PROCEEDINGS OF THE SOCIETY OF PUBLIC ANALYSTS.

THE monthly meeting of the Society was held on Wednesday evening, December 4, 1895, at the Chemical Society's Rooms, Burlington House, the President (Dr. Thos. Stevenson) occupying the chair.

The minutes of the previous meeting were read and confirmed.

On the proposal of Mr. A. E. Ekins, seconded by Dr. Voelcker, Dr. F. L. Teed and Mr. John Hughes were appointed to act as Auditors of the Society's accounts for the year.

The following gentlemen were proposed for election. As Member: A. C. Chapman, F.I.C., Analytical and Consulting Chemist. As Associates: Norman Leonard, B.Sc. (Lond.), F.I.C., and Harry M. Smith, assistants to Dr. Stevenson.

The following gentlemen were elected Members of the Society: Thomas Hawkins; Percy Heriot; Frank H. Leeds, F.I.C.; Alex. K. Miller, Ph.D., F.I.C.; C. A. Mitchell, B.A. (Oxon.), F.I.C.; C. H. R. Moore, F.I.C.; Clarence Arthur Seyler, B.Sc. (Lond.), F.I.C.; and Benjamin Watmough.

Dr. BERNARD DYER (Hon. Sec.) read the list of officers for 1896, as proposed by the existing council.

The following paper was read by Mr. Dibdin:

THE MICROSCOPICAL EXAMINATION OF WATER.

By W. J. DIBDIN, F.I.C., ETC.

For some years past it has been the custom for public analysts to include a microscopical examination of the matters held in suspension in water when making an ordinary chemical analysis; but this practice is not universally adopted, and the valuable information which may be so obtained is not infrequently missing in many published results. With the view of placing this important point in its proper position, I venture to submit the following details of the method which I have found to yield unexpected results in my own practice, and which, it is to be hoped, will, after careful trial, be widely, if not universally, adopted.

Hitherto the mode of collecting the suspended matters has been by simple subsidence, often in the bottle in which the sample is collected, but often by allowing the water to stand for some hours in the special settling tubes introduced by Mr. Wynter Blyth, and which I myself employed for a considerable period. These tubes are $2\frac{1}{4}$ inches diameter, and 20 inches long, being contracted at the bottom to a diameter of half an inch. At the bottom of this narrow end, a cup is ground to fit so that the solid matters as they fall are deposited therein. When the subsidence is considered complete, a ground-glass plug, with a glass handle equal to the length of the tube, is placed in position inside the settling-tube just above the cup, when the latter can be removed, and with it the suspended solids, which can then be examined in the usual way.

In the course of a considerable experience with this method, I observed that no small portion of the sediment was collected on the sloping sides of the tube, and that all the free swimming organisms did not fall to the bottom, a considerable proportion thus escaping observation. After various trials to overcome these defects, I have adopted a method which removes these objections, and, while rapidly and conveniently enabling the whole of the suspended matters to be placed under one cover-glass on the stage of the microscope, at the same time enables a determination of the volume of the suspended matters contained in a given quantity of water to be recorded. I use the expression "volume" in preference to "weight," as in many otherwise pure waters the total quantity is so small as to be practically unweighable when collected from such a quantity of water as is usually taken for the purpose of analysis; and

again, because the fact of drying so alters the character of the deposit that it no longer represents the condition in which it existed in the water.

By the introduction of the specially-prepared samples of hard filter-paper now so generally employed in the laboratory a ready means is afforded of collecting the sediment by simple filtration, and then washing the so collected sediment into a suitable tube, which I call the "Micro-filter," and in which all the excess quantity of water can be separated, until the whole of the solid matters are contained in one drop of water, thus collecting not only the dead matters, but also the living organisms. This drop of water is then carefully placed on the usual glass slip and examined, first in its natural condition under the microscope, and then, when desirable, after being dried, stained, and mounted in balsam, or water if preferred, for further examination under higher powers for the presence of the various bacteria, etc. One great advantage of this method is that, while the ordinary gelatine plate culture affords valuable information as to the presence of the free bacteria in the water, their presence, often in infinitely greater numbers, entangled with, and feeding upon, the solid matters, is demonstrated in a most striking manner.

