THE MILROY LECTURES

ON THE

EARTH IN RELATION TO THE PRESERVATION
AND DESTRUCTION OF CONTAGIA.*Delivered at the Royal College of Physicians of London*

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EARTH.

MR. PRESIDENT AND GENTLEMEN,—That which we commonly speak of as “earth” is largely composed of excreta and the dead remains of animals and vegetables which, as the result of fresh biological processes, are either returned to the bodies of living vegetable organisms, or, after becoming mineralised and soluble, are washed downwards by the rain and ultimately find an exit in the sea. It is obvious that not only does “earth” vary in composition with the varying conditions of subsoil, climate, flora and fauna, but that “earth” must undergo seasonal variations necessitated by the vigorous up-growth in the spring or the decay of the fall—the heat and drought of summer or the flood and frost of winter. The interstices between the particles of “earth” are filled at one time with air, at another time with water, and the line of demarcation between earth and air on the one hand, and earth and water on the other, is often not very definite. Again, the dust which is suspended in the air and which settles on everything is liable to contain infective particles, harmless to breathe but dangerous if they fall upon a wound. It is obvious that such particles may be regarded as belonging to the earth or the air. Some of them doubtless emanate from the earth, having been raised as dust; but we must admit that there may be organisms which grow in the air, live in the air, and die in the air without ever touching earth or water and which elude all attempts at identification or artificial cultivation. While there are organisms which may live equally well in air or water others are probably more exclusive in their obligatory conditions. The mutual interaction of earth, air, and water must never be lost sight of. It is the life in the earth, both vegetable and animal, which helps, by its influence on vegetation, to maintain the quality of the atmosphere. Again, it is the earth which gives the quality to spring and river water. Pure water is a body of definite chemical composition and pure air is a tolerably definite mixture of gases, and it is not difficult to approximately measure the degree of pollution of either. The chemical composition of earth, however, is complex and constantly changing, so that it is not possible for the chemist to fix any standard of quality. The practical agriculturist by the aid of touch, smell, and vision will say at once whether any given sample of earth is foul or pure, sour or sweet, rich or poor, fertile or sterile, and we must perforce content ourselves with the terms used by the practical man. The word “earth” in the ensuing lectures will usually be regarded as meaning humus in a healthy condition.

There are certain organisms which are constantly found in the earth, and which appear to be ubiquitous. They adhere to our skins and clothing, get under the nails, and lodge in the hair. They produce various disorders of wounds and diseases in wounded persons, and we now recognise that in the absence of those precautions which we call “antiseptic” it is never safe to inflict even the smallest wound. The organisms which produce the various wound infections are saprophytes which flourish external to the body. They are ubiquitous and (probably) necessary, and so long as we have a whole skin and uninjured mucous membrane they do us no harm. As all organic matter is constantly circulating, passing through death to other forms of life, and necessarily undergoing humification in the process, it follows that the agents of these changes, the microbes which are to this end hatched in the soil vary with the circumstances. Dr. Houston¹ gives the estimated number of microbes per gram found in twenty-one samples of soil. These vary from 8,326 in a virgin sand and 475,282 in a virgin peat, to 115,044,492 in the soil from the trench of a sewage farm. Broadly speaking, the microbes

bear a direct proportion to the amount of dung. Warington estimated that a gram of dung from a cow fed on hay contained 165,000,000. They all presumably have their optimum conditions—chemical and physical qualities of the nutritive medium, access of air or other gases, lightness or darkness and temperature—and when the optimum conditions concur, growth and multiplication go forward at a pace which we can hardly appreciate. The fact that for the growth of some the access of air is necessary, while others obtain their oxygen from the medium in which they grow, and others again are able to take in oxygen from either source, has formed the basis of a classification which has assisted our understanding.

