
ions.
a moment compare our present surroundings
nly sixty years ago to give some idea of the
itation that has been made. Sewers for the
fœcal matter were almost unknown: sewage
n unknown term; the streets and roads were
aved, if paved at all; the water supply was
often impure, and the condition of the dwelling
cely be conceived. What do we find as to the
ondon in 1840. One of the early pioneers of
late Mr. Roe, the Surveyor to the City Com-
ewers, says in a report of that date:—
evaporating surface of stagnant and pestilential
the houses and streets of the metropolis has
to be equal to a canal 10 miles long, 50 feet
t deep, and if spread out 6 inches in thickness
pestilential swamp 800 acres in extent, being
nes as large a surface as the whole population of
ie down upon." He does not attempt to estimate
onies" of bacteria it would accommodate. In a
eport, amongst other equally impressive cases, he
rence to a certain dwelling house in London that
is flooded to a height of 3 feet, with excrement,
d animals and other offal saturated with filthy
not surprising to hear in the same report that
ients then in the London Fever Hospital, 211
n this locality! One can scarcely believe that
n of things could have existed so recently, and
sixty years such a remarkable change could have

c construction of drains and sewers is now an
act, improvements in house drainage and fittings
most daily strides, the supply of potable water
mpure wells is almost a thing of the past, as is
e in improper receptacles. The economical, and

THE SIX CHIEF BRANCHES OF MUNICIPAL ENGINEERING.

ENGINEERING.

- Bridges.
- Sewerage.
  - Water Carriage
    - Partially Separate System.
    - Separate System.
    - Complete System.
  - Dry System.
    - Earth Closets.
    - Tubs.
    - Pails.
    - Middens.
  - Disposal.
    - Irrigation.
    - Filtration.
    - Precipitation.
- Water.
  - Collection.
    - Rivers.
    - Springs.
    - Gathering Grounds.
    - Deep Wells.
  - Supply.
    - Constant.
    - Intermittent.
    - Pumping.
    - Gravitation.
- Road Making.
  - Traffic.
  - Macadam.
    - Road Rolling.
  - Paving.
    - Stone Setts.
    - Wood.
    - Asphalte.
    - Bricks.
  - Foot-walks.
- Tramways.
  - Cable.
  - Electric.
  - Steam.
  - Horse.
  - Compressed Air.
- Prevention of Floods.
- Street Lighting.
  - Electricity.
  - Gas.

LAW.

- Electric Lighting Acts and Orders.
- Sanitary Acts.
  - Special Acts.
  - Bye-Laws.
- Gas and Water Acts.
- Parliamentary Work.
  - Oppositions and Promotions.
  - Extension of Boundaries.
  - L. G. B. Inquiries.
- Arbitrations.
- Contracts.

SURVEYING.

- Quantity Surveying.
- Field Work.
  - Levelling.
- Valuations.

MISCELLANEOUS.

- Removal of Snow.
- Scavenging.
  - Collection.
  - Disposal.
- Road Watering.
- Hygiene.
- Landscape Gardening.
  - Recreation Grounds.
  - Cemeteries.
  - Parks.
- Disinfection.

ADMINISTRATION.

- Staff.
  - Tradesmen's Accounts.
  - Wages.
- Contracts.
- Committee.
  - Statistics.
  - Reports.
    - Correspondence.
  - Records.

ARCHITECTURE.

- Building Surveyor.
  - Dangerous Structures.
    - Safety of Theatres.
  - Inspection of Plans.
    - Streets in Progress.
      - Defects in Dwelling Houses.
      - House Drainage.
    - Buildings in Progress.
      - Factories.
- Corporation Buildings.
  - Municipal Offices.
    - Police Stations.
    - Fire Stations.
  - Artisans' Dwellings.
    - Public Baths.
    - Mortuaries.
  - Markets.
    - Abattoirs.

at the same time efficient paving or metalling of our roadways is receiving close attention, the sewage as it emerges from the sewers need no longer pollute our rivers or streams, but can be dealt with in an endless variety of ways; the lighting of our streets by electricity or improved gas burners points almost to the prolongation of the light of day, and advances have been and are being made in every branch of the profession to which we belong.

Much has been done in the past, but much remains to be accomplished in the future. Our sewers, scientifically as they are constructed, still require improvement, if not in their shape, in the materials with which they are constructed, and the question of their proper ventilation is still a long way off a settlement. The debateable question of the best method of sewage disposal still exercises our minds, and the "waste-not" faction still clamour that no system which breaks the "food circle" can be correct. Greater simplicity is still required in the sanitary arrangements of the dwelling, and the proper and economical housing of the working classes is still an unsolved problem. We have not yet found a pavement which complies with all our requirements, as if durable it is slippery, or if not slippery it is noisy. Our street lighting is by no means satisfactory, and the controversy between gas and electricity is by no means settled. These and many other points show us that there are many fields still open for discovery and improvement. Nature hides her secrets very jealously from our search, and they are only dragged forth by patient investigation, experiment, and toil.

> Take the spade of Perseverance,
> Dig the field of Progress wide;
> Every blinding root of error
> Harrow up and cast aside.

What I have desired to convey to you in this very imperfect address is that the knowledge which a Municipal or County Engineer should possess is almost without limit, as it is not possible to say on what question he may at any time be called upon to advise the local authority. It is therefore, I venture to think, of the greatest importance that this officer should have ample opportunities of enlarging the scope of his knowledge and experience by intercourse with his professional brethren, and by visiting other towns and localities, and by the inspection of engineering works. It is just such Conferences as this which we are now holding that tend greatly to enlarge our knowledge and our ideas, for it enables us to come together and exchange our different views of professional subjects, to try and learn what others know, to avoid mistakes that others have made, to submit our theories to others, to listen to their remarks upon them, and generally to bestir ourselves to keep pace with all the scientific advancement which is going on around us. I do not think that local authorities quite realise the immense benefit it would be to their officers and to the communities they serve if they were officially sent to take part in such conferences as this we are now holding, or to the meetings of the Incorporated Association of Municipal and County Engineers, which are held throughout the year at different localities in the United Kingdom. I wish local authorities would realise that such meetings tend to raise the views and enlarge the ideas of their officers, and that the knowledge acquired at such conferences can but benefit the ratepayers. Our American cousins are quite alive to this fact, and consequently meetings and conferences are always largely attended in that country; in addition to which officers out there, who hold similar positions to ours in this country, are frequently sent to Europe for several months at a time to gain information as to what is being done over here. The result has been that America is rapidly gaining upon us in Sanitary Engineering knowledge, and if we are not careful may pass us in the race where at present we are in the van. Nothing is easier than to get into a self-satisfied groove, but self-satisfaction means stagnation, and a groove gets deeper and deeper. I will not detain you longer. We have met together for the discussion of various papers of considerable interest to us all, and which cannot fail to advance our professional knowledge. It is, as I have said, an intense pleasure for me to be here, and I thank you for the hearing you have given to my address.

