REMARKS

ON

THE FIRST PRINCIPLES OF SANITARY WORK.

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THE subject of my discourse is sanitary science and preventive medicine; although "as old as the hills", it is, as a science, of modern growth. In no other branch of science have we so few landmarks, and so few charts upon which the rocks and quicksands are fairly laid down. In no other science are there so few recognised dicta which can be accepted as axioms or dogmas, or acknowledged as postulates upon which a more elaborate fabric may be erected. This paucity of material does not arise from its absence, but because the axioms have to be agreed to and complied with by the masses before their truth can be ascertained. The results of the applications are too often marred or rendered nugatory by the independent action of a free people; whilst, if the axioms be applied to a people who are not free, there is a similar result; for it is impossible to obtain a compliance with sanitary law in private among those who do not know the reason why such commands are issued, however much a despotic authority may be able to control and to direct public actions. Thus it happens that sanitary science must be the outcome of a clearer knowledge; and its perfection can only be brought about by a judicious instruction of the people in the fundamental principles upon which, as a science, it naturally depends.

The foundation of local self-government is based upon the knowledge of the majority of the electors; and it is certain that the elected will not (except in a few instances) proceed much in advance of the intelligence of those who elect them. I hail, therefore, the opening of a congress such as this as a step in the right direction, because its object is to interest and instruct the people in those first principles of sanitary work which will enable the electors to choose the good and refuse the evil, with more discrimination, from among those who wish to take part in the noble art of local self-government; and by that means enable them to check the consummation of some of those gigantic jobs which are sometimes carried out in the name of sanitary science, but which are only started for the purpose of benefiting some private individual.

The first principles of sanitary law are so often in antagonism to private interests, so often opposed to the pecuniary advantage of the few—who are also at times themselves the mainsprings of local authority—that it is not surprising to find unsparing efforts constantly made by interested individuals to show that the first principles are wrong. These efforts may be made in good faith, one or other of the fallacies of induction which Lord Bacon describes as "idols of the understanding", blinding the judgment, and causing the opponents of right principles to delude themselves into the belief that they are public benefactors, by reason of their antagonism to the proposed change. These and other kindred causes tend to keep the science of disease-prevention on the threshold of that domain which a more perfect knowledge will accord to it, and which is only to be obtained by a generous instruction of the people in those axioms which are already established as scientific facts, and which, as such, are bases for future work. This science is destined to alter the whole field of medical practice; to render obsolete much of our present knowledge as to the natural history of disease, and the measures which are now required for its treatment. The inquiry must come as to how the incidence of disease is to be prevented, rather than, having arisen, how it is to be cured. This will apply to every kind of complaint, and will not be limited to the zymotic class. Recent observations have shown that there is not much difference, except in degree, between tuberculosis and pyæmia; and that all the class of so-called strumous or scrofulous maladies, including consumption, are as capable of prevention as is ordinary blood-poisoning. The inquiry must be made, therefore, why phthisis appears so often in our death-lists, as well as scarlatina or typhoid fever. Nearly all the diseases which are fatal to young people are amenable to prophylactic measures,

and capable of diminution in their fatal effects. If these deaths can be diminished—and of this there can be no reasonable doubt—it is probable that they may be altogether prevented by a right application of knowledge; and then pneumonia, bronchitis, mesenteric disease, and other causes of death among young people, will cease to be common among us, as well as those deaths which are produced by enthetic disease. Many of those evils which affect bony tissue, and which now give occupation to the surgeon, will then become diseases of the past. Those ailments which disfigure the human form will then be found more often in fiction than in fact among civilised people. It is a glorious field, and opens out to our view magnificent prospects. The death of the child will be the exception, and not the common end of more than half the human beings which are brought into the world. It is a serious thought that the majority of the population of the kingdom are deprived of their natural birthright, viz., "health and life", by the ignorance of sanitary law which now prevails. When a more perfect knowledge obtains, we shall not be able, as now, to say with Pope,

"As man, perhaps, the moment of his breath,
Receives the lurking principle of death;
The young disease, that must subdue at length,
Grows with his growth and strengthens with his strength."

Disease in the young now strengthens with his strength, because we live in unnatural states, because we breathe impure air, drink foul water, use corrupt food, and disobey the laws of nature:

"Where order in variety we see,
And where, though all things differ, all agree."

There is no occasion for the idea expressed by Pope that hereditary disease must run its fatal course. There is a power in the human frame to throw it off. That power is stronger in youth than the tendency to decay. It is seen in all families. Healthy children are born to unhealthy parents. There is a constant struggle in the human economy to recover its position, and remove from its tissues those matters which are unnecessary, and which are foreign to its requirements. The elements of disease are not parts of necessary tissue. If the efforts for their expulsion be made through channels which are capable of acting as exits for excreta, they will be successful, and the intruder will be expelled; but if they be made by organs whose daily perfection is necessary for the continuance of life or the performance of some endowment of the body, disease arises which may or may not end in health. If, then, we add to the troubles of the system more work for the diseased organ to do, health cannot be the outcome of the action. If we, by our social and moral customs, increase the quantity of morbid matter in the blood, we lessen the chance of health to the individual.

I have come to the conclusion that there is no truth in the theory which I once heard propounded by an eminent sanitary authority: "That sanitary science was responsible for the propagation of a weakened race of beings, and was therefore tending to people the earth with a debilitated race of men." This is not the effect of sanitary science, but a consequence of a neglect of it. There is no occasion whatever for tissue or matter which is not required for the perfection of the human economy to be propagated for generation after generation, "growing with its growth, and strengthening with its strength", if the laws of nature be obeyed. The sequences of a disobedience to these laws are seen for three or four generations; but if the errors of the fathers be not followed by the children, there is sufficient power in the human frame to throw off the burthen, and to reclaim its birthright of good health. The gouty great-grandfather has the dyspeptic and rheumatic grandfather, the hysterical and neuralgic father, whose children throw out the mischief by some skin eruption or other evacuation; and the evil which the great-grandfather induced by his indulgence in the pleasures of the table, the bottle of port, and general laziness is lost sight of. Let his progeny do right, and obey God's laws, and, at the end of three or four generations, there will be a removal of the gouty diathesis or the tubercular constitution. An observation of several generations in numerous families is convincing me that this is a right deduction. It must be so, otherwise there could not be a single healthy person among our English people. If we follow backwards the connections of each one of us, in five generations there have been sixty-two stocks, and in six generations, a hundred and twenty-four individuals, from each of which every person has had the chance of inheriting disease, if inheritance were a progressive law. The chance of escape would be infinitesimal, and no healthy person could be found among us at all. True, it is a common thing for diseased children to be born of diseased parents, and for these children to die of that inherited disease in their infancy. It is uncommon, even if it ever occur except from accident, for the offspring of healthy people to be diseased at their birth; whilst delicate fathers and mothers very often produce sturdy children, who grow up without a particle of disease about them.

However much, therefore, it may take the fancy of those opposed to

sanitary work to support the idea that it would be better for the human race if insanitary conditions were allowed to hold sway among us, there is no real truth in the statement. It is contrary to our experience in nature for such a clumsy contrivance to exist, by means of which the human family would long ere this have been like the extinct monsters of former ages. We may banish the idea, then, that sanitary work promotes the growth of a diseased race and tends to weaken the whole human family. The natural tendency of disease is either for it to destroy the blighted being, or for the diseased material to be expelled from the body. If a few generations could be brought to obey the laws which common sense and sanitary science have already pointed out as necessary to be observed, hereditary disease might become a thing of the past, as much as some of those maladies which used to be common among us, but are now altogether lost sight of. But hereditary tendencies are of great importance at the present time, and must be carefully studied by the student in preventive medicine. If we consult any treatise upon medical practice published in the early part of the century, we find that the most learned physicians of those days taught that diseases had various names which distinguished them from others, and which were mainly derived from the particular organ affected. Thus inflammation of the lung was described as a disease completely separated from inflammations of other organs. It was regarded as an entity in itself, which must be discovered early and treated *secundum artem*. Pneumonia was pneumonia, and nothing more. Now, however, physicians who are not routinists have discovered that pneumonia is more often the local manifestation of a general malady than a disease limited to a particular locality. The physician now tries to find out whether the disease has a zymotic or malarious origin, in which case he knows that it is only the point at which the fever is more active in its effect than at other parts of the body. If not zymotic, it may be gouty in its character. He has then to inquire whether that gout has been inherited, or has been obtained by the manner in which the patient has been accustomed to live. Or he may find that it is tubercular in its origin, or due to infection from pyæmia or septicæmia. It may be syphilitic in its character, or be due to a malignant diathesis. These particular observations are of much more importance than the mere fact of there being local disease. They are tending to reduce to very moderate dimensions the classes of disease which affect the human frame. The registration of deaths in its present form is of no scientific value; and, except the inference which may be drawn from the total number of deaths as compared with those which are produced by zymotic causes, is useless for scientific purposes. It will be observed that deaths registered as caused by pneumonia may have had an origin in some constitutional condition of the system, which, if it were tabulated, might give valuable information. The table as at present constituted places deaths, which have had a similar origin, in every part of the list. I would suggest, as a necessary alteration of the law regarding registration of deaths, that the certificate which details the cause should be transmitted direct to the registrar; that it should be a confidential document, the nature of which the registrar should be prohibited from disclosing; and that it should be the property of the State alone. I make this suggestion because a large portion of the deaths which now arise are due to causes which are not, and cannot be, registered. I especially refer to those which have had a syphilitic origin, or which have been caused by continuous indulgence in intoxicating drinks. A very large portion of the diseases which affect particular organs, and in which the first starting-point is a kind of fatty degeneration of tissue, have their origin in the habitual use of intoxicating liquors. Head, heart, liver, kidney, lung, are all subject to this change, and the consequences are diffused over the whole list. The Registrar-General's returns, as at present constituted, give but little real insight into the habits of the people.

It is necessary for every family to have some knowledge of their hereditary tendencies, before they can take the best measures for the removal of such tendencies from their own persons. The prevailing diatheses and the hybrids which arise from intermarriage must be recognised and treated accordingly, if good health is to be obtained. Treatment must not be limited to those times at which there is a local manifestation of disease. Prophylactic measures are necessary in apparent health, as well as during actual illness. It is a mistake to suppose that the date at which a given illness has apparently commenced is that at which it really began. In the case of pneumonia, for instance, it may simply announce the moment at which the mischief has reached the boiling point; it may be the evidence of an attempt on the part of nature to rebel at the treatment to which the body has been subjected, rather than to be the actual commencement of ill-health. It is an effort of the system to throw off morbid matter, and to commence its active removal. A dwelling-house is not a comfortable place to live in whilst repair and redecoration are being carried out. The necessity for

repair and redecoration commenced some time before the workmen were actively set to work. It is not less so with the human frame. Illnesses are the means which nature sets up to throw out morbid or used-up material. It is generally the patient's fault, either from ignorance or wilful disobedience to law, if an organ become damaged in the operation. I wish particularly to dwell upon inherited tendencies, because it is often said that they belong to the inevitable, and families subject to them have to submit. This is not so; they can be removed. There is no reason why delicate parents should bring up delicate children, provided they are brought up in obedience to the laws of health; but, if they be coddled because they are said to be delicate, if they be removed from all those influences which make people strong and healthy, especially if they be made to take intoxicating drinks as a matter of course, they will be like to a naturally hardy shrub which has been kept in a hothouse and not allowed to experience the changes from heat to cold, or to feel those winds and storms which rivet it more strongly in the soil. If afterwards it be planted in the open, it dwindles or remains a poor looking shrub, liable to be acted on by blight, and is easily broken down by a moderate tempest or destroyed by a cold night. So it is with human beings if they be not in due time exposed to the changes which arise from heat and cold, to drought and moisture, to exercise and proper changes of food, and kept from stimulants. It is impossible for them to reach a healthy and vigorous manhood, or to go to the grave without the infliction of organic disease.