The details of the process are as follows: The neck of the bottle containing the sample is first carefully cleansed, to remove extraneous dust, and then one litre of the water, or proportionately less when the quantity of sediment is evidently large, is decanted into a litre-flask, which has been carefully cleansed and washed with pure filtered water. This flask should have a narrow neck, such as those used in the well-known Bischof's bird-fountain, which I have found to be specially suited for the purpose. A clean filter-paper, 3 inches in diameter, is placed in position in a funnel resting in the neck of a flask of at least a litre in capacity, and then the flask containing the sample is inverted so that its mouth is just inside the filter. The water will at once fill the filter-paper, and so close the mouth of the flask, which then acts in the ordinary way of the bird-fountain, feeding the supply in the filter until the whole of the water has passed through. During this operation care must be taken to exclude dust by placing a perforated card, through which the neck of the flask passes, over the funnel. When the water is thus filtered, the deposit is washed from the filter-paper, to which it lightly adheres, into the micro-filter by means of an ordinary wash-bottle having a fine jet and charged with pure water.

The micro-filter is prepared by selecting a length of combustion-tubing, from 8 to 10 inches long, which, after thorough cleansing, is plugged with clean cotton-wool, and then heated to redness in the middle of its length and pulled out to a capillary tube, the narrowest part of which should be something less than 2 millimetres in diameter. It is nicked with a file at the two points at which the tube is exactly 2 millimetres in diameter and neatly broken. By this means two micro-filter tubes will be prepared. They are then converted into filters by charging the small end with a suitable porous diaphragm, prepared by mixing about equal parts of powdered air-dried clay and Kieselghur. This mixture is moistened and worked into a smooth, stiff paste, which is spread out on a slab to the depth of about 2 millimetres. The filter-tube is held perfectly upright and forced steadily down on the mass, and then worked round in small circles. By this method the capillary tube will be neatly charged with a plug of the clay and Kieselghur, which is at once warmed in the

Bunsen flame and gradually heated to redness, so forming a perfect diaphragm admirably suited for its purpose. As the fine sediment from the water will often choke the pores of this small filtering plug, the surplus water may be conveniently removed by putting the small end of the glass tube through an aperture perforated in an indiarubber stopper fitting into a convenient bottle, another tube from which leads to an exhaust pump, which, when worked, creates a vacuum in the bottle, and so pulls the water through the filter. When only about half an inch of water remains the micro-filter is removed, and the depth of deposit which will now be collected on the filter-plug is measured, and the results expressed in terms of millimetres of deposit in a 2-millimetre diameter tube per litre of water. Thus, a numerical factor is obtained to express the actual quantity of suspended matter present in the water; of course, in the case of dirty water, when the deposit from a litre would be too great to be contained in that part of the micro-filter-tube having a diameter of about 2 mm., half or a quarter of a litre may be taken, or even less, and the depth of deposit actually found should be multiplied accordingly, so that the results in all cases, even the most foul waters, where only a few c.c. of the water can be used, may all be expressed in the same terms. So delicate is this method that I have repeatedly demonstrated the presence of most objectionable matters contained in a single tumblerful of so-called ordinary good drinking-water.

