SECTION I.

SANITARY SCIENCE & PREVENTIVE MEDICINE.

ADDRESS,

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PRESIDENT OF THE SECTION.

My first duty to-day is to thank the Council of The Sanitary Institute for the honour they have conferred on me in inviting me to preside over this section of the Congress.

It is an honour which I wish had been placed in abler hands than mine, and I must crave your indulgence for a short time while I offer a few observations on the causes and prevention of cholera, a disease which threatens in its onward march to visit our shores, and that at no distant date.

There is a certain area, bounded by more or less definite limits, wherein cholera is always endemic in India. This is comprised between the base of the Himalayas on the north, and the Bay of Bengal on the south; the north-west and central provinces on the west, China and northern Burmah on the east. Within this area is located the delta of the united waters of the Ganges and Brahmaputra. Whether this is the only endemic area is a question which I shall have to refer to again. And here let me briefly review the climatic state of this region. Traversed from north to south by the most uncertain and most impetuous river in the world, Bengal proper, or the true delta of the Ganges, is a mere alluvium, deposited, as it would appear, in a vast estuary, into which this great river poured forth his earth-laden water.

History tells us that within a comparatively short period this river has wandered out of one course into another, throughout an extensive tract of country, nearly every part of which has in consequence been left, virtually, in a condition of newly deposited land. Floods and heavy rains leave this flat and

rivulet-broken soil in a condition of moisture, with the most profuse vegetation in the damp season, while during the long season, in which scarcely one drop of rain falls, the thin layer of loam covering the vast sand-bank of which the country is composed, becomes almost entirely destitute of moisture.

Throughout nearly the whole of the year there glares down upon this plain the almost vertical blaze of an inter-tropical sun. One can well understand that here an opportunity is afforded for the development and maturation of micro-organisms amid the dense vegetable and animal products exposed to every influence that most favours decomposition. And it was from the inundated rice-fields of Jessore, lying on the borders of this tract, that arose in 1817, as an epidemic, the plague of cholera which is again manifestly gathering fresh energy as it proceeds on its westward course.

Let us now pass on to some of the conditions favourable to the origin and spread of this disease.

It may be laid down as an absolute rule in reference to cholera that its epidemic occurrence in any one place implies, besides importation of the contagium, certain local conditions, these being:—

(*a.*) General sanitary defects.
(*b.*) Peculiarities of climate.
(*c.*) Peculiarities of soil.

The history of epidemics in India and in Europe teach us that universally filthy surroundings accompany outbreaks of cholera all over the world, and it can be readily understood why it is next to impossible to control an outbreak where such favourable conditions exist for the development of an epidemic after the importation of the seeds of the disease. This holds good for cholera wherever we meet it. To anyone acquainted with Eastern habits it is easy to conceive how any infectious disease is conveyable by water, or by milk adulterated with it. With hardly any exception in Eastern cities the drinking water is subject to all sorts of contaminations, and in villages is little better than diluted sewage. As to any system of conservancy outside the principal towns and cantonments there is none.

Those who have visited Kashmir, where cholera has recently been raging, can easily understand an epidemic occurring there. Srinagar, the capital of the state, has no sewers, but rivulets of water flow down the open gutters into which are passed the night soil and other filth of the population, except such as is, still more unfortunately, thrown into open cesspools in back-yards and areas, which become nests of infection. The water supply is taken from the river banks where it receives the sewage of the town.

If filth alone could *create* cholera Srinagar would breed an epidemic every summer; but surface sewage, narrow filthy streets, and a polluted river offer a ready and fertile hot-bed for the propagation of this disease when once imported.