It is all-important for individuals to be aware of the tendencies which they may have inherited. He who has a gouty constitution or a tendency to fatty degeneration from indulging in excess of certain matters, may live quite differently from one who has a tubercular diathesis; whilst the man who is more easily affected by malarious disease should avoid conditions which scarcely affect the former at all.

The time has not yet arrived at which it will be possible to speak with much advantage in a public assembly regarding general diseases. Our work, as far as this congress is concerned, is to deal with those causes which produce malarious or zymotic disease, and lessen the general health of the people. The incidence of the malarious class does fall more heavily upon some families than upon others; and some suffer much more fatally than others, as if they were predisposed to become its victims. At present, we have no certain knowledge as to the reason for this. The class itself is quite capable of prevention. The causes which lead to it are produced by circumstances which are absolutely removable, either by the State or by individual action. I have been accustomed to treat this part of my subject in the light of an algebraic equation, in which I assume that enthetic or zymotic disease is made up of members represented by $x y z$, the problem being to find the value attaching to each member of the formula $x y z$. By enthetic or zymotic disease I mean any of those diseases which belong to the zymotic or infectious classes, and which are dependent for their increase upon matter which has been in contact some time or other with another and a similar case. I will explain the value which I apply to each member in the formula. x represents the human body as it should be in health. Each function or endowment of the body as performed leads to the production of some used-up material. This is represented by y ; it always exists more or less in the blood, or is stored up as formed material, and cannot be used again for the same purpose. It is always in course of removal by the excretory organs of the body. It should be kept down to a normal standard, otherwise the natural balance is destroyed, and something goes wrong. z is matter from without. It is upon y that z increases and multiplies. If the quantity of y be normal, there is nothing for z to grow upon, for it will not flourish in the blood and juices of a healthy person. If, therefore, every function of the body be properly performed, if every endowment be naturally used, the introduction of z is comparatively harmless. It is only upon excreta or used-up matter, either in or out of the body, that z can grow. If y in any shape be abundant in the blood, and not removed as fast as it is formed, z increases and multiplies in that blood, and induces changes in it which may be incompatible with life. If there be little pabulum, the case is a mild one; and, if that pabulum be of very slow growth, it may be a long period before the patient can be liable to a similar attack again, and it may induce such conditions as may render a recurrence an impossibility. Two members of the formula $x y z$ cannot produce a case of disease. The whole three must be present. x and y alone cannot produce it, neither can x and z if y be kept at a normal standard; for, if z happen to be introduced into the body, there is nothing for it to grow upon, and it aborts. We cannot keep out y altogether, for it is formed in the very act of living. It is a sequence of life. If, therefore, any special endowment of the body be not sufficiently exercised, or any function not properly performed, there

is an alteration of the balance, and pabulum is provided, of a debased character, for morbid matter to run riot in. Thus it is that diseases of the enthetic class are epidemic at some times, and not at others, and among some people, and not among others, fatal effects more certainly following in those whose blood or other juices contain particular forms of impurity.

Each type of disease requires a different kind of pabulum for its production, just as wheat grows better in some soils than in others, whilst there are soils in which it will not grow at all, but where water-grasses flourish. So we have scarlatina abounding among one set of people, typhoid fever among another, and dysentery among a third. There is nothing more curious or out of the way in the rise and fall of epidemics than there is in the abundance or scarcity of certain forms of vegetable life, according as the season is dry or moist, or hot or cold, and according as the material required for its nourishment is abundant or the contrary. At any rate, z is required for the production of a case. You ask as to its nature. z belongs to the vegetable kingdom; it may be very close to that part of the organic world which Dr. Allman recently described at Sheffield as the starting-point for both vegetable and animal. On the nomination of Mohl, he has styled it protoplasm. Mr. Huxley calls it "the physical basis of life". Dr. Allman says it is a liquid. I join issue with him upon this point; it is not liquid, it is not volatile, but it is particulate; and, although he calls it liquid, his own admissions imply a belief in its particulate character. Those granules to which he alluded so forcibly in his address at Sheffield are solids, however much liquid they may have attached to their constituent substances. They are totally destitute of structure, as far as our finite appliances can make out, but they are possessed of contractility, and are endowed with some vital principles quite beyond our microscopical powers to discover. It is not possible for any one to say that they are really structureless, because we cannot see their parts. They are differentiated in their functions and in their powers, and must therefore be differentiated in their matter, which could be seen if our powers were equal to their minuteness. To assume that our knowledge is final; to conclude that they must be structureless, because we cannot see their structure by our present microscopical aid, is as unsound as for anyone to declare his disbelief in the planet Neptune because he cannot see it with the naked eye. It is one of the weak parts of Dr. Allman's address in which he concludes that we have reached the limits of our powers, and that protoplasm must therefore be structureless. I consider z to be a particle of protoplasm altered in its functional power, so that it is capable of development only when it comes into contact with used-up matters which are the proper excreta of humanity; and just as the germ of the common mushroom cannot germinate unless in contact with the excreta of some of our domestic animals, so the germs of enthetic disease fail to multiply if used-up matter in its proper form be not provided for it. $x, y, z =$ a case of enthetic disease; the problem is how to prevent its extension. z is thrown off in abundance from every case. It increases and multiplies out of the body as well as in it. It is an organic living particle which can flourish and propagate its kind, if pabulum be provided for it, but which cannot do so if the requisite matter be absent. The great work which the sanitarian has to perform is so to dispose of excreta that the human body shall not return within its own economy the used-up matter upon which it has fed, and which has resulted from the performance of its proper endowments, nor yet keep within reach any of the same materials by means of which z may be allowed to multiply, and at some future time be introduced into the system of another person, and so reproduce the disease. z is neither liquid nor volatile, but is a solid particle, which in some forms can be seen and weighed, and is as much a living particle as is the germ upon which the dry rot in wood or potato-blight depends. Its position in the organic world is now definitely established to be vegetable; and, reasoning from analogy, there are some facts which are proved regarding some members of the family which it is fair to assume as applying to all. I am not going into the moot point of germ-theory as opposed to glandular theory regarding the production of disease. It may be that the truth lies between the two, and that the fatal result arises from the secretion of the vegetable germ, rather than from the speck of albuminous matter of which it consists. It may be that these growths produce a poison similar to snake-poison or woorara in its effects, and which kills by its action upon the nerve-cells of the body. It may also be that the eruption of scarlatina or measles may be caused by an acid produced by the micrococcus upon which the disease depends, allied to formic acid in its chemical characters, but which is so evanescent in its nature that the chemist cannot catch it any more than he can catch the poison which kills in a case of cholera. These are at present only speculations; but they are lines upon which it is probable that future discoveries may be made.

There are four distinct and specific forms of infectious fever in which

it has been proved that, coincident with the disease and accompanying it through its stages, there are forms of vegetation in the juices and tissues of the body which decidedly differ from normal states, and which are always associated with the disease in question. The pathology of these infective processes has been thoroughly worked out by Dr. Burdon Sanderson; he has, guided by the work of eminent continental pathologists, himself verified the facts, and they come before us with great authority. It seems to be fairly proved that small-pox, sheep-pox, splenic fever, and relapsing fever are propagated by vegetable organisms. They were made out by Dr. Keber of Dantzic in 1868; and Dr. Sanderson tells us that Professor Cohn of Breslau has also made out that the organisms which are present in vaccine lymph are also found in the lymph of variola, so entirely similar as regards form and development that it is impossible to draw any distinction between them. Professor Cohn gives a graphic description of these appearances, which is published in Mr. Simon's report to the Privy Council on Scientific Investigations for the year 1874. The same paper contains an account of the investigations of Dr. Weigert of Breslau as to the existence of micrococci in the lymphatics of the skin in persons who had died of small-pox. Dr. Sanderson says (page 32): "That organisms of a particular form existing in the lymph of small-pox, taken in connection with the occurrence of similar organisms in the channels of absorption leading from the pustules, suggest the probability of these having to do with the morbid process, but cannot be accepted as proof that they possess the property of propagating the disease. For the establishment of such proof, it would have to be shown either that, when deprived of its organisms, though otherwise unaltered, it is deprived of its activity; or that, when the organisms are introduced alone, they manifest the contagious property of the liquid or tissue from which they are derived." It has been shown that many contagious liquids lose their activity when they are deprived of their suspended particles. This has been shown over and over again in the case of vaccinia; but the *per contra* must be regarded as impossible, because the bodies themselves are so minute that there is not the slightest prospect of any one being able to separate them from the containing liquid in anything like a state of freedom.

There are methods of investigation which approach very clearly to the required conditions, and which enable us to assume with some degree of certainty that the organisms, if not themselves the cause of the disease, are always the vehicle by means of which the cause is carted about the country. We cannot investigate the pathological condition under which small-pox is produced in those stages in which it is most important to gain information, but comparative anatomy enables us to bridge over the chasm. Sheep are subject to a disease which is the exact counterpart of small-pox. It is precisely similar in its origin, its progress, and its manifestations. Dr. B. Sanderson tells us that the virus contains organisms similar to those of small-pox and vaccine. The result of the investigations which were carried out by Dr. Klein can leave no doubt in the mind of any reasonable man as to the connection between the vegetations and the disease. He describes them as necklace-like filaments, of jointed structure; in some they are granular, which, under the highest possible microscopical powers, are seen to be highly refractive spheroids; in others, the filaments were so dense as to present the aspect of a felt-like mass, such as is seen in similar growths. He concludes that the highly refractive spheroids are the forms which are characteristic of the lymph in sheep-pox in its active condition. He was able to trace separate conidia in a state of germination, and, by their life-history, to connect them with vegetable matter.

There is another disease to which animals are subject, called splenic fever, or Milzbrand. It is sometimes called splenic apoplexy. It occurs in the horse, as well as in the ox, and was the first disease with which a specific organism in the blood was clearly associated. The peculiar staff-shaped bodies which are always contained in the liquor sanguinis in this disease were first made out in 1855. The most striking feature of the disease is its rapid progress; it runs its course in a few hours. In the horse, it is often called acute splenic tumour; it is accompanied by carbuncular infiltrations of the mucous membrane lining the alimentary canal. The carbuncles are not so often met with among cattle as they are in horses. The discovery of the rod-like bodies which always accompany the disease was made by Pollender. A year or two afterwards, Dr. Brauell confirmed Pollender's discovery (*Virchow's Archiv*); he considered them to be diagnostic of the disease. Other physiologists have corroborated these observations, and have shown that the rod-like bodies are from $\frac{1}{1000}$ to $\frac{1}{500}$ of an inch in length, the width scarcely admitting of measurement. Although the evidence was much doubted at first, it is now agreed by all physiologists who have inquired into it that the rods are living organic bodies, and can communicate the disease to apparently healthy animals. The activity of

the rods is dependent upon their vital functions; and, whether the rod is the absolute cause of the disease or not, it is always present, and the disease cannot be propagated without it. A curious fact has been established regarding it. The rods do not pass through the membrane which separates the mother from her offspring; and, when pregnant animals are affected by splenic fever, the blood of the embryo is not contagious, and does not contain the staff-shaped bodies.

There are two other points which have been also proved regarding splenic fever. The contagious property as it exists in the circulation is only temporary. Dr. Brauell tells us, through Dr. Sanderson, that the moment the blood shows signs of putrefaction, it loses its infective power. The motionless rods give place to actively moving bacteria, which are not capable of spreading the disease. This point is an important one with regard to the incidence of other and similar diseases. It has been shown, also, that the actively moving bacteria are not the progeny of the splenic rods, but appear rather to have eaten them up, and to have acted upon the dangerous organisms much as the infusorian animalcules and entomostracean crustaceans do in impure water, viz., remove the *matrices morbi* from the liquid, and are friends and not enemies. But the contagium has also a state of existence in which it is highly resistant. Bollinger tells us of ten cases which occurred in one stable near Zürich, between August 1868 and February 1872; there were no other cases in the neighbourhood; other horses and cattle surrounded the stable. The contagious agent must have been latent in that stable during the period in question. Each case appeared to arise independently of the preceding one, and indicated a form of contagion quite different from the staff-shaped bodies which disappear so soon from an acute case of the disease.

Some of you may ask the question as to what splenic fever in the horse has to do with the prevention of disease among human beings. I say much, because these same rod-shaped bodies have been discovered in the blood of human beings who have died of fever. There is a disease not unfrequent upon the continent, which is termed by Buhl of Munich "mycosis intestinalis"; intense infiltrations occur in the mucous membrane with extravasations of blood. It was known in some of the cases that there had been communication with animals similarly affected. The tissues of the infiltrated parts were infested with the staff-shaped rods. These discoveries give us a clue to the causes of those infiltrations which arise in the course of other fevers. The rods are not there, but there are myriads of microzymes which have superseded some forms of life which corresponded with the rods. They may also explain to us the causes of those congestions which frequently arise in the ordinary fevers of this country, and which are followed by hæmorrhages, abscesses, and enlargement of glands. The congestions may be caused by a mycosis, which is a colony of vegetable organisms, but they became changed in their character before it is possible for them to be examined by the microscopist. "It may be that the presence of these bodies is as much a part of the process as the emigration of the colourless corpuscles from the blood-vessels is a part of ordinary suppuration."

The fourth form of disease which has been clearly associated with living organisms is relapsing fever. It was first proved in Berlin by Dr. Obermeier, who unfortunately died of cholera whilst making his investigation, and probably lost his life by his devotion to science. The presence of the organisms in the blood, and their association with the fever, were clearly made out. They disappeared as the fever subsided, reappearing when a relapse took place. The morphological and botanical characters of the organisms were subsequently determined by Professor Cohn, and a place found for them in the vegetable kingdom. They are proved to be spirilla, belonging to the group spiro-bacteria of the natural order *Schizosporææ*. This genus he has placed in the family of Oscillatoriaceæ, of the class *Alga*, or seaweed. By means of this classification, we are able to see daylight, as regards these forms of disease. Another eminent botanist, Dr. von Naegeli, has classified micrococci under the name of *schizomycetes*, and connected them with the great family of fungi. There is much to favour this notion; but the aerial nature of the fructification of fungi, as opposed to the aqueous forms under which the algae flourish, leads me to conclude that the micrococci are algae rather than fungi, especially in those forms of disease which are propagated by the agency of water.

The spirillæ of relapsing fever are always present during the hot stage. They cease to be visible after the temperature has fallen. They can be kept alive for a short time out of the body, and there is evidence enough to show that they can propagate the disease. The contagiousness of the fever, the tendency to recur which its name indicates, and the coincidence of living organisms pathognomonic of the disease, are clearly established. The number of the organisms increases with the increase of temperature, and seems to point out that the rise has something to do with the vegetable growth, somewhat after the course which

follows during the germination of ordinary seeds. The rapidity with which the multiplication goes on in a congenial soil; the fight which takes place between the natural order of things and the unnatural; the effort to throw out the foreign material, all have their significance and find their analogy in all the class of enthetic diseases, from plague and cholera at one end of the list, to a simple ague fit at the other.

Besides the four diseases I have mentioned, some observations have been made regarding the communicability of diphtheria. Cryptococci, or cacozymes, as I prefer to call them (to distinguish from the microzymes which are derived from healthy protoplasm), are found in the diseased tissue, and are said to spread the complaint. Diphtheria has been propagated by taking diphtheritic exudation from a case, and inoculating animals with it; a similar disease has then been set up. Similar processes could not be induced in the animal organism simply by putrescent or decomposing material. Dr. Sanderson does not consider that this has been satisfactorily proved, but others have thought the evidence fairly sufficient. It would be inexpedient, even if it were possible, to prove it conclusively. To inoculate a human being with matter from a diseased animal is an experiment which is not likely to be made, but the facts deposited by Dr. Oertel of Munich have their significance.

The certainty with which glands can be propagated from animals to human beings is well known, as also in the case of malignant pustule or "charbon". The alliance of the latter disease with carbuncle, and the connection which may be traced between it and diffuse cellular inflammation, erysipelas, and hospital gangrene, are also well known facts. Thus we have connecting links with numerous diseases which are infectious, and which are propagated by morbid matter from man to animal and from animal to man. But the operation is not limited to its effects upon animal life. Rust, smut, and their allies among fungi, bring occasional ruin upon agriculture. The *Peronospora infestans* is likely to remove the potato from our list of common foods. Another form of the same family, the *Botrytis bassiana*, is the terror of the silkworm grower. The salmon fisheries have been seriously damaged by the ravages of living vegetable organisms; whilst, at this present time, the vine grower is in intense alarm on account of the ravages of *Phylloxera vastatrix*. The aspect of the vegetable kingdom is sometimes changed by parasites. The potato blight has an ordinary fructification, which is aerial, and can only be produced under special circumstances. There must be an excess of carbonic acid in the atmosphere, something not very considerably above the four hundred parts in a million which naturally belong to it. There must also be an excess of moisture and an absence of sunlight. These adjuncts are required for the rapid production of the ordinary fructification of the peronospora. If a bright sun and a drying wind arise at the proper time, the loss of a particular crop may be averted. The ordinary fructification, and even the mycelium or root-matter, are evanescent; but it is not so with another form of fruit, which is found among the *débris* of the damaged crop, and sometimes in the rotting tuber. The resting spore continues to live; it is enclosed in a material capable of resisting the action of heat and cold, of sunshine and of rain, and has even germinated after being in boiling water for a short time. These spores probably exist in the soil, ready to spring up into activity whenever the necessary meteorological conditions arise, and continue long enough to allow of their germination. The genus *Peronospora* has a wide distribution, and it affects a large portion of the vegetable kingdom. How far it is possible for the protoplasm from which it springs to change its character—say, from *bassiana* to *infestans*, according as it attaches itself to the caterpillar or the potato-haulm—is one of those problems which some physiologists say to be contrary to nature, but which I consider to be within the range of probability. One thing is certain, that the same parasite can equally affect both classes of organic nature. It is thought by some that fungi only attach themselves to, and can only subsist upon, those plants which are weakened by some causes. This would only be following the rule which I believe to apply to human beings; but then the parasites themselves, by their irritating secretions, are able to induce a condition which allows them more play, and by producing debility enables them to take possession of their victim with greater rapidity. There is a second problem which requires solving; it is of great importance, viz., how far vegetable tissues which are diseased by fungous growth are capable of affecting the animals which feed upon them; and again, how far animals which have become affected with disease are able to spread that or some other form of disease, not only among their own species, but to other animals and to man himself, if he feed upon their diseased flesh.

I have mentioned the experiments which indicated the possibility of diphtheria being propagated from man to animals. Glands can arise in both classes. Vaccinia is a disease common to both. There seems to be no difference between small-pox and sheep-pox. The transmission of trichina from animal to man is undoubted, and the communication

of tapeworm is not uncommon. Cases of malignant pustule are obtained by infection from animal to man. There are several other diseases which arise either from contact, or as a sequence to the consumption of diseased meat or bread; and gangrene is not an uncommon result of the consumption of spurred rye in those districts upon the continent in which rye-bread is used. The secale or spur of ergot is a mass of fungous growth belonging to the class *Claviceps*, a genus of ascomycetous fungi. Its consumption is followed by a condition of the tissues which produces gangrene. There are some curious facts connected with the fructification of this plant; there is the production of a multitude of spermatia and so-called stylospores, which have active movement in air; they are motionless in water, but they soon germinate and emit filaments, and are ready for action in congenial soil.

We cannot look upon the diseases of organic nature with perfect complacency; we must not consider that they only affect our pockets, and not our health. Before English people can have that perfect health which is the birthright of every child born into the world, it will be necessary to alter our plans regarding the breeding of cattle, and the methods of housing and feeding them. Our domestic animals fall an easy prey to every kind of epidemic. For all sanitary law is, as a rule, ignored by the farmer. Knowing something of the customs of the country, I was not surprised when I heard an inspector from the Metropolitan meat market declare upon oath, in Croydon police-court, that 80 per cent. of the meat which was sent to the London market was the subject of tubercular disease, and that, to exclude it from the market, would leave London without a meat supply. The foul air in which animals are often kept, the foul water with which they are supplied, and the musty food which is given to them to eat, easily accounts for the readiness with which they fall victims to every kind of malady. The deaths among cows during the calving process is very great, and is one of the reasons why meat continues dear. Such deaths ought not to occur at all. We cannot remove disease from our midst, or reduce our death-rate much below 17 in the 1,000, until we can ensure a more healthy progeny among our domestic animals. To do this, something more is necessary than to insist upon measures for the prevention of disease among men.

I have mentioned the position that organisms producing relapsing fever occupy in the vegetable kingdom. The spirilla belongs to the class *Algae*. Professor Cohn has placed in the same class all the germs which give rise to epidemic diseases among men. It has been proved that bacteria are not the actual producers of these diseases; Cohn places them, however, in the same list, under the name of *microbacteria*, in a class by themselves. The micrococcus is grouped under the name of *sphaerobacteria*, and divided into three classes, viz.: 1. Those which give rise to colour like to that which causes "red snow"; 2. Those which cause a certain class of ferments; and 3. Those which produce pathological changes in the blood. I should alter this classification into micrococci and cacozymes—the harmless and the hurtful forms. I must, however, refer you to the list for the complete classification.

The peculiarities of fructification which belong to the Oscillatoriaceæ in which we have an evanescent and also a persistent form of germ, and with the evanescent an extraordinary power of motion, by means of which they are enabled to insinuate themselves deeply into living tissues (especially if those tissues are not normally healthy), is one of the wonders of their mission. Having found entrance within the portals of a living thing, they assert their individuality, and soon produce a new crop of similar material, provided there is pabulum suited to their requirements; this pabulum appears to be used up matter of different kinds. It may be that different forms of disease are produced from similar germs, according to the position the germ attains to, or the food it has to assimilate; just as the head of the tænia becomes by transposition a hydatid cyst in the human liver, or gives rise to the staggers when it affects the brain of the sheep. It may be also that there are forms of vegetation induced by transplantation which can only be produced in that way; just as the common mushroom spore cannot germinate unless it has come into contact with the excreta of some domestic animals, so it may be possible that some of our diseases can only arise by the introduction of a proper germ at a time when it can come into contact with some other agent which is as yet unsuspected of having anything to do with the process. The large class of gregarina which exist as parasites within the bodies of animals from the highest to the lowest forms, having vibratile cillia and capable of much active movement, multiplying with extreme rapidity, have functions which are not yet determined. It may be that these parasites are powers in the equation $x y z = \text{enthetic disease}$; some of them or their allies may be necessary to enable the particle z to increase and multiply, and may account for their fertility in one person who has been infected, whilst another escapes.

This is not a far-fetched and chimerical idea, for Professor Dodel

Port of Zürich points out that the fructification of the *polysiphonia subulata* (one of the red sea-weeds of our coasts) is completed through the agency of the beautiful little vorticella. A ciliated infusorium occupies the same position in the process that the bee occupies in the fructification of the willow catkin. But these are points which botany has not yet determined, and I must leave a very enticing subject for more important and more practical work.

I will now go on to what I call the canons of sanitary work. The basis upon which preventive medicine stands as a science is that of the *particulate nature of contagia*. It is the first canon law. We know that zymotic disease will not arise if the particle z is kept out of the process. Again, z cannot increase and multiply unless the material which has been used up in supporting the functions of the higher forms of life be also present. There are, therefore, two manifest duties for the sanitary authority to perform; first, to remove the pabulum y , upon which z is able to increase and multiply, from its neighbourhood to man; and also, so to alter its character that it is no longer able to nourish z if the particle should be imported; second, to prevent the importation of z , or if it be in our midst, so to alter its nature that it cannot fructify. These duties can be performed if the laws which regulate the introduction and the growth of z are well understood and counteracting agents regularly employed. There are two forms of germ, the evanescent and the persistent. Measures which may be successful against the former and may limit the spread of a present epidemic, will not necessarily prevent its recurrence in the future at the same place unless both kinds of germ are considered.

There are several ways by means of which the natural order *schizosporæ* may make itself felt, viz., by the air, the water, the earth, or the food. The contamination of the air in the neighbourhood of our dwelling-houses both above and below the level of the ground must be counteracted. This contamination is effected in two ways: 1. By the ordinary processes of decay which are always going on in organic nature; and 2. By the aggregation of living creatures. Both give rise to excess of carbonic dioxide; without the latter, it is probable that fungi could not flourish, but it is animated nature which introduces myriads of the germs of debased protoplasm which is food for z to flourish in.

The higher the animal life is in the scale of creation, the more injurious is the excreta of such animals, and that of man most of all.

The remedy for these evils is *ventilation*; anything which impedes it is contrary to sanitary law. *Motion* is the second most important fact, and is the *second law* of sanitary work. Currents of air must be established to lessen the quantity of carbonic dioxide to something less than four hundred and fifty parts in a million; and by introducing a fresh supply of oxygen, the albuminoid matters which living creatures give out may be altered in their chemical characters, and by that means they will no longer give renewed life to z . Motion of both air and water is a principal law of sanitary work. Air in motion is soon deprived of those organic matters which allow the growth of z , and the latter, as well as the food upon which it feeds, being very evanescent in its character, are soon changed into innocuous and even into useful material. This was very forcibly impressed upon my notice in the year 1854, when I ventilated the soil-pipe of my own house by extending it upwards between the sewer and the trap; my successor in that house took away the soil-pipe, and in a few weeks a death from typhoid fever occurred in that house. Stagnant air in the house-drains of this town produced more or less evil in almost every house in the place, until our local senators were convinced of the evil. It was in Croydon that the law for ventilating sewers was first put into operation by a local authority. But the local authority were then in advance of the intelligence of the people; and, although the command was issued, the work was not generally done until much more proof of its necessity was afforded. Now, the ventilation of the sewer and of the house-drain is required by the law of the land, but it is not nearly so general as it should be. Those openings into sewers, were at first called stink-pipes, and were sometimes taken away because they gave evidence that the law of motion was not complied with. The foul smell which came out, showed that the sewer was a sewer of deposit, that it contained stagnant sewage; and the neighbour, like the ostrich of the desert, who when danger threatens hides its head, takes away the safety-valve and tries to smother up the evidence which the stink-pipe gives out, and sends it into somebody's house, instead of insisting upon the removal of the foul sewage from the sewer. No smell will ever arise from a properly constructed sewer, and if there be such smell, it is conclusive proof that there is deposit either in that sewer or in some other in close communication with it, or in the soil around it. No stagnation, either of air or of sewage, should be possible in any sewer.

Assuming that sewers are necessities in a thickly peopled neighbourhood, they must not be allowed to ventilate into houses; and now a

third law comes into operation, viz., that it shall not be possible for air to pass directly from a sewer into any house until it has been diluted by pure air and has had time to have its albuminoid matters oxidised. *There must not be any communication directly between the sewer and the interior of the house.*

There is no occasion for any departure from this law, and it should never be allowed in practice.

There is another danger which arises from sewers if they are not constructed of impervious materials; brick sewers are open to great objection when they pass through pervious soil in close proximity to houses. Unless they are very freely and efficiently ventilated, they contaminate the air of the subsoil of a town until it becomes a perfect hotbed of mischief. This is a frequent cause for the continuance of enthetic disease in districts in which the water-line rises and falls at distinct intervals. The way in which gases travel long distances underground is sometimes shown by the distance which coal-gas travels when a fracture has taken place in a gas main. Sewer-gases, which only form in badly constructed sewers, are just as penetrating. The products of decomposition find their way through the bricks into the soil, and then into the foundations of the houses. There are some houses in this town which are built over sewers, and which must sooner or later be dangerous to the occupants. The builders of such houses ought to be compelled to notify the fact to every incoming tenant. Ventilation should be provided in every case in which a trap has been fixed, otherwise stagnation must arise. This is another fundamental law.

The next law is that sewage must be utilised. It must be conveyed as soon as it is formed away from the neighbourhood of human beings. *z* is found to flourish most luxuriantly in sewage which is about to undergo putrefaction, but in which putrefaction is not actually established.

The safety, as far as it is safe, of the old-fashioned cesspool out of doors arises from the fact that putrefaction is rapidly set up, and with it all danger from the multiplication of *z* it removed. This is also seen in the dissecting-room, or at *post mortem* examinations. There is much danger from dissection-wounds for a few days after a death; but if a student cuts his finger whilst dissecting a body in which putrefaction is advancing there may be an ugly sore, but there will not be a poisoned wound. In the cesspool, *z* may be indefinitely multiplied before putrefaction is established, and germs of mischief may find their way out of cesspools into wells and water-courses, and may do much mischief. No sanitary authority ought on any pretence to allow a cesspool to exist within its jurisdiction.

If there be no sewers, and I contend that they are not necessities in a thinly peopled district, excreta should be reserved in some utensil in contact with earth or some other deodoriser able to arrest the changes which otherwise must take place, and before the power of change can reassert itself the material should be taken away and utilised in the ground. The pail system is far safer and far more economical for a village population than a system of sewers, and it is a serious blunder to introduce into small places the works which thickly peopled cities require; but then the work of collection must be controlled by an efficient local authority. Sewage which has been removed from the town by water-carriage must be applied at once to the land by means of surface-irrigation. This subject has been repeatedly mooted at congresses, and by inquiries made by Royal Commissioners and Committees of both Houses of Parliament, and the general conclusion which has always been arrived at by unbiassed witnesses has been similar to that which was agreed to at the first sanitary congress ever held in this kingdom. In October 1866, the Leamington Sewage Congress, after a long discussion in a large assembly of scientific and practical men, agreed to the following resolution: "That the system of irrigation, when carried out in a scientific manner, removes the difficulty which now arises from the present noxious plan of polluting the rivers of England." A rider was added, which caused it to be unanimously accepted, viz.: "But that there are circumstances in which other systems may be applicable." Thirteen years have passed away since that time, and I am still more convinced than ever of the truth of the following conclusions.

1. Sewers are necessities for crowded populations.
2. Having sewers, they are silent highways along which human excreta may be safely and efficiently removed by water-carriage.
3. Sewer-gases and smells from decomposing sewage are not necessities of the system.
4. If sewage be judiciously applied to land, the spread of enthetic disease by its means becomes an impossibility.
5. After a proper application by surface-irrigation, the effluent water may be safely discharged into the nearest water-course.
6. The application of sewage to land must be conducted on scientific

principles; otherwise failure, first financially, and then by producing nuisance, will arise.

7. A local board is the worst possible body to have the management of a sewage-farm. The management requires an intimate acquaintance with several sciences, with agriculture, with sale and barter, and an immediate personal command of capital: without these powers it cannot become a financial success. The manager of a sewage-farm must be an autocrat and not be liable to those attacks which are certain to be the lot of active members in a popularly elected local board. The Croydon Local Board, with the best intentions, will have to reap the harvest which is sure to follow from the farm having too many masters; and the ratepayers of the parish who did not know when they were well off, and who are primarily responsible, will have to pay the ultimate cost.

The eighth conclusion at which I have arrived, is that a local authority, in providing for the utilisation of sewage by irrigation, must be prepared to pay the difference in value between the price of the land and its ordinary agricultural worth. One penny in the pound on each rate, or at the most threepence for the year, ought to be amply sufficient for this purpose, as well as for the payment of interest on money sunk in unexhausted improvements. The Beddington farm, which has now been in operation more or less for twenty years, costs more than this; but if the farm had to be formed now, the experience which has been gained (if it were available, and if members of a local board could condescend to think that anybody else knew what was wanted better than themselves), would enable the board to carry out the work at a much less cost. I say if that experience were available; but, unfortunately, local self-government tends to scatter experience to the winds. Those works, upon which considerable sums of money have been sunk in as yet unexhausted improvements, are not followed up, because present managers do not know anything about them.

The ninth conclusion to which I have come is, that although sewage should be conveyed to the soil as rapidly as possible, *rainfall* should go to *river*. It is a wrong thing to conduct rainfall into sewers, as by this means a sewage-farm is swamped with unnecessary water. Not that storm-water from the streets of London should be sent into the Thames, or the washings of thickly peopled cities at once into the water way, but ordinary surface-water should be strictly excluded, and when possible, the rain-water from house-roofs should go the water-courses. This is a good reason for excluding sewers from thinly peopled districts; ordinary sewers will only drain the subsoil, empty the water courses, and dry up the smaller sources of our rivers, and produce as much evil in the subsoil as cesspools now do. They are serious blunders too often perpetrated for the personal benefit of private individuals.

The sixth great law of sanitary work is for sewer and water services to be decidedly separated, so that no interchange of either liquid or gases should be possible. It was shown not long since, that just where a water-pipe passed over a sewer, there the pipe was defective, and as a consequence a serious epidemic arose. Sewage soon decomposes iron; and if water-pipes be allowed to lie in sewers, and to occupy portions of cesspits on the roadside, or to be in communication at those points at which water is delivered into a house and slops and sewage removed, there can be no real safety for the people. I am sometimes astounded when I hear men who put themselves forward as sanitary authorities utterly ignore this fundamental law.

The seventh law is that the *individual house* is the unit of sanitary work, that it is in each house, and it is with each individual that the first action must be taken to diminish the power of *z* to grow and produce its kind, whilst should *z* be introduced, it is the *individual case* which is the unit of repression. But all these canon laws have their foundation upon the particulate nature of contagia, and it is by bearing this one fact in mind that sanitary work can produce sufficient fruit to be successful.

VACCINATION.—Dr. Williams, of Mold, North Wales, has received a first class Government grant of £40:6 for efficient and successful vaccination in his district (third time).

HOSPITAL SUNDAY IN BIRMINGHAM.—The subcommittee appointed to consider and determine upon the division among the various charities of this year's Hospital Sunday collections at Birmingham have decided to make the following apportionments: General Dispensary, Children's Hospital, and Eye Hospital, 45 per cent.; Women's Hospital, Homœopathic Hospital, Orthopædic Hospital, Institution for the Blind, Deaf and Dumb Institution, and Sanatorium, 46 per cent.; Lying-in Charity, 5 per cent.; and Dental Hospital, 4 per cent. The collections which will be made next Sunday are this year for what is known as the amalgamated charities, which come in turn with the separate annual collection for the General and Queen's Hospitals.