

## **River water and dissemination of disease / by George Wilson.**

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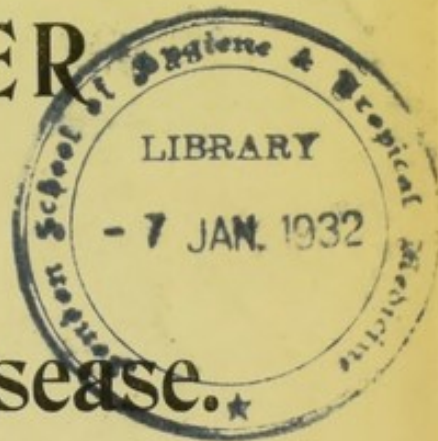
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# RIVER WATER

AND

# Dissemination of Disease.



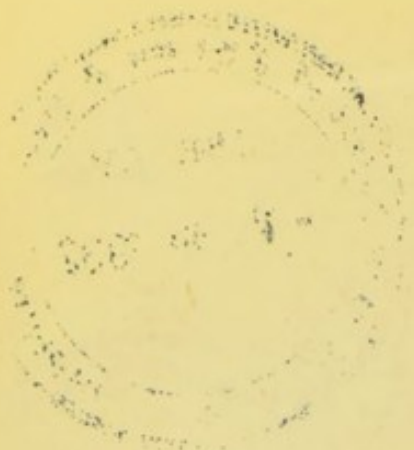
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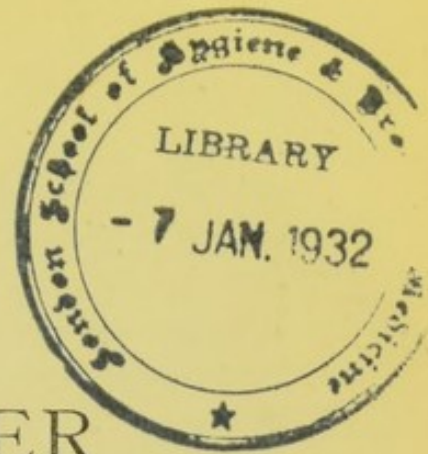
MEDICAL OFFICER OF HEALTH MID-WARWICKSHIRE COMBINED DISTRICT.

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# RIVER WATER

AND

## DISSEMINATION OF DISEASE.

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WHILE I fully appreciate the honour conveyed to me in the request to open this discussion, I am deeply sensible of the difficulty of directing it on lines which will lead to such conclusions as may lay claim to general acceptance. I will, however, take it for granted that so far as dissemination of disease is concerned, the points to be discussed will be confined to river water which is contaminated, or liable to be contaminated, with animal matters of fœcal origin, and which is therefore exposed to specific pollution. I will also assume that the danger to public health associated with such water is connected solely with its use for dietetic purposes, without reference to any such degree of pollution as would give rise to foul effluvia, and dissemination of disease traceable in that direction.

Now, I need hardly say at the outset that recent sanitary literature has established beyond all possible doubt that river-water, as indeed any water used for drinking purposes, which is fœcally, and especially, specifically polluted, has been productive of numerous recorded outbreaks of disease. I take it that I may pass over with brief reference any allusion to the share which river-water contributes to malarial diseases in foreign countries, to entozic diseases, or to epidemic prevalence of Diarrhœa or Dysentery. Outbreaks of these last two



diseases are so intimately associated with other insanitary conditions that it is often difficult to measure the exact causative influence of impure water ; but that polluted river-water does exert a powerful influence in disseminating Diarrhoea and Dysentery has long ago been placed beyond dispute. Nor need I more than refer to the vexed question of impure water being a direct cause of outbreaks of Diphtheria or Scarlatina. Though limited outbreaks of these two diseases have been attributed to such agency, the evidence is by no means conclusive, and, indeed, according to the weighty authority of Dr. Thorne Thorne, the Medical Officer of the Local Government Board, polluted water may be entirely eliminated as a cause of Diphtheria, and I think also of Scarlatina.

The broad issues of the discussion, therefore, will largely hinge on the dissemination of the two diseases—Cholera and Typhoid, or Enteric, Fever—and more particularly on the question whether a river-water which is focally polluted, and which is therefore liable to the specific pollution of either of these two diseases, can ever be pronounced to be absolutely safe for dietetic purposes. Further, in order to give force and point to the discussion, it will, I think, be serviceable to select a concrete example, and frankly debate whether in view of our knowledge of dissemination of disease by river-water, the water-supplies of London derived from the Thames and the Lea, which constitute four-fifths of the total supply, and both of which are undoubtedly polluted with sewage, can be regarded as free from risk in spite of all safeguards in respect to storage and filtration, and the more rigid enforcement of the Rivers' Pollution Prevention Acts, or Conservatory Acts.

Now, although it was not till after the first half of the present century that the water dissemination of Cholera and Typhoid Fever began to be fully recognized, it must be remembered that the conditions for explosive outbreaks on a large scale did not widely exist. Waterworks on rivers were not made extensively possible until engineers had become able to make full use of steam-power, and had developed pumping-engines and all the accessories of water distribution for the use of populous communities. Shallow wells continued to be the main source of supply, alike in towns and country villages ; while excrementitious matters were stored up in foul cess-pools, deep midden



ashpits, and filthy privies, all of which drained freely into the wells; but as a rule only the slops and surface-waters found their way directly into the streams. But no sooner had engineers solved the question of supplying increasing localities with river-water, than they began to introduce the water-carriage system of sewage disposal. The eagerness of early sanitary reformers to get rid of human refuse at any cost blinded them to the fact that by pouring sewage into the nearest water-course, they were merely removing the evil from one place to take effect elsewhere. Rivers were in reality converted into sewers, and the communities down-stream, while they loudly complained of nuisance and endangered water-supplies, added to the prevailing befoulment by following the general example. And so, when the second great Cholera visitation of England declared itself in the terrible epidemic in London in 1849, the late Dr. Snow first advanced the doctrine that the disease propagates itself from person to person by means of the intestinal discharges of the sick, and he claimed for this doctrine that it gave the true explanation of the influence which sewage-polluted water had been known to exercise, and at that time was exercising in London, in determining the local distribution of the disease. On the third great visitation of Cholera in 1853-54, his views received the strongest corroboration in the historic outbreak traced to the water from the Broad Street pump, near Golden Square, Westminster, and were still further substantiated by the reports of Mr. Simon, the late Dr. Farr, and others on the incidence of the disease in districts supplied by different London Water Companies. At the onset of the same visitation, the tidal waters of the Tyne, which had been used to supplement the water-supply of Newcastle and Gateshead, were found to be clearly implicated in the terrible outbreak of Cholera in these two towns; while during the fourth visitation in 1865-66, the epidemic in East London was conclusively traced by the late Mr. Netten Radcliffe to the sewage-polluted, and probably specifically polluted, water of the River Lea supplied by the East London Water Company. And thus, in spite of Pettenkofer's telluric theory, and the cosmic theories of epidemiologists familiar with the disease in the East, the water-borne theory of the disease became fully established, and, through the lucid reports of Sir John Simon, was finally accepted by English Sanitarians.



Since 1866 this country has escaped any serious visitation of Cholera, but during the past two years the disease has crept so near our shores, and last year appeared here and there in slight sporadic outbreaks, that we are face to face with the question:—Are our sanitary defences so complete, are our public water supplies so safeguarded, that even, if imported, we can prevent the disease from again taking root and spreading in our midst? Two years ago there was a terrible outbreak in Hamburg, and at this moment even, the disease threatens to creep along the shores of the Baltic and German Ocean from St. Petersburg, where, according to recent accounts, it is raging with virulence. In Prof. Koch's well-known monograph on "Water Filtration and Cholera," published last year and translated by Mr. Ball, of the Local Government Board, to which I will presently make further reference, the water dissemination of the disease is at all events most clearly established in respect to the Hamburg epidemic; and that the water origin of the present epidemic at St. Petersburg is fully believed in there is proved by the announcement made in the papers that barrels or butts containing boiled water are located throughout various parts of the city for the free use of the inhabitants.