Saprophytes, including those which produce wound infection, are presumably of service in bringing about the decomposition of complex organic bodies. Whether we are able to check the growth and multiplication of these facultative parasites outside the body is doubtful, and whether or not we should be gainers by so doing, is still more doubtful. Bacteriologists have experienced no little difficulty in discovering the exact conditions which are necessary for the growth and development of many of the micro-organisms which have been studied. Some organisms are more exacting than others, and those which are best able to accommodate themselves to varying circumstances naturally obtain the mastery when several are attempting to grow simultaneously in the same medium. Some of the larger saprophytes, such, for instance, as the common mushroom, require no little skill for their artificial production, involving far more attention to exact details than is necessary with ordinary green-leaved garden plants. We know that for a few weeks in the autumn they may appear in great numbers in dry pastures where horses have been fed, provided the conditions of the air as to temperature, light, and moisture be favourable, and we also know that directly the necessary conditions fail, the mushroom harvest is at an end. We also know how strange is the predilection of certain fungi for the dung of particular animals, and I would allude to a list furnished to me by Mr. George Murray, F.R.S., which shows that the optimum conditions for the growth and development of these short-lived and delicate organisms must be marvellously subtle, probably quite beyond the ken of the chemist.

I will now proceed to deal *seriatim* with some of the contagia which are best understood, and will begin with

TETANUS.

Among the organisms which are habitually found in earth is the bacillus of tetanus. It is said to be present in almost all rich garden soils, and that the presence of horse-dung favours its occurrence. It is strictly anaërobic, and has been artificially cultivated by Kitasato in an atmosphere of hydrogen. It forms spores, and grows best at a blood heat. Marchesi has found it at a depth of 2 metres, but no lower. The pure cultivation of the bacillus, which has a disagreeable aromatic odour, is often not very virulent. It is fatal to animals as well as man, and among animals the horse appears to be most liable to be attacked. Infection always takes place by inoculation through the wounded skin² or mucous membrane—never, it is believed, through the healthy alimentary or respiratory tracts. Cases of “idiopathic” tetanus are reported, but it has fallen to the lot of few of us to see a case, and professional opinion seems to lean to the idea that in such cases the inoculated wound has been overlooked. The toxin which the bacillus brews locally in the wound is toxic to the central nervous system, and the antitoxin to be effectual must, it is said, be injected subdurally into the central nervous system. The exhaustion of the nervous system seems to increase its vulnerability, which is, perhaps, the reason why tetanus has been relatively common in the domain of military surgery. There seems to be no doubt as to the ubiquity of the tetanus spore. Every child who falls on the ground and gets an abrasion of the skin, all tillers of the soil who get accidental wounds in the course of duty, and every horse which “breaks its knees” by falling in the London streets, runs a risk of inoculation with tetanus. I have made inquiry of many practitioners in the Thames valley where market gardening is the chief industry, and where countless tons of London horsedung are spread upon the land, and learn from them that tetanus is, in their

experience, the rarest of diseases. Seeing that the bacillus is so strictly anaërobic, one is justified in supposing that the tillage of the soil, which brings it in contact with the air and sunshine, must be unfavourable to its growth and virulence. The bacilli must die out under such conditions, and the inoculation of the spores alone is said by Vailliant, Rouget, and Vincent to be incapable of setting up tetanus. If the bacillus or the spore be carried in dust, or if either be washed into the water and drunk, we have no evidence that any harm results therefrom. In common with other microbial diseases, tetanus is more virulent in the tropics than in temperate climates. Friedberger and Frohner state that it is so common among horses in St. Domingo, especially after the operation of castration, that geldings are worth twice as much as stallions.

In an article by Mr. Sidney Villar in the *Journal of Comparative Pathology and Therapeutics* for December, 1897, an observation by Mr. Joseph Woodger is quoted to the effect that tetanus is particularly common among horses used in dust-carts, and Mr. Villar continues: "In my own practice in Middlesex there are two farms where the disease is specially prevalent. One of these, at Alfreton, is occupied by a farmer who habitually spreads on his fields large quantities of London refuse; at the second farm, five miles away, the bailiff brought two large loads of the sweepings of London roads in 1893 and dressed his home meadows with it. On these meadows his colts and young stock were pastured, and for two and a half years tetanus was endemic on his farm; during this period six colts became affected, and I believe only one entirely escaped the disease."

This experience of Mr. Villar seems to point to the danger of placing upon grazing land material which is probably mixed with broken glass or crockery.