On "*Town Refuse and Refuse Destructors*," *by* C. JONES, M.Inst.C.E.

ABSTRACT.

Town refuse. Material to be dealt with.
Original modes of treatment not now tolerated.
Late unsatisfactory legal decision as to the responsibility of Contractors or Local Authorities.
Best mode of dealing with the difficulty, viz., "Fire."
Handling the material, objectionable and unremunerative.
Refuse can be consumed, or nearly all.
Original furnaces, failures owing to faulty construction.

Fryer Destructor, 1892.
Warner "Perfectus" Destructor.
Whiley's "New Destructor."
Boulnois improvements for feeding, &c.
Conveyance of material and description of method of feeding the apparatus.
Arrangement to prevent nuisance from dust being blown about, and for preventing the temperature in flues being lowered.
Residuum and its value.
Steam producing power. Opposition to erection of destructor.
Site for same.
Destructor, may be built anywhere without nuisance being caused.
Dr. Stevenson's opinion as to Destructor with Cremator.
Invention of Fume Cremator, and description of same.
At Ealing sewage sludge mixed with ashes and mixture destroyed without nuisance.
Report of F. M. Rimmington, Esq., to the Corporation of Bradford.
Towns where steam power is being utilized, and purposes for which it is used.
Value of Destructor on Sanitary grounds. General conclusion.

On "*Street Gullies and Road Cleansing*," *by* W. B. G. BENNETT, Assoc.M.Inst.C.E., Borough Engineer, Southampton.

HAVING frequently found in the course of my experience a considerable difficulty in cleansing efficaciously the modern street gully and the removal of road slurry, I have endeavoured after much attention and experiment to devise some improvement to replace the present road gully now in universal use, and to facilitate the taking up and removal of the road slurry arising from the sweeping of the carriageways.

The ordinary street gully being well known it is unnecessary for me to enter into a lengthened description of the same, more than to say, the primary object of a road gully is briefly to pass the rainfall to the sewer, and intercept the road detritus and other matters often of an objectionable nature, and prevent their entrance into the sewer. For this purpose it is generally made with a catch-pit of various dimensions placed at certain depths below the point of overflow under the surface of the road. It is usually covered at the level of the street channel with a movable iron grating, varying in dimensions but generally about 20 inches by 15 inches, which, in nearly all cases, is the only means of access to the same; through this small opening the whole of the deposited matter has to be dipped out from the bottom of the catch-pit by what is known as a gully tool, an implement very similar to a ladle attached to the end of a light rod several feet long, and I find, however expert the labourer may be in manipulating this implement, the operation is one occupying considerable time, and as every ladle-full has to be thrown into a slurry cart the operation is very often attended with inconvenience to the public, besides which this method of cleansing owing to the construction of the modern gully is only palliative, and a large quantity of offensive accumulation is always left behind.

To minimise the insanitary effect of this, a deodorising material is usually thrown into the pit and on the surface of the road and grating, as may be frequently seen by the casual observer.

My experience has led me to the conclusion that to efficaciously cleanse a road gully, it must be constructed so as to permit the deposited matter being speedily, entirely and constantly removed, and discharged without inconvenience directly into a cart or other appointed conveyance, and upon sanitary grounds I will even go so far as to say that all gullies should be cleansed once every day, especially in hot weather; with a desire to secure this desideratum, I have devised several appliances. I term them first, the "Hydraulic Self-cleansing Street Gully," briefly described, it is intended for use in places where water can be obtained at sufficient pressure from the town mains, and is arranged to be self-emptying as well as self-cleansing; the *modus operandi* is as follows:—When the mud cart arrives at the point where the gully is fixed, the man turns back the grate, and opens the water tap, when the mud container rises automatically and tips its contents into the cart, which operation being completed, the water tap is reversed and the dirt container retires to its place, the exhaust water doing duty a second time in cleansing the gully pit. A provision is also made to flush out the container with clean water.

At Southampton, where three miles of air main is laid in the streets in connection with the Shone System of Sewerage, from which service connections can easily be laid on, the waste heat from the combustion of the house refuse in a Destructor being utilized as the motor required for compressing the air, I operate one of these gullies by compressed air.

From the tabulated statement of replies which I received, it

could be seen that in nearly all the towns enumerated, the gully tool mentioned in this paper is the only appliance used, and that once a fortnight appears to be the time for cleansing the gullies, but in some places, monthly.

Movable dirt boxes have been introduced in several instances, this being an advance in the right direction.

Another purpose for which these hydraulic, and I may also say pneumatic, gullies may be used, and which will especially commend them to those who are responsible for the cleansing of roads, is their capability of taking up quickly and cleanly, and discharging directly into the carts the slurry swept from off the roads, thereby obviating the accumulative sweepings remaining in the streets, and the manual labour required for scooping up and throwing this liquid mud unprotected into the carts, which is now the common practice, often resulting in annoyance to the public. These gullies therefore become an excellent adjunct to the horse sweeping machines, and tend greatly to reduce the number of their attendant carts, consequently enabling more work to be performed by them. When required for this service the gullies can be obtained of suitable dimensions with specially arranged tipping gear, and placed in the roadway or other places at convenient intervals for the purpose of the work.

My researches also lead me to the further conclusion that it may be possible in a general system of rainfall drainage for towns, instead of constructing large gullies of the catch-pit type now in general use, to put down small chambers about two feet square and twelve or eighteen inches deep, covered with ordinary iron grating in the channel, and connections with stoneware pipes, unobstructed by traps, direct to a main rainfall sewer, which may at any convenient place be intercepted by one of the self-cleansing street gullies, of suitable dimensions, and the combined contents of the several chambers received into it and discharged at one operation. This arrangement would be found very convenient in places where a cluster of gullies are necessary, as for instance, a circus, or any place formed by the junction of several streets.

