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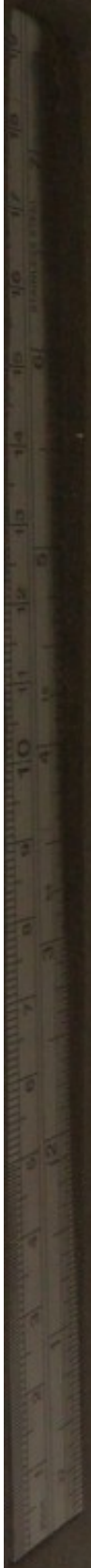
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MODERN EPIDEMIOLOGY

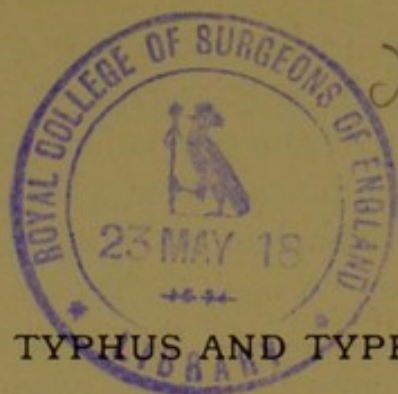
Incubation

MODERN EPIDEMIOLOGY

By J. FOSTER PALMER

Typhus fever is essentially a disease of the tropics, but it has been claimed as having been introduced into the British Isles. Like the plague, it has appeared in the wake of war. In the sequence of military operations, it has appeared to any of those vast countries which have been recorded of the plague. It has perhaps, attracted more attention than any other disease. This is a disease of the fifteenth century, when it was first brought to our notice, and it has since appeared in force in various parts of the world. There is a unanimity of opinion in regard to its nature, and the effort has been made to ascertain its extent and potency.

This success, however, has not yet reached into its origin. It is given to its predisposing conditions, which seem to be that by means of general measures aiming at the improvement of the body—the resistance to disease—successful cultivation of the body. During the war against typhus was by

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MODERN EPIDEMICS: TYPHUS AND TYPHOID.

By J. FOSTER PALMER, L.R.C.P., M.R.C.S., President of the Chelsea Clinical Society.

I.

TYPHUS.

TYPHUS fever is essentially a plant of home growth. We may claim it as having been, during certain periods, endemic in the British Isles. Like plague and cholera it always follows in the wake of war. In Europe, at any rate, it is a constant sequence of military operations. Although unable to lay claim to any of those vast conquests over mankind which have been recorded of the plague, it has done terrible work, and has, perhaps, attracted more attention in this country than any other disease. This has been chiefly since the close of the fifteenth century, when it began to be recognised and to appear in force in various records. There is now a fair degree of unanimity in regard to its origin, and considerable success has attended the efforts which have been made to reduce its extent and potency.

This success, however, has been due, not so much to researches into its origin, as to the attention which has been given to its predisposing causes. Typhus is one of those diseases which seem to support the view already suggested, that by means of general and individual sanitary measures—measures aiming at the maintenance of a sound mind in a sound body—the resisting power of the individual may be more successfully cultivated than by exclusive attention to microscopic etiology. During most of the time when the campaign against typhus was being carried on, bacteriology was an

unborn science. It is even possible that had this science been as much *en evidence* as it now is, attention might have been diverted from the patient and long-continued examination into the conditions under which typhus assumes an epidemic form. So complete and successful has this examination been that we may be said to have a fairly complete knowledge of these conditions, and that where such knowledge is employed for their removal, and the citadel is thus fortified against its invisible or ultra-microscopic foes, the latter may be left to beat a retreat at their leisure. If we know the conditions under which typhus is found to spread, we know the means to be used for its prevention.

It is to overcrowding, want of ventilation, and dirt, that the greatest achievements of this disease have been attributed. That it is both contagious and infectious is almost universally admitted, and these are undoubtedly the conditions most favourable to its convection and distribution. They are especially apt, except where there is the strictest supervision, to obtain in prisons. Those whose hands are against their fellow-men are not likely to get too much consideration from their keepers when they are paying the penalty of their crimes. In former times our prisons were simply hot-beds of typhus. In provincial towns, during the assizes, the pestilence would spread beyond the prison walls, sometimes carrying off the whole court, judge and jury included. At one of these "Black Assizes," as they were called, which took place at Oxford, *all* who were present died within forty hours, including the Lord Chief Baron, the Sheriff, and about three hundred others. The disease was introduced into the court by the prisoners, who had long been confined in the jail under the most favourable conditions for its development. At that time, and for long after, the jail was greatly overcrowded, and in an extremely offensive condition, while the prisoners were almost starved. Personal cleanliness was, under such conditions, impossible.

