III.—S. MONCKTON COPEMAN, M.A., M.B.Camb.,

Demonstrator of Morbid Histology at St. Thomas's Hospital.

Dr. Copeman said that having been appointed as special commissioner of the Association for the investigation of this subject in Yorkshire, he had had an opportunity of carrying out an inquiry over a very considerable area. So far from the serious nature of the affection having been overstated, he was convinced from the evidence he obtained from others, and from the results of a house-to-house inquiry carried out by himself in one of the poorer parts of Sheffield, that it was even more widespread than had been asserted. Many people who had never come under medical care showed a lead line on the gums, and many spoke of attacks of colic and constipation, so that their systems would probably be undermined and less resistent to attacks of other diseases. The effect of the water certainly seemed to be due to its acidity; but the nature of such acidity and the best means for its neutralisation were matters which were still *sub judice.*

IV.—W. N. THURSFIELD, M.D.,

Medical Officer of Health Shropshire Combined District.

Dr. Thursfield said that lead piping was seldom made out of virgin lead, but out of lead that had been remelted. Old Roman lead piping had been found not to give up any traces of lead to water.

Resolution.

On the motion of the President, seconded by Dr. Louis Parkes, the following resolution was adopted and directed to be transmitted to the Council of the Association: "That the Local Government Board be respectfully requested to undertake the investigation of the lead-dissolving properties of various public water supplies in this country.

A DISCUSSION
ON THE
ELECTRICAL TREATMENT OF SEWAGE.

In the Section of Public Medicine at the Annual Meeting of the British Medical Association held in Birmingham, July, 1890.

I.—JAMES MacLINTOCK, M.D., B.Sc.,

Medical Officer of Health Bradford.

In Bradford, as in other large communities, the question of sewage disposal has become one of great importance and difficulty, and in view more especially of the renewed attention to the condition of the rivers and watercourses throughout the country generally, it has become necessary to seek after the system of treatment which should, at no prohibitory cost, most effectually remove the obnoxious matters.

The special difficulties in Bradford are two: 1. The presence of a large proportion of manufacturing refuse in the sewage; 2, the absence of available land in the immediate neighbourhood for irrigation or filtration works. With regard to the former, it can readily be understood how materially the character of the sewage is altered by the admixture of dyes, acids, alkalies, and organic matters from the different processes to which the wool is subjected in the course of manufacturing. Some of these may not be absolutely hurtful to health, and yet greatly add to the difficulties of treating the sewage, for although the presence of colouring matter is not a bar to admission of a sewage effluent into a stream, yet most authorities aim at producing an effluent as free as possible from colour. From the nature of the manufactures in Bradford—the great majority of the mills being engaged in the woollen industry—it is found that the refuse is not composed entirely of innocuous matter. A large quantity of grease and other organic matter from wool washing gets into the sewage and materially enhances the difficulty of treatment, as well as in itself being of an offensive and dangerous character.

The following are analyses of an ordinary sample of raw Bradford sewage and of ordinary non-manufacturing sewage.

	Bradford Sewage.	Harrogate Sewage.
Total solids	127 grains per gallon ...	55 grains per gallons
Chlorine	12 ,, ...	11.5 ,,
Free Ammonia	32 parts per million ...	55 parts per million
Albuminoid ammonia...	15 ,, ...	3 ,,

Bradford is situated in the midst of a large number of manufacturing districts. It is entirely surrounded by busy and populous communities, which are ever on the watch to resist the establishment of any sewage or other works, which might prove detrimental to their interests. From the conformation of the land no site is available for irrigation or filtration works within the boundaries of the borough. The corporation has therefore been forced to adopt the system of precipitation, lime being the material employed.

You all know that to the system of lime precipitation there are several objections, its chief recommendations being its simplicity and comparative cheapness. It fails to remove the dissolved organic matter, and by rendering the effluent alkaline promotes putrefaction after admission into the stream. The sludge resulting is of little value, and in most places where this process is in operation it has now to be removed at considerable cost. Thus, although the lime process is carefully carried out at Bradford and the results for such a process are undoubtedly good, yet it was considered necessary to adopt, if such could be found, a more perfect system. It would be out of place in a brief paper like this to mention all the other methods of treatment which have been examined and considered. Suffice it to say that in October of last year a deputation of the Bradford Corporation visited the Electrical Purification Sewage Works erected at Crossness by Mr. Webster, the well-known contractor, and patentee of the electrical treatment of sewage.

