THE TEACHINGS OF PROFESSOR FRANKLAND'S REPORT ON METROPOLITAN WATER SUPPLY, 1894.

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THE latest addition to Professor E. Frankland's familiar series of Annual Reports to the Registrar-General on the Quality of the Water supplied by the Metropolitan Water Companies presents features of special interest and suggestiveness.

By graphic representations of the monthly fluctuations of contained organic matter, Professor Frankland demonstrates the marked inferiority, in regard to chemical purity, of the raw river waters utilized in 1894, as compared with those used in 1893, and once more alludes to (a) the *chemical* superiority of the Lea over the Thames as a raw material, especially in times of flood, and (b) the greater *chemical* purity of the Lea in its upper as compared with its lower reaches.

A second diagram contrasts the organic purity of the raw Thames water at Hampton, with that of the average filtered water as delivered in London, and in this connection attention is again directed to the fact that water impounded in times of severe floods may most seriously affect the quality of the "supply as delivered" in the following month, even to the extent of making it in that month of worse quality from a *chemical* point of view, than the raw river water passing the companies' works at the same time. Commenting upon this remarkable state of things, Dr. Frankland, in his 1893 report, recommended the provision either of (a) some means of substituting the *river*, for *stored*, water, whenever the chemical quality of the former is better than that of the latter, as roughly estimated by observations of the colour in a two-foot tube, or of (b) sufficient storage to tide over the longest floods. This, it will be remembered, was one of the two conditions (the other being efficient filtration) with which the late Royal Commission safeguarded their opinion that no danger exists of the spread of disease by the use of drinking water derived from the Thames and Lea. Large though insufficient storage capacity appears, however, in this particular (chemical) respect, to be distinctly more disadvantageous than a relatively small amount, for certain companies who possessed comparatively little provision of this kind were actually enabled, just after the floods of June and December, 1894, to deliver water of better quality than that supplied by the Chelsea Company, who, notwithstanding their much greater storage capacity, had obviously been unable to entirely exclude flood water, and had been compelled to use it afterwards. On the other hand, in regard to *bacterial* purity, the deliveries of the companies possessing least storage were amongst the least satisfactory.

Believing with Koch and with American observers at Lawrence, Mass., that *efficient* sand

filtration is practically a perfect safeguard against the introduction of cholera and typhoid bacilli into drinking water, Professor Frankland attaches the highest hygienic importance to the bacterioscopic examination of river-derived drinking waters as the only trustworthy method by which their efficient filtration and bacterial purity can be ascertained. To facilitate such examination in the Metropolis he advocates the establishment of small bacteriological laboratories at the various river-water intakes. It is to be hoped that the time is not far distant when such provision will form part of the equipment of all filtering works, so that (as is now the case in the Metropolis) the engineer-in-charge may at once be informed when any filter is working unsatisfactorily, for to quote Professor Koch, "It is the business of those in charge of the works to take care that the filtered water always satisfies bacteriological requirements."

The results of bacterioscopic examination of the *unfiltered* river waters used by the Metropolitan Companies in 1894 once more demonstrate—(1), the immense destruction of bacteria which is effected by storage in subsidence reservoirs, and (2), that the bacterial quality of these waters may differ widely from their chemical qualities. Thus, the water pumped from the natural gravel beds near the Thames is nearly identical chemically with the Thames water itself, but the bacterial purity of the gravel-water far exceeds that of the Thames water, and, indeed, not infrequently that of the filtered Thames water sent into London. Again, although the water of the Lea was found during the year to be chemically purer than the Thames, and also in its higher as compared with its lower reaches, yet the determinations of 1894 have demonstrated that bacterially the higher portion of the Lea is enormously inferior to the lower portion, and also to the Thames at Hampton. Dr. Frankland specially draws the attention of the Lea Conservancy Board to this unexpected condition, and one naturally recalls the strictures of the late Royal Commission on the large heaps of gas-lime, manure, and town refuse which, as far at any rate as Hertford, "are placed on the edges of the banks (of the Lea), and within a few feet of the stream itself," and which obviously, in times of rain and flood, become a serious source of pollution.