But before considering the question at issue more fully, I would briefly direct attention to the disease which we have always with us, though in greatly lessened amount—I mean Typhoid, or Enteric, Fever. The literature of the disease is of still more recent date than that of Cholera, because it was not till 1848 that it was first differentiated from Typhus and Continued Fever by the late Dr. Stewart and Sir William Jenner, and is still referred to by German writers as *Typhus abdominalis*. Since then, however, the most notable outbreaks of disease disseminated by polluted water have been those of Typhoid Fever, many of which have received most careful investigation, and have been duly recorded in the Medical Officer's Reports to the Privy Council and Local Government Board. It is true that only very few of these reports refer to outbreaks traceable to polluted river-water; but in respect to polluted wells, reservoirs, or water-mains, there is a long recorded list sufficiently appalling. In some of these there was no direct proof that the water implicated was at the outset specifically, as well as focally, polluted—such as the shallow-well epidemic at Terling, in Essex, investigated by Dr. Thorne Thorne in 1867; the



polluted water-pipe outbreak at Sherborne, in Dorset, investigated by Dr. Blaxall in 1873; the deep-well outbreak at Houghton-le-Spring, investigated by Dr. Page in 1889; and the severe outbreak at Worthing during last year, investigated by Dr. Theodore Thomson. In his lucid report on the Worthing epidemic, Dr. Thomson has made it abundantly clear, by carefully conducted experiment, that the water from the new heading which was driven in April last year, and the well with which it was connected, could have been easily polluted by leakage from old disused drains close by; and that when the disease broke out, sewage from infected houses was conveyed in leaky sewers also in close proximity to the heading and well, so that the water became, without doubt, specifically polluted at an early stage of the outbreak. Further, Dr. Kelly, the Medical Officer of Health, obtained evidence of excremental fouling of the new workings, but there was no trace of any Fever cases among the workmen. Dr. Klein, however, in addition to finding an abundance of *bacterium coli* in the water from the well, discovered the presence of the Typhoid bacillus in water from one of the mains supplying the town, and so far the chain of evidence became complete.

With regard to direct specific pollution of drinking water, I need only allude to the very severe outbreak of Typhoid Fever at Over Darwen, investigated by Dr. Stevens in 1874; and the outbreak connected with the Caterham water-supply, investigated by Dr. Thorne Thorne in 1879. The former outbreak was traced to specifically tainted sewage which was found leaking from a drain into the trunk water-main of the town, and the latter to the excreta of a workman suffering from enteric symptoms, which were passed in the new adit of the Caterham well while he was at work. This last outbreak has often been quoted as illustrating to what extent an amount of specific faecal pollution, which, in such a huge volume of water is too slight for detection by any ordinary chemical methods, can infect a whole supply.

But, say the Royal Commission in their Report on the London Water Supply of last year, we do not attach the slightest importance to the Caterham outbreak, because the infected well-water was not filtered; for, to quote their own words, they assert that the Caterham outbreak "affords no evidence as to the amount of risk, if any, attending



the consumption of the water from the Thames and Lea as delivered by the Companies," and to support this statement, they enter into a calculation which goes to show that it "would take nearly half-a-million cases of Typhoid Fever occurring within a fortnight, with all the evacuations passed directly into the Thames, to effect a degree of pollution of the water, after filtration," mind you, "equal to the pollution which caused the Caterham outbreak." They enter into a similar calculation in respect to the painstaking inquiry of Dr. Barry into the serious outbreak of Typhoid Fever in the Tees Valley in 1890 and 1891, which he traced to the consumption of water taken from the Tees, and delivered after filtration by the Darlington Corporation and Stockton and Middlesborough Water Board. Relying on this calculation, and basing their opinion on the fact that there was no direct proof of specific pollution above the intake, and that, if specific pollution did take place, it was at a distance of seventeen miles above; and backed up, moreover, by the counter-statements of the representative of the Waterworks Company, they virtually give a verdict of "not proven," and attach no weight to Dr. Barry's conclusions, which implicated the filtered water of the Tees, but give special prominence to the arguments and counter-statements advanced by the Company's representative.

But though the Royal Commission could see no indication of risk to the London consumers of the Thames or Lea water-supplies as afforded by the Caterham outbreak, or the Tees Valley epidemic, or, indeed, by any of the previous outbreaks of Cholera or Enteric Fever to which I have alluded, there are several epidemics referred to in Prof. Koch's monograph on Water Filtration and Cholera which are highly instructive, and which in most important particulars strongly militate against the optimistic views of the Royal Commission. Let me now briefly direct attention to the main facts connected with some of these outbreaks. Hamburg and Altona are contiguous towns, and, along with Wandsbeck, may be regarded as a single community, but with this difference, that each has a separate and a different kind of water-supply. Hamburg at the date of the Cholera outbreak of 1892 took its water directly and unfiltered from the Elbe, at a point where the river is but relatively little polluted, but at high tides may become exceptionally polluted by the sewage discharged into the river