The result of the inspection was to a certain extent favourable, and ultimately an arrangement was entered into between the Bradford Corporation and the Electrical Purification of Sewage Company, by which the former agreed to vote a certain sum of money towards the cost of experimental works at the Bradford Sewage Works. The company undertook the management of these works for such reasonable time as might be deemed necessary. Accordingly, in the beginning of March of this year the company began operations by treating something like 1,000 gallons per hour. The plant necessary for the electrical treatment is as follows:—(1) An electrolytic shoot or channel; (2) an electric generator; (3) motive power for generator; (4) necessary conductors for conveying the current to the shoot from the generator; instruments for measuring the current used and the potential at which it is supplied. The electrolytic shoot, constructed of brickwork, is 25 feet in length, $24\frac{3}{8}$ inches wide, and 4 feet in depth. It is divided into eighteen cells, each of which contains twenty iron plates, measuring 3 feet × 1′ 2″ × ½″, and weighing on an average 70 lbs. each.

These plates are placed vertically in the shoot, and present their edges to the direction of flow of the sewage. The cells are divided one from the other by partitions so arranged that the sewage in traversing the shoot passes alternately under and over them. Every alternate plate is connected respectively with the positive and negative poles of the generator. All the plates in each cell are connected up in parallel, and the cells are connected in series one with the other. The generator is a dynamo by Mather and Platt, of Manchester, capable of developing 100 volts and 180 ampères, but for this plant the full output of the machine is not required. The motive power is supplied from shafting in connection with a steam engine belonging to the Corporation. The raw sewage first enters the shoot, and passes into a settling tank, and then enters another shoot similar to the one described, except that it possesses eight cells instead of eighteen, and from there flows rapidly into three small tanks, and thence along a channel into the stream. During the process a greasy scum collects on the surface of the tanks and on the iron plates in the shoot. This is collected into a small tank partitioned off for the purpose.

It is at once seen that the sewage is undergoing a change during its passage along the electrolytic shoot. Gas is disengaged, the fluid is changing colour to a slight degree, assuming a greenish hue; and, most important of all, a flocculent precipitate is being rapidly formed. In the first settling tank the greater part of this precipitate settles as sludge. The rest of the sewage flows into the second shoot, is there subjected to further electrical treatment, and is finally allowed to flow through the different tanks, where a further deposit takes place. The effluent flows into a channel, where it is still further aërated, and then, as before stated, into the Bradford Beck, which is a tributary of the river Aire.

Before discussing the condition of the effluent, it may be as well to state here what takes place. There can be little doubt that the active precipitating agent formed by the electric current is hydrated ferrous oxide, and that in a nascent condition. It is thus in its most powerful state, and is continuously being formed. It has been ascertained by experiment that the addition of the ordinary iron salt to the sewage does not give the same or anything approaching the same results. Two reasons for this suggest themselves, the first being the fact that the iron oxide in the electrical treatment is used just as it is being made, and the second is that the arrangement of the plates and cells ensures the most intimate and thorough mixing of the precipitating agent with the sewage.

The two questions to be examined are now the efficiency of the treatment and its cost. As regards the result, we have the sludge and the effluent to consider. It seems to me that the chief point of importance in connection with sludge is its quantity; at any rate in a non-agricultural district such as that in which Bradford is situated, the quantity is the chief consideration. The electrical treatment possesses this distinct advantage, that, unlike lime, it adds very little to the sewage, and therefore limits the quantity of sludge to the lowest amount consistent with the removal of the solids from the sewage.

It has been found, also, that the grease, etc., present in the sludge tend to make it more easily burnt. The resulting ash contains a slight percentage of iron, and Mr. Webster suggests that this might make an excellent filtering medium, not unlike the polarite in the Acton process. The effluent, as you see from the specimen before you, is bright-looking, with a slight yellowish-green tinge, due, no doubt, to the small quantity of iron it contains.

It has not been found possible in the small laboratory attached to my department to make elaborate analyses of the effluent, even if such were necessary. The analyses which Dr. Arnold Evans—whom I have to thank for the great interest he has taken in this subject, and for the assistance he has given me—and myself have made clearly show that the electrical treatment does produce an effluent which is fit to go into a stream, such as the Bradford Beck. A great many samples have been taken and analyses made, of which the following is a fair example:

	Sewage before the Electrical Treatment.	Effluent after the Electrical Treatment.
Total solids...	127 grs. per gallon	66 grs. per gallon.
After ignition	69 ,, ,,	47 ,, ,,
Loss on ignition	58 ,, ,,	19 ,, ,,
Chlorine	10 ,, ,,	9 ,, ,,
Free NH_3	32 parts per million	21 parts per million.
Albuminoid	15 ,, ,,	5 ,, ,,

From the above analysis, it is evident that in Bradford we have to deal with a sewage containing an excessively large amount of solids. The effluent after the electrical treatment shows a reduction of nearly 50 per cent. It must be carefully noted, however, that the loss on ignition was 58 grains per gallon out of 127 grains total solids, or nearly 46 per cent.; while in the case of the effluent the loss on ignition was only 19 grains per gallon out of 66 total solids, or a little under 29 per cent. Thus it may be taken for granted that something like 70 per cent. of the putrescible and noxious portion of the sewage was removed.