In connection with Marchesi's observation that the tetanus organism has not been found at a greater depth than two metres, I would allude to a fact, to which I shall return later, that this approaches the maximum depth to which the earthworm burrows. It is obvious that if a spore were carried downwards by a worm it would meet with anaërobic conditions favourable for its preservation. It is remarkable that in face of the ubiquity of the cause, the disease in man should be so rare. This is probably in part due to the fact that we wear boots.

ANTHRAX.

Anthrax is a disease which is undoubtedly connected with the soil. The bacillus was discovered by Pollender in 1849, a discovery which is just fifty years old, and marks the dawn of pathological bacteriology. The identification of the bacillus in the laboratory and the diagnosis of the disease in animals from quarter evil and septicæmia is not without difficulty, and are sufficient to throw a shade of doubt over some of the earlier observations, but the discovery of bacilli anthracis in the blood clinches the diagnosis. It was in 1850 that Rayer and Davaine described the bacilli, and in 1877 Pasteur communicated to the Academy of Sciences the important fact of sporulation observed in these bacilli by Koch and himself, and, further, pointed out that the bacillus anthracis was essentially aerobic, and was quickly destroyed in the blood of the dead animal after the onset of putrefaction.

In August, 1878, M. Pasteur fed sheep on lucerne previously watered with a pure cultivation of bacillus anthracis, and found that "in spite of the immense number of spores taken in with the food many of the sheep escaped death." The mortality was much increased when the infected food was mixed with prickly material such as the leaves of thistles and the chopped heads of barley, and the *post-mortem* examination of sheep rendered *charbonneuses* by fodder of this kind gave reason to suspect that they were really "inoculated" through injury by the prickly food at the back of the throat.

It is recognised by professional "knackers" that they run little risk of contracting "charbon" by manipulating dead animals far advanced in putrefaction, and both Pasteur and Koch have shown that putrefaction soon destroys the bacilli in the blood and tissues of an animal, and that being aerobic sporulation does not take place inside the putrefying body, but is very liable to occur in the blood which escapes from it whether upon the earth or a dung heap.

In August, 1878, Pasteur made a necropsy on the body of a sheep and then buried the carcass. Ten months and fourteen months afterwards Pasteur found spores of anthrax in the earth of this animal's grave, and established the fact by the inoculation of guinea-pigs. The spores were found in the surface soil over the grave, although since the burial the ground had not been moved. Similarly spores were found in the soil over the grave of a cow buried two years previously, and at a depth of 2 metres. These spores were found over the graves of dead animals after all the operations of cultivation and harvest. Earth taken at a distance from these graves did not give charbon.

He attributes the uprising of spores to the action of earth worms, and claims to have actually recovered spores from the bodies of earth worms living in soil polluted with anthrax. In a footnote Pasteur calls attention to the fact that in Cantal

there are pastures which from time immemorial have escaped (*sont épargnés*) and others in which from time to time the cattle were decimated, which are known as "*montagnes dangereuses*," and are abandoned for several years at least. "But the cause, whatever it may be, which produces charbon in a locality disappears with time." In Beauce Pasteur saw certain fields in which the folding of sheep had been interdicted for several years—that is, since the last death thereupon from charbon. "Now we placed flocks of sheep on five of these fields, and the mortality was *nil* except in one flock where it amounted to 1 per cent."

M. Colin de Alfort, a professor at the Veterinary School, controverted some of Pasteur's experiments; a further report therefore was made on May 17th, 1881, by a commission composed of M. Bouley, M. Davaine, M. Alphonse Guérin, and M. Villemin. Earth from a twelve-year grave, a three-year grave, and from virgin soil was kept at a temperature of 90° C. for fifteen minutes, and the fine sediment injected into guinea-pigs. Of 5 guinea-pigs inoculated with twelve-year earth on March 19th, 4 died on March 21st and 22nd from septicæmia and 1 died on March 23rd from charbon. Of 5 guinea-pigs inoculated with three-year earth on March 19th, 4 died from March 21st to 23rd from septicæmia and 1 died on March 23rd from charbon. Of 5 guinea-pigs inoculated with virgin soil on March 13th none died. One had a small abscess at the seat of puncture. Of 6 guinea-pigs inoculated with twelve-year and three-year earth on March 30th, 5 died from septicæmia on April 3rd and 1 died from charbon (twelve-year earth) on April 3rd. Of 3 guinea-pigs inoculated with excreta taken from the bodies of living earth worms, 2 died from septicæmia and 1 from charbon on March 30th. Of the 19 animals killed by the above experiments, 15 died from septicæmia and 4 from charbon.