below the town. The origin of the outbreak was believed by Koch to be attributable to specific excremental pollution by persons suffering from Cholera living in boats near the intake, and when once the disease broke out, continued specific pollution was rendered possible by tidal influence. Wandsbeck obtains filtered water from a lake which is not exposed to contamination, and it therefore escaped any outbreak. Altona, which derives its water supply from the River Elbe, seven English miles below the Hamburg sewer outfalls, also escaped any severe visitation, although its source of supply was at a point in the river where the water was far more highly polluted than opposite the Hamburg intake, because the river had carried down with it the whole of the Hamburg sewage and its products. How is this practical immunity accounted for? Simply, according to Koch, because the Altona water-supply is first pumped into subsidence tanks, and then slowly passed through a series of sand and gravel filters which were of the usual construction. His views concerning the purifying effects of subsidence reservoirs and filter-beds have been generally corroborated by experiments made in this country and America, and the Royal Commission laid great stress on the general results, which may be briefly summarised as follows:—In river-water there is always a more or less considerable quantity of mud or other substances in suspension, which, when the water is at rest, as in subsidence reservoirs, fall to the bottom as sediment, and carry along with them a very large proportion of the bacteria which may be present. This purifying influence is, however, still more markedly increased by filtration, which is partly mechanical and partly vital in its action. A new filter composed of clean sand has little or no effect in producing either chemical or bacteriological purification,—its action is simply mechanical,—but in the course of a couple of days or so, a slimy layer charged with living microbes is deposited on the surface, and it is by these organisms which constantly increase in numbers, and also penetrate the filter to a slight depth, that both the nitrification of animal matter and the arrest of other microbes is effected. Relying more especially on the evidence of Dr. E. Frankland (who used to teach that focally polluted river-water could never be rendered safe by filtration), and quoting from his monthly report to the Registrar-General, the Commission maintain “that the raw water of the Thames and Lea can be



transformed into a beverage quite as good, from their point of view of health, as a deep-well water." The Commission, however, admit that occasionally the efficiency of filtration, which ordinarily keeps back 98 to 99 per cent. of the microbes in the water, falls far short of this standard of excellence, and the water is delivered in an unsatisfactory condition ;—the explanation being the necessity of relaying the filtering material when its filtering capacity is greatly impeded by the slimy bacteriological layer deposited on its surface, and the consequent necessity of allowing the water to pass at far too rapid a rate, and practically unpurified, until a fresh bacteriological layer is formed.

Now, it is in respect to this contingency that Professor Koch's monograph becomes so very instructive. He lays special stress on the great care which was taken in the supervision of the Altona filter-beds, and on the fact that during the whole of the Hamburg epidemic, the pace of filtration was not allowed to exceed 100 millimetres per hour, or 1.39 cubic inches. But even at this slow pace, he believes it to be probable, according to the investigations of Fraenkel and Piefke, that the bacteria of Cholera cannot be kept back by sand filters. At all events, Cholera was slightly prevalent in Altona during the Hamburg epidemic ; but out of the 500 cases reported, 400 were believed to have been brought from Hamburg. But, although the Altona filter-beds had been regarded as models of their kind, it transpired, on investigation, that during the previous ten years the town had repeatedly suffered from outbreaks of Typhoid Fever, which, according to Reincke, did not run their course contemporaneously with the epidemics at Hamburg, but followed the latter epidemics by some weeks, and were restricted to the same area as the water-supply. The water dissemination of the disease was at first disputed, but was strongly corroborated by the bacteriological examinations of Spielberg in respect to the outbreaks of 1885-86, and by Wallich's in the winter outbreaks of 1886, 1887, 1888, 1891, and 1892. These investigations proved that just before and during the outbreaks there was a marked increase in the number of bacteria in the filtered water, and the insufficiency of filtration was believed to be due to the freezing of the surface of some of the filters, and the formation of ice on others.

Without referring to the Typhoid epidemic in Berlin in 1889,



which Koch also quotes as due to insufficiently filtered river-water, I maintain that these several epidemics afford indisputable evidence of the dissemination of Typhoid Fever by river-water, which, though not accorded by the Royal Commission to the Tees Valley outbreak, is, I venture to say, sufficiently conclusive. But the Commission were evidently of opinion that the London water-supplies from the Thames and Lea were also sufficiently safeguarded against possible Cholera dissemination, and with regard to this view Koch's monograph is still more instructive. After detailing the circumstances attending the severe outbreak of Cholera at the large Lunatic Asylum at Nettleben, which he attributed to the insufficiently filtered water of the "Wild Saale," he enters minutely into the causes of the outbreak of Cholera in which cases of the disease spread over the whole town of Altona in January and February of last year. At that time Hamburg was free from the disease, but in December it was ascertained that there was a small after-epidemic of twenty-seven cases, which, no doubt, specifically polluted the Altona water supply, even though every possible precaution was taken as regards filtration and supervision in respect to bacteriological examination. Early in that month it was seen that a quickly-passing increase of bacteria had taken place in the filtered water, which gradually kept accumulating till the middle of January, and this was found to be due to the freezing of the sand layer of one of the filters. During the month of February, daily bacteriological examinations of samples of water from each of the ten filters were carried on, which showed that the water from all of them contained, on an average, a four to a ten fold increase in the number of bacteria after each cleansing. Further, and when the sand was renewed in any filter, as in March, the number jumped up to as many as 1364 and 1880 in a single cubic centimetre, while the number continued to be considerably above the standard of 100 microbes to the cubic centimetre, which is the maximum standard for safety laid down by Koch.

I have referred to these experiments because the Royal Commission, in their Report, appear to attach the greatest importance to the vital action of subsidence reservoirs and filter-beds on the purification of water, and come to the conclusion that if sufficient storage and filtering areas are provided, the river-water supply of



London may be regarded as hygienically safe. Professor Koch, however, does not share this view, for, to quote from his monograph, he says that "our previous blind trust in water-filtration has been considerably weakened by the circumstances just described, and it will be a question in future whether, in erecting new waterworks, it would not be better to choose other water in place of surface—that is, river water." And then he instances a large number of German towns which, during recent years, have obtained their water-supplies from deep wells.

Although it may appear to be somewhat presumptuous to challenge the conclusions of a Royal Commission, I venture to say that, in the face of this more recent evidence, they cannot be accepted as either a final or very authoritative solution of the whole question. Without any accusation of want of fulness or fairness in their Report, there seems to have existed in their deliberations a mental bias, which we know at times unconsciously affects the most judicial minds. Why, for example, should the Broad Street pump outbreak of Cholera have been alone selected and belittled as having no bearing on the question, and the Cholera epidemics, connected with the river-water supplies of London in 1853-54 and 1855-56, been passed by without notice? Then, again, why should the Tees Valley epidemic of Typhoid Fever have been regarded as carrying no weight, when so much importance is attached to the statement of witnesses that they knew of no cases of Typhoid Fever which could be attributed to the drinking of Thames or Lea water? We do not wait to condemn the water of a well as unsafe or unfit for drinking purposes until the occurrence of disease is traced to its use. Ever since the Caterham outbreak, it has been accepted as an axiom that the Chemist can only tell us of impurity and hazard, but not of purity and safety, and to my mind the Bacteriological Analyst cannot yet lay claim by his methods to giving us any additional guarantee on which we can absolutely rely. It may be quite true that as many as 98 to 99 per cent. of the microbes in river-water are removed by filtration, but what about the small percentage left? So much importance has been attached to their presence in water before filtration—has it been made quite clear that they do not multiply and replenish the water when stored in the house-cistern, and what about their significance then?



The Commission base their conclusions on the assumption that neither Typhoid Fever nor Cholera can be disseminated except through the agency of the so-called specific germs of these diseases. That is a doctrine, however, which, according to the experience of many Medical Officers of Health of rural districts, cannot be accepted without great reservation, and there are grave doubts among Bacteriologists as to whether or not the Typhoid bacillus may not be a saprophytic microbe, which may multiply and thrive in water, and only assume special virulence under certain polluting conditions. Then, again, as to the Cholera microbe, there have been vague rumours from India that it is polymorphous, and not always distinguishable from the *bacterium coli commune* which thrives in the healthy intestine. Last autumn, too, it will be remembered that there were sporadic cases and outbreaks of Cholera in various parts of the country, which, on examination of the fœces, Dr. Klein pronounced to be true cases of Asiatic Cholera in some instances, and in others there were cases which on bacteriological examination he declared to be not distinguishable from true Asiatic Cholera. It will also be remembered that in respect to most of these scattered cases it was impossible, in spite of the supposed agency of infected Cleethorpe oysters, from the neighbourhood of Grimsby, to trace the wanderings of the Cholera microbe, or rather of its host or carrier. In Grimsby insanitary conditions were plentiful, and the spread of the disease there was readily accounted for. Then, again, admitting the presence of specific microbes as necessary to the spread of Enteric Fever or Cholera, no account is taken of their chemical products such as ptomaines and toxins, which most Bacteriologists are inclined to maintain are the real disease-producing poisons; nor of those possible modifications and reversions of type to which I have just alluded, and which would altogether nullify the contention in the Report that pathogenic microbes, such as the Typhoid bacillus, cannot maintain their vitality, and that both their virulence and powers of multiplication are much enfeebled after but a few days. In respect to this contention, much stress is laid on the evidence of Dr. E. Frankland (whose former position in respect to the risks of river-water pollution was, I think, much sounder than his recent bacteriological conversion), which went to show "that the Cholera bacillus is soon destroyed



in river-water where there are many competing microbes, and that in all probability water passing any considerable distance down a river would lose them." But what now about the Altona outbreak of last year, which was attributed by Koch to the specific excreta of some twenty-seven cases in Hamburg, being discharged into the river seven miles above the Altona intake? Much stress, moreover, is laid on the assumption that these delicate specific microbes "cannot brook the presence of vulgar bacteria," and are, in fact, destroyed by them in the struggle for existence, a contention to which Koch, curiously enough, makes no allusion in his monograph; and though this view may be supported by experiments in the laboratory of the Bacteriologist, it may be very much questioned as taking place in the great laboratory of nature.

Another assumption in the report is this:—That, as these specific microbes are larger than non-pathogenic bacteria, they are more liable to be retained in the process of filtration; but to this view Koch gives no support, and the details of the outbreaks which I have quoted from his monograph are strongly opposed to it. The Altona outbreaks of Typhoid Fever are also strongly opposed to the contention that the Typhoid bacillus requires for its due development, among other conditions, a somewhat high temperature, and that, as floods are more liable to occur in January and February than in the autumn, there is far less risk of the bacilli retaining their vitality if they are washed down in flood-time. As I have already pointed out, the Cholera outbreak in Altona of last year, and the Typhoid epidemics of recent years, all occurred in the winter time. Nor can any weight be attached to the argument advanced by the Commission, that as no Typhoid bacilli have been discovered in the London water, they are not presumably present; nor to that other argument of an indefinite kind, that, because Typhoid mortality has been actually less in amount in London than in other large towns provided with water-supplies which are not excrementitiously polluted, the London water-supply can, in any degree, be chargeable with the production or dissemination of the disease. It is evident that the incidence of the disease should be inquired into as regards the districts supplied by river and deep-well water in London itself, and even then with due consideration



of all local conditions, before any reliable conclusions could be drawn.

But I think I have said enough, and more than enough, to prove that in respect to Typhoid or Cholera dissemination by fœcally polluted river-water, however much diluted, London cannot be said to be adequately safeguarded, and never can be adequately safeguarded, so long as any portion of its water-supply is derived from the befouled rivers of the Thames and the Lea—rivers which are liable to become more polluted still as the population on their banks extends and increases, as drainage works multiply, and water-closets become more general. For it is well known that whatever schemes of sewage purification may be adopted, in times of flood such schemes are more likely than not to greatly intensify the degree of temporary pollution. Glasgow, Manchester, Liverpool, and, recently, Birmingham, have taken steps to provide water supplies from unpolluted sources; but London, the greatest city in the world, and the meeting-place of all nations, still lags behind. And yet there are gathering-grounds in Wales unappropriated, and not required by other localities, of sufficient elevation to supply the whole of London by gravitation, even if the population in future years became more than double its present millions. It is to be hoped that the London County Council has not been lulled to a sense of security by the Report of the Royal Commission, which makes excellent reading, but in the face of Professor Koch's monograph is sadly lacking in convincing logic. No amount of increased storage or extended filtering area will guarantee safety so long as there is excremental or filth pollution; and as these two rivers are the natural drainage outlets for large tracts of cultivated land and increasing populations, serious pollution cannot be prevented. I have no wish to be an alarmist, and I believe the risk to health is at present a minimum risk; but the risk is always there, and at times of flood, or if any outbreak of Typhoid Fever or Cholera occurred up stream, would be enormously increased, and may at any time declare itself in an epidemic outburst of disease which, with a water-supply from unpolluted sources, would be rendered impossible.