On another occasion, at the Old Bailey in 1756, the Lord Mayor and two of the judges died, besides many others. So fatal, indeed, was typhus in the prisons, and so much neglected,

that even when medical officers were appointed, which was not often the case, they were especially exempted from attending cases of typhus.

Such instances of the unchecked activity and prevalence of the disease might be multiplied indefinitely. They are simply the natural outcome of the condition in which our prisons were formerly kept. Prisoners, whether debtors or felons, were crowded together to an incredible degree in dirty and foul-smelling dungeons, sick and healthy together, and often starved by the cruelty of the keepers. In fact, all the conditions favourable to the development of typhus were present in the highest perfection.

This state of things, however, exists no longer, and it is to a layman that the change is chiefly due.* Since the great work accomplished by John Howard, the terrible epidemics of jail fever have become things of the past. It was typhus which first stimulated into intelligent activity the benevolent mind of Howard, and it was Howard who gained what is, perhaps, the greatest victory over disease that has ever been accomplished by a single hand. Typhus, by the thoughtful interpretation of numerous observations, and the steady application of the principles thence deduced, has become a comparatively rare disease.

It is, indeed, absolutely preventable. Cases may be, and frequently are, introduced into the wards of hospitals; but if ventilation is efficiently carried out, it does not spread. A stagnant atmosphere with accumulated organic matter seems to be essential to its development. Where this condition exists, typhus, if present, will never fail to spread; where it is absent, typhus will as certainly die out. The virtual extinction of typhus has been effected by continued attention to two essential points, one on the collective, the other on the individual side. The first is the avoidance of overcrowding by increased cubic space and better ventilation; the second

* Howard possessed, no doubt, considerable medical knowledge, and for a time actually practised medicine on the continent with some success; but he appears to have had no regular medical training.

is the abolition of the cruel system under which prisoners were liable to be starved when they were unable to satisfy the extortionate demands of their jailers. The predisposing causes of typhus are now well known; but it is never safe to neglect the cultivation of the personal power of resistance. This power is, no doubt, best sustained by the avoidance of all extreme courses. *In medio tutissimus ibis.* The fact is exemplified in Howard's own life. Avoidance of all excess saved him, it is true, from many illnesses. But he appears, by his own admission, to have carried his abstemious habits too far. In his work on the *State of Prisons* (p. 431), he attributes, and no doubt justly, his escape from infection in the numerous prisons he visited to *temperance* and *cleanliness*. At the same time he was careful never to enter a prison before his breakfast; believing, and rightly so, that the incipient exhaustion following a night's fast, would increase the susceptibility to disease. When, however, the infection at last seized him, he pointed out, though not altogether scientifically, what he considered to be the defect of this system, *viz.*, its exclusiveness. "My mode of life," he said to a friend who came to see him on his death-bed, "has rendered it impossible that I should get rid of this fever. If I had lived as you do, eating heartily of animal food, and drinking wine, I might, perhaps, by altering my diet, be able to subdue it. But how can such a man as I am lower his diet, who has been accustomed for years to exist upon vegetables and water, a little bread, and a little tea? I have no other method of lowering my nourishment, and, therefore, I must die. It is such jolly fellows as you, Priestman, that get over these fevers." Truly a pessimistic theory of treatment. He might, indeed, have had a better chance of recovery under a different system, but not for the reason suggested. A life of semi-starvation and total abstinence was not, as Howard must have known from his experience of prisons, the best means of preventing an attack of typhus, nor of increasing the chances of recovery. Such a system tends in two ways to depress the vital powers, first, by the strain on the digestive organs caused by a long-continued vegetable diet, and, secondly, by

the exclusion of certain ingredients contained in animal food in an easily assimilable form. The starvation treatment of disease referred to is now, of course, a thing of the past, but the recognition, at the close of his life, of the possible danger of too rigid and invariable a scale of dietary, is instructive.

Camps, however, as well as jails, favour the spread of typhus. It is probably this disease which is referred to in the Old English Chronicles as breaking out during the war between King Alfred and the Danes in the ninth century, and in the Irish Annals as being so prevalent in Ireland during the invasion of that country by the Danes in the tenth and eleventh centuries.* It certainly broke out during the war between Charles I. and the Parliament, both at Oxford and Reading, extending to all the intervening country and for miles around. It prevailed in the autumn of 1658, carrying off the Lord Protector. It was first recognised in the sixteenth century, in which there were fifteen epidemics; the same number occurred in the seventeenth, nineteen in the eighteenth, and twenty-six in the first eight decades of the nineteenth. In the early part of this century, during the Peninsular war, it was far more prevalent than it had been at any time since the improvement of our prisons. This was due to its importation from our camps abroad. At the close of the year 1808 it broke out among the Spanish soldiers and was conveyed by them to the army under Sir John Moore. Depressed by starvation and fatigue the army fell an easy prey to the disease. The supplies had been defective all along.† They had been partially appropriated by the Spaniards, and, in addition to this, the country was stricken with famine. Thus the year 1809 saw a great influx of typhus into England from abroad; for during the same year took place that fatal expedition to the Netherlands under Lord Chatham, when such large numbers of our troops perished in the Island of

* Typhus fever seems to have always been extremely prevalent in Ireland, from the very earliest times of which we have any record to the present day.

† The Army was, and had been from the first, without sufficient means of transport.—Napier. *Vide* Craik and Macfarlane's *History of England*, vol. viii., p. 355 *et seq.*

Walcheren, or were sent home to carry typhus with them. Starvation in this case was chiefly the result of sloth on the part of the commander, the provisions being practically exhausted during the dilatory siege of Flushing. The epidemic was still further intensified by overcrowding, for the sick were often huddled together in barns and warehouses, devoid both of light and air.* It is clear from the accounts of this epidemic that the disease was typhus, and not, as was supposed by some at the time and afterwards, an intermittent fever of local origin. The army medical officers appear to have recognised the epidemic character of the disease; but, by a mistake which was very natural at a time when the distinction between typhus and typhoid was not understood, attributed it to the water drunk by the troops. To remedy this, large quantities of Thames water were sent over for them to drink instead. As a preventive a good supply of food would have been more to the purpose. As might be expected the naval portion of the expedition, with free access to the purer air of the sea, and with a better commissariat, almost entirely escaped. It needs constantly to be borne in mind that the one great prophylactic against typhus is ventilation. More distinctly infectious than other disease (with the exception, perhaps, of small-pox among the unvaccinated) it is only by free dilution with atmospheric air that infection can be prevented. To the knowledge of this one fact, gained chiefly by the experience of our camps and prisons, is due, more than to anything else, the gradual diminution of typhus in our islands. For many years after the calamities above recorded it continued to assume an epidemic character, but under improved sanitary conditions it has gradually given way. The outbreak during the Crimean war was not followed by its importation into England on any considerable scale, and when, during recent years, it has been imported into any of our institutions, as in the case of a London convent a few years ago, it has often assumed so mild a form as to be at first unrecognisable.†

* *Vide* Craik and Macfarlane's *History of England*, vol. viii., p. 392.

† *Vide* Report of Mr. Spear to the Local Government Board on the outbreak of typhus fever in Nazareth House, Hammersmith.

The experience of other countries has been practically the same. Trousseau claims that France has suffered less than the rest of the countries of Europe; but the accounts of the wars of Louis XIV. and of Napoleon, and even those of more recent times, hardly confirm this view. France, like England, has had her share of the evil, and, like her, has benefited by the prevalence of good counsel following accurate observation*. It is the same in the new world. "Typhus," says Osler, "is now a rare disease."

It is strange that so well-marked a disease as typhus is in its severer and more typical forms should have been so long confounded with typhoid. The rapid and less-prolonged rise of temperature may have been overlooked before thermometers were in general use; but the sudden onset of the symptoms, the petechial eruption, and the special effect on the brain and nervous system, appear to us who have been taught to distinguish the two diseases to mark it off with sufficient distinctness. Still stranger, perhaps, that typhus should have been practically exterminated, while its nature and etiology were still undistinguished from those of typhoid. Yet it was not till the overwhelming potency of typhus in this country had been greatly reduced by the wholesome reform in our prison laws, and the altered state of our prisons, that science had succeeded in differentiating it from other diseases to which it bore some resemblance, and in defining their respective causes. Observations with this differentiation in view have been pursued since the beginning of the present century.† Bretonneau was probably the first to distinguish between *typhus* and *typhoid* fevers,‡ and his views were promulgated in France by the writings and lectures of Trousseau and others, but it was not till about the year 1836 that the identity of the two diseases began to be generally called in

* It was stated at the Congress of the Association Française by Dr. Droineau that typhus was again showing a tendency to become epidemic in some parts of France.

† In view of the differences of opinion now present, I ought, perhaps, to define it as the nineteenth.

‡ The latter he called Dothienenteria, from *δοθίην* and *έντερον*.

question. Lombard of Geneva, Gerhard of Philadelphia, and A. P. Stewart of Glasgow, had each separately, and almost simultaneously, commenced a series of observations. The results coincided, and all three were independently induced to believe that they were entirely distinct. Thus, in France, in the United States, in Switzerland and in Scotland the distinction between typhus and typhoid was generally recognised at least ten years before its recognition in England and some other countries. It was the experiments of William Jenner in 1849, following those of the observers above mentioned and others (chiefly French), which finally converted the profession in this country, and definitely decided the point in favour of the non-identity of the two diseases—a discovery, the importance of which has hardly been surpassed in the history of medicine.* For not only are they distinct in their essential characters, but their causes are different. Typhus is extremely infectious, while typhoid is only infectious to a limited extent, and in relation to certain excretions. Typhus is conveyed through the medium of the atmosphere, while typhoid is usually carried directly into the intestinal canal by water or other liquid used for drinking. In general terms it may be said that typhus enters the system through the lungs, typhoid through the stomach. For their prevention, there-

* The first discovery of the intestinal lesion in typhoid was due to Prost of Paris in 1804. It was probably this which led to the observations of Bretonneau. Thus the first half of the century was taken up with these researches, beginning with Prost in 1804, and ending with Godelier in 1856. The majority of the observers and exponents have been French. The following names may all be mentioned as having taken part, more or less, in the introduction of this important pathological fact: Prost (Paris, 1804), Bretonneau (Tours, 1813), Petit, Serres and Pommer (Paris), Trousseau and Velpeau (Paris, 1820), Chorud and Andral (Paris), Louis (Paris, 1829), James Jackson, jun. (Massachusetts, 1833), Peebles (Glasgow, 1835), Perry (Glasgow), Lombard (Geneva, 1836), Staberon (Berlin, 1836), Kennedy (Dublin, 1836), Gerhard and Pennock (Philadelphia, 1836-37), Montault (Paris, 1837), Shattock (Boston, 1838), Stillé (Philadelphia, 1838), Jackson, sen., and Enoch Hall (Massachusetts, 1838-39), Valleix (Paris, 1839), Rochoux (Paris, 1840), A. P. Stewart (Glasgow, 1840), Bartlett (Philadelphia, 1842), Gueneau de Mussy and Rodier (Paris and Dublin, 1847), William Jenner (London, 1849), Grisolle (Paris, 1852), Godelier (Paris, 1856).

fore, drainage is the first consideration in regard to the latter; ventilation to the former.

Typhoid is still among us, but its causes are understood, and can be traced; and if traced, removed. This, in former years, when it was being daily confounded with typhus, was an obvious impossibility. Typhus has, as we have seen, been greatly diminished in its incidence, and may be, by the enforcement of more stringent laws on the construction and habitation of houses in thickly-populated districts, almost entirely eradicated. This, however, will need the co-operation of the inhabitants themselves, without which the most comprehensive general measures may be rendered negative. All the conditions favourable to the development of typhus may be traced to a single mental condition—sloth. Sloth is the parent of dirt, overcrowding and starvation. When sloth spreads through any community these results inevitably follow, and typhus usually follows with them.

Typhus fever has not yet been traced to any micro-organism. Certain organisms have been found in the blood of patients suffering from the disease, but none that can be isolated and proved by inoculation to be the actual microbe which produces it. It is almost to be hoped that before this consummation is reached typhus will have become so rare by the spread of sanitary education that the discovery of its microbe (if there is one) will be still more difficult, if not impossible. It would show, at least, that the resources of science are not confined to a single method of killing cats (and other organisms), and that the human intelligence is equal to the task of exterminating a disease without a personal introduction to the particular microbe which causes it.

In view of this defect in our knowledge of its pathology, the question arises, "Does typhus ever break out spontaneously?" *i.e.*, the conditions being all present, is communication from a previous case essential? In the absence of the microbe this point cannot yet be determined with any certainty. If, however, we assume the existence of a microbe, we know that it must be one of so potent and subtle a character that it would be a dangerous experiment to allow such conditions to

continue in existence on the chance that the microbe might be excluded. Where dirt, overcrowding and starvation prevail for any considerable period it may be trusted, sooner or later, to find its way. Where these conditions are absent, microbe or no microbe, the disease will not make much progress.

These undoubtedly are the essential proximate causes of typhus fever, which, before they were fully understood, made, under the name of "jail fever," such frightful havoc in our prisons and the districts surrounding them; and as the "camp fever" has for centuries followed the movements of all European armies, and was a more potent factor in frustrating the far-reaching and ambitious schemes of the first Napoleon than the combined power of all the nations of Europe.

Thus typhus fever has been attacked in its most favoured haunts, and the success which has, during the last hundred and fifty years, attended the combined and active attempts to extirpate it, even without the knowledge of its primary cause, may serve to encourage inquirers to discover the means of checking the spread of other epidemic diseases, especially cholera, with the microbe of which we are already acquainted. At the same time it must ever be remembered that in these climates typhus is only latent, and might, if the defence is not sustained, regain some of its former potency.

MODERN EPIDEMICS: TYPHUS AND TYPHOID.

By J. FOSTER PALMER.

II.

TYPHOID.

TYPHOID, so far as its nomenclature and recognition are concerned, is distinctly a modern epidemic. That it can be essentially a new disease is hardly conceivable. There is nothing in old records which points to it with any great probability, unless it be the occasional references to an "unknown disorder" or to a "great mortality among men". That it was long confounded with typhus we know. That it has also been mistaken for various other feverish affections is more than probable. The physicians of past ages, with their somewhat rapid and violent methods of treatment, would hardly be content to practise the slow, patient, "expectant" treatment required in cases of typhoid. They would probably have "choked off" their patients with purgatives long before the characteristic symptoms had time to develop themselves. This would account for the absence of any disease of olden times which we can distinctly recognise as typhoid, and also for the extraordinary rapidity with which, in some epidemics, many of the cases proved fatal.

Typhoid is not, like typhus, a disease which is gradually becoming extinct; nor is it, like typhus, confined chiefly to

I think that, according as the influenza attacks the respiratory apparatus, or that of locomotion, or the cerebro-spinal system, it gives rise to the various known types and, after immediate recovery, to a long train of disturbances which vary according to the system attacked; and thus the gastro-intestinal tract comes to be affected. Sometimes the attack is so severe as to produce a clinical condition recognised as more or less grave. At other times it is subacute. No gastro-intestinal symptom is evident and the case seems to be one of those forms of influenza without localisation. But the intestinal lesions are revealed later by the daily pyrexia noted in our patients, and the train of disturbances corresponds to those encountered in all cases of influenza, and which indeed are characteristic of the malady. Whatever may be the interpretation to be applied to the cases presented by me, from the point of view of practice I have to admit that treatment is absolutely negative. While the salicylate of soda helps to cut short the initial febrile period, it does not act upon the second, nor does the salicylate of quinine, which by some is regarded as specific in stopping the slight fever that follows for a few days an attack of influenza.

The intestinal disinfectants have no action—neither benzonaphthol, salol, nor saccharine. The patient requires to be kept in bed, and on a rigorous liquid regimen. This is the only cure. During convalescence, tonics assist recovery.

the least favoured and fortunate of our fellow-creatures, the overcrowded, the poor, the starved, the criminal. On the contrary, it is a disease which makes no distinctions. It attacks the wealthy, the noble and the luxurious, and has, during the current half-century, plunged the whole nation into mourning and brought two heirs to the throne to the brink of the grave.

It is indeed strange that two diseases so different in almost every respect should so long have been considered as one. Still more strange does it at first sight appear that the quality of the air we breathe should be more readily brought under human control than that of the water we drink; that air-borne typhus should be more amenable to preventive sanitation than water-borne typhoid: for typhus has been successfully dealt with, while typhoid is still in our midst. These distinctions, however, are perhaps too absolute. The etiology of typhoid is hardly yet understood in all its bearings. Still these results are sufficient to bear out in some degree the suggestion already made, that boiling and filtering are not the sole essential factors of sanitation, as air may be rendered pure and harmless without undergoing either process. On the other hand, with all our boiling and filtering, the preventive and sanitary measures of recent times, which have had so marked an effect in reducing the incidence of typhus and other zymotic diseases, including cholera, have left typhoid fever, in many localities, practically untouched. Certain local epidemics have ceased after the introduction of sanitary improvements, but in many large towns the mortality from typhoid, alone among zymotic diseases, has either remained stationary or has increased.

Bacteriologically, too, the diseases are distinct. The typhoid bacillus, now usually called, after the discoverers, the Eberth-Gaffky bacillus, is well known. It is constantly present in the disease, and is easily cultivated in the usual media, although the disease has not yet been produced from the cultures. It is found especially in the spleen and the urine, from which the best cultures have been made. It is also found in the intestinal and mesenteric glands, the liver

and bile. It very much resembles, and is closely allied to, the bacillus coli communis, but is now usually distinguishable from it. The bacillus of typhus, on the other hand, is yet to seek. There is no microbe that we know to be constantly associated with it. In this respect, as well as in its infective potency, it has more resemblance to small-pox, scarlatina, measles and whooping-cough. It would seem that the more subtle and powerful the infection of a disease, the more difficult is it to find the microbe on which this infection depends. Typhoid, on the contrary, appears to be more allied in this respect to the malarial fevers, with the micro-organisms of which we are now so familiar. These organisms, though probably capable of spreading by means of the atmosphere, may also be suspended in various fluids, and thus, even if the diseases they give rise to are usually air-borne, may become water-borne, or milk-borne, or mosquito-borne.

