ORIGINAL COMMUNICATIONS.

MEDICO-TOPOGRAPHICAL REPORT ON CALCUTTA.*

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It would be unnecessary and inappropriate in treating of a locality like Calcutta to enter into details regarding geographical position, general characters of the country, and various other points which ordinarily form parts of a topographical report. I propose, therefore, only to consider certain phenomena of locality which have in greater or less degree formed subjects of my own study in connection with the question of the seasonal prevalence of disease, and more especially of the prevalence of certain special forms of disease—cholera, small-pox and malarial fevers.

1. *Nature of the soil.*—The alluvium on which the town of Calcutta is situated has been examined to a depth of 481 feet by means of boring, and has been found to consist almost entirely of alternating beds of sand and clay of various consistence and of varying degrees of purity. The portion of it which chiefly concerns us—that lying over the permanent water-level—is composed of a surface layer of varying thickness containing humus, lying over beds of loose sand and clay. The distribution of these beds is very irregular, one or other element preponderating in varying degree in different places, while at some points we find only one represented in passing downwards to the water level. Localised areas of different nature are, therefore, closely associated with one another ; areas of sand, of clay, or of both intermixed, being irregularly distributed over the soil. Interpolated between the layers of sand and clay a distinct bed of peat is frequently recognisable, and in some places attains a considerable thickness. This peat is of impure character, but is at the same time, in some cases at all events, capable of serving as fuel, and is indeed actually employed as such by the natives.

The purity of the sand and clay in the soil, as before mentioned, varies greatly according to the extent to which an intermingling of the two elements has taken place In many places beds of pure loose sand or of dense clay extend from close to the surface down to the water-level ; in others we find alternating strata of the pure material, and in still others mixed layers predominate.

In any attempt to estimate the relation of soil-conditions to the prevalence of disease, it is essential that these localised variations should be clearly realised and kept constantly in view. It is apparently often deemed a conclusive argument against the influence of soil-conditions on particular forms of disease, if it can be pointed out that localised outbreaks of any disease which forms the subject of enquiry in this respect, occur at different seasons of the year within the same alluvial area. Such an idea can, of course, only arise from a misconception of the meaning attached to the term "alluvium,"—from a belief that the term is descriptive of a soil of precisely uniform character throughout, and not merely of soils of very various nature which have been formed by a particular agency.

When once we realise the localised variations present in the soil in Calcutta, we necessarily cease to demand an absolute uniformity in the seasonal prevalence of any disease over the entire area as the evidence of the influence of soil-conditions on the occurrence of that disease. In any area occupied by a soil composed of irregular aggregations of materials differing so widely from one another in physical properties as dense clay and loose sand, it is clear that very considerable local variations in soil-conditions must coexist at different points within it, according as one or other of the soil-constituents predominates and according to the relations which they mutually bear to one another. Localised areas within the site covered by the town of Calcutta must, from the constitution of the soil, be very differently related towards those conditions which are regarded by the soil theory as influential in the production of disease. For example, houses situated on sites in which clay is absent or only feebly represented, and in which the soil down to the permanent water-level is composed almost entirely of sand, must necessarily be very differently related to soil-emanations from others situated over dense clay. Again, the relations of houses situated over level or hollowed clay beds, must differ from those of others overlying sloping or convex ones. Where beds of clay are superficial, and are not so arranged as to secure the rapid removal of organic matter washed down from the surface of the soil by lateral drainage, an accumulation of such matter will necessarily take place more superficially than where a considerable depth of sand is present, and such superficial accumulations are liable to be reduced to a condition of inactivity by desiccation at times of year when deeper-lying ones have merely been reduced to conditions most favorable to the occurrence of rapid changes within them. Under reversed conditions, on the other hand, whilst the deeper layers are flooded and reduced to inactivity the higher lying ones may merely have acquired the degree of moisture necessary for their activity.

In any case it is evident that the variations in local soil-conditions present within the area of Calcutta are amply sufficient to account for minor local deviations from the general rhythm of seasonal prevalence of any disease normal to the locality, and that the occurrence of such deviations cannot be regarded as conclusive evidence adverse to a belief in the pathogenic influence of the soil. The average normal rhythm of prevalence may merely be the expression of the preponderance of certain soil-conditions throughout the soil of the area as a whole at certain seasons, the localised deviations from it are only what might be looked for in correspondence with the local variations of the soil.

While treating of soil-conditions and their possible influence in the production of disease, it may be noted that in a locality like Calcutta it appears to be a mistake

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to have houses so directly related to the soil as they generally are. In very few cases in Calcutta is sufficient provision made to prevent the access of soil-emanations in large amount to the interior of houses. Not only are the houses very insufficiently raised from the soil, but the risks inherent in direct continuity with the soil are greatly enhanced by the fact that the excavation requisite for the foundation of such great masses of masonry as Calcutta houses generally are, tends to put the interior of the houses into direct relation to the deeper layers of soil, by removing the surface humus-containing stratum which th re is some reason to regard as endowed with protective properties in respect to emanations generated lower down. Excavations are also of course, liable to cut through less permeable into more permeable layers, and therefore specially to favour the escape of soil-emanations at the points at which they have been made. It is clear that in this way substantial masonry buildings may involve dangers from which the light mat structures of the poorer natives are exempt, due to the fact that they rest on the undisturbed surface of the soil. But dwellings consisting of large masses of masonry involve other conditions which under certain circumstances specially favour the access of soil-emanations to their interior, for, due to the extent to which they accumulate and retain heat, large masonry buildings must frequently be apt to serve as chimneys or ventilating shafts of the areas of soil which they cover. There are two principal methods by which the access of soil-emanations to the interior of houses may be obviated. The first of these consists on laying a bed of impermeable material over the entire area to be covered by the house ; the second, in raising the house on arches, or piles, so as to secure free cross ventilation beneath the flooring. There is much to be said in favour of pile-building. Pile-building, where occurring on land, is often regarded as a mere hereditary persistence in a habit acquired under other circumstances. No doubt to a certain extent this is actually the case ; I am inclined, however, to suspect that the hereditary persistence may be largely due to the fact that the pile-builders have by their habits obtained an advantage in the struggle for existence over those of their compeers who may have abandoned the habit. The sanitary advantages of pile-built houses as securing free ventilation beneath the flooring, and therefore as preventing the access of emanations to the interior of the dwelling, cannot be more strikingly exemplified than by a comparison of the dwellings of the inhabitants of the Sikkim and Kumaon Himalaya. In both cases the dwelling rooms of the people are, as a rule, well raised from the ground ; and in both the space beneath the flooring is commonly employed for the accommodation of cattle and other domestic animals. Here, however, the parallel ceases, for while the houses of the Lepchas and Bhutias in Sikkim are raised on simple bamboo-piles or on isolated stone-pillars, those of the Kumaon paharias are simply two storied masonry buildings, in which the human inmates occupy the upper story and the domestic animals the lower one. The consequence of this difference is, that while the houses in Sikkim are, as I can attest from personal experience of sojourn in them, so thoroughly cross ventilated beneath the flooring as to be in great part protected from the entrance of offensive emanations from below, the houses of the inhabitants of the Kumaon hills are said to be intolerably offensive and saturated with vile effluvia. Running parallel with this we find a difference in regard to the manifestation of disease in these two regions, the Kumaon population being liable to recurrent epidemics of Mahamari, a disease unknown in the Eastern Himalaya.

2. *Soil Temperature.*—A series of observations on the temperature of the soil, which I carried out during several years within the area occupied by the Presidency Jail, gave the following general results. The soil at a depth of 3 feet from the surface, ranges in temperature from about 85° to 68° F., attaining its maximum towards the end of May and its minimum about the middle of January. The temperature at a depth of 6 feet ranges from 82° or 83° to 72° F., the maximum being maintained from the latter part of May to the middle of July or August according to the amount of the rainfall, and the minimum occurring in January. So long as the weather remains dry, the fluctuations in temperature in the upper layer of soil follow those in atmospheric temperature very closely ; but, on the occurrence of rain, this correspondence ceases to occur. The fluctuations in the temperature in the lower layer are naturally much less conspicuous and abrupt, and the line of elevation and depression follows a long, gentle curve. The maxima of temperature in the two layers approach one another more closely than the minima,—a point in which the relations of temperature correspond with those occurring in the case of the carbonic acid contents of the soil air at similar depths. During the cold weather the temperature of the deeper layer considerably exceeds that of the more superficial one. These relations are reversed during the hot weather, a period next ensues, on the onset of the rains, in which the temperature in both layers is almost alike, sometimes one, sometimes the other showing a slight excess ; and this is succeeded by one in which a prolonged and steady depression of the temperature of the upper layer beneath that of the lower one occurs, until the maximum difference is attained in January and February coincident with the period of absolute minimum temperature. These varying relations in temperature of the superficial and deeper layers must exert an important influence on the degree of soil ventilation occurring at different times, though, as we shall see further on, the most important determinant in th is respect is to be found in the rainfall. One thing, in regard to which there can, I think, be little doubt, is th at elevation of soil temperature is an important factor in the production of the oppressive form of hot weather which occasionally makes itself unpleasantly conspicuous in certain seasons. So long as the soil temperature is not excessive, mere elevation of atmospheric temperature, if unaccompanied by excessive humidity, has comparatively little effect in this respect.

3. *Level of the water in the soil.*—The average annual water-level in the soil of Calcutta is, according to observations recorded during a period of six years, 12′·4,

ranging from a monthly average of 8′·2 in September to one of 14′·7 in May. The average annual fluctuation in level is 6′·4. The greatest falls seem to succeed the greatest rises, and the least falls the smallest rises. The water-level cannot be accurately estimated from data of rainfall alone, and more especially from data of local annual rainfall. The distribution of the rainfall throughout the year exerts an important influence, and variations in amount of loss by evaporation also modify the results. Even, however, if the data of temperature and of atmospheric humidity be taken into account along with those of the rainfall, the determination of the water-level is only approximate and unsatisfactory when compared with that obtained as the result of direct observation.

4. *Fluctuations in the amount of carbonic acid in the soil as a measure of variation in soil-ventilation.*—Taking such data as are at present available in regard to this nt, we attain the following results. The carbonic acid contained in the soil-air attains its maximum amount for the year during the rains; the absolute maximum occurring in September. During October it begins to diminish in amount, but continues to be present in considerable quantity until February. A rapid decrease now sets in, reaching its acme in March and April, and from this point an increase manifests itself, slightly marked during May, June and July, and becoming rapid and conspicuous in August.

These fluctuations are probably to be regarded as mainly the expression of coincident variations in the degree of soil-ventilation. Any fluctuations in the amount of carbonic acid in the soil-air must clearly be dependent either on variations in the amount produced, or in the degree to which what is produced is retained and accumulates. That the fluctuations occurring in Calcutta are mainly due to the latter of these agencies is probable on various grounds. The most conspicuous fluctuations occur independently of corresponding fluctuations in the soil temperature, but are very closely related to variations in the degree of soil moisture. The great determinant of a rise in the amount of carbonic acid appears to be the occurrence of heavy rainfall, and as the rise manifests itself in the deeper layers long before the moisture added to the surface by the rainfall can have reached them, we can hardly regard the result as due to the increased moisture of the soil inducing an increase in the organic processes leading to the evolution of carbonic acid. This being so, there seems to be little reason to doubt that the influence of the rainfall is due to its sealing up the pores of the superficial layers of soil and thereby obstructing the escape of emanations from the deeper ones. No doubt variations in the amount of carbonic acid generated do occur, but they are in Calcutta almost entirely obscured, due to the varying degree of soil-ventilation coincident with them. The slight increase in the amount of carbonic acid in the soil in May, while conditions favouring soil-ventilation are still unimpaired, may possibly be an index to an increase in the evolution of the gas coincident with the maximum of soil temperature.

5. *Atmospheric temperature.*—The average monthly temperature in Calcutta, as determined by observations extending over a period of 23 years, varies from 67·7° to 86·2° F., the minimum falling in January, the maximum in May. For the eight months, from March to October, the average temperature remains above 80° F.; the greatest changes occurring between the months of October and November, and again between January and February.

6. *Atmospheric humidity.*—The relative humidity of the air in Calcutta varies greatly at different times of year, for, taking 100 as corresponding with the saturation point, we find that in March the averega humidity only equals 67, whilst in August it amounts to no less than 88. For the period from June to October the humidity varies from 80 to 88, whilst from December to March it is only 68 and 67. There are thus five months of excessive humidity and four months of relative dryness,—these two periods being separated from one another by months of intermediate character. The greatest changes occurring between any successive months are those between October and November, and between May and June.

7. *Atmospheric pressure.*—The average monthly atmospheric pressure attains its maximum in December and January, and its minimum in June and July; the greatest differences between the average pressure of successive monthly periods presenting themselves between the pressures of October and November, and of May and June.

8. *Rainfall in Calcutta.*—The entire year in Calcutta may, as regards rainfall, be divided into four periods: 1*st.*—The period of excessive rainfall including the months of June, July, August and September; 2*nd.*—The period of minimum rainfall during November, December, January and February; 3*rd and* 4*th.*—Two periods of intermediate fall, the first of which includes three months, March, April and May; the second only the month of October. The highest average monthly rainfall occurs in August, and it is in this month that the highest average of days of rainfall is attained. The highest average fall per day of rain does not, however, occur then, but in June.

9. *Amount of atmospheric dust, and proportions of distinct organic elements present in it at different seasons.*—The absolute amount of dust contained in the atmosphere is, as might be conjectured on *a priori* grounds, directly determined by conditions of dryness and velocity of wind. The inorganic and amorphous constituents are regulated in amount by the same conditions, but the numbers of spores and other vegetable cells which are constantly present in the atmosphere, and usually present in considerable numbers, are not so determined, as they appear to be independent of conditions of velocity and direction of wind, and certainly are not diminished by moisture.

10. *Local conditions of soil and atmosphere as associated with the fluctuations in seasonal prevalence of disease.*—The principal causes of mortality in Calcutta are cholera, diarrhœa and dysentery, fevers and small-pox; we have now to consider the seasonal fluctuations in the prevalence of these in relation to the various condi-

tions of locality which have just been described. A distinct seasonal rhythm characterises the phenomena of prevalence in all these diseases as indicated by the returns of mortality,—the fluctuations being specially marked in the case of cholera and small-pox, and less decided in that of the other two. This of course does not of itself imply that seasonal conditions of locality have any direct action on the production of the specific causes of the disease, nor does the difference in degree of seasonal fluctuation manifested in the different diseases necessarily imply that the variations in local conditions are more influential as pathogenic agents in one case than in another. Much of the seeming difference may be due to differences in the type of the disease-processes, to the fact that in one case the diseases are of such an acute nature that the mortality caused by them necessarily corresponds in time closely with the periods of the original reception of the cause by the organism affected; whereas in the other case not only are we dealing with comparatively indefinite types of disease, but also with types including many chronic forms. In the case of the latter it becomes very difficult to determine with any accuracy whether their specific causes are really developed more largely at one period rather than another, and, if they do appear to be so, to ascertain precisely what ought to be regarded as the periods of maximum and minimum evolution. This comes out very clearly in the case of malarial fevers in which neither the seasonal mortality nor morbility can be taken as a safe index to the seasonal variations in the evolution of malaria. Every attack of malarial fever certainly cannot be regarded as necessarily corresponding with the reception of a distinct dose of malaria. Once the habit of fever has been acquired—once the specific agent has obtained a hold on the constitution, non-specific causes are quite sufficient to excite paroxysms of the characteristic morbid phenomena, and therefore any accurate seasonal correspondence between specially abundant evolution of malaria and special mortality or morbility from paroxysmal fevers cannot be looked for as a necessary phenomenon. Considerations of this kind at once dispose of arguments founded on such a want of correspondence in the local seasonal rhythm of cholera and fevers as presents itself in Calcutta, and advanced as evidence that cholera cannot be influenced in any essential way by local conditions of soil. It must farther be granted, however, that even were the want of any seasonal correspondence in the seasonal evolution of the causes of malarial fevers and cholera clearly demonstrated, the case against the dependence of cholera on soil-conditions would not be made out, seeing that all specific malarials generated in the soil cannot be regarded as necessarily developed in precisely similar portions of it, or under precisely similar conditions in such portions.

Leaving these general considerations, what are the seasonal phenomena of prevalence in the principal causes of mortality in Calcutta?

A. Fluctuations in the seasonal prevalence of cholera.—Starting with a low prevalence in January, the disease shows a rapid rise in February, and attains its maximum in March and April. A marked diminution takes place in May, which is continued through June to the minimum in July, August and September. A rise now occurs in October and November, and is followed by a fall in December; the prevalence in the latter month, however, remaining above that of January.

On comparing the phenomena of prevalence with the data regarding physical conditions of locality, we do not find that any individual meteorological condition can be regarded as the determinant of prevalence. The conditions which appear to coincide most closely in degree with the prevalence of the disease are depression of the water-level, free ventilation of the soil, and a relatively low degree of atmospheric humidity. When these conditions are simultaneously present the maximum of prevalence occurs; but one or other of them may be present alone in high degree without any corresponding elevation in prevalence. Whilst the conditions above alluded to seem to be the most influentially related to prevalence, there is evidence which appears to indicate that conditions of temperature also have some power. The diminution in prevalence characterising January as compared with November and December appears to be only explicable as due to the depression of atmospheric and soil temperature. The question of the precise relation which we are to suppose the prevalence of the disease to hold to the local conditions with which it coincides is a very obscure one. It is clear, however, that the local conditions may influence prevalence in two ways. They may either determine the amount of development of a specific material, or they may determine the degree of diffusion and preservation of one which is constantly produced in like amount.

B. Fluctuations in the seasonal prevalence of diarrhœa and dysentery.—The mortality from diarrhœa and dysentery follows a very different seasonal curve from that present in the case of cholera. The maximum mortality here occurs during the last quarter of the year, and the minimum in the second quarter, whilst during the first and third quarters the mortality occupies an intermediate place, showing a decrease in the former and an increase in the latter period. When dealing with such vague information as that furnished by the data regarding bowel complaints, it is useless to enter into any detailed comparison of prevalence with special local conditions, the only coincidence which comes out with any distinctness being that of humidity and depression of temperature with increased prevalence. One point, however, seems to be worthy of remark, and that is, that there is no evidence of the existence of any common condition affecting local sources of water supply and simultaneously affecting the prevalence of cholera and bowel complaints.

C. Fluctuations in the seasonal prevalence of fevers—In the case of fevers the mortality is concentrated on the third and fourth quarters of the year. A sudden and very great diminution occurs in January; the decrease continues in February, and the figures remain low until the third quarter of the year, when a rise again occurs. Here, so far as a cursory examination of the data enables us to judge, depression of temperature and drying up of superficial accumulations of moisture are the local

conditions which appear to be influential. As before pointed out however, it is impossible to determine how far the mortality is due to freshly acquired malaria and how far to the ultimate effect of antecedent malarial influence.

D. Fluctuations in the seasonal prevalence of small-pox.—The seasonal rhythm is here as unequivocally marked as that occurring in the case of cholera. The disease attains a minimum in the beginning of the cold weather, rises rapidly through December, January and February to a maximum in March, falls slightly in April and rapidly through May and June to the low prevalence which characterises the rainy season. The condition of locality with which the prevalence of small-pox is most closely connected appears to be dryness of atmosphere. It is not difficult to see why this should be the case, if it be granted that the principal source of the disease is a material developed within the bodies of the sick and transferred from one organism to another by means of atmospheric particles ; as in proportion as the dryness of the air increases, so must the facility for the entrance of particles into the air and the likelihood of their retaining their essential properties unaffected by decomposition changes rise. The depression of temperature with which the initial rise in prevalence coincides may, no doubt, also, in some degree, favour transfer by leading to close aggregation of the population. The data regarding small-pox appear to afford a striking example of the extent to which general conditions of locality may influence the prevalence of a specific disease without directly determining the development of its essential cause,—without affording any evidence that the cause is developed external to the affected organisms. This, however, by no means affords ground for regarding the phenomena of seasonal prevalence as valueless in attempting to determine the question whether any given form of disease be due to intrinsic or extrinsic causes—be due to a material or cause taking origin in the animal organism or in conditions of locality. It has been urged that the seasonal fluctuations in cholera are not more marked than those in small-pox, and that therefore the association of cholera with certain conditions of locality cannot be regarded as any evidence of the influence of the latter on the development of the specific cause of the disease. Now it is no doubt true that the mere fact of a disease exhibiting seasonal fluctuations in prevalence does not mark it out as due to specific causes developed in the locality external to the affected organism. But where phenomena of seasonal fluctuations in prevalence present themselves with sufficient distinctness and regularity to constitute a subject worthy of investigation, the question which has to be decided is ; are the seasonal fluctuations such as can be accounted for consistently with a belief in the development of the pathogenic agent within the animal organism and its propagation by transfer from one organism to another? In the case of small-pox, it seems to me that they are so—in that of cholera they certainly are not.

8th March 1880.

ACUTE ŒDEMA.

By Surgeon Shirley Deakin, F. R. C. S., Eng.

At the present time, when the appearance of an epidemic of œdema of the legs is giving rise to much discussion in medical circles in India, the following notes of cases which occurred among the prisoners of the District Jail, Allahabad, may be of interest to your readers. Two distinct outbreaks of the disease occurred,—one in 1878, the second in 1879, and in both instances all the prisoners affected had been resident in the jail for a long time, the shortest period having been 6 months 13 days.

The disease did not prevail generally in the Allahabad district, and the jail cases were the only ones I have seen. Assist.-Surgeon Kali Das Nundi, however, informs me that he attended a native family of five individuals,—man and wife, and three children aged 3, 8 and 15 years,—who were attacked with œdema of the legs during the end of 1878 and the early part of 1879. The disease lasted about four months,—all the patients recovering ; he also saw a few other cases in the same neighbourhood, (Colonelgunge, Allahabad).

Regarding the outbreak of œdema of the legs in 1878, I wrote in my annual Sanitary Report for that year: "Although the death rate has been so high in 1878, *viz.* 52, compared with 9 in 1877, the general health of the prisoners has been very good ; they have been free from outbreaks of epidemics, excepting, perhaps, that numerous prisoners suffered from œdema of one or of both legs, and that two of the prisoners so admitted died from dysentery. This condition did not appear to be connected with any special debility of constitution ; the gums were nearly always firm, and no indications of scurvy existed among the prisoners. Several of those affected appeared to be in robust health, and I suspected malingering, as I noticed lines of constriction below the knee in some cases. These were caused by tying cloths round the part to diminish the pain, and with the cessation of the practice there was no improvement, notwithstanding that for three nights I had a few men handcuffed with their hands behind them, as an experimental measure."

In the Sanitary Report for 1879 I stated that "six cases of œdema of leg were admitted to hospital in Juen and July : all these prisoners had been in jail more than six months, they all used the water from No. 1 enclosure well. The use of this well was discontinued on the 20th of June, and no more cases occurred after the 17th of July. In 1878, 17 cases occurred,—14 among prisoners using the water from this well. When the use of the water was then discontinued the disease shortly afterwards ceased. All the other conditions are common to all prisoners. At the same time it is difficult to see why only a few prisoners should suffer if so many were exposed to infection, as some 300 men use this water. All these men are habituals (class II), or else first class, and therefore long-term prisoners. It is worthy of note that no prisoner was affected who had not used the water for at least six months, most of them for upwards of one year." In the Annual Jail Report for the same year