Wherever there has been a recurrence of cholera the same monotonous conditions exist; revolting contamination of the drinking water and the utter negligence in the disposal of excrementitious matters. And while we in England trust to sanitary measures for protection against the invader, the question asked is: are we safe in depending on such means of protection as we have as yet enforced? Have we no unhealthy quarters in our crowded cities which the mass of the population resort to for labour, and for the excitement incidental to city life? Have we no defects in our drainage systems and methods of removal of animal waste? Is our water supply above suspicion? Is not the aggregation of human beings on limited areas a source of danger, and especially so when among those are numbered the idle and dissolute, the loafers, the street arabs, and casuals, who congregate in certain quarters and huddle together in foul rooms—unfortunates who cannot escape the results of their physical organization?

And if such is the case are those who are officially responsible for watching over the public health doing all they ought to do to afford us protection. We have abolished quarantine—and I think wisely—and have thrown the gates wide open to every invader. Can we prove that we may have reliance on such measures? that there are no weak points in our sanitary administration?

With the full knowledge of the responsibility attached to the position I hold as your President, I would earnestly and in all seriousness impress on sanitary authorities the importance of setting their house in order, or surely there will be a deadly reckoning to avenge for past neglect. It is true that in this country people have been provided at a vast cost with some of the essentials of a healthy life, but it is equally true that in our large cities the "bitter cry of outcast London" is, in some respects, as applicable as it was nigh fifty years ago.

"Is it well that while we range with science glorying in the time,
City children soak and blacken soul and sense in city slime?
There the master scrimps his haggard seamstress of her daily bread.
There the single sordid attic holds the living and the dead.
There the smouldering fire of fever creeps along the rotten floor,
And the crowded couch of incest in the warrens of the poor."

As regards climate in the non-epidemic areas, the epidemic spreading of cholera occurs during the rainy and warm seasons.

I shall endeavour further on to show what factors specially are concerned in producing variations in the amount of cholera. There can be no doubt that a relatively high temperature favours the production of cholera. Warmth, and up to a certain degree moisture, are the physical conditions which, combined, above all others foster the development of the specific poison.

The last condition, namely, the peculiarities of soil which favour the spread of cholera is not by any means the least important factor.

We find that from the earliest records of the disease a remarkable fact has been noted, viz.: That cholera has always attained its widest diffusion and its greatest intensity in those localities which are distinguished by a certain physical soil character, namely, permeability to water and air, and on those kinds of rocks which have a large capacity for retaining the moisture which has fallen upon them.

A careful study of the literature of the disease indicates that in considering the incidence of cholera upon any particular soil, it is not the geological character of the soil itself, but the saturation dependent thereon in which the true explanation of this phenomena is largely to be sought, but even this does not cover the whole case, for it again is affected by the soil heat, rainfall, sub-soil water level, soil air and the general climatic influences, to say nothing of the nature and quantity of the organic matter in the soil.

There appears to be no doubt that a relatively high temperature, both of air and soil, materially favours the production of cholera; in the case of air, this is not shown so much by the prevalence of the disease at times of maximum temperature, as in the absolute abatement or extinction of an epidemic with a fall in atmospheric temperature.

On the other hand from facts which have been slowly and laboriously collected, concerning the soil temperature in various parts of India where cholera is more or less endemic, we find that a high temperature of the soil corresponds differently, yet more closely with the course of cholera prevalence than does that of air.

The credit of the earliest and most systematic attention to this point belongs to Lewis and Cunningham, who in 1876 made a most valuable series of observations on soil temperature in Calcutta. They found that at a depth of six feet from the surface a soil heat of between 78° and 79° Fahr. corresponds with the maximum prevalence of cholera, and that the soil temperature at Calcutta is higher than that of the atmosphere during the cold season. More recent observations in the Punjab, by Firth, confirm Lewis and Cunningham's results.

So much for soil heat; but as concerns soil moisture, as affected by rainfall, we find that in Calcutta, as well as in all endemic areas, the maximum of cholera falls in the dry season (October to May) and more particularly in that part of it which is at the same time the season of greatest heat (March to May).

In the non-endemic area we find some points of resemblance and some of contrast to those offered by the endemic area.