Plague and typhus we look upon as air-borne, typhoid and cholera as water-borne diseases. But these terms are only relative. If malarial fevers may, under certain conditions, become water-borne, it seems equally clear, from the observations of Sir Charles Cameron, of Dublin, that typhoid may frequently be air-borne. Sir Charles's long experience of that typhoid-stricken city leads him to believe that "the rôle which water plays in the distribution of the disease, though considerable, does not seem to be quite so great as is generally believed".* Local epidemics, he considers, may be sometimes traced to infected water or milk, to vegetables from infected soil, and to other similar sources; but in view of the fact that Dublin has the best water supply in the world, and that the establishment of this water supply was not followed by any diminution of typhoid, he cannot admit that the general prevalence of typhoid in that city can be in any great degree due to its water supply, nor to its milk or food supply, nor even to defects in the city's house drainage, which is by no means exceptionally bad; but that some more wide-

* "Cavendish Lecture for 1892," *Transactions of the West London Medico-Chirurgical Society*, vol. v., p. 104 (Baillière, Tindall and Cox, King William Street, Strand, W.C.).

spread cause must be looked for. This cause he finds in the evaporation of bacillus-loaded water into the air in houses standing over dry and porous soils. In support of this argument he points out that whereas on the gravel soil in Dublin one person in every ninety-four is attacked with typhoid, on the clay soil only one in a hundred and forty-five is attacked. These views are somewhat different from those usually prevalent in typhoid etiology, but he is convinced, from an extensive experience of typhoid fever in Dublin, that there is a certain relation between its distribution and the geological character of the soil. This conviction is by no means necessarily in conflict with previous experience of typhoid as a water-borne disease : it is only on a par with the discoveries made with regard to malarial fevers. As these fevers, although essentially air-borne, may, by the absorption of their organisms, become water-borne or mosquito-borne, so, by the evaporation from the soil of water containing typhoid organisms, typhoid may in like manner come to be, in a limited sense, an air-borne disease.

However this may be, it gives no reason to look upon typhoid as being due to uncontrollable causes, nor does it justify us in diverting our attention in the least from the question of pure water supplies. It only increases the necessity for circumspection by extending the field of vision. It shows that typhoid, like plague, is not limited to one method of propagation, and that we cannot always escape from the evil influence of polluted water by refusing to drink it. The water of a town must be kept pure whether the inhabitants drink it or not. Whatever may be the actual life history of the typhoid bacillus ; whether, as Prof. Sims Woodhead supposed,* it is descended from an independent harmless saprophyte which becomes pathogenic only under certain altered conditions, or from an unbroken series of organisms which have been pathogenic ever since the creation of the world, it appears certain that it can exist for a time both

* *Bacteria and Their Products*, by German Sims Woodhead, M.D. (Walter Scott, London, 1891).

in air and water in an independent state with its virulence latent.

The good people of Dublin may boycott the foul waters of the Liffey, and procure a perfectly ideal supply from the distant hills of Wicklow. But the river, with its impurities, is still there, and they have not thus cut off all its opportunities of doing harm. Deprived of one means of access it finds another, and, absorbed into the soil, carries with it the microbes of typhoid fever to be taken up by evaporation into their houses. It is only when the surface soil is dry, or nearly dry, that the organisms are taken up by the air, and therefore the more porous the subsoil the more likely is the air to be contaminated. In the porous soils the water is more completely drained away, and hence the greater prevalence of typhoid on the gravel than on the clay soil. As a partial preventive against this source of infection Sir Charles Cameron suggests the efficient watering of the streets and covering the ground floor of every house with a layer of concrete. These, however, seem to be very untrustworthy expedients, and calculated rather to effect the concentration and storage of the poison for increased activity at some future period. There is no safety but in the purification of the river and the removal of all sewage and decomposing organic material to a distance.

I have dwelt upon the instance of this particular town in order to impress the importance of the fact, so often lost sight of, that typhoid, though usually conveyed by water, may sometimes be spread by other means, and that it is a fatal mistake to label typhoid as a water-borne disease, and then, having attended to the water-supply, fold our hands in blind confidence that it cannot spread. Total abstinence from water is not an all-sufficient preventive. The microbes of typhoid in polluted wells and rivers, cut off from the usual direct route into the human stomach, may find their way there indirectly through the soil,* through the air,† through underground vegetables,‡ through river-fed oysters,§ through bread made with impure

* "Cavendish Lecture," *Transactions of the West London Medico-Chirurgical Society*, vol. v., p. 111.

† *Ibid.*, p. 112.

‡ *Ibid.*, p. 111.

§ *Ibid.*, p. 111.

water and imperfectly cooked,* and even through cooking utensils washed in it.†

Thus it is of the first importance that the purification of rivers should be attended to. Most large towns have rivers running through them, and such rivers prove, in each case, according to the measures taken, a blessing or a curse. All sources of pollution must be cut off, and the sewage taken either to the sea or to some properly constituted sewage farm, and by no means deposited in the river. Without these essential measures nothing else is of any avail. Those would-be sanitary reformers who talk about procuring a supply of drinking water from some distant lake while their own river is contaminated are like the ostrich who hides his head in the sand and thinks he cannot be seen because he himself sees nothing.

From another point of view, too, it is more than doubtful whether these suggested ideal water-supplies have a beneficial effect on the health of a city. One thing was brought out very clearly by the late Royal Commission on the water supply of the Metropolis. The evidence unmistakably showed that while the microbes of typhoid and cholera will flourish and increase in water free from bacteria, they will inevitably be destroyed in water which contains ordinary harmless bacteria. In other words, their delicate constitutions render them unable to compete in the struggle for existence with the more robust and numerous "vulgar" organisms with which river-water abounds.‡ The Thames, we are aware, swarms with bacteria, and the inference seems to be that London owes, in part, its comparative freedom from typhoid to these cannibal organisms which devour their pathogenic brethren, and that a new supply of mountain water of ideal purity would be followed by an increase, instead of a diminution, of the disease.

Our first object, of course, is to prevent, by a perfect

* "Water-borne and Bread-nurtured Typhoid Infection," *British Medical Journal* for 1894, ii., p. 599.

† "Typhoid Fever and Cream Compounds," *Ibid.*, p. 613.

‡ *Vide*, especially, Prof. Ray Lankester's evidence.

system of drainage well carried out, the entrance of the typhoid bacillus into our water supply at all; but, if it should gain admittance, it is, perhaps, as well that we should be able to fall back upon these scavengers to destroy it before it works further mischief. Where both these conditions obtain, typhoid is not likely to assume an epidemic form.

For the prevention of typhoid, as of all other diseases, the great *desiderata* are good and plentiful supplies of air and water. One is useless without the other. For real practical purposes we can draw no distinction between air-borne and water-borne diseases. Indeed, all such carriers of infection may be looked upon as being, in reality, only proximate causes of disease. The immediate cause in most of the greater epidemics is to be found in the susceptibility of the individual. The microbes of typhus, of diphtheria, of influenza, and even of typhoid, must be frequently present, in a greater or less degree, in the air we breathe and the water we drink. Yet unless a certain pathological condition obtains in the human body, by reason of which it becomes a suitable soil for the organism, it is very doubtful whether such microbes will grow and flourish. These pathological conditions, rendering the subject of them susceptible to infection, may no doubt be set up in the system by breathing foul air or drinking polluted water, and this preparation is a far more important factor in the production of epidemics than the actual number or conveyance of the organisms. The development of these organisms in the human body we may look upon as practically an artificial culture, for which a certain preparation is necessary; this preparation being an abnormal state of the system, varying with reference to different forms of pathogenic life.

With most of the greater epidemics, with the exception, perhaps, of small-pox, this seems to be the case, and it is probable that a perfectly healthy man may swallow or inhale typhoid or cholera bacilli with impunity. The experiment, indeed, has, upon some occasions, been successfully carried out. When unsuccessful we may assume a previous deviation from the standard of perfect health. Cholera does not spread unless there is a contaminated water supply, and even then,

those who are personally clean and lead sanitary lives usually escape. Plague does not spread except among those who have been starved or breathing polluted air. Typhus and pneumonia attack by preference those whose lives are rendered insanitary by living in vitiated air. Typhoid fever, diphtheria and scarlatina, chiefly those living in unhealthy surroundings, caused either by defective drainage or impure water. In view, therefore, of the relatively small proportion of those living under sanitary conditions, and even under insanitary conditions, as in some large towns, and among our troops in India,* who are actually attacked by typhoid fever, we may, with some confidence, assert that, in the human body, insusceptibility is the normal condition, and that the evolution of the typhoid bacillus in the human subject is virtually an artificial cultivation, and is only possible in certain abnormal conditions, the nature and origin of which are not at present understood.†

Among the causes of such initial deviation from the standard of health may no doubt be included the continued breathing of impure air and drinking of impure water, the depression of the nervous system by fatigue, starvation, loss of sleep and alcoholic or sexual excess. But apart from all these proximate causes, which are all more or less temporary, there is one that must not be lost sight of, and that is the congenital predisposition to zymotic disease which is found to be so prevalent in certain families. This predisposition with regard to typhoid exists in a marked degree, as already mentioned, in our own Royal Family. We can hardly suppose that the drainage and water-supply in our Royal

* In the account of the observations on anti-typhoid inoculation described by Prof. Wright (*British Medical Journal*, 1900, i., p. 122), among 8,460 *uninoculated* soldiers there were only 213 cases of typhoid, or 2·5 per cent. Of the men at least 895 were under observation during an epidemic. Of these 33 men were attacked, or 3·6 per cent.

† This view, which I have long contended for, and which, of course, applies to many other of the zymotic diseases besides typhoid, is now, I believe, being increasingly held by bacteriologists. In the words of Prof. Stockman, the bacilli "are only pathogenic to the enfeebled organism".

Palaces is exceptionally bad, or that the control of them has fallen into the hands of secret foes or Anarchists. Even if it were so, the evil effects of the bacilli would fall with the same average incidence on members of the household and others who are similarly exposed to their influence, which they do not. We must, therefore, admit the existence of a special congenital predisposition. It appears to be combined, too, with a similar tendency to diphtheria, and to exist in connection with a more or less chronic morbid enlargement of the tonsils and other glandular structures, in what Mr. Lennox Browne, I believe, calls "glandular families". In some, the hereditary tendency to typhoid and diphtheria is very striking.

In the prevention of typhus fever, as we have seen, the first consideration is the purity of the atmosphere. When this becomes contaminated by a too-close packing of living human beings, and thus impregnated with organic particles, the products of excretion, from respired air, etc., to a greater extent than its oxygen is able to cope with, epidemic disease, if once introduced, will spread with alarming rapidity. This condition appears to be especially favourable to the development of typhus.

Since these facts have been recognised much has been done to remove the evil; but there still remains the danger of its recurrence in large towns, where the present healthy returns may lead to a relaxation of vigilance on the part of the local authorities, and oblivion of that demon of overcrowding which ought to be ever before their eyes. In London, for instance, building has been going on at an unprecedented rate, and perhaps over too limited areas. Economy of ground area involves an increased consumption of oxygen over a given space. This means an increased introduction into the atmosphere of carbonic acid and the organic products of respiration, and is only another form of overcrowding, of which it seems to present, in a greater or less degree, all the essential features. This is a point which must not be overlooked at a time like the present, when flats for the well-to-do classes are being built twelve or thirteen stories high, while, at the same time, the poorer classes are

being turned out of tenements which, although admittedly unhealthy in many respects, had at any rate the free air of heaven above them. This the more modern dwellings, the so-called "model lodging houses," have not. In these structures, whatever may be their advantages, there are certain very decided shortcomings from a sanitary point of view. No amount of artificial ventilation or building regulations or sanitary inspection will alter the fact that families are piled up one above another in close proximity, and that large numbers of human beings are compelled to live over a very limited space of ground. The present administrative County of London is included in an area of about 75,000 acres, containing about 500,000 houses and a population of upwards of 4,000,000. This gives an average of eight persons in each house, and 53·3 to an acre of ground. In the Holborn district, which is one of the most thickly populated, there were 215 to the acre. It remains to be seen whether this degree of concentration can be exceeded with impunity. That it will be exceeded if flats and model lodging houses become general there can be little doubt. It must be a very false economy, from a sanitary point of view, to economise ground at the expense of atmosphere. In a block of modern "dwellings" there may be, and often will be, in addition to the constant accumulation of impure exhalation in the air, a stratum of small-pox in one flat, of scarlet fever in another, and of typhus or typhoid in a third. A more favourable condition for the spread of disease than such a stratified series of pathogenic atmospheres can hardly be imagined.

On the other hand, the water-supply is, perhaps, even more under control in towns than in the country. In towns it is a known and constant quantity, and can be traced from its source through every step to its destination, and the cause of its contamination, whatever it may be, removed. In the country the water-supply is diverse, as well as the causes of its pollution, and neither the water-supply nor the drainage can be placed under any comprehensive system of control. Each house has to be examined separately, both as to its water-supply, and as to whatever substitute for drainage it

may happen to possess. It is probably for these reasons that typhoid epidemics in the country sometimes assume such formidable proportions. I have seen, both in Bedfordshire and Cumberland, typhoid fever prevailing to an extent unheard of in London. In large towns an incidence like that of some village epidemics would amount to a veritable plague.

In towns some epidemics have been traced to the water-supply at its source, but this is rarely the case. The system of supply is now so well understood by engineers, and is carried on upon so large and comprehensive a scale, that there is not often in the present day much danger of water being polluted at its source. Of the first importance is aeration. Without this, the best system of filtration is futile. Where stagnation is prevented by the constant agitation of the water in contact with air, as in all large reservoirs, oxygenation will prevent the accumulation of pathogenic microbes by sterilising the soil they flourish in. It is at a later part of its course, in the pipes and cisterns, that the water is most likely to be contaminated. This is usually brought about by the escape of sewer-gas from the drains and sewers. Where there is an interrupted supply, sewer-gas may be drawn into the water-pipes whenever the water is shut off. The traps at the entrances to sewers are rarely air-tight, and the suction-power of empty water-pipes is considerable. They will draw in gas through a small leakage. Thus, any defect in house-drainage will enable typhoid bacilli from the river or the soil to enter, not only the house, but the water also, although the latter may come, as in Dublin, from an entirely independent source. With the constant-supply system all this is to a large extent avoided. The overflow of cisterns by a pipe leading directly into the drains is now, I hope, universally abolished. If not, it ought to be. It was formerly a fruitful source of contamination.

(To be concluded.)





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