Since 1879 M. Pasteur had asserted that most soils when inoculated were capable of causing death from septicæmia quite apart from any contamination by the death of anthrax animals. Of three guinea-pigs inoculated on March 28th with worm castings taken from above the graves of some of the victims of the Commune, situated on waste land, one died from septicæmia on April 1st and two were unharmed.

Pasteur had clearly demonstrated that the anthrax bacillus is essentially aerobic, that it is soon destroyed by putrefaction, and that for sporulation free exposure to air and a temperature above 15° C. are necessary. These facts seem out of harmony with the view that earthworms bring spores from a deeply buried carcass to the surface, while the skinning and transportation of an animal dead from anthrax must necessarily be a most dangerous process.

All are agreed that anthrax is a disease liable to haunt localities.

It is alleged by Friedberger and Frohner that the spores may vegetate in the soil and surface water quite independently of the animal body. The disease is said to occur among horses, cattle, and buffaloes in Eastern Bengal, Manipur, and Burmah without the agency of infection and to be in that part of the world a truly miasmatic disease. As spore formation requires something like a blood heat, it is only what might be expected to find the disease becoming endemic among cattle and horses in tropical countries. Where infected animals drop dung and other discharges on the soil it becomes impossible to say whether the infective spore originates in the soil or in the animal. These authors assert that "there exists a well-marked connection between the disease and the amount of moisture in the soil. It appears most frequently in lowlands and plains exposed to inundations and great heat." Copeman also asserts that the disease is prevalent on damp soils containing much humus, as, for instance, upon peat bogs and near the borders of lakes and rivers which have overflowed. On the other hand, we have Pasteur speaking of "*montagnes maudites*" in connection with anthrax, and asserting that the mortality is great in soils which are *secs et calcaires*.

Many of the outbreaks of anthrax in this country have been in the neighbourhood of Bradford, and have been traced to the use of infected wool refuse as manure. A map published by the Board of Agriculture shows that the outbreaks of anthrax are most frequent in those counties of Great Britain where dry foreign wools, hairs, hides, and skins are manufactured into goods. It is the anthrax spore which is

the danger, and if, as is the case, a high temperature and free admission of air be necessary for sporulation, an excess of water would be unfavourable for that process. There seems a concurrence of opinion that the bacillus anthracis is killed by putrefaction and soon disappears in the unopened and unskinned body. The advice which is usually given in this country to bury anthrax carcasses deeply and unopened and unskinned is doubtless sound, although it is doubtful if the depth of the grave adds materially to the anaërobism of the surroundings. It is very doubtful if in an unopened body spore formation be possible after a short period of burial. It is clear that the animal should be buried at the spot where it dies, and that the spot should be enclosed and planted with a few saplings of some indigenous tree. The value of "quicklime" is doubtful.

All Pasteur's experiments in relation to graves appear to me to be vitiated by the fact that they took place in an anthrax district, and it is very difficult to say whether the spores were derived from the buried animals or from the dung of infected ones which had been used as manure, or from the blood-stained wool which, we are told, is of "bad omen" in a flock. It is a noteworthy fact that of the 19 guinea-pigs inoculated by the Alfort Commission 4 only died from anthrax and 15 from septicæmia, and that the earth from the three-year-old grave and from the twelve-year-old grave conveyed anthrax in the same proportion, that is, 1 in four inoculations. There seems no doubt that spores may be found in earthworms or their castings, and there is equally no doubt that if the worms have brought the spores from the depths of the earth, such spores must have originally been formed on the surface. It is, of course, quite impossible to say whether a worm swallowed the spore on the surface or below it, and it is certain that recently dead bodies have no attractions for worms.

There are some discrepancies amongst observers as to the infectivity of food grown on anthrax ground. On the one hand, Pasteur was unable to do much harm to sheep by feeding them on lucerne sprinkled with spores, and, on the other hand, we have a story quoted by Pasteur of an old woman whose goat and cow died from anthrax when fed with clover stolen from over a grave two years after the burial of an anthrax animal.