Another appliance (which was shown by a full size working model) has been devised for use in towns where water or air motor cannot be obtained.

The casing for the hydraulic gullies I have constructed of concrete, made in moulds to the dimensions required, with clinkers from the Refuse Destructor mixed with a proper proportion of Portland cement.

CONFERENCE OF SANITARY INSPECTORS.

ADDRESS

BY

PROF. A. WYNTER BLYTH,

PRESIDENT OF THE CONFERENCE.

THE Sanitary Institute has at length attained its proper position. It is confessedly the chief society in the kingdom having for its main object the furtherance of all knowledge relating to the prevention of disease; it watches over and promotes health legislation; it encourages and rewards invention, by its museums, by its exhibitions, and by its congresses; but, according to my idea, its chief claim for continued and prosperous existence is its great services in hygienic education. The Institute is the first body which ever organized permanently educational lectures with the express purpose of giving the necessary technical knowledge to inspectors. These educational courses have not been confined to the metropolis, but have been established in nearly all the great population centres, and most of the County Councils have been induced to set aside a portion of the educational grant for that purpose; nor have the advantages been confined to inspectors. In each instance a fair number of the general public has attended. The results of this general diffusion of accurate knowledge on the prevention of disease are incalculable, for the fact cannot be too widely accepted, that sanitary laws in advance of the average mental culture of the people are so many dead letters. In Russia, in Turkey, in Spain, and many other parts it would be quite possible to enact laws superior to our own with regard to the prevention of disease, but the sanitary condition of the countries would not be improved to a great extent; for hygiene begins in the household; it must be imparted by parent to child; its precepts must be lisped at the mother's knees, and piped in infant school; then, and then only, will the sanitary officers of any country get the hearty co-operation of the people. The Institute was also the first body to give practical

embodiment to the idea that candidates for the post of inspector should be tested by examination; it is at present the only body the certificate of which is recognized by the Local Government Board. It is a matter of general knowledge that other examining bodies are in existence; as yet they have not received official sanction, and whether they will receive it I know not; but from the history of the medical profession this fact can be learned—that it is not to the interest of inspectors to multiply examining boards. There are some thirty or forty bodies which are capable of granting a legal qualification to practice medicine in the three kingdoms; the result is that a young medical man thinks he is bound to multiply his degrees; he is not satisfied with the qualification of the physicians and surgeons, but considers that the more letters he has after his name, the better the chance of practice or of appointments. He passes a great portion of the best years of his life in studying for examinations, and spends no small portion of his substance, the final result being neither to the advantage of himself nor to that of the community. The only class of persons who are benefited is the class of professional examiners. Speaking as one of the class of examiners, it is to my personal interest to promote and foster the multiplication of all examining boards; but speaking as one of the class of sanitary inspectors—for each health officer, by virtue of his office, is a sanitary inspector—I declare no less emphatically that this multiplication is against the best interests of the sanitary inspectors. How the medical student sighs for the one portal system, and how the medical profession, as a whole, has endeavoured, and endeavoured in vain, to evolve one examining body from the chaos of qualifying bodies is to be read in the medical history of the last ten years.

Should the inspectors sacrifice their interests to satisfy the restless ambition of a few discontented spirits, it is easy to forecast the result. Within a little time there will be some dozen examining bodies, and the ambitious inspector will not be satisfied with the certificate of one of them, but he will, like the young medical man, take two or three, this being a mere question of money. The certificates themselves will be unequal in value, some, as in the analogous case of medical degrees, will be of high value, others of low value; but neither the public nor the local authorities will appreciate these differences. A man holding a certificate of the lower kind will be equal in their eyes, so far as qualification goes, to the certificated man who passed through the examination of the stricter. Besides which the multiplication of examining bodies has of itself a tendency to increase the number of certificated men; and the greater the number of certificated men, the greater competition for appointments, and the greater the competition, other things being equal, the lower the salary. The progressive stiffening of the Institute's examination has had the good effect of greatly diminishing the number of applicants for an advertised berth. In the old days every clerk, plumber, builder, and out-of-work loafer would answer an advertisement, but the condition enforced by the majority of local authorities that a man must have the certificate of the Institute has altered all this. Now the local authority, thanks to the Institute, has only to select the man whom they think most suitable from a comparatively-speaking small and select body.

Having been placed by virtue of a qualifying examination on a similar basis to that of the pharmaceutical chemist, the modern sanitary inspector has a definite position to maintain; in his hands, to a great extent, lies the future of the public health service, and therefore I will next make a few observations on the subject of "conduct." In the sense I am using the term "conduct," it is almost synonymous with "manners." Conduct is distinct from ability, and from even morality. Talent is an endowment at birth, which may be cultivated, but never acquired. Good or bad morals are also, to a larger extent than teachers of religion will allow, engrained and built into the system; the possession of ancestors, the majority of whom have been good and virtuous, who have had healthy minds and healthy bodies, is a gift of value unsurpassed. But good manners are capable of being acquired by all, and a man is judged by those with whom he comes into casual contact in the daily routine of duty almost entirely by his courtesy or otherwise. Whether the large powers of entry into the Englishman's castle, and the powers of interference with personal liberty of the subject which the inspector possesses, can be beneficially increased will depend upon the conduct of inspectors individually and collectively. Power can only safely be given to those who prove themselves fit to exercise it. Of all nations, the English are most tenacious of the principle of the privacy, even the sanctity, of the home; and this principle is outraged if an official enters without knocking, without permission, and with hat-covered head. Let a home be a room with dirt-begrimed windows, tenanted with squalor and misery, the furniture a broken chair, the bed a heap of rags, yet I advise inspectors, as a matter of policy, to use due ceremony on entering, such as they would on entering the threshold of the clean and wealthy. Emerson took his hat off to a flower as the emblem of beauty, and an outward sign of homage may well be given, not out of respect to the rags or the squalor, but as a recognition of the principle of home sanctity. The propriety of a silent tread and soft voice in the presence of sickness or sorrow is too obvious to need more than mention. Speech is silver, silence is gold, says the proverb, so it is only exceptional that an inspector requires to harangue sinners against statute or bye-law. His duty begins with observation, it ends with report. Censure where there should be commendation, abuse from owners, temptation from those who would veil bad material or work with a bribe, and, worse than all, false accusation, are troubles some or all of which the inspector is likely to encounter, and demand the exercise of the utmost patience, the utmost self-control. A man's temper is not always self-governable, but self-control by continual exercise can be certainly improved. In a dispute it must be remembered that the man who preserves, has an advantage over the man who has lost, his temper, similar to the advantage of a sober over a drunken man. If the softer answer that turns away wrath prevails not, take refuge in silence, for it takes two to quarrel. The inspector's qualities are sorely tried by "accusation." I regret to remark that the majority of local authorities have shown themselves incapable of making just inquiry into charges against officers. Whenever a local authority has to investigate a charge so serious that it may involve loss of character or office, the authority is practically a court of justice, and should never forget the elementary principles of justice, viz., that the charge should be definite, not general and indefinite; that the accused should have a copy in writing of the charge; that he should be present during the whole time that witnesses for or against him are examined; that he should have an opportunity of cross-examining the witnesses, and ample facility for preparing his defence. So little have these principles been followed, that it has happened more than once that a local authority, actually in the absence of the officer, has investigated a charge, considered it proved without hearing the other side, and passed a vote of censure.