This conclusion is borne out by the results of Wanklyn's process. Thus while the free ammonia was reduced from 32 to 21 parts per million, the albuminoid ammonia was reduced from 15 to 5 parts per million, giving a reduction of 66 per cent. of the objectionable constituents of the raw sewage, a result which the lime treatment falls far short of accomplishing. Microscopic examination of the sewage before treatment revealed an abundance of infusoria, bacteria, and other low forms of organic life, while in the effluent no living organism could be detected. From investigations conducted in Paris, Mr. Webster states that the organisms were reduced in number from 5,000,000 per cubic centimètre of raw sewage to 600 in the effluent.

A very important consideration is the amount of secondary putrefaction that takes place on keeping. If the electrical effluent be kept in a stoppered bottle for some days it becomes very dark in colour, a change which does not take place if it be kept in an open vessel, and in such a vessel it may be kept a long time without offensive smell being given off. Under the ordinary conditions of a running stream the effluent becomes materially improved from the äeration that takes place.

Another test, which to some may appear the most valuable of all, is that small fish, tadpoles, etc., have been kept alive for weeks in a glass vessel containing only the effluent to which some moss had been added.

To sum up, there is every reason for believing that in electricity as used in Mr. Webster's patent we have an agent capable of purifying even the worst sewage to such a degree as to render it fit to enter an ordinary stream. As to the question of cost, I am sorry that I have no definite information to lay before you. There can be no doubt, however, that a large initial expenditure is necessary on account of the immense quantity of iron employed, and the large amount of tank room necessary. From the quantity of iron present in the sludge and the effluent, it is quite clear to me that a considerable amount of iron must be daily consumed, but as to the length of time that elapses before the plates must be replaced, I am unable to inform you. The experiments have been so interrupted that a sufficient time has not yet been given in which to form an estimate. I believe that if any difficulty arises in the employment of electricity for the treatment of sewage, it will be not the want of efficiency but the great expenditure which it entails.

II.—ALFRED HILL, M.D.,

Medical Officer of Health and Analyst Borough of Birmingham.

THE President said he did not think the effluent from the electrical treatment was sufficiently pure to go into a stream to be used lower down for drinking purposes. The effluent, on the other hand, from the Birmingham sewage farm was purer than the river water into which it flowed. The milk from the cows on the farm was most excellent; 13 per cent. of total solids was the average quality. Bradford ought to seek for a solution of its difficulties in this direction.

III.—A. BOSTOCK HILL, M.D., D.P.H.CAMB.,

Professor of Toxicology, Queen's College, Birmingham.

DR. BOSTOCK HILL said that he had examined all the plans of precipitation hitherto proposed, and had visited Bradford and observed their old lime precipitation process in 1885. While it was difficult to appreciate all the figures in a paper without having them before one, still, as far as he remembered them, it seemed to him that the results as given by Dr. MacLintock were not very favourable. He would like to ask Dr. MacLintock whether any analysis had been made of the sewage filtered from the suspended matter, as that was the only way the effect of any process on the dissolved organic matter could be ascertained. He would also like to ask whether Dr. MacLintock had any information as to the cost of the new process, whether or not there was an increase in the cost as the process went on. Up to now it seemed to him that the process did not compare very favourably with other existing methods, especially that of treatment by land.

IV.—ALFRED CARPENTER, M.D.LOND., J.P.,

Examiner in Public Health, University of Cambridge.

DR. CARPENTER advocated sewage farming as the only useful method of utilising sewage. He referred to the Birmingham Sewage Farm as a satisfactory solution of the difficulty as regards Birmingham. The electrical treatment could not remove much of the dissolved organic matter of sewage.

THE ABATEMENT OF THE SMOKE NUISANCE.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association, held in Birmingham, July, 1890.

BY SIDNEY BARWISE, M.B.LOND., D.P.H.CAMB.,
Medical Officer of Health Blackburn.

THE time is come when I think we can with great advantage review the progress that has been made in the means of abating the nuisance caused by smoke, and consider the reasons for the complete failure (except as regards the metropolis) of the legislation on this subject.

The agitation against smoke started in the year 1306, when, in response to a petition from Parliament, Edward I, by proclamation, "prohibited the burning of sea-coale in London and its suburbs, to avoid the sulphurous smoke," and commanded all persons to make their fires of wood. That the anti-smoke movement, after nearly six hundred years, has not yet attained its object is evident to sight, taste, smell, and touch in any manufacturing town on working days. Manifestly either means of abating the nuisance have not been discovered, or our legal procedure is at fault.

A glance at any manufacturing town on a Sunday, and again on a working day, proves at once that the smoke cloud does not