Anthrax in the human subject is a rare disease. Man is never infected through the alimentary tract, as appears to be the rule among animals. Cutaneous anthrax (malignant pustule) is caused by direct inoculation.

Pulmonary anthrax, or woolsorter's disease, was first noticed in the Bradford worsted district after the introduction of alpaca and mohair as textile materials in 1837. It appears to be generally accepted that "this form of anthrax may attack any person exposed to the inhalation of anthrax spores in dust arising from the products of diseased animals." And yet I have hitherto found no records of pulmonary anthrax from the inhalation of dust from highly manured ground which must, one would suppose, especially in the West Riding of Yorkshire, often contain anthrax spores. The lungs of the agricultural labourer and the market gardener appear to be immune to the infectivity of anthrax spores. It seems to be of very great importance to bear in mind: (1) that anthrax spores persist even in the finely pulverised soil of worm castings, which must be very easily dried and converted into dust; (2) that anthrax may undoubtedly infect man by the inhalation of dust; and (3) that pulmonary anthrax among agriculturists has not been recorded. The persistence of the anthrax spore in the earth does not admit of a doubt, but there is no evidence that man is ever infected directly from the earth. How far anthrax in animals is due to inoculation rather than to feeding requires further and very careful investigation.

DIARRHŒA.

Diarrhœa is a disease which in its epidemic form has been supposed to be engendered in the earth.

The third quarter of the year 1898² was characterised by a very large infantile mortality, mainly attributable to diarrhœa. The rainfall for the quarter was unprecedentedly small, the temperature was above the average, and the harvest was one of the best on record.

Excluding the towns, infant mortality in the remainder of England and Wales was in the proportion of 184 to 1,000 births. Diarrhœa caused 22,524 deaths, equal to an annual

rate of 2.85 per 1,000, or 1.21 above the average rate of mortality in the third quarters of the previous ten years.

The mortality from diarrhœa was, however, mainly urban; the rates averaged 3.85 per 1,000 in the thirty-three great towns. Among counties it is the rural which have least and the industrial which have most diarrhœa; and if we turn to the mortality returns for those counties where diarrhœa was especially rife, we shall find the mortality greatest in the urban districts. It is a point not without interest to note that the diarrhœa death-rate and the fever death-rate in this quarter bore no relation to each other, and that, while the diarrhœal death-rate was 1.21 above, the fever death-rate was 0.03 below the average for the corresponding quarter of the last ten years. In the following table some figures are collected which show this very strikingly.

Table showing the Death-rates per 1,000 from Fever and Diarrhœa during the Third Quarter of 1898.

	Fever.	Diarrhœa.
England and Wales	0.16	2.85
London	0.11	3.19
Wolverhampton	0.18	6.38
Leicester	0.13	5.34
Manchester	0.09	5.38
Preston	0.28	6.41

Diarrhœa is a disease of hot weather. Ballard thought that when the 4-feet temperature of the earth reaches 56° F. diarrhœa becomes common. Tomkins of Leicester (Leicester is a "diarrhœa town") shows that the disease becomes common when the 1-foot thermometer stands at 60°. Snow of Buffalo, U.S.A., showed that in 1886-88 diarrhœa mortality was highest when the minimum atmospheric temperature attained its highest average range. The London statistics for 1887 and 1888 collected by Dawson Williams show a similar relationship between diarrhœa and a high average minimum range of temperature. Copeman considers it highly probable that the disease is due to "microphytic processes" going on in the upper layers of the soil. "This would afford an explanation of the fact that summer diarrhœa is especially a disease of cities having a polluted soil."

The bacillus enteritidis sporogenes is believed by Klein to be the cause of infantile diarrhœa.³ It is an anaërobic bacillus which forms spores and may be easily cultivated in milk. It is fatal to rodents when injected hypodermically and produces a foul-smelling bloody oedema of the cellular tissue and adjacent muscle tissue. The spores were found in 4 out of 10 cases of infantile diarrhœa examined and in 6 out of 8 cases of "cholera nostras." It was found in 8 out of 10 samples of milk purchased in London milk shops between April and the end of June (when diarrhœa was not epidemic?) including samples of so-called "pure sterilised milk." It has been found in large quantities in sewage and in sewage effluents. It is found in horse dung and in all matters polluted with it. It has not been found in pig dung or cow dung or in the dung of a healthy human being.