On "The Propriety of Organizing Sanitary Inspectors or Inspectors of Nuisances who are the Holders of Recognized Certificates," by W. PARSONS.

ABSTRACT.

MR. PARSONS' reference was made to the requirements of the London Public Health Act, and particularly to that portion providing that Inspectors should be the holders of a certificate

approved by the Local Government Board; and that since the passing of this Act the Sanitary Institute had been recognized as the examining body.

A meeting was convened in April, 1892, at which the following resolutions were passed:—

"That whilst recognizing the parental care other examining bodies desired to offer the Sanitary Inspector, we are of opinion that The Sanitary Institute is quite capable of completing the work it originated, and that we feel ourselves indebted to that body as the pioneers of granting certificates, and for the noble work they have already achieved in not only raising the status of Sanitary Inspectors, but in studying the interests of the public generally; and their certificate is definitely recognized by no less than twenty-seven Metropolitan Local Authorities, seventy provincial, and one colonial; and that an institute be formed and designated the Institute of Certificated Sanitary Inspectors, the objects being to raise the status of certificated Sanitary Inspectors, and to devote itself to the advancement of Sanitary science and the dissemination of Sanitary knowledge among its members and the general public."

"That the Institution consist of Fellows, being persons of distinction and scientific eminence; Members, who hold, or have held, public appointment for three years and upwards, and possess the recognized Certificate; Associates, holding public appointment for a less term and holding Certificate, who shall be eligible for Membership after having held office for the qualifying period, or those holding Certificate and not a public appointment, upon the production of two testimonials, to be approved."

Mr. Parsons then explained that the Institute of Certificated Sanitary Inspectors had received in response to a memorial presented, the recognition of the Sanitary Institute together with other privileges. He dwelt on the great advantage arising from the blending of theoretical with practical knowledge of Sanitation, and its necessity as a qualification of competency.

"*Difficulties in the Prevention of Infectious Disease*," *by* S. C. G. Fairchild, Sanitary Inspector, Clapham.

ABSTRACT.

Although considerable progress has been made in the protection of the public by the passing of The Infectious Disease

Notification Act, The Disease Prevention Act, and The Public Health (London) Act, there are details in the working of these measures which, if not carried out promptly and thoroughly, take from the public that protection intended to be given.

The section dealing with notification of infectious disease by the head of the family, &c., is seldom carried out in many districts, thereby a loss of time takes place before any steps can be taken by the Sanitary authority; for it frequently happens that several hours, if not a day or two, elapse before the notification from the medical practitioner in attendance is received by the Medical Officer of Health; during this time the patient may have been in contact with the other members of the family without anything being done towards isolation. Nor is it possible to prevent children from going to school. If every Sanitary authority insisted upon the notification from the head of the family a large number of cases of infectious disease would be prevented.

The regulations of the Educational Department in connection with school attendance affecting the teachers' reputation, some teachers resort to all manner of expedients to get the children to school with little regard to the dangers that may arise, and occasionally parents deliberately send their children to school from infected houses.

One of the difficulties to contend with is the opposition of some people to the hospital. Patients are kept at home in houses that are totally unfit for the purposes of separation, nor can the inmates always be trusted to carry out anything like proper isolation; and it is to be regretted that there are a few medical practitioners who do not use their influence to assist the sanitary officers.

It would greatly assist in carrying out disinfection if the medical gentleman attending infectious cases kept at home, was obligated to notify the recovery of the patient.

In disinfecting it is impossible to be always certain that every infected article is placed in contact with the vapours in use. Many persons believe that disinfection means destruction, consequently many infected articles are purposely removed.

Many of the difficulties in the prevention of infectious disease are simply the result of ignorance and prejudice, and may be remedied in a few years by making Hygiene a compulsory subject in every school throughout the Kingdom.

On "*The Sanitary Institute and its Relation to Sanitary Inspectors, with a Resolution*," by W. H. Wells.

ABSTRACT.

In addition to admitting Sanitary Inspectors to an active part in the work of the Congress, I propose briefly to indicate some further steps which I consider the Institute should take in the interest of the Inspector and his work.

1. Membership of the Institute should be open to the Chief Inspectors of the large cities and towns, and to elect representatives of the various associations of Inspectors in the kingdom.

2. That at least two seats on the Council of the Institute should be provided for and occupied by Inspectors.

These two propositions aim at providing a channel along which the views of Sanitary Inspectors could be conveyed to the very heart of the Institute.

3. That certificates of a higher grade be established. With the present certificate men of great experience and ability rank no higher than the mere novice fresh from the cram. The addition I suggest would result in elevating the status and dignity of the Sanitary Inspector, attracting all as it would, to a continued effort of self-improvement, and bringing out into prominence from the rank and file those men who by their ability and perseverance render themselves worthy of the distinction.

It has been stated by some that the Inspector has too much to do; I am not of that opinion, and to my mind the fact that so much is required of him does but indicate how useful to the local authorities, and ratepayers generally, the Inspector can be. I strongly deprecate any suggestion for narrowing the field of his labour, nay, rather I would increase it still more by making him responsible for the efficiency of the drains and sanitary fittings of all new houses, and place under his supervision the scavenging of the streets, collection of house refuse, and management of the destructors. The advanced certificate I propose should not only require a theoretical acquaintance with these latter duties but a sound practical knowledge, only to be gained by actual experience.

4. That the Institute, prior to each Congress, issue a circular to every local authority, requesting them to send their Inspector of Nuisances to the meeting and pay his expenses.

If the Institute is to do all the educational good it can it should, in addition to its other functions, aim at gathering around it once a year all the Health Officers that circumstances will permit of being spared for a week from their duty.

I suggest this in the hope that something practicable may be done in the direction of enabling those to attend whose far too meagre salaries at present prevent their so doing. It cannot be said that so small a charge would be improperly laid upon the rates, as all increase in the efficiency of a Health Officer is reflected directly in good upon the ratepayer, and if national health has any money value at all, no reasonable cost should be spared by the nation in increasing the opportunities for the technical and scientific education of those upon whose advice the nation relies, and I do not hesitate to give a high position amongst this group of public officers to the humble Inspector of Nuisances.

5. The last and most important suggestion of all which I have to make is that The Sanitary Institute should undertake, through the proper channel, to induce the legislature with all possible speed to codify, simplify, and otherwise improve and extend the Sanitary law of the kingdom, as applied at any rate to England and Wales.

Lawyers who have at different times to plead on both sides of a question may rejoice in double meanings, argumentative definitions, and multitudinous piecemeal legislation, but from our point of view these things are to be deplored; the Sanitary law of the land is a disgrace to a country professing to lead in such matters. The anomalies, shortcomings, and contradictions in our Sanitary statutes are patent to all of us, and yet we sit with folded hands praying for some one to do something, and feeling thankful and hopeful when a disjointed fragment or two of improvement is now and then thrown to us, whilst we make not the slightest apparent combined effort to force on a radical reconstruction of the entire book.

The latest effort, the Public Health Act of 1891, was confined in its application to London, thus legislating for a portion of the country only, which is another incomprehensible feature in the wisdom of our law-givers. Why are we all so hungry, so patient, so dependent, and so helpless? We have by this time had experience enough to know fairly well what this country needs in the way of Sanitary legal powers, and we, with the town clerks, the surveyors, the medical officers, and with the Sanitary Institute at our head, possess the brains from which the needed reformation should in the first instance evolve. Surely our members of Parliament are not pedestalled aloof from a personal knowledge of our country's need in this respect, or is it that when in remote moments of zeal for the country's hygienic weal they call around them in secret corners advisers of narrow vision, as the slow, jerky, and imperfect additions to our Sanitary law would imply?

I believe that our legislators are ever ready, Ireland notwithstanding, to give prominent consideration to the health laws of our land. The fault that it is not successful lies at the feet of our local executive officers, who inanely grumble and struggle on, attempting to combat disease and death by the aid of a little law, much exercise of persuasive genius, and terrorising the ignorant with an exhibition of assumed power. This is far from being as it should be; tact, persuasion, and the power to morally convince, should always be to the fore, but the strong clear authority of the law should ever be behind to support the efforts of the sanitary officer, and who more clearly than he who has experienced rebuffs and defeat, can point out the weak places which need the support of legal power?

My proposition in this regard is, that the Sanitary Institute call around it men well versed in the execution of existing statutes, and after accumulating and discussing the various points involved, formulate a comprehensive draft of such an Act as will, so far as possible, remove all existing anomalies, contradictions, weaknesses and difficulties, and for the Institute to do its utmost to obtain the enactment thereof.

I propose the following resolutions that The Sanitary Institute be requested to consider:—

1. The admission of Sanitary Inspectors to the membership of the Institute.

2. The admission of Sanitary Inspectors to the Council of the Institute.

3. The establishment of a Certificate of Competency for Sanitary Inspectors of higher grade than the present one, and its division into three classes—2nd, 1st, and Honours.

The present Certificate to be styled Elementary.

4. That the Institute request each Authority at its own cost to annually send to Congress its Inspector of Nuisances.

5. That the Institute form a committee for the drafting of a Model Sanitary Statute, and do all in its power to accomplish its enactment. Said committee to include, by invitation of the Institute, such Local Government Officers in England and Wales as would in their opinion be useful, whether such officers are members of the Institute or not.

Resolution No. 3, after a full discussion of the subject, was not carried; for other resolutions see page 346.

"*Superannuation for Sanitary Inspectors*," by J. L. Bell.

I am fully aware that the subject of Superannuation has been brought forward on more than one occasion, but at the same time I consider it such a vital question that it should not be allowed to drop.

If any one is, or any body of men are, entitled to be considered in their old age, I contend it is the Sanitary Inspectors.

The officers and men of the army and navy are entitled to pensions on completing their term of service, yet the Sanitary Inspectors have nothing to look forward to when they are no longer able to work.

They are surrounded by as many dangers as our fighting forces, dangers which cannot be seen to be grappled with. In giving advice in houses where some virulent disease is prevalent, or inspecting a district where some dangerous disease is epidemic, or in removing patients to hospital, oftentimes carrying them in their arms some distance, and then nursing them in the ambulance, these, I say, place the lives of Inspectors in as much jeopardy as a soldier on a field of battle.

Then why should the officers in the Civil Services be entitled to pensions? their duties are not harder or more dangerous than an Inspector's, and their pay is better. It is simply the fact that they are Government servants.

Again, look at the officials under the Poor Law Board; they are entitled (on the recommendation of the Guardians and the approval of the Local Government Board) to pensions or superannuation. Surely an Inspector, or say any official under a Local Authority, after having spent the best years in its employ and being too old for work, ought to be able to resign and receive some recompense for his length of service. Masters of Workhouses (whose lives, as a rule, are far more happy than an Inspector's) with nice quarters to live in, good food, &c., and plenty to wait on them, collectors, relieving officers, drill masters, porters, &c., they, if they behave themselves, are sure of being provided for when old age creeps on. I have never yet been able to see where the difference comes in between an official under the Poor Law and one under a Corporation, excepting that the Poor Law official is the more favoured of the two.

Again, officials under the Lunacy Law are given pensions by the County Councils or Courts of Quarter Sessions.

With regard to the Police Force I have nothing to say against their Superannuation, as they contribute to the fund a portion of their own salaries. Their widows, too, are somewhat provided for, for in case of death the widow, in some instances, obtains one year's pay. Whoever heard of an Inspector's widow being paid a year's salary if perchance the husband contracted in the execution of his duty, say, cholera, small-pox, or diphtheria, and died from the effects of it.

I propose that a deputation should be formed to wait upon the Local Government Board to urge our claims to pensions, and also the desirability of our being appointed immediately under the control of the Local Government Board.

In the event of our not succeeding in getting direct superannuation, I would suggest that a fund should be formed to which the Inspectors should pay a part, and to which it should be compulsory for Local Authorities to contribute.

Mr. Boulnois, City Engineer for Liverpool, in his Municipal and Sanitary Engineers' Hand-book, has sketched a scheme for the superannuation of Municipal officials; the principal points are as follows:—

(1) Officers to pay into a fund $3\frac{1}{2}$ per cent. of their salaries.

(2) Corporations to pay $1\frac{1}{2}$ per cent., and to allow $4\frac{1}{2}$ per cent. compound interest.

(3) Superannuation to be on a fixed scale, say $\frac{1}{60}$ of average salary for the last ten years, multiplied by the number of years' service. The officers to retire at sixty years of age.

(4) In case of death before superannuation, his representative to draw the amount standing to his credit.

(5) In case of voluntary resignation, the officer to withdraw the amount standing to his credit without interest.

(6) In case of dismissal, the officer to withdraw his own money contributed, but not the Corporation money or any interest.

(7) In case of dismissal for fraud the whole to be forfeited.

(8) In case of long illness, advances to be made not exceeding one-fourth of the sum standing to the officer's credit; this sum to be repaid before a second advance be made.

If this scheme, or some modification of the same, was to be made compulsory, it must result as Mr. Boulnois says, in a better feeling between officials and employers, with the probability of the best officials being retained, as they would have a sum of money at stake with the Corporation, which was increasing every year.

Officials would also be relieved of anxiety and care for the future, and additional security would be ensured in case of fraud by an officer.

The Corporation of the City of Manchester has devised what is called a "Thrift Fund," which is on very similar lines to Mr. Boulnois' scheme. The officials in this case pay into the fund $3\frac{3}{4}$ per cent. on their salaries, and the city $1\frac{1}{4}$ per cent., on which the Corporation allow interest and compound interest at the rate of 4 per cent. At the age of sixty-five years the official may retire and withdraw the amount standing to his credit, with interest and compound interest at 4 per cent.

I find if a man is appointed, say at the age of thirty, at a salary of £100 per annum, and paid into this Thrift Fund till he was sixty-five years of age, he would be entitled to retire and take the amount standing in his name, which would be about £380. Of the two schemes I have mentioned, in the place of direct superannuation from the Local Government Board, I consider Mr. Boulnois' scheme the best, and I see no reason why it should not be successfully worked.

In conclusion, gentlemen, first of all we must be *united*, for without union I am afraid we shall never get superannuation; secondly, we must not cease agitating until we have brought our claim prominently before every Member of Parliament.

For Resolutions passed at this Conference, see page 346.

CONFERENCE OF LADIES ON DOMESTIC HYGIENE.

ADDRESS

BY

MRS. ERNEST DAY.

DEEPLY sensible as I am of the honour which the Committee of the Sanitary Institute have conferred, in asking me to preside at this, the first meeting of ladies, held in connection with their annual Congress, it is with unfeigned regret that I occupy the position which we all hoped, none more sincerely than I, would have been filled by a lady in every way more worthy to be your President. It is only in the unavoidable and much-to-be-deplored absence of Lady Douglas Galton that I have consented, as her deputy, to do my utmost to fill her place to-day, encouraged in my effort by the thought that I am carrying out her wishes, and merely taking up the threads of a work with which she has all along been closely identified, and to the preliminary and important stages of which she has devoted her valuable judgment and experience.

Indeed, my only excuse for venturing to appear even in the character of a deputy-president is the great interest which I feel in all that concerns domestic hygiene. I am here as one most earnestly anxious to learn from those who have been good enough to promise to address us, ways of promoting the cause of health. Questions will be discussed to-day on subjects of the deepest import to us as women and as citizens.

Much has been done since Miss Nightingale, whose home in your county makes her in some sense a local as well as a universal benefactress, first introduced into hospital and home, nursing principles and sanitation, until then hardly understood and certainly not practised, followed by Kingsley, who more than thirty years ago spoke to the members of the "Ladies' Sanitary Association" on the subject of preventible infant mortality as "The Massacre of the Innocents." We shall hear this morning what Dr. Freeman now thinks to be the hygienic cause of the still terrible, if decreased, infant mortality.

Closely allied to the loss of our loved ones comes the question of food, especially with reference to the sick, about which we are to be told by Miss Lamport.

Conspicuous amongst the means for keeping us in health must be considered ventilation, which will be brought before us by Miss Barrett; while the not less important point of exercise, in its physical and mental aspects, will be treated of by Miss Charlotte Smith.

I hope this afternoon to suggest some of the ways in which we may become missionaries of health to our less instructed sisters; while Dr. Schofield, who has already devoted himself so ably to our advancement in the science of hygiene, will speak with the authority which his professional experience gives, of the value to us of such knowledge.

For many years past these annual Congresses have been held by the Sanitary Institute, each one marking a step of progress in the sanitary reforms of our country. But this is the first occasion upon which women have been invited to take any prominent part in the conference, though individual exceptions have occurred from time to time. It rests with us to make the best possible use of this opening for co-operation, and not allow it to pass by in unproductive talk. The wisest counsels will fail to bring forth good results if not put into practice; the most beneficent sanitary legislation will be ineffectual if allowed to become a dead letter, as it will surely do if women are not prepared to go hand in hand with men in carrying out the laws of health in the home. This is so essentially the woman's province that, unless we are willing to recognise our responsibilities, we are actual hinderers instead of helpers.

I rejoice greatly that we have been called upon by the Institute to take up our share in their noble work.

We cannot face the difficult problems of modern civilisation with its overcrowded houses, contaminated air, polluted water, adulterated food, unhealthy dress, and overstrained nerves, without wishing to do our small part as units in the great aggregate towards physical reformation. By our abuses God's best gifts have been perverted, and what was freely bestowed on all, is enjoyed only by the few.

Let us, therefore, gladly avail ourselves of this opportunity of learning from one another, and from those who are especially well qualified to teach, with full purpose to make practical and personal amendment; for, however widely our hygienic reforms may spread, I think we shall all agree that they should commence in our own homes, and for the benefit of our husbands and children. Not until each home is a centre from which will radiate perfect love, and perfect purity, can we consider that our work is accomplished.

On "*Food with special relation to the Sick*," *by* Ethel Lamport, Lecturer on *Hygiene and Sick-nursing* to the Ladies' Sanitary Association.

ABSTRACT.

Two chief points to remember with regard to Food for the Sick are that it need not be unpalatable, and that it need not be monotonous.

The difference between the food required by the healthy, and by the sick.

Patients must only have as much food as they can digest.

In all febrile diseases the mouth should be cleansed with non-poisonous disinfectant before food, the hands and face washed, and the patient made generally cool and comfortable.

Suggestions for invalid food so as to get as great a variety as possible.

The digestion of certain kinds of food, whether rapid or delayed, must be taken into account on drawing up a sick diet.

On "*The chief Hygienic causes of mortality amongst Infants and young Children*," by J. P. Williams-Freeman, M.D., Lic. San. Sci.

ABSTRACT.

The four chief causes of death in children under five years are:

(1.) Diseases of respiratory system.
(2.) Diseases of nervous system.
(3.) Diarrhœa.
(4.) Whooping cough.

Each cause is most active amongst infants under one year, and diminishes with each year of life.

Brief discussion of ætiology of each group, with special Hygienic means of prevention.

General hygiene of infancy and childhood must be based on knowledge of natural history of the child.

The child's position in the evolution of man must be the constant guide to a proper hygienic environment.

On "*The Need for Fresh Air in Modern Houses*," *by* Edith A. Barnett.

ABSTRACT

The characteristics of modern life are:—

I. Town, not country.
II. Greater number of hours in artificial light.
III. "Better" building.
IV. More luxurious fittings and accessories.
V. Greater proportion of indoor employments.

That to breathe fresh air is necessary no one denies, and the breathing of fresh air is impossible, unless:—

1. Certain *space*.
2. *Inlet* of fresh air.
3. *Cleanliness.*
4. *Sunshine.*

Space.—Town populations constantly increase; town rents constantly rise. Tendency to devote best rooms to show: *e.g.*, flats. Children's rooms, servants' rooms, bedrooms. Already limited space blocked with furniture and hangings. Increased luxury in dress necessitates space for storage. Space round the house often *nil:* where there is a garden it is unused, town dwellers having an insane fear of being overlooked.

Inlet.—Still more insane fear of through draughts; supposed to be genteel to live shut up. In average town houses doors and windows all closely shut. Oscillation between fixed ventilators and open windows: *both* necessary. Draughts often dreaded, because they endanger the ornaments and blow the hangings about.

Inlet through walls avoided by "better" building. Anæmia among country poor. Hatch-doors universal in cottages and farm-houses a generation ago; now heavy front doors carefully shut. Inlet of foul air by modern drainage arrangements, especially when added on to an old house.

Cleanliness made more difficult by our modern furniture. Upholstered furniture, hangings, bows, screens, &c., on walls; all so many dust-traps. Taken in connection with the servant difficulty, and more luxurious habits in eating, the result is want of cleanliness in nine houses out of ten. Advantages of polished wood furniture. Bed-hangings gone out, but in their stead curtains, screens, draperies without number. Ornaments and nick-nacks hold dust; dust in inhabited houses means decaying animal organic matter.

Cleanliness of persons as well as things. Opportunities for bathing not a class question.

SUNLIGHT is carefully shut out of the modern house. "Dim, religious light." Mrs. Skewton's pink curtains. Even if we prefer sunshine, our cherished "things" do not like it; they fade if they are new, look shabby if they are old. Spare cash is scarce, and to save our pockets and our friends' criticism we pull down the blinds. The gentility of sitting in the dark.

Number of hours by lamp and gas-light: a notable alteration for the worse during the last twenty years. Evening entertainments are modern contrivances. Gas *v.* candles. Products of combustion, light for light; night-lights unnecessary in days of matches.

The conclusion of the matter: a fashion to be set.

On "Our opportunities of spreading Knowledge of Hygiene to Women and Girls," by Mrs. ERNEST DAY.

ABSTRACT.

Value of hygienic knowledge to women; how the untrained may obtain it.

Desire to spread the knowledge to those less instructed.

Example stronger than precept; woman neglecting the sanitary condition of her own household, the health of her dependants, physiological laws in regard to her own dress.

Existing organisations for the dissemination of such knowledge. (*a*) Mothers' meetings, infantile mortality, cleanliness, food, hints on cookery and nursing, simple illustrations from known to the unknown. (*b*) Girls' clubs and G.F.S. Rooms, workers in factories, ventilation, personal cleanliness. (*c*) Sunday school classes, prevention of contagious diseases.

Advantage of some elementary training in hygiene and domestic economy to the pupils and teachers in Board and National schools.

Desire to make it compulsory. Cookery encouraged, hygiene omitted, laundry work commenced; illustration Leeds Board Schools.

Its value as part of night school code, future generation.

Middle Class, High Schools and Colleges practical hygiene, gymnastics, theoretical teaching not general. Ipswich High School. Science and Art examinations; physiology, interesting study, appropriate; God's laws, physical and spiritual.

On "Physical and Mental Effects of Exercise," by CHARLOTTE ALICE SMITH, Undergraduate London University.

ABSTRACT.

1. Effect of exercise on (*a*) body, (*b*) mind, (*c*) morals.
2. Diseases and alterations of brain cells favoured by deficiency.
3. Nutrition and the functional vitality of the tissues dependent on the supply of oxygen of fresh air.
4. Non-development of body and mind with reference to criminals and idiots.
5. Views of European nations and various specialists, with extract from Dr. Blatin's speech before the French Chamber of Deputies.
6. Hygiene in girls' schools, and modes of exercise, with bodily and mental effects.
7. Grecian views on the subject of development.
8. A few simple rules for adult exercise.

On "The Necessity of Home Education in Hygiene," by A. T. SCHOFIELD, M.D.

ABSTRACT.

THE present position of woman in hygienic knowledge and practice as compared with the middle ages when her knowledge of other arts and sciences was far smaller. The value of the study to women generally for their own sake and for others.

What is included in the word hygiene within the *housewife's* sphere with regard to physiology, anatomy, nursing, home sanitation, ventilation, food, cooking, &c.

Within the *mother's* sphere in forming intelligent hygienic habits in children in the nursery, play-ground, and schoolroom, teaching them how to care for their own and other children's health with regards to bath, draughts, woollen clothing, for games, their postures, &c. From the age of three or four, children are interested in knowing the why and wherefores of things that are arranged for them, and the practice of the laws of health at that age soon becomes habit.

Within the *mistress's* sphere, in training servants who will make other homes and centres of hygiene, or of unhealthiness.

In the *nurse's* sphere where she may make it the surrounding influence of the children's life, at a time when they have much leisure and are always absorbing new ideas.

In the *teacher's* and *governess's* sphere, when the knowledge that is given with authority and tabulated by the children for future reference and use.

In the *invalid nurse's* sphere, where the teaching is so practical and efficient, that it rarely fails to inspire the patient with a love of hygiene for its own sake. As in the *district visitor's* sphere where the "sweet reasonableness" and sympathy of woman is so heavily taxed, but where so slowly it greatly convinces the poor that, through hygiene beauty and strength are for them as truly as for the great.

RESOLUTIONS PASSED AT THE CONGRESS HELD AT PORTSMOUTH, 1892.

During the Congress certain resolutions were passed at the various meetings, and were in due course submitted to the Council of the Institute. After careful consideration certain decisions were come to by the Council, which are set out below following each Resolution.

As the various meetings at which the Resolutions were passed cannot now be informed of the action taken, the Council thought it well to set them out here for the information of those interested.

Resolutions passed in Section 1.—Sanitary Science and Preventive Medicine.

1. "That Section I. is of opinion that in towns with populations of over 20,000 inhabitants, private slaughter-houses should be totally abolished and be superseded by public abattoirs under the control of the local authorities."

Resolution of Council:—"To forward the resolution to the Local Government Board with the approval of the Council suggesting that compensation should be provided for."

2. "That in the opinion of Section I. the execution of the Vaccination Acts should be transferred from the Poor Law Board of Guardians to the Sanitary Authorities, especially in large towns."

Resolution of Council:—"To take no action."

Resolution passed in Section II.—Engineering and Architecture.

3. "That in order to prevent the increasing pollution of rivers by manufacturers' refuse, enlarged powers should be given to local authorities to compel the offenders to purify the polluted waters, and in default the local authority should have power to carry out the necessary work at the cost of the offenders."

Resolution of Council:—"To forward the resolution to the Local Government Board with the approval of the Council."

Resolutions passed in the Conference of Medical Officers of Health.

4. "That it be a recommendation to the Council of The Sanitary Institute to urge upon the Local Government Board the policy of special expenditure upon cholera precautions and cholera isolation hospitals incurred by Port Sanitary Authorities as the country's first line of defence, being borne by Imperial funds and not by local rates."

The following recommendation was adopted by the Council:—"That it would be impossible logically to limit this policy to Ports, and if Imperial funds are to be spent by Local Authorities they must be under Imperial control."

5. "That it be a recommendation to the Council of The Sanitary Institute to urge upon the Local Government Board the necessity of a census being taken every five years."

By direction of the Council, a communication to this effect was sent to the Local Government Board.

6. "That in the opinion of this Conference of Medical Officers of Health, where tuberculosis of a single organ of the body is associated with impairment of the nutrition of the flesh, the whole animal should be condemned, and that where tuberculosis affects more than one organ, or where serous surfaces are extensively implicated, the whole animal should in all cases be condemned."

The Council thought it desirable that as there is a Royal Commission appointed to consider this subject, the Institute should defer action until this Commission has reported.

Resolutions passed at the Conference of Sanitary Inspectors.

7. "That this Meeting is of opinion that the removal to an isolation hospital of all persons, irrespective of social status, who are not, in the opinion of the Sanitary Officers, effectually isolated, should be made compulsory."

The Council consider that this is practically the present state of the law.

8. "The admission of Sanitary Inspectors to the membership of the Institute."

There is nothing to render Sanitary Inspectors ineligible as candidates for membership.

9. "The admission of Sanitary Inspectors to the Council of the Institute."

The Articles of Association provide that all members who come under the definition in the Memorandum relating to

Fellows are eligible for nomination for the Fellowship, and that Fellows may be nominated Members of Council.

10. "That the Institute request each authority at its own cost to annually send to Congress its Inspector of Nuisances."

Complimentary Tickets are sent to Local Authorities, asking them to appoint delegates. Some authorities have appointed Inspectors as delegates, and the Council would also be glad to learn that the Local Authorities paid the expenses of their Inspectors, but the Institute is hardly in a position to ask them to do so.

11. "That the Institute form a Committee for the drafting of a Model Sanitary Statute, and do all in its power to accomplish its enactment. Said Committee to include, by invitation of the Institute, such Local Government Officials in England and Wales as would in their opinion be useful, whether such officers are members of the Institute or not."

The following recommendation was adopted by the Council:—"That in the event of the Institute being in a position to undertake such a responsibility, they should not lose sight of the subject."

12. "That a deputation be formed to wait upon the Local Government Board to urge our claims to pensions, and also the desirability of our being appointed immediately under the control of the Local Government Board."

"That a Committee be formed to consider the subject of superannuation, and to approach the Local Government Board."

The Council consider that Pensions are mainly questions of political economy, and the intervention of the Institute would hardly be likely to advance the objects which the Inspectors have in view. With reference to Inspectors being directly under the control of the Local Government Board the Council hold that in the interests of sanitation it is desirable that they should not be liable to dismissal or reduction of salary without the consent of the Local Government Board.