The more the whole history of cholera outbreaks both in India and elsewhere is studied, the more hopeless seem the inconsistencies in its behaviour with reference to rainfall and soil moisture.

They will appear less glaring however and become more intelligible if it be borne in mind that rainfall as a causal element is purely indirect through the soil. Soil moisture is not only a question of so much or so little rainfall, but also of the physical character and saturation point of the soil, to say nothing of the state and level of the subsoil water. It is obvious that when the subsoil water level is low, copious rains will produce an effect quite different from that of moderate rain when the subterranean water level is high, and *vice versâ*, and that this result again will be further varied according as the soil is a highly porous one (sand) or a moderately porous one (loam or marl).

Chiefly owing to the writings of Pettenkofer much attention has been given to this question of subsoil water level and its bearing on cholera prevalence, particularly in India, where Lewis and Cunningham made systematic observations for eight years in and around Calcutta.

Their work on the whole showed that in Calcutta the prevalence of cholera is associated with a low level of the soil water. Observations in India go so far as to show also that where the water level is high, no marked outbreaks of cholera occur.

The subsoil water level must be looked at in the light of an index to the changes in soil humidity, from mere moisture to actual saturation of the overlying soil strata, as well influencing the question of soil ventilation. In regard to this latter factor, although our methods of estimating it are imperfect, and with reference to non-endemic localities our data are meagre, still, in the true endemic area, as Lewis and Cunningham indicated, degrees of soil ventilation seem to bear a direct relationship to cholera prevalence, and moreover, as will be shown subsequently, offer a clue to the connection of this disease with soil.

A careful analysis of the writings of Lewis and Cunningham, Pettenkofer and others, based on evidence gathered partly from the endemic home of cholera in Lower Bengal and other parts of

India, as well as from other countries in which the disease has prevailed as an epidemic, indicates to us that the only soil states which appear to bear any constancy to cholera are: (1.) Porosity and permeability. (2.) An average soil heat of 79° Fahr. at six feet deep. (3.) A low level of the subsoil water.

This clears the ground, somewhat, but it remains still to enquire what evidence is offered by the soil itself as to the existence of what all unite in considering does exist—the specific organic cause of cholera.

Elaborate microscopical examinations of soil from various parts where the disease exists, both endemically and epidemically, have been made, but mainly with negative results.

Notwithstanding the outcome of all research on these lines the consensus of opinion is in favour of the theory that the comma bacilli, so constantly found in cholera dejecta, are closely connected with the specific cause of the disease, even if they are not the specific cause itself.

Though the bacilli have been very rarely found in soils, yet many observations have been made regarding their behaviour in both water and soil. Dr. D. D. Cunningham, of Calcutta, made an elaborate series of observations on these points. All experimental facts seem to indicate that the so-called choleraic commas are extremely feeble in the struggle for existence when gaining access to ordinary soil and tend rapidly to die out. This question, however, is not quite so simple as this would seem; and is further complicated by the fact that the more one studies this subject the more convinced one gets that in all likelihood there is a plurality of species of comma-shaped bacilli, and that these do not behave uniformly in either water, soil or any other media. We may not be dealing with distinct species, but with races or modifications due to change of environment. As Dr. Adami has very recently stated, there must be some little latitude in our conception of species among the bacteria: we must be prepared to discover considerable variations in the properties of any one species. By a due appreciation of this dictum, it is probable that many experimental inconsistencies may be explained. The existence of more than one variety of comma in different cholera dejecta is probably dependent upon the very varying conditions of the individual patient's intestinal tract—analogous to the variation in symptoms and mortality of cases, as well as to variations in value of certain remedies in the disease. It is well known that in the present epidemic cases occur, which both in respect of symptoms and mortality must be regarded as choleraic, but in which the intestinal contents are devoid of cultivable commas, or indeed of commas at all. Such may be merely cases in which the commas have failed

to find intestinal conditions in which they could breed true: just as outside the body the same commas can, under the influence of artificial external conditions, assume important and more or less persistent morphological and physiological properties.