When the depth of the deposit has been thus recorded, the filter-tube is scratched with a sharp file about half an inch from the filter-plug and broken off. To remove the deposit which will often be found closely adhering to the plug, a fine, clean platinum wire is pushed up the tube, and used to loosen the fibrous sediment and pull it away from the plug. Upon inverting the tube for a few moments, the sediment will fall to the open end. The tube is cut again with the file close to the plug and the plug end broken off, the tube being held horizontally the meanwhile. We now have the deposit contained in the minute quantity of water held by capillary attraction in the tube thus open at both ends. On holding the tube upright over the microscope glass slide, and giving it a gentle downward shake, the deposit will fall down with one drop of water, and may then be at once covered with a thin glass, and examined preferably at first with a low power, and then with higher powers as may be found desirable. I venture to predict, from experience with various operators, that no little astonishment will be expressed by those who have employed the usual methods at the unusually large quantity and varied character of the deposit so obtained from waters which are constantly passed as containing no suspended matters. Notably the presence of decomposing organic substances swarming with various kinds of bacteria will probably be the most striking when once the observer has accustomed himself to the method of finding them. Many observers are under the impression that these minute organisms cannot be readily seen with the quarter-inch objective usually employed. This is an entire mistake. The only precautions necessary are to work with the critical image, and to focus carefully the minute gelatinous specks which will be often seen close to or along the edge of particles of *débris*. When such are observed, the employment of the D eye-piece will bring them out distinctly, provided the object-glass be properly corrected for the cover-glass, and no other power will be required to differentiate bacilli from micrococci or diplococci. If it is desired to

proceed still further, the use of an oil-immersion lens of as wide a numerical aperture as is obtainable will be necessary, when, especially if the preparation is stained by one of the usual methods, the bacteria will stand out boldly. How far direct microscopic examination may enable a skilled observer to differentiate between pathogenic and non-pathogenic organisms remains for the future to show. Up to the present we can only say that such and such types are present in greater or less numbers, and this without the lengthy process of the gelatine-plate cultures, but which, nevertheless, afford a doubtless valuable aid to the diagnosis of the quality of a drinking-water. By the combined results of that method with the one which I have described, aided by the ordinary chemical examination, no careful analyst could possibly certify as pure water contaminated with objectionable matters, and it may be confidently asserted that, whatever elements of doubt may have more or less legitimately existed during the past as to the value of an ordinary analysis of water, the question has now entered upon a new phase, and is becoming more nearly based upon the foundation of exact knowledge.

Before any results are accepted, care should be taken to make a series of blank experiments with the purest water obtainable, in order that the accidental errors due to dust, etc., may be known and allowed for. A certain minute quantity of fibre will be washed from the filter-paper, and I have found starch granules from the same source. The character of these accidental contaminations is so marked, and essentially different to the objectionable matters found in more or less foul waters, that the careful operator cannot fail to differentiate between them. It will be evident that a few clean linen fibres, even with an odd leguminous starch grain, are entirely different to the decomposing matters so often met with.

In the table attached I give a series of typical results, with the full analyses in each case, in order that the effect of the method may be clearly seen.

They are placed in order of the source of the water, viz., deep and shallow wells, rivers, and brooks, in drought and in flood, etc., and well show the variation in the quantity and quality of the suspended matters as determined by the extremely rapid and exact method I have ventured to submit to the criticisms of the society.

In connection with the microscopical work, I may call attention to the special stand constructed by Messrs. Powell and Lealand, at my request, for the purpose of facilitating the counting and examination of the colonies obtained on gelatine-plate cultures. The stage has mechanical movements to the extent of 4 inches, and is arranged to support the ordinary glass culture plate generally employed. When the colonies are viewed with dark ground illumination, by means of a 4-inch object-glass and binocular vision, the process of counting proceeds with comfort and exactness, as well as greater rapidity.

DISCUSSION.

Mr. WYNTER BLYTH referred to the method of Dr. Klein in searching for the typhoid bacillus, which consisted in filtering a litre of water through a Pasteur candle and then cultivating the sediment. He also described the method of filtration of organisms in use by the biologist of the Massachusetts Board of Health. He considered that it would be better to state the results in cubic millimetres, which

WATER

Table of Analyses and Microscopical Examination
All quantities are stated in grains per gallon, except organic

SOURCE OF WATER.	EXAMINATION IN A 2-FOOT TUBE.					Phosphoric Acid.	AMMONIA.		Chlorine.	OXYGEN ABSORBED IN		Nitrogen as Nitrates, etc.
	Appearance.	Colour by Lovibond's Tintometer Scale.			Free.		Albumi- noid.	Fifteen Minutes.		Four Hours.		
		Red.	Yellow.	Blue.								
Chalk well	clear	colourless			V. S. T.	0·0001	0·0014	1·55	0·010	0·019	0·370	
Chalk well	clear	colourless			V. S. T.	0·0001	0·0038	1·70	0·014	0·029	0·370	
Chalk well	clear	colourless			none	0·0000	0·0021	1·75	0·017	0·021	0·345	
*Deep well	—	—			abundant	0·0220	0·0880	2·50	0·057	0·091	0·540	
*Deep well	—	—			traces	0·0030	0·0010	1·60	0·014	0·061	traces	
†Deep well, 60 ft. deep	—	—			—	traces	0·0010	5·65	—	0·027	1·010	
Deep well, in clay ...	clear	colourless			V. S. T.	0·0000	0·0030	2·10	0·013	0·030	0·140	
*Spring, on side of hill	—	—			consider- able trace	0·0110	0·0340	1·80	0·202	0·436	trace	
†Spring, turbid after heavy rains ...	—	—			—	0·0020	0·0010	1·25	—	0·027	0·028	
†Spring	—	—			—	0·0000	0·0000	0·50	—	0·020	—	
*Well	pale greenish	slightly turbid			V. H. T.	0·0030	0·0020	6·00	0·012	0·024	1·88	
*Well	yellowish	turbid			traces	0·0010	0·0020	7·60	0·012	0·027	0·16	
†Well	—	—			—	0·0000	0·0050	2·70	—	0·040	0·29	
*Well	yellowish	turbid			V. H. T.	0·0010	0·0031	9·20	0·197	0·337	4·36	
*Rivers	—	—			heavy traces	0·0060	0·0070	3·80	0·084	0·116	traces	
*Rivers	—	—			traces	0·1090	0·0250	332·50	0·160	0·289	traces	
River in drought ...	slightly turbid	1·0	2·1	—	slight trace	0·0010	0·0130	1·30	0·057	0·092	0·160	
River in flood ...	very turbid	2·5	4·8	—	heavy trace	0·0060	0·0360	1·50	0·114	0·295	0·080	
Filtered river water in drought	clear	0·3	0·7	—	—	0·0001	0·0056	1·25	0·035	0·058	0·188	
Filtered river water in flood	clear	0·4	0·9	—	S. T.	0·0007	0·0091	1·50	0·057	0·109	0·144	
†Brook, above sewage outfall	—	—	—	—	—	traces	0·0030	2·50	—	0·152	0·150	
†Brook, below sewage outfall	—	—	—	—	—	0·3000	0·1500	3·75	—	0·541	0·010	
†Unknown	—	—	—	—	—	traces	0·0010	1·35	—	0·028	1·290	
†Shallow well, 14 ft. deep	—	—	—	—	—	0·0020	0·0040	11·75	—	0·084	1·150	

In each case the examination of suspended matters was made by the author. The chemical
Dr. J. A. Voelcker and Mr. E. W. Voelcker.

ANALYSES

of some Typical Waters from Various Sources.

carbon and nitrogen, which are stated in parts per 100,000.

ORGANIC ELEMENTS.			Total Solids.	Cultivation tests by Gelatine Plates.	SUSPENDED MATTERS.	
Carbon.	Nitrogen.	Total.			Mm. of deposit in micro-filter from 1 litre.	Microscopical Examination.
0.055	0.010	0.065	28.00	39	trace	Few infusoria, fibres, and débris.
0.078	0.024	0.102	31.40	76	trace	Various fibres (some dyed), diatoms, and little débris.
0.050	0.007	0.057	26.20	33	0.5	Few fibres (some dyed), general organic débris, bacilli, and micrococci.
—	—	—	—	—	2.5	Black flocculent, spiral vessels, infusoria (paramœcium), scale of lepidoptera, animal feathery hair, brown vegetable cellular tissue, dyed cotton-fibres, etc., spongy parenchyma, amœbæ, numerous particles of organic matter (some gelatinous in appearance, swarming with bacilli, micrococci, and diplococci), fungoid mycelium, (?) beggiatoa.
—	—	—	34.16	—	1.0	Fine mineral débris, confervæ, algæ, streptothrix, various small infusoria.
—	—	—	42.28	—	1.7	Cotton-fibre, dyed wool-fibre, infusoria, vegetable epidermis, quantity of mineral matter.
—	—	—	35.20	—	trace	Dyed fibres, anguillulæ, fungoid mycelium, and yellow red stained tissues, organic débris, with bacilli, micrococci, etc.
—	—	—	21.84	—	4.0	Infusoria, diatoms, few fibres, algæ, numerous bacilli and micrococci, débris, etc.
—	—	—	8.60	—	24.0	Mineral and organic débris, rotifers and other infusoria, fungoid mycelium, diatoms, algæ, anguillulæ, sphæroplea, spongy parenchyma, colonies of bacilli, micrococci, and diplococci, cotton-wool and other fibres (some dyed).
—	—	—	2.24	—	1.5	Brown flocculent, blue-dyed wool and other fibres, gelatinous masses infested with bacilli, micro- and diplococci, fat globules, fragment of insect.
—	—	—	43.96	1250	12.0	Filamentous cellular growth, animal hair (? mouse), dyed wool-fibre, rotifer, diatoms, desmids, potato starch.
—	—	—	20.16	250	15.2	Ferruginous (mostly fine granular matter, with some bacilli and micrococci).
—	—	—	17.36	—	10.0	Quantity of finely-granulated matter, cotton-fibre, vegetable epidermis, fungoid mycelium, few bacilli.
—	—	—	62.16	8500	10.4	Dyed and undyed wool, and cotton fibres, numerous moving organisms, confervæ, fungoid mycelium, numerous bacilli and micrococci.
—	—	—	29.12	—	16.0	Brown mud, quantity fine mineral débris, numerous scales of insects, vegetable débris, etc.
—	—	—	670.60	—	27.0	Brownish-gray mud, confervæ, diatoms, various infusoria, vegetable tissues, oscillaria, anguillulæ, amœba, etc.
0.170	0.035	0.205	19.00	6120	3.0	Usual river débris, larvæ of insects, diatoms, coloured fibres, etc.
0.424	0.053	0.477	29.40	10200	84.0	River débris, with numerous diatoms, fragments of insects, fibres (cotton, wool, etc.).
0.119	0.043	0.162	17.40	19	0.5	Fibres and organic débris, with very numerous bacteria, etc.
0.215	0.060	0.275	23.7	153	1.0	Few fibres (some dyed), living animalculæ, decaying matter, starch cells.
—	—	—	29.40	—	17.0	Mineral débris, oxide of iron with brown filaments, confervæ, vegetable débris, diatoms.
—	—	—	37.80	—	18.0	Quantity fine granular débris with few fibres, the whole swarming with various infusoria and bacteria, etc.
—	—	—	31.90	—	11.5	Brown mud, parenchyma, and other vegetable tissues, fragments of insects, confervæ, etc.
—	—	—	73.10	—	10.4	Cotton and wool fibres (some dyed), few infusoria, quantity oxide of iron, woody fibre, few diatoms, mineral débris.

analyses of samples marked * were made by Dr. Bernard Dyer, of those marked † by In the other cases by the author.

would enable the size of the tubes to be varied. He was confident that such a method of filtration as described by Mr. Dibdin was of the highest value. It was now a question whether it would not be advisable to perform analyses always on the filtered water. To translate potato starch, diatoms, desmids, and so forth, into carbon and nitrogen was but of little utility in comparison to the identification of the organisms themselves, and of the nature of the deposit.

Dr. VOELCKER observed that, while determining the quantity of deposit obtained, it was necessary to bear in mind also the *nature* of the deposit, and this to a certain extent influenced the interpretation of its quantity. In dealing with an ordinary town supply, the condition of which was pretty constant, it was fair enough to regard the deposits obtained from different samples as quantitatively comparable; but in many cases it was greatly a matter of chance what quantity and what kind of deposit was found in the samples. In fact, a sample might be quite different, both as to chemical characteristics and as to suspended matter, from the supply whence it was taken.

Dr. RIDGAL asked whether Mr. Dibdin could give any figures as to the free and albuminoid ammonia in water which had been subjected to his process of filtration, as compared with water that had not been so treated. It seemed to him that a few millimetres of this suspended matter (which would probably contain a good deal of matter, the nature of which was not nitrogenous) would not seriously affect the amount of ammonia present.

Mr. D. A. SUTHERLAND said that to facilitate the counting and separation of the colonies he considered it preferable to attenuate 1 c.c. of the water by mixing it with 10 c.c. of gelatin broth, and again attenuating 1 c.c. of this mixture with another 10 c.c. of broth, and so on. Dr. Woodhead had recommended this plan to him, and he had found it to answer very well. He considered that any examination from a bacteriological point of view of a sample of water received in the ordinary way could be of little or no value. It was essential, especially when the colonies were to be counted, that their cultivation should be commenced at the moment when the sample was actually drawn. He noticed that the deep well water referred to in the table appeared, from its analytical results, to be much worse than the water from the shallow well. He would like to inquire the depth of the so-called deep well, as in his experience he had found wells only thirty or forty feet in depth termed deep wells. The lining of such a well was frequently defective, allowing of surface contamination from a wide area, and this class of well could not be too severely condemned.

Mr. HEHNER thought that too much importance ought not to be attached to the mere number of organisms in the sediment. Water from the purest of mountain streams contained multitudes of diatoms, which, in fact, were rather an indication of purity than otherwise. With regard to the question of uniformity in the statement of results, the Society had, as Mr. Dibdin had pointed out, made great and successful efforts in this direction. Up to the time when the Society's Water Committee took the question up, every chemist determined what he pleased, and returned his results in any notation that was convenient to him; but the great majority of English analysts, and many on the Continent and in America, now worked upon one uniform plan. Now, however, that decimal systems of notation were being so widely introduced, it would, he thought, be a great improvement if the results of water analysis were stated in decimal notation.

Mr. JOHN WHITE said it seemed to him that the filtration of the water through paper was a weak point. Most of the papers of the class referred to by Mr. Dibdin would pass barium sulphate in suspension, so that it was pretty certain that micro-organisms would go through, especially if the papers happened to contain what were technically known as "pin-holes." For collecting the suspended matter, however, for subsequent microscopical examination, this method was certainly the best that had hitherto been proposed. He did not quite understand how Mr. Dibdin had arrived at the figure 84.5 mm. given in the table. If he had drawn out a tube 84 mm. long, and of a uniform diameter of 2 mm., it was a most remarkable feat of dexterity in glass manipulation.

Dr. WASHBURN said that he had known bacteria pass through even a Berkefeld filter, owing probably to some slight crack. As the morphology of bacteria varied very greatly under different conditions, it was not possible to identify them completely by microscopical examination alone. With regard to counting the number of colonies, he thought it best to so dilute the water that the colonies were sufficiently separated and of such a size as to be easily recognised, either by the naked eye or with the aid of a small hand lens.

Mr. CASSAL said that some persons regarded the microscopical examination of water as a matter of very minor importance. His own opinion was that a microscopical examination carefully carried out afforded most useful evidence, and was, in fact, an adjunct of the utmost value to the chemical part of the analysis. From his somewhat extensive experience in the analysis of water, having been constantly engaged for a number of years in analysing waters, he felt sure that a water analysis for sanitary purposes could not be regarded as satisfactory if it did not include a proper microscopical examination, even in the case of waters the general characters of which were well known. Mr. Dibdin's process was specially applicable, and was specially valuable in the case of a water containing small quantities of suspended matter; and he thought that the results which had been detailed were of much interest and importance. Since Mr. Dibdin had been good enough to show him his method of working, he (Mr. Cassal) had applied it to a number of samples of water with very satisfactory results, and he had found that he was largely helped by it in forming his opinions on the samples. The process was not intended to separate out all the micro-organisms—meaning by this term the "bacteria"—which might be contained in a water, and he did not understand that Mr. Dibdin had intended it for any such purpose; but the process nevertheless arrested what he might call a "sufficiency" of such organisms when they were present in the suspended matter. Of course, with waters which contained considerable quantities of suspended matter, a sufficient amount could be obtained for examination by allowing settlement in suitable apparatus, and for this purpose he had long been accustomed to use the ingenious settling-tube introduced by Mr. Wynter Blyth, with the slight modification of a glass-tapped cup or separator fitted to the end of the tube, which allows a drop to be taken out at will on to a slide. Although this method was sufficient when dealing with comparatively large amounts of suspended matter, which could easily be obtained by subsidence, Mr. Dibdin's practice of measuring the volumes of sediment obtained obviously yielded useful indications, if those indications were considered intelligently; and that this was

so was testified to by the fact that, even some members who had spoken a little disparagingly of Mr. Dibdin's experiments in this direction, were nevertheless anxious to have further information on the point. Allusion had been made to certain so-called experiments carried out several years ago, and reported in the eleventh annual report of the Local Government Board for 1881-82. These "experiments" consisted mainly in the haphazard addition, without proper mixture, of small amounts of urine, excremental matter, and infected liquids, to samples of water, and in then submitting these to certain chemists for analysis. He (Mr. Cassal) had had occasion to look into these "experiments," and in a paper written by Dr. Whitelegge and himself most of the fallacies and absurdities in this report had, he believed, been called attention to and exposed. The report in question, except in one respect, was worthless, and the experiments it detailed were ludicrous; but it was still occasionally referred to as if it contained information of value. The point in regard to which the report was of interest was that some of the infected samples had been examined microscopically, and the microscopic results were amply sufficient to absolutely condemn them. With regard to the bacteriological examination of water, Mr. Cassal again felt it necessary to point out that far too much importance was being attached by some people to the present value of bacteriological processes in water analysis. The mere counting of colonies afforded but an additional test of a rough and misleading character for the existence of pollution; and as to the detection of specific pathogenic micro-organisms, in no single instance in which an outbreak of disease could be attributed to drinking polluted water had bacteriologists been able to assert that they had, with any certainty, identified those micro-organisms which would produce the disease in question. On the other hand, having regard to present bacteriological methods and knowledge, it would be foolish to pass a water as safe upon negative bacteriological results.

Dr. PAKES observed that if Mr. Cassal had read the last Local Government Board report he would be aware that Dr. Klein had, in the case of one of the last two epidemics of typhoid, been able to identify the typhoid bacillus in the water. He (Dr. Pakes) had himself succeeded in absolutely determining the presence of the typhoid bacillus and the bacillus coli communis by bacteriological methods in samples of water that had been passed as pure by analytical chemists.

Mr. CASSAL had not seen the particular report referred to by Dr. Pakes; but he presumed that that report was like others that he had seen, in which the investigator stated that he had found a micro-organism which he was unable to distinguish from the typhoid bacillus. This was very different from any statement to the effect that the typhoid bacillus had actually been identified, and that it was a bacillus which would produce typhoid.

Dr. DYER desired to thank Mr. Dibdin for having kindly examined for him by this process a considerable number of water samples. He had himself tried this process of separation, and concurred in all the remarks that had been made as to its ingenuity, and as to its probable usefulness in enabling the ordinary microscopical examination of the grosser particles of suspended matter in water to be made with more exactness than had hitherto been possible. At the same time, he had compared Mr. Dibdin's method with that of subsidence in the old-fashioned conical glass, and found that, although the new process was undoubtedly more delicate, the results,

qualitatively speaking, were substantially the same. With regard to the quite separate question that had been raised about the distinction between pathogenic and non-pathogenic organisms in bacteriological water examination, he thought that there were really very few cases in which there was any necessity, even if it could be done with facility, to look for or demonstrate the existence of special pathogenic organisms in water. Cases did occasionally arise, no doubt, in which it was desirable not merely to know that water was contaminated, but to trace the introduction of a specific disease, and under some circumstances it might be possible to do it. As a general rule, however, the main point was to demonstrate the presence of sewage. If sewage was present, it mattered little whether pathogenic organisms were or were not present at a given moment, since the water must in any case be condemned. With regard to bacteriological examination, he thought that those analysts who had not familiarized themselves, to a certain moderate extent, at any rate, with bacteriological work, were apt to somewhat under-estimate the value of simple bacteriological methods as aids to the formation of a correct deduction from the chemical results. Sometimes the chemical results were just a little doubtful or suspicious; and it very often happened in cases of that kind that a bacteriological examination yielded results which were of very great assistance to the analyst. It was desirable to make not merely gelatine plate cultivations at the ordinary temperature, but also agar-agar cultivations, with and without the addition of phenol, at blood heat.

The PRESIDENT said that this method had been brought under his notice by Mr. Dibdin some months previously, and he had found it very advantageous. Criticisms had been passed upon the mode of measuring the amount of the deposit, but seeing that the object was to measure merely the bulk of the suspended matter, and not its weight or absolute amount, he thought that Mr. Dibdin's method would probably answer all ordinary purposes better than previous methods.

Mr. DIBDIN said that there was no difficulty in cutting off the tube of the micro-filter at a point where its diameter was exactly 2 mm. He had found that this was about the most convenient for practical work. It was of course necessary to adhere to one fixed diameter in order to obtain comparable results. The measurement of the depth of the sediment was only relative, and not absolute, in consequence of its often flocculent character. Dr. Voelcker's remarks pointed to the desirability of the samples being collected by the analyst himself, or by a careful and specially-trained assistant. He (Mr. Dibdin) did not attach quite so much importance as Mr. Sutherland did to the bacteriological examination being started at the moment of taking the sample. The main point was that the sample should be a fair one, and free from any extraneous matter. The fact of the deep well water showing more objectionable features than that from the shallow well might easily be accounted for by the existence of a fissure in the chalk, which, if it extended into the neighbourhood of a cesspool, would offer a very probable explanation. Such points as this were of course liable to arise in individual cases; no universal rule could be laid down. The figure 84.5 mm., alluded to by Mr. White, had been obtained by calculation from the results of experiments upon a much smaller quantity than the one litre to which the figure referred. Dr. Washburne seemed to think that there was no need for microscopical examination if only the water was sufficiently diluted in making the

gelatin-plate cultivations. He (Mr. Dibdin), however, had found from his own experience that in practice the microscopical examination was of the greatest value, as it not only indicated the presence of bacteria, but the character of the sediment. The microscope was one thing and plate-cultures another, and both should be employed. With regard to Dr. Dyer's remarks as to comparison between the conical-glass method and the use of the micro-filter, he might mention that in the case of the latter a water could be prepared for microscopical examination in half an hour's time, whereas, in the case of a sedimentary process, twenty-four hours elapsed before the examination could be made, which even then was only partial, and took no account of the quantity.