In face of the wide distribution of the microbe it is evident that the vulnerability of the individual must be an important factor in determining an attack of diarrhœa. If we are to consider diarrhœa as a soil disease it is evident that its cause exists only in the upper layers. It is more common among city streets than in agricultural districts. According to Klein the probable cause is largely to be found in horse dung which is pulverised and blown about generally. That it is a "soil" disease in any true sense is certainly not proven.

[The lecturer at this point discussed dysentery, cholera, and Malta fever as soil disease, and then proceeded as follows:]

PLAGUE.

Plague has been regarded as a soil disease, but recent evidence must materially modify this opinion. Experiments carried out in districts where a disease is epidemic or endemic necessarily acquire a measure of certainty from that fact alone. The unfortunate accident which occurred last year in Vienna, much as one may deplore it, was an object-lesson of the greatest value and converted what many regarded as mere theories into facts which all can read and understand. In the recent epidemics in the East the theory that plague grows "in the soil" has received no support whatever.

In India the two facts which have come to the front are the danger in relation to plague of (a) rats, and (b) abrasions on the skin; and it may be said that the following are the most important items in the spread of plague:

1. Filthy habits of the people, such as spitting over the floor and others mentioned above.
2. Filthy houses.
3. Overcrowding, and consequent rapid increase of contagious disease when once imported.
4. Presence of rats, insects, and other vermin.
5. The naked condition of the people going about, such people presenting almost unlimited opportunities for the entrance into their tissues of plague poison by inoculation and through abrasions.
6. Pollution of soil and houses with the excretions of man and animals.
7. Filthy clothing and absence of bodily hygiene.

DIPHTHERIA.

Dr. Arthur Newsholme in his work on *Epidemic Diphtheria* (1898) while admitting that personal infection is the chief means by which diphtheria is spread, contends that

The specific micro-organism of this disease has a double cycle of existence, as have the specific micro-organisms of enteric fever, crysipelas, scarlet fever, rheumatic fever, etc. One phase is passed in the soil, another in the human organism. One is saprophytic, the other parasitic.¹ It is not strange, therefore, that the epidemic prevalence of all the above diseases is favoured by deficient rainfall if this is sufficiently long continued. This deficient rainfall implies a low subsoil water and a subsoil above the level of this water which is relatively dry and warm, probably the optimum conditions of the saprophytic life of the above pathogenic micro-organisms. The causes of the transition of the diphtheria bacillus from the saprophytic to the parasitic phase of life may be surmised both as regards (a) season and (b) years of special epidemic prevalence. Diphtheria is most prevalent in the autumn and early winter months, when the optimum temperature and the optimum degree of humidity of the soil are rapidly disappearing or have departed. It is also most prevalent after the wet weather occurring in or immediately following exceptionally dry years. Both these conditions tend to raise the ground water and to drive out any pathogenic micro-organisms from the soil.

Dr. Newsholme is of opinion that in order to account for the epidemic and even pandemic waves of diphtheria, "the diphtheria bacillus under certain conditions becomes more actively virulent and infective, more remote from its saprophytic phase of life, and that thus persons who can resist the ingress of the feebler fall victims to the more powerful micro-organism." The latter is, probably the correct hypothesis, and the evidence already given clearly points to the conclusion that of the external cultural conditions leading to increased virulence of the diphtheria bacillus, and greater readiness for assuming a parasitic life, exceptional deficiency of rainfall, and consequent exceptional deficiency of moisture in and exceptional warmth of the subsoil form an essential part.

The above is a very ingenious hypothesis, but it is essential to point out that the diphtheria bacillus has not been recovered from the soil, and that the bacilli of rheumatic fever and scarlet fever have not yet been identified. Before Dr. Newsholme's hypothesis can be accepted a great deal more evidence will be necessary.