These considerations open up the whole controversy as to whether cholera commas in their life history undergo change in form and to whether they can assume a resting or spore stage, in which though overlooked and regarded as absent, their germs are all the while merely waiting suitable external conditions to renew their well known shape and effects. The more the life history of the comma bacillus is studied the clearer it becomes that this microbe is not one of the ordinary schizophyta, or if it be, then it is merely an evolutional stage of some higher organism, or what is not unlikely, a true parasite, existing in man and animals in one form and needing another hoste, possibly the soil itself, wherein to complete its life history.*

Experiments with various samples of soil show that choleraic commas do rapidly and completely disappear and die out from soil when such is kept for a period of about three weeks, either dry or absolutely saturated with moisture, or however dry or moist when exposed to a temperature below 50° F., or when mixed in soil with putrefactive matter or with a large excess of fœcal matter.

This incapacity on their part for continued life under such circumstances is apparently due to a want of oxygen, to excess of cold or heat, and to the presence of fungi and saprophytic forms of life hostile to them.

On the other hand, in moist states of the soil short of saturation, and in media, offering conditions short of those just enumerated, their inability to discover commas, as commas after a lapse of time, is no proof of the destruction and disappearance of the cholera germs, as these seem to be capable of undergoing morphological changes and of assuming a resting or spore stage, in which their duration of life seem to be indefinite, and from which on being transferred to more congenial soil—*e.g.* the alimentary canal of man and animals—they can assume active properties and powers.

In the *endemic area* the soil is probably the main if not the essential site of the processes and changes resulting in the production of the poison, which in man induces cholera. The soil concerned in these changes is, in all likelihood, that layer lying above the water level or the first impermeable stratum in

* I beg to refer to a most interesting article on this subject by G. F. Dowdeswell, M.A., F.L.S., &c.—*Lancet*, July 28, 1890.

a locality and once seeded with the specific organisms, the development in the soil or diffusion from the soil depends on certain conditions of that layer.

These conditions are, permeability to air, a certain degree of moisture which must not be excessive, a mean annual temperature of 72° F., a moderate amount of contained organic matter and an absence of decomposing and putrefactive processes. Any locality presenting these conditions throughout the year may be said to be capable of affording an endemic habitat for the cholera organism.

It is quite possible, as Naegeli has pointed out, that excessive dirt in a locality may be an efficient cause for the prevention of certain forms of disease in it, the excess of saprophytic organisms tending to the suppression of more or less parasitic ones, but no one could regard it as therefore desirable to increase the accumulation of dirt.

Lower Bengal, as typified by Calcutta, fulfils the above conditions. Assuming that prevalence of the disease in that area is a fair test of production of the cause, we ought to find, if these conclusions are correct, that the amount of specific material developed increases with the mass of generating stratum: this is exactly what we do find, as the maximum and minimum of cholera prevalence in Calcutta coincides with the maximum and minimum of the water level—or, in other words, with the maximum and minimum of non-water-logged soil.

If we go a step farther and equally assume prevalence in the same area to be an index of diffusion, there are two main channels by which a material developed or harboured in the soil may reach human beings in any locality: these are the water and the air occupying the soil interspaces. The phenomena of seasonal fluctuation in prevalence appears to fail, as far as the endemic area is concerned, to explain or support the idea of the water supply being the main channel of diffusion. Were it so, the maximum prevalence ought to occur at that period when the meteorological conditions are calculated to facilitate the entrance into the drinking water of materials derived from the bodies of those suffering from the disease. June, July, August and September are the periods when most material is washed into the tanks and drinking-water supplies in Calcutta, yet these are the months of minimum prevalence.

So too in May the rainfall is heavier than in April, yet instead of an increased there is a decreased prevalence, while in November more cases of the disease occur than in October, although the latter month presents greater chances of inwash of material by rain into the tanks and wells than the former.

If, however, we regard the air as the channel of diffusion by

which the cholera poison passes from the soil to the subjects of the disease, we find that the facts are different.

Exactly in accordance with that hypothesis, maximum soil ventilation occurs during March and April coincidently with the maximum of prevalence: and the minimum of soil ventilation occurs during the rainy season, which is the period of minimum prevalence.

Strong as is the evidence in favour of the diffusion in the endemic region, from the soil of the specific cause of cholera by means of soil air emanations and dust yet it does not cover all cases as shown by the lessened incidence of the disease on all places provided with a pure and good water supply. Calcutta is a case in point, the disease has certainly lessened there, but has not disappeared. The existence of a pure water supply has reduced the number of cases by reducing the facilities for the propagation of the disease by virtue of a wholesome drinking water being substituted for one polluted by the recent dejecta of the cholera-stricken. This experience without appreciably weakening the soil theory of the disease merely strengthens the belief that possibly both channels are at work, and that too great reliance must not be put on either the one or the other.

These remarks apply altogether to the endemic home of cholera. It must, however, be noted that it has been the custom for most writers when speaking of the facts concerning the occurrence of cholera outside the well known endemic area of Lower Bengal, to maintain that the nearer the soil of any district approaches in character and conditions to that constituting the lower part of the Gangetic plains, the greater will be the risks and likelihood that cholera will be found to prevail there.

It is very much to be doubted whether this is a sound statement, but rather that the tendency of the disease to prevail on all alluvial soils, especially near rivers, such as in the valleys of the Brahmaputra, the Nerbudda, the Tapti, the Indus, and Euphrates, is due to the fact that those districts are endemic homes of the disease equally with the Gangetic valley. I am inclined to believe that cholera is after all endemic in several parts of India, which at present are not so considered.

It is, however, certain that personal intercourse between infected and non-infected places in India, while undoubtedly accounting for a very large number of cases, is insufficient to explain or account for some of the remainder, which in the main can only be explained by regarding the disease as truly endemic in, hitherto, unsuspected spots, and only requiring the establishment of certain indicated conditions in their superficial soil to determine the production of cholera, the chief of these being a

drying zone of soil, always containing the specific material causative of the disease.

The soil appears to play a direct part in the production and diffusion of cholera, *only in the endemic areas;* outside the endemic area the soil strata appears to have nothing whatever to do with the disease, its appearance there is due to importation of the virus and its diffusion as an epidemic to sanitary defects. Soil and climate alone have not been observed to originate the disease in non-endemic areas.

"*On Tuberculosis; or, does Consumption arise from Flesh-Eating?*" *by* JOSIAH OLDFIELD, M.A., B.C.L.

DISEASES are produced in a great number of ways, but the chief methods of propagation are:—

Firstly, by the INHALATION of disease germs into the lungs with the air breathed, and thence by the blood stream throughout the body;

Secondly, by the INGESTION of disease germs, together with the food eaten into the stomach and intestines, and thence by osmosis or by the absorption by the lacteals and lymphatics, or through some abrasion of the mucous membrane by a species of inoculation, into the lymphatics or the blood stream, and thence over the whole body.

Of these two causes of disease, I believe ingestion to be far the more serious, for a number of reasons, of which the simplest perhaps is the fact that a person may go with practical impunity into the presence of contagious disease if he is careful to avoid swallowing his spittle, and does not eat or drink anything while exposed to the infected atmosphere.

There are two serious modes, therefore, of disease propagation, viz. (1), inhalation; (2), ingestion; and of these two the latter is far the more serious.

The discovery of a cause renders the search for a remedy much more simple, and so if disease comes in through inhalation and ingestion, its entrance can be prevented by ceasing to inhale and ceasing to ingest.

To stop breathing and eating altogether is a remedy perfectly simple in theory, impossible however in practice.