No part of this report will be read with greater interest than the observations recorded on the causes of the great variations in the amount of microbial life in river waters during the course of the year. Changes of temperature or exposure to varied amounts of direct sunshine have hitherto been regarded as responsible for these variations, the Royal Commissioners stating in their recent report that bacterial life is injuriously affected by "even such a tempered amount of light as is present under ordinary conditions in Thames water." Professor Frankland now, however, demonstrates that the amount of rainfall, or, in

other words, the volume of water flowing in the river, is the chief cause of these variations. In a series of most interesting tables and diagrams he brings the number of microbes in raw Thames water into contrast with each of these alleged causes, and his conclusion is as follows:—"That the number of microbes in Thames water is determined mainly by the rate of the flow of the river, or in other words by the rainfall, and but slightly if at all, by either the presence or absence of sunshine or a high or low temperature. With regard to the effect of sunshine, the interesting researches of Dr. Marshall Ward leave no doubt that this agent is a powerful germicide, but it is probable that the germicidal effect is greatly diminished, if not entirely prevented, when the solar rays have to pass through a comparatively thin stratum of water before they reach the living organisms. If this be so, however, it can be no matter of surprise that the effect of sunshine upon bacterial life in the great mass of Thames water should be nearly, if not quite, imperceptible."

In regard to *filtered water*, if 100 microbes or their spores per cub. cent. be taken as the permissible limit of bacterial life, the effluents of the Chelsea, the West Middlesex, the Lambeth, and the New River Companies were almost uniformly of great bacterial purity. Never once throughout the entire year did the Chelsea filtered water exceed the above limit. The West Middlesex and the Lambeth both transgressed once (in January), and the New River Company twice (January and June). Ten samples of the Grand Junction Company's effluent (four from the Kew and six from the Hampton filters) exceeded the limit, the worst results (464 and 278 per c.c.) being in January and June. Four samples of the Southwark and Vauxhall Company's effluents, taken respectively in January, February, July, and December, were also unsatisfactory. The very small storage possessed by both of the two last-named companies is considered mainly responsible for these results. The East London Company's filters worked very irregularly up to (but not after) the end of July, and up to that time (except during May) there was always at least one unsatisfactory sample. Most of the foregoing abnormal results occurred when the raw river-water was bacterially very impure.

The closing pages of the Report are devoted to a *résumé* of the results hitherto obtained at the Lawrence (Mass.) Experimental Filtration Station, which are briefly—(1) that within the limits of 300,000 gallons to 3,000,000 gallons per acre per day, variations in rate of filtration have practically no effect on the purity of the effluent, and that filters may be satisfactorily operated even at the rate of 5,000,000 gallons per acre per day, provided a uniform rate is maintained, (2) that the finer the size of the sand-grains, between the limits 0.2 m.m. and 0.9 m.m. diam., the higher the percentage of bacteria removed, (3) that, with any

moderate rate of filtration, depth of sand within the limits of 1 foot and 5 feet, exerts but little influence upon the percentage of bacteria removed, (4) that scraping the surface of a sand-filter does not interfere with bacterial efficiency, provided there is no mechanical disturbance of the main body of the sand.

It is well-known that Professor Koch has pointed out certain difficulties attending efficient filtration during times of frost which he ascribes to (1) freezing of the superficial sand-layer causing at first total arrest of filtration, and later on excessively rapid filtration through the portions of the surface which are the first to thaw and become permeable, and (2) the impossibility of cleansing the sand-surface of open filtering basins, which have become thickly covered over with ice. Professor Frankland, however, refers to, and reserves for future report, some entirely novel phenomena affecting filtration, which the recent severe weather in England has brought to light, and the publication of his observations will be awaited with much interest.

PROFESSOR E. FRANKLAND ON THE POTABILITY OF FILTERED RIVER WATER.

THE water both of the Thames and the Lea receives, above the points where it is abstracted for the purpose of the metropolitan supply, various contributions of organic matter of animal origin, such as the drainage from manured land, the effluents of sewage works, and even raw sewage itself. This animal matter may also, at any time, be accompanied by zymotic matters dangerous to health. But, although the sentimental objection to the presence of animal matter cannot be removed, it is gratifying to find, as the result of recent researches, that the zymotic matters of a pathogenic kind are rapidly destroyed in running water, so that the most minute microscopic inspection of the water as it reaches the intakes of the various companies has hitherto failed to discover in it a single pathogenic germ. Further, it is now an established fact, that efficient sand filtration would prevent the passage of such germs into the filtered water, even should they arrive in a living condition at the intakes of the companies. Thus the hygienic objection to the use of filtered water taken from the Thames and Lea is removed. The result of recent observations, carefully and laboriously conducted in this country, in Germany, and especially in the United States of America, is confirmed by the absence in London, since the year 1866, of zymotic diseases traceable to the water supply. To secure this desirable result, however, *efficient* filtration is essential; and there can be no doubt that the immense loss of life during the cholera epidemics of 1849, 1854, and 1866 was due to the want of attention to filtration. —From the *Annual Summary of the Registrar-General*, 1894.