Dr. Newsholme's figures generally seem to show that diphtheria is now a disease more of the towns than of the rural districts. It is not very easy to understand how, in a city where pavements and other impermeable coverings to the soil are general, the bacillus is driven by the rising subsoil water into the air. Of course, it may be driven out of the sewers and sewer ventilators, in which case it becomes a sewer disease rather than a soil disease. Most of the facts collected by Dr. Newsholme are explained as readily, if not more readily, on the theory that diphtheria is an air disease as upon the theory that it is a soil disease. That diphtheria is a soil disease is certainly not proven.

MALARIA.

A few years ago I should have spoken of "malaria" as undoubtedly caused by something in the soil itself, but the discovery of hæmatozoa in the blood of sufferers from malaria has altered our point of view. The most widely spread poison in the world has become something which is visible and tangible and inoculable. No discovery which has ever been made in the domain of medicine is likely to have such far-reaching effects. Further, it seems certain that the infection of human beings may take place *via* the mosquito, and we are now concerned to find out whether this is or is not the only medium through which the blood of man receives the parasite. Some who are well qualified to speak would answer in one way and some in another.

If, however, on the one hand, we are able to show Europeans the importance of protecting themselves against the attacks of insects, we must, on the other, continue to make use of our accumulated knowledge as to the conditions of soil which in-

directly cause remittent fevers to be endemic. The conditions of soil which give rise to malaria are too well known to need any lengthy discussion here, but airborne infection or waterborne infection cannot be lightly dismissed.

It is generally conceded that the turning up of virgin soil is one of the most fruitful causes of malignant malarial fevers, and under this heading is included blackwater fever, which has recently become so common. Surgeon Bowden, R.N., D.S.O., informs me that the turning up of fresh soil is often followed by an influx of mosquitos. On the other hand, the cultivation of the soil seems ultimately to lead to the decrease and disappearance of malaria.

After referring to a group which (like malaria) seems to be dependent upon the bites or stings of insects which, affecting animals rather than man, yet throw much light upon the pathology of infection, a group including ngana or tsetse fly disease, the "louping ill," a disease which is common in the North of England and Scotland which has been noticed to be fatal to sheep frequenting certain pastures; Texas fever of cattle, and the South African horse disease, the lecturer concluded as follows: There are other diseases more or less suspected of being soil diseases, but the facts are at present too few to make any discussion of them profitable. These are yellow fever, beri-beri, swine fever (undoubtedly propagated by fouling of the surface soil), cancer (?), thread worms, hydatids, and ankylostoma duodenale.

REFERENCES AND NOTE.

- ¹ Local Government Board Report, 1897-98. ² Quarterly Return of the Registrar-General. ³ Twenty-seventh Local Government Report, 1897-98. ⁴ It is not contended that there is a regular alternation of saprophytic and parasitic generations, but that such alternations do occur.

THE LETTSOMIAN LECTURES

ON

SOME CLINICAL ASPECTS OF GRANULAR KIDNEY.

Delivered before the Medical Society of London.

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LECTURE II.

ALBUMINURIA.

Of albuminuria in granular kidney it is not necessary to say much. We know that it is usually small in amount, and that it is not constantly present. It may be found at special times only or may be absent for irregular periods, and might therefore be described as cyclical or intermittent respectively. It may be absent for long periods—even, it is said, altogether, though this is hard to prove. Its amount may be large—as much as half or more—but this generally depends upon some accidental complication, intercurrent nephritis or failure of the heart.

Given a clear case of granular kidney, these variations in the albuminuria do not cause surprise; but clinically the question often presents itself in a somewhat different form. In a given case albuminuria may be the chief symptom; we have then to decide whether granular kidney is the cause or not. It often happens that the evidence is not conclusive, for the patient appears to be in ordinary conditions of health. We are thus introduced to a problem of very great difficulty—that of so-called physiological or functional albuminuria.

For the present purpose we may regard the causes of albuminuria as falling into two groups, according as they lie in the kidney or outside it. In the latter case it may depend, on the one hand, upon some changes in the tissue or blood before the blood has reached the kidney, and may therefore be called prerenal; and, on the other, the urine may be normal when secreted, the albumen being added to it after secretion; these may be called postrenal. In each of these groups there may be some obvious cause or no cause obvious. Thus, the forms of albuminuria may be arranged into five groups: