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# ESSAY

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ON THE

## CAUSES, SYMPTOMS & TREATMENT

## BURDWAN FEVER,

OF

THE EPIDEMIC FEVER

OF

OR

# LOWER BENGAL

## G. C. ROY, M. D., F. R. C. S.,

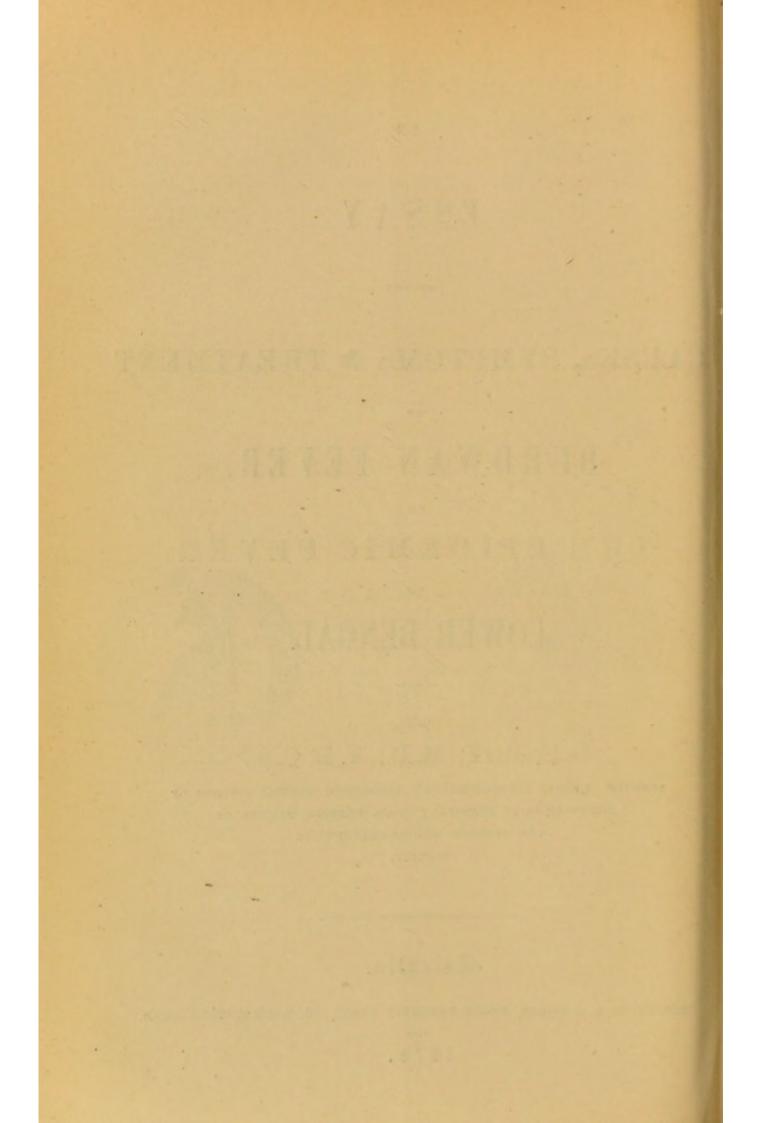
BY

SURGEON, BENGAL ESTABLISHMENT; INSPECTING MEDICAL OFFICER OF DISPENSARIES IN BURDWAN; CORRESPONDING MEMBER OF THE GLASGOW MEDICO-CHIRURGICAL SOCIETY.

### Calcutta.

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1874.



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# ARCHIBALD BILLING, M. A., M. D., F. R. S., &c.

THIS

THE FIRST WORK OF THE AUTHOR

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DEDICATED

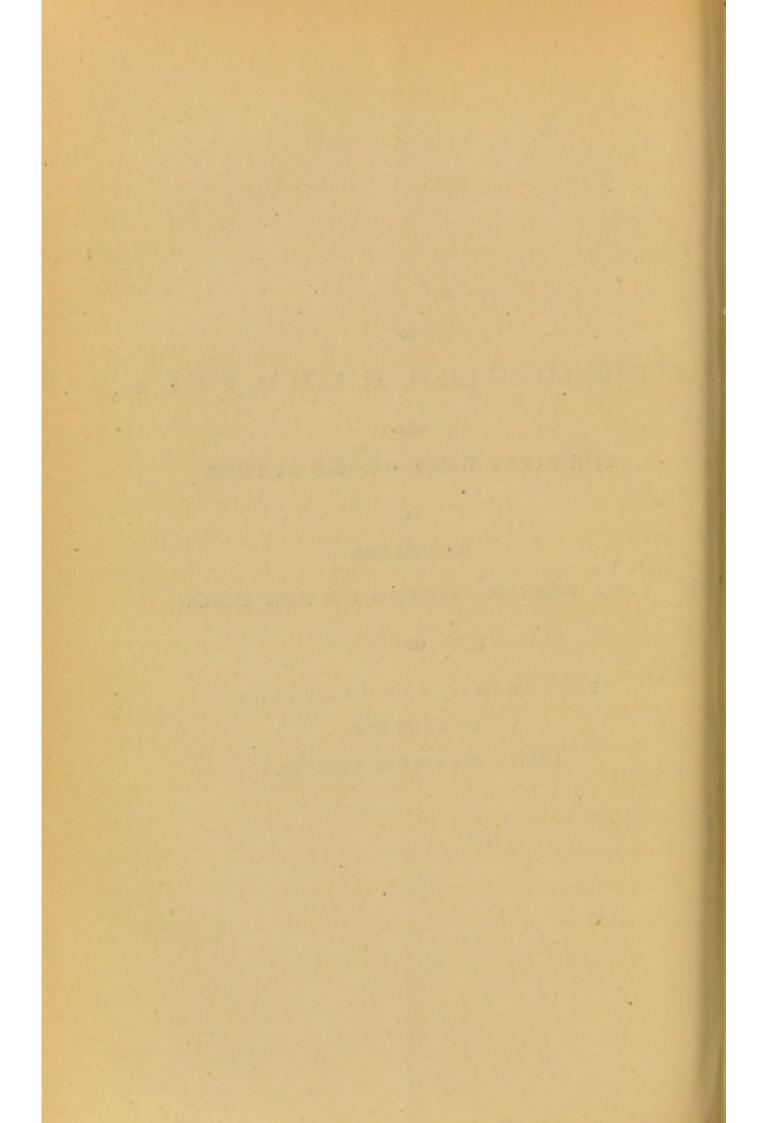
AS A TOKEN OF GRATITUDE FOR MANY MARKS

OF

FRIENDSHIP AND SYMPATHY

SHOWN TO HIM

DURING HIS STAY IN ENGLAND.



### PREFACE.

In the following Essay the writer lays no claim to originality, nor does he pretend to throw any more light on the mysterious subject of the etiology of the fever that has been devastating Bengal for some years past, than might be elicited from a survey of those causes that are palpable violations of broad sanitary principles. The essay has been based upon nearly two years' experience and observation in the affected district of Burdwan, and was originally undertaken to take its chance in the competition for the prize which was so graciously offered by his Excellency the Viceroy of India. Unfortunately it was then submitted in such a crude and disjointed form from want of sufficient time and leisure, that it met with the fate it deserved. Since then, enlarged by the addition of much new matter, it appeared in series in the Calcutta Journal of Medicine. A few copies of the complete Essay has been reprinted for circulation among friends and Journalists, in the hope that the facts herein contained might lead to further research on a subject which demands the earnest attention of the profession, the community and the Government.

Burdwan, July 1874.

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### THE BURDWAN FEVER.

### 1.—CAUSES.

The devastation of the Epidemic has a very sad tale to tell. Countries that once smiled with peace, health and prosperity, have been turned into hot-beds of disease, misery and death. Villages that once rang with the cheerful merry tone of healthful infants, now resound with loud bewailings and lamentations. Huts, which offered too little space to their occupants, are left without a tenant. The skulls of human beings have ceased to shock the sight,-they now strew the fields at every few yards' distance. And this deplorable condition has come on and is continuing in defiance of the strenuous effort of the Government to limit its area of devastations. Clever brains have been employed in the solution of the problem, as how best to meet the foe in the face and stop its onward march; experiences and observations of Special Commissions have been called upon to solve the nature of the disease and its probable source of origin. But after all, the phenomena of nature have remained a "mystery" up to the present day and a sealed book to the eyes of mortals. The fell disease has mocked every human effort and absorbed in its powerful grasp day by day and inch by inch every blessed spot which once used to be prized for its salubrity.

To trace the course of this disease will be a very interesting task. Some 50 years ago in 1824 it made its appearance in Jessore and then stepped into Nuddea in 1856. The depopulation it caused at Oola first

created alarm and drew public notice. Four years after, it extended itself into the district of Hughly and encroached upon Kanchrapara. Here it raged vehemently and spread into Halishahar, Tribeni, Culna and Guptipara in succession. Whilst it was making onward progress to the west, both the banks of the Hughly became affected, and the villages on either side of it up and down simultaneously presented one melancholy scene. From Tribeni it passed into Mugra, and thence to Panduah in 1862. Here it divided itself into two courses. The one, following a steady northwesterly route along the railway line to Mamari, reached Burdwan in 1869. The other branched off to Dwarbasini south-west, and reached Parambo and Shabazar where it committed dreadful havocs. Overleaping an extent of territory not less than 20 miles in area, it broke out next year at Coomurgunge, followed by an outbreak at Jehanabad. The year following, 1864, from Parambo and Shabazar it proceeded northwest by the eastern bank of the Damudar in a straight line to Jamalpore and Selimabad, where it appeared in 1869. Thence it spread in a northerly direction and met the first course at Mamari. Thus the whole district became one continuous scene of disease, and for some time the fever hovered round the eastern bank till in 2 years more it crossed over to Sreekristopore and Jotseram. Now from Jehanabad, as from a common centre, it spread northwards to Chandoor, Bulchand, Akloky-westwards to Goghat, Kamarpookur as far as Kotulpore, eastwards to Mayapore, Krishnanagore, and southwards to Bally and Hajeepore. The northern course spread into the

villages higher up till it was joined by the southward extension of the disease from Burdwan. In the district of Burdwan itself its outbreak was simultaneous, and no history of priority or lateness can be made out from the statement of the villagers. It has since spread to Boodbood, Munglecote, Cutwa, and latterly has shown itself in its worst form in some of the villages of Beerbhoom and Midnapoor.

It will assist us much in our future inquiry to trace once for all the physical geography of the Delta of the Ganges and the topography of Lower Bengal with reference to its rivers and canals. The whole of Lower Bengal is situated on the Delta of the Ganges, which consists of numerous streams and branches that cut up the land in a network. Here empty also the Padma, the Brahmaputra, the Damudar, the Rupnarayan, &c., after a long winding course, washing several tracts of country of which they are virtually the drainage channels. In the rainy season some of them bring down volumes of water in which a large quantity of earthy matter is suspended. It is said that a glass of water taken out at this time of the year contains about one part of mud in four. "The violence of the tropical rains and the fineness of the alluvial particles in Bengal cause the waters of the Ganges to be charged with foreign matter to an extent wholly unequalled by any large European river during the greatest floods. The Ganges frequently sweeps down large islands, and Colebrooke relates examples of the rapid filling up of some branches of the river and the excavation of new channels where the number of square miles of soil removed in a short time is astonishing, the column of earth being 114ft high.

Forty miles are mentioned as having been carried away in one district in the course of a few years. If we compare the proportion of mud, as given by Rennel, with his computation of the quantity of water discharged, very striking results are obtained. If it were true that the Ganges in the flood season contained one part in four of mud, we shall then be obliged to suppose that there passes down every four days a quantity of mud equal in volume to the water which is discharged in the course of 24 hours. If the mud be assumed to be equal to one half of the sp. gr. of granite, the weight of matter daily carried down in the flood seasons would be equal to 74 times the weight of the great pyramid of Egypt."

The swelling of the rivers in the rainy seasons and the overflowing of their banks form a characteristic feature of the rivers of Bengal. On account of this inundation the countries immediately bordering the banks are elevated more and more with deposit of alluvial sediment and are in a considerably higher level than the inland plains for some distance. This slope from the river to the plains should be borne in mind in connection with the question of drainage of the villages. The width of the rivers increases in proportion to their proximity to the ocean. A small rivulet expands into a wide stream as it rolls on to empty its water into the neighbouring sea. In proportion to its expansion, the rapidity of its current gets lessened and the deposit of fragments of stone and mud at its mouth is the result. Thus great changes take place in the Delta of a river by the prolongation of land and encroachment upon the sea by

the formation of sand banks, by the filling up and silting up of its bed, by evacuation of the bed of the river from one portion, and the opening out of a new channel in the other. These changes are more prone to occur in the mouths of the streams that are fed by the surface washings of the villages in the rainy season, than in the mouths of those fed by the melting of snow. Although most of these rivers get dried and their beds silted up after the rains, yet at the next rainy season they are opened out afresh by the force of the current, and afford the same facility to the drainage of villages. Circumstances might, however, so happen as to offer material impediment to the discharge of this drainage water by the narrowing of the mouth of each out-let caused by the firm setting of the deposit.

The effect of the inundation is partly advantageous and partly injurious to the soil. When this water does not stand long in the plains but is swiftly carried away by the khals which are the feeders of the larger streams, it adds to the fertility of the land by deposits of silt. Besides, it flushes the land and is a great purifying agency. It replenishes the tanks and carries away the aquatic vegetation. But when it is allowed to stagnate long, it turns the plains into unproductive marshes, which change is still more characteristic if the water of inundation holds suspended in it a large quantity of sand. This stagnation of water impregnates the soil with moisture and favours excessive growth of vegetation.

The soil of Bengal consists mostly of a mixture of sand and clay in different proportions. The superficial stratum contains a preponderance of silica which in

some places forms the entire bulk. The stratum deeper down consists of tenacious clay of different degrees of depth which is very glutinous and retentive of moisture. The water percolates through this very tardily unless the clay is mixed up with a large quantity of sand, which allows filtration through its interstices. Still further down the sandy permeable layer is met with. In digging a well, generally the shaft must be sunk to a depth of 16 ft. before any water can be obtained. Sometimes water is reached more superficially, but at other times a good depth has to be dug into. The clay, consisting of salts of potash, lime, alum, silica and organic matter, is peculiarly favourable to vegetable growth. As I have mentioned above, water percolates through this soil very slowly and it can be well understood that, with a heavy rainfall in Bengal if there exists any impediment to the superficial drainage, the water will slowly sink in and impregnate the soil with dampness. The greater the depth of this stratum of clay the more effective will the impediment prove itself.

The towns and villages in Bengal are generally built on an elevated piece of ground which slopes towards the fields. They consist of an aggregation of huts with narrow lanes and by-lanes. The mud, for the construction of huts, is generally dug out of a portion of land facing the intended dwelling. The economical habits of the Hindoo prompt him to leave the pit thus formed unfilled up, which the surface washings of the rainy season convert into a water reservoir used for all household purposes. Here are washed and emptied all the refuse of the house, here is formed a convenient tank for bathing for the zenana, and from this polluted source, water for cooking, if not for drinking, is in most cases supplied. This tank is made to serve as a drainage-reservoir of the neighbourhood, and receives surface washings of the rainy season. It is seldom that its proprietor spends money to clear its bottom, which in time becomes filled up with stinking mud. The water of it becomes so obnoxious as to become unfit for any purpose. The setting of the layer of mud materially obstructs the flow of subsoil water.

Besides these tanks which form the standing drainage reservoirs, there are running streams or khals which carry away the surplus water to the neighbouring fields or rivers. These khals are numerous and correspond one for each village, some are even navigable at one end and pass by the name of Nuddee, as the Kana Nudee, Sarswati khal, &c. Were it not for their agency, the places, far removed from the river bank, would have been uninhabitable and uuproductive from the extent of water that would have deluged their surfaces. The khals sometimes lead into lowlying tracts where, in the absence of an outlet, the ground remains under water for 12 months in the year. These Jullas, as they are called, are not numerous, and generally they have some sort of communication with a neighbouring stream. But it is not the inland places alone that require the agency of the khals for their drainage. For, owing to the condition previously mentioned, viz., the height of the villages being greater towards the river and their slope away from it, these also do not discharge their water into the river direct,

but the water will have to be carried into it through the same intermediate channels. It will thus be seen how useful these natural drainage channels are for the integrity of the villages ; for any interference with them will seriously upset the balance of health of the villages of which they are the drainage outlets.

I have already said that the villages stand higher than the surrounding fields which separate one from the other. The extent of the fields is three or four times greater than the superficial area of the villages. In process of time every bit of that land has been brought under rice cultivation, so that the rice fields present an uninterrupted sight for miles around in the harvest season. It is the peculiar nature of the crop that the fields should remain at least one foot under water before a good out-turn can be expected. This water is prevented from flowing out by als or bunds that bound the field of every individual peasant. Assuming eighty inches as the amount of rainfall in one season, more than one seventh of it has no outlet and is allowed to saturate the ground. This shallow sheet of water, spread over miles and miles, must necessarily affect the hygrometric state of the atmosphere and cause subsoil dampness. Besides, the decomposition of the stumps of rice-stalk, left after reaping the harvest, ought to be a fruitful cause of unhealthiness. Accordingly we observe Bengal enjoying the unenviable notoriety of being the hot-bed of fever which is ever endemic and rages with peculiar violence in that season of the year when the subsidence of water from the face of the earth affords greater facility to decomposition.

After these preliminary observations, we will be in a better position to find out for ourselves the causes that have been in operation to bring about the present state of unhealthiness. The public are too much given to the train of thought that the cause of malaria must be a new agency, or at least one, that was not at all in operation previous to the present outbreak, as if all causes are followed immediately by their respective results. They discard any view or theory if it assumes a cause that has been in existence for some time past. Thus if one tries to show that the soil is badly drained, the sceptic is ready with his argument that the same drainage operations had existed from the earliest date of his recollection. Again, if one points out that the ponds and the rice-fields are injurious, he will be equally disbelived since it would be urged, they are of no less than fifty years' standing. Thus inquirers are led to unravel the mystery in the unknown phenomena of the celestial world, or seek the aid of electricity in the solution of all difficult problems. We forget that there is in nature, pervading all her phenomena, the principle of toleration. An act might pass as innocuous as long as it is within this limited bound, but directly that limit is overreached when a manifestation of disagreeable symptoms shows the reluctance on her part to pass the affair without notice. A glutton may indulge himself in his pleasant repasts for years and years without coming to grief, till at last a stage will be arrived at when the digestion will become impaired, and an obstinate diarrhœa will bring his blissful existence to an end. A drunkard may have his dram with impunity,

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but the cumulative effect of it will show itself subsequently in a sudden attack of delirium tremens. Instances like these might be multiplied to show that we need not rack our brains to find out an unknown agency for the explanation of the fever, but bearing in mind that line of argument, it will be easy to fix on some, out of hundred and one causes, that have made Bengal a habitat of Malarious fever. We will presently show that it is the Endemic disease which has now assumed the virulence and spreading character of an epidemic. The causes of this epidemicity we will discuss afterwards when we have done with the mention of those that primarily engrafted the disease on the land.

Under these are included—(A) seasonal peculiarities, as variations of temperature and moisture, (B) want of sanitary arrangements in Bengal villages, and (c) dampness of soil. Other causes are assumed to explain the spread of it, as (D) over-population and poverty, (E) contagion, and (F) epidemic influence.

(A) Dr. Saunders attributes the generation of fever chiefly and solely to seasonal influence. The land in Bengal is partly submerged during the rainy season, and there is excessive wetness of the soil everywhere : but the sky during the monsoon months continues to be overcast, the necessary consequence of which is that very slight evaporation from the surface takes place, the diurnal variations in the temperature being unimportant. But when the sky clears in the month of September, or, in some years, in October, and the land has been more or less drained of the surplusage of water in the rice-plains of Bengal, then very rapid evaporation goes on from the surface, the atmosphere becomes surcharged with moisture, and, with the advanced season of the year, the daily range of the thermometer varies from 18 to 25 degrees. It is the continuance of these conditions which excites an enfeebled state of the system, and prostrates large masses of the community with disease, in this season of the year. Most of these poor creatures have to labor in the open air and exposed to a temperature of 140° in the sun's rays during the working hours of the day, the early morning temperature being as low as 60°. These variations of temperature and variations in the hygrometric condition of the air, act injuriously upon the impoverished, half-clad and under-fed inhabitants, and prove trying to their constitutions.

In support of his argument Dr. Saunders gives the degrees of variation of temperature and moisture in the different months of the year, the sum and substance of which may be taken to be the following :---

The variation of temperature in June is 8.1, in July 5.6, in Agust 6, in Setember 6.4, in October 8.6, in November 14.7, in December 16.3, in January and February 16.9, in March 16.5, in April 15.2, in May 12.9.

Range of moisture in June .2, in July .14, Agust .15, in September .17, in October .35, in November .3, in December .32, in January .32, in February .37, in March .4, in April .36, in May .3.

Hence it will be seen that the range of temperature is progessively on the increase from October till the maximum is reached in February when it again begins to decline. The hygrometric condition also varies and ( 12 )

the range is greater from October till March when the variation reaches its height. Both these conditions therefore are most marked, and must exert their baneful influence with greater certainty in the month of February, when the range of temperature is great and the quantity of moisture existing in the air is very variable at different times of the day. But is this in harmony with the actual condition of health of the people? The January and February months in Bengal, prior to the appearance of the Epidemic, always showed a small number of fever cases, and, even in this unhealthy time, improvement begins to manifest itself, directly the month of Feburary is reached. October and November are, in fact, the most unhealthy months with reference to fever, when, according to the Hindu proverb, the eight portals of death are open to receive the departed mortals. Yet according to the table above given, these months do not occupy the foremost place. Dr. Saunders places some stress on the fact that these high ranges must be associated with actual intense cold and not with continuous warmth. Even then January ought to be the fever-month instead of October, which last in Bengal is scarcely reckoned amongst the winter months.

(B) Bengal villages are noted for want of sanitation and cleanliness, and the habits of the people tend to make them more filthy and fruitful hot-beds of disease. The arrangement of the huts in one block prevents ventilation and purification of air. Besides, the rooms are low and are not provided with a sufficient number of windows for perflation of air. The floors are damp and perhaps an only mat forms all the necessary fur-

niture of a peasant's cottage. Close to his door are tied the bullocks, the companions of his toil, whose excreta are allowed to collect in heaps and rot for the whole year to supply him with manure for his next harvest. Careless and indifferent, he does not mind about cleanliness, and the whole surrounding area is allowed to remain fallow, and gets overgrown with rank vegetation. Cesspools, pits and marshes exist at every step, and nobody thinks it his business either to fill them up or cut out a drain for outlet. His poverty does not allow him to clothe himself sufficiently, and thus scantily clad, he is exposed to all variations of temperature ; he is engaged the whole day in his fields from the beginning of the rainy season to the end of winter, ploughing, sowing, mowing, reaping, thrashing, &c., and working for hours and hours whilst wading ankle-deep in mud. His diet is meagre and not sufficiently nutritious, and sometimes he is content to have a single meal a day. The disposal of the dead is by cremation in the case of Hindus, and by burial in the case of Mahometans ; cremation takes place by the side of a stream or pond ; and burial is had recourse to either in the compound or close by. No place is considered more suited for easing oneself than the bank of a river or the side of a tank, from which perhaps the village draws its whole water-supply. When all these conditions, with a number of other minor ones, are placed before the reader, should he wonder to be told that disease has broken out in the locality and is carrying away numbers of victims! Why, sanitary science will be a mockery if better health and lower mortality could have been compatible

with such deplorable condition that I have described. But when on the other side of the scale we place the villages, that are exempt from this pestilence, though they enjoy equal advantage as regards sanitary measures, our belief on this as the originator of the disaster becomes much shaken. It can hardly be denied that the greatest mortality has been in the most populous villages, where there has been a greater accumulation of filth and dirt, and those have been more slow to recover where jungles, bamboo topes, cesspits and tanks abound. The part, which want of sanitation has played in the Epidemic, has therefore greater reference to the predisposition and aggravation of the disease than to its immediate causation.

Out of these headings of general insanitation two have been more signalised than the rest, viz., jungles and bad water. When the fever first showed itself in the district of Hughly, the exuberance of vegetation was pointedly marked out as the chief cause of unhealthiness. With eager desire to nip the growing evil in the bud a wholesale order was given to free the villages of vegetation. The mania was carried to such an extreme that mangoe topes and other fruit trees were cut down much to the distress and loss of the owners. It is not large trees, but the perennial shrubs which die every year and rot and decompose on the ground, that are objectionable. The existence of excessive jungle undoubtedly gives rise to a peculiar smell which can be perceived directly on entering a jungly village from an open field. The bamoo sheds so much leaves that a cluster of them will 'carpet' the ground thick to some distance around. It has been

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argued that jungles and fever have not proved themselves commensurate, and on the other hand, that jungle-free villages have suffered as much as the rest. My general experience does not tally with the opinion herein expressed, as, with a very few exceptions, I can safely assert that both bear some degree of relationship. Of course I do not include under jungles any thick plantation of large trees, but only rank growth of wild shrubs and bush wood. Jungles are the indication of a moist condition of the soil, with which they bear a certain relation. Excessive jungle implies supersaturation of the soil with moisture which, as we will presently observe, is itself a fruitful cause of disease. Villages bordering the river side are more jungly as a rule, than those far removed to the interior. In some dry rocky soils of the North-Western and Central Provinces scarcely a shrub grows, and in those localities enlarged spleen is a medical curiosity. The places on the right bank of the Damudar, as Shadeepore, Jotseram Sreekristopore, are very jungly and the virulence of the fever was proportionate, whilst others, on the same side and more inland with less jungles, as Sankta, Dhamuaree, Soobuldah, Oochalun, Kytee, Chuck Chundu, suffered less. Some have specified particular classes of jungle as more objectionable, but, with the restriction I have given above, I am not partial to any variety. The growth of Belatee Bharenda is by some looked upon as very significant, but if this plant has grown more abundantly of late than any other, it is simply because it is more tenacious of vitality.

The belief is common that bad water is the source of local unhealthiness, and some go the length of asserting that Malaria is due simply to an impure water-supply. Whether there is any particular ingredient in this bad water which is productive of malaria I am not aware

of; nor would I give it more credit than that by deteriorating the general standard of health, it paves the way for all endemic or epidemic diseases. One broad fact militates strongly against this theory. The places where malaria first showed itself are those bordering the river side, and the progress of the disease in the Jehanabad circle will show that it spread inland from the banks of the Damudar and the Darkessur. Now these are the very places that for 8 months in the year enjoy the benefit of pure wholesome river-water. The villages on the Hughly as Kanchrapara, Halishahar, Tribeni, Guptipara are all on the banks of the river. The water here is as pure as that of Barrackpore, which we take for our standard for the sake of convenience, and yet they fared worst in the visitation of the epidemic. It is but fair to mention that those villages which I will presently point out as having suffered least are those that enjoyed, along with other advantages, a good water-supply. Dr. Smith believes that 'where there is an ample and pure supply of water there is as a rule comparatively little fever.' But he adds 'instances of exceptional character where people drink good tank-water yet great mortality has occurred. On the other hand at Polashee on the Koontee the people, having no tanks near them, drink the water of the old half-dried-up river, a source by no means inviting, and yet it is a fact that the place does not seem ever to have been particularly unhealthy, and that mortality of late years has undoubtedly been low.' The bunding up of the mouths

of some rivers and canals has undoubtedly deteriorated the water-supply of the district through which they passed. For according to the Hindu idea of looking upon every running stream as pure and holy, the water-supply is chiefly drawn from such sources, and the integrity of tanks in those villages is consequently never preserved. The sudden cutting off of that supply will sooner or later show itself on the already depraved health of the inhabitants. This is just the condition of the villages through which the Kana Nudee used to flow, the closing of which, opposite Selimabad, has given rise to loud outcries on the part of the villagers who justly attribute their sickly state of health to that injudicious step of the Government. One who has personally witnessed the bed of the Kana Nudee from Haralla for some miles down, will fully sympathise with them in this belief. In places where crystal water was once procurable, shallow pools have been left overgrown with decaying vegetation and teeming with animalcules.\* The other evil effects of bunds thrown across water-outlets will be dwelt upon under the next heading of causation.

(c) Medical opinion has been almost unanimous in attributing the present unhealthy state of the country to dampness of soil and increased subsoil moisture. The evidence on this point, however, is purely an inferential one, for it must be borne in mind that when we speak of increased moisture, we have no previous data wherewith to make any comparison. No one knows what the subsoil water level of those districts

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<sup>\*</sup> We are glad to notice that since the above was written, Government have undertaken to commence operations at the point the Kana Nuddee took its departure from the Damudar, with a view to open out its channel.

was previous to the outbreak of the fever; but we base our conclusions on the following facts :---

1st.—That the fever is not persistent but varies in its severity with the change of season, beginning when the rainy season sets in, reaching its climax when the ground is thoroughly saturated, and gradually abating and remaining in abeyance when the powerful summer sun dries up the ground to cracks and fissures.

2nd.—It is more severe in the year attended with unusual rainfall.

3rd.-Comparative freedom of places situated within the zone of fever, which have every thing in common with the rest, excepting an elevated site and dryness of soil. Although these facts are sufficiently significant, yet I must confess that personal inquiry from the villagers leads to no definite result. Thus I have failed to elicit the opinion from their own observation that their soil has become more damp of late, or that the khals carry water more tardily than before. I have seen tanks dug in some of these feverstricken places to the depth of 21 feet without reaching the water level; and Mr. Metcalfe records his experiment of a shaft sunk in the bed of the Banka river to the depth of 8 ft. without oozing of water from any side. But my own observation as well as that of Mr. Metcalfe was taken in summer when, as some writer wittily remarked, the soil is so dry that 'we might as well expect to draw blood out of stone as water from the parched-up ground in that season.'

Supposing the dampness of soil to be co-existent with malaria, the question remains to be solved, how has that dampness been induced ? Several causes present themselves to our observation : (a) Naturally heavy and sometimes unnaturally heavy and unequal rain-falls, (b) Inundation, (c) Peculiarity of soil and its property of retaining moisture, (d) Existence of tanks and unreclaimed marshes and rice-fields, (e) Naturally defective drainage, (f) Obstructed drainage, either artificial as by bunding up the course of water channels by dams, weirs, rail-roads, &c., or natural, as by alteration in the courses of rivers and silting up of their beds.

(a). No doubt, all these causes have been operating to bring about the unhealthy condition, and we cannot apportion the share which each has in its generation. A peculiarity of climate in the tropics is the constant down-pour of rain in certain seasons of the year, the rain-fall sometimes amounting from 80 to 100 inches. There should be good slope and efficient drains to remove this excess of water, which must otherwise sink in, or collect in stagnant pools. The villages have never had any surface drains, but, as has been observed in the preceding pages, the water obeying the natural law of finding its level, makes its way out. The constancy of the action, repeated year after year, works out a channel or khal which ends by discharging into some navigable stream. This natural drainage is always insufficient for a plain tract of country without any undulation for several hundred miles in extent. Artificial draining is strongly indicated, in absence of which the soil remains permanently damp, and malaria becomes endemic.

(b). The effects of inundation I have already pointed out before. It is the slow subsidence of water from the face of the villages that acts injuriously on the health, otherwise experience shows that the flushing of the villages has the salutary influence of scouring the ground and sweeping away impurities. The inundation after a heavy rain-fall is known to give rise to increase of fever.

(c). The peculiarity of soil helps in some degree to impregnate itself with moisture. The superficial portion being a mixture of clay and sand in excess, the water rapidly percolates through it, till it meets with an obstacle in the adhesive alluvial stratum. The greater the thickness of this layer the more prolonged will the obstruction be and the saturation more complete. Under such circumstances, the generation of malaria will be but a question of time. I do not think this point has received the due attention it deserves, and as yet engineering observations are wanting to establish the extent of this condition with the proportionate amount of unhealthiness in the land.

(d). No Bengal village can be found where tanks are not found at every few yards' distance; unless the structure of the soil is so sandy as to offer material obstacles to their existence. Thus at Kanchrapara no tank or even a well can exist long without being filled up by the falling in of the sides. The tanks that have no raised earthen mounds on their banks are practically the drainage reservoirs, and draw into them the drainage water. Having no outlet they are virtually deep obstructed drains. When deep they draw into them subsoil moisture, but the constant deposit of ground-washings so fills up their beds and closes their interstices that they cease to act as such. It is a known fact that the bed of an old dry tank will not fill in by percolation of water unless it is dug out a few feet deeper; that whereas water will begin to ooze after a depth of 15 ft. is dug into a fresh soil, the beds of the old tank must be dug deeper than 20 ft. before water will make its appearance. This obstruction to free subterranean current will have a tendency to make the soil water-logged. The houses bordering the tanks are damp and are looked upon as unhealthy.

From a very remote period low marshy soils have been noted as hot-beds of malaria. The Campagna of Rome and the plains of Algeria, may be cited as notorious examples. From time immemorial they have been justly dreaded for their unhealthiness. We have two constant conditions existing in the marshes, namely, moisture and decaying vegetation. Hence moisture and decaying vegetation, wherever observed, have, from a very ancient date, become synonymous with malaria. That these two factors are the principal unhealthy agents, have been shown by positive proofs, for by eliminating them from the soil by drainage and proper cultivation, a once unhealthy spot may be converted into a healthy one. Such has been the case with the Roman marshes, and such also is the history of improvement of Algeria, as is testified by the Report of Royal Commission of 1870. Such is also the case with the Port Canning Reclamation land which, at its first occupation, was found nearly uninhabitable, whilst a few years of sanitary work have built a town, where formerly tigers and wild beasts prowled and roamed with undisturbed felicity. We have in Bengal marshes which go by the name of jullas, and the saucer-shaped depression existing between Hughly and Burdwan cannot but have a prejudicial influence.

The area of these natural marshes is utterly insignificant compared to the area that has been virtually turned into a marsh by the extensive cultivation of rice in lower Bengal. The increasing population must have caused an increasing demand for their staple article of food, which was still more in requisition from the increased export of grain which has received unprecedented encouragement of late. This has led every peasant to engage himself in its production as the sure means of profit, and every bit of marginal land that formerly remained fallow has now been brought under the plough. So much has rice cultivation increased that even in the hearts of villages patches of land have not heen spared to yield a crop. Hence we have moisture and vegetable decomposition going on to an extent which has no parallel in any other country. The proximity of rice-fields is always considered unhealthy on that account, and a province with extensive rice cultivation is much below par in its standard of health. Barcelona and other places in the West Indies were so malarious during the harvest season that the people had to desert the neighbourhood for six months to escape its deadly influence. Orders were passed forbidding any cultivation of rice for some distance from the confines of inhabited land. Jessore, Burrisal, Backergunge and other places in Eastern Bengal enjoyed the unenviable notoriety of being at all times the habitat of fever, whilst the Hughly and Burdwan districts were in the height of their blissful state of healthiness. Those are the very districts that have at all times supplied not only the whole of Bengal but other countries with their produce of rice, and how far the endemicity of fever in those

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districts was the effect of that extensive rice cultivation further observations should corroborate. For the present, the following facts may be adduced in proof of the supposition :-- 1st.-- That with the increase of rice cultivation in the districts of Hughly and Burdwan the fever has made its appearance in these places. 2nd.-That the fever continues as long as the fields are under water from September to January, and begins to abate just after the harvest is reaped and the fields dry up. Rice cultivation is objectionable not per se but on account of moisture and vegetable decomposition that are the necessary attendants on such conditions. It has been objected to by some on the ground that other places have suffered that have no contiguous rice-fields, as if rice-fields alone were obnoxious to health. Those, who advance such objections, evidently forget that the cultivation of rice necessitates a certain violation of sanitary principles which could be also brought about by a hundred other agencies. That rice cultivation is one of the very powerful means of rendering the soil humid, can be satisfactorily made out by inspection of the country in the fever season, when it will be found that though the villages are dry, and their water drained off, there is stagnation in every field, the extent of whose surface in square miles is, at the lowest estimate, three times as great as that of the villages themselves.

(e). I have mentioned before that a great part of the drainage water passes into the tanks and the rest flows out into the fields and thence into the khals, by which channels it is ultimately disposed of. All these standing drainage reservoirs are defective and insufficient. Defective, because, being stationary and not having any outlet, they must necessarily impregnate the surrounding country with subsoil moisture. A running drain is undoubtedly preferable to a stagnant one, and is more effective in its operation. The only running drain that carries the rain-water is the khal that skirts along the border of the village. Its breadth and depth are in most cases quite insufficient for the volume of water that has to be removed. Besides, the obstruction the water meets with in passing out of every field is too great a hindrance. Supposing the khals had been deep and broad enough for drainage purposes, and their channels down to their ultimate destination patent throughout without any obstruction or silting up of river, would the drainage of fields and villages, I ask, be perfect? Would not the bunding of the individual fields keep in the water and prevent its flowing out? I have witnessed the ponding of water in patches of fields very close to the water outlet, and I am at a loss to find out any means for obviating this evil, unless a thorough system of irrigation is introduced, making it unnecessary for the peasant to retain water in his field for the supply of the whole season. These preventive measures will be dwelt upon hereafter.

(f). Under the heading of drainage, great stress has been laid on the obstruction which has been offered to the khals artificially by embankments thrown across them, or naturally by the natural deltaic influence interfering very much with the capacity and patency of a stream. Artificial obstruction is mainly caused by bund raised across the khal to retain water in its bed for agricultural and domestic purposes, or by the

construction of a high earthen embankment round a village to prevent any damage from the inundationwater getting into it. I have personally investigated the instances of the former kind of obstruction met with in the Jehanabad subdivision which were pointedly marked out by the writer of 'The Epidemic fever in Bengal' as have been the immediate cause of the outbreak of fever. As the pamphlet carried with it an appearance of authority and conviction, and created a sensation among those interested in the subject, we give them in the author's own words :-- ' The subdivisional town of Jehanabad is situated on the eastern bank of the Dwarkessur river. Its drainage, following the laws we have already explained, flowed into the paddy fields lying to the North-east of the town whence a part of it used to fall into the Kana Nudee. But the major portion, after passing over the paddy fields, collected in the Byra Julla and thence discharged into the Kana Nudee through Gurbari khal. This khal, pursuing a serpentine course, traverses a large tract of country and, receiving the drainage of a large number of other villages besides that of Jehanabad, opens into the Kana Nudee at a place called Gopinathpore. Its mouth was closed by the Zemindar through whose property it passed in the Bengali year 1273 (A.D. 1866 and 1867) for the purpose of retaining water on the rice-fields which are very high and from which the monsoon water ran off into the Khal. This closure helped to keep the khal full, and at the same time rendered it incapable of receiving the drainage from the paddy fields, and the latter in their turn failed to draw water from the villages of which they

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were the drainage media. This lock-up was followed by the outbreak of an epidemic almost simultaneously in all the villages of which the khal was the drainage outlet;—in a mitigated form in the year immediately succeeding the one in which the khal was closed and virulently the year after' (Pp. 15, 16).

Again: 'In the same tract of country and for precisely the same purpose, another stream, called the Koko Nudee, which was the drainage channel of a large number of villages and which likewise emptied itself into the Kana Nudee, was similarly closed at its mouth at Dhurrumpota in the same year, viz., 1866-67, and the same was followed shortly after by an outbreak of epidemic fever in a number of villages, &c. We should here mention that the cross dam over this khal is provided with an apology for a sluice which is so adjusted as to let out the water only when the khal is full to overflowing and when the crop of the adjoining fields is likely to suffer from excess of moisture. This of course does not help the drainage of the villages in as much as the whole of this tract is very high and the villages situated therein are not much higher than the surrounding paddy fields. The consequence is that the khals and the paddy fields being full do not draw the drainage from the adjoining villages.'

The authenticity and correctness of these remarks have been shaken by the following result of a personal investigation recorded on the 13th May 1873. 'I paid a visit this afternoon to the bund at Paharpore (close to Gopinathpore.) It is 30 feet broad at its base and about 15 feet in altitude and extends right ( 27 )

across the Gurbari khal very close to the point where it discharges its water into the Kana Nudee. The villagers, invited to give information on the point, told me that the bund had been in existence about 20 years ago and remained in working order for 8 years, shutting in the water completely. In the event of an inundation they used to have a side-cutting to let out the excess of water. This always retained water in the khal and kept it full even in summer. After 8 years' satisfactory working a portion of it was washed away by heavy rain. The gap remained open for four years producing much scarcity of crop in absence of water until in 1866-67 it was reconstructed by the zemindar Baboo Joy Kissen Mookerjee. Sufficient earth was thrown over the remnant out of the original bund so as to raise it 2 feet higher than the former level; but the next year's flood washed away the northern extremity of the embankment, causing a breach about 18 feet wide, spacious enough for a full current to pass with freedom. The people suffered much from want of good water both for drinking and agricultural purposes, there being no drinkable tank in the village ! So virtually no obstruction existed for five years previous to the outbreak of the epidemic, and at the time the fever did make its appearance the obstruction was no longer in existence and the khal was patent throughout and remained so up to June 1873, when at the urgent request of the inhabitants the bund was reconstructed with a side channel higher up for the drainage of surplusage of water. I am happy to state that the reconstruction of it last year before the rains has not materially affected the

health of the district which, if at all, has shown signs of improvement of late. In reference to the para. on the Koko Nudee, I submit the following fact :- The 13th May 1873. I visited the Koko Nudee and the bund. The khal or stream has its source at Sonagachee and ends at Dhurmopota by joining with the Kana Nudee. The present bund was constructed about 8 years ago and the fever has broken out only 3 years ago. It was in perfect condition for 7 years but gave way only last year through pressure of water. The engineering mechanism displayed in its construction was such as to preclude any idea of obstruction, for whilst it retained a certain quantity of water, it always let out by a side opening above a certain level, the excess of drainage water. The outflow was constant and efficient enough in as much as the water in the khal never overflowed its banks as long as the bund was in perfect condition, whilst it retained water enough for agricultural purposes. Now before the construction of the present cross dam, about 13 years ago there was a pucca wall with a sluice to let out the excess of water. At times the pressure of the water behind was so great as to make it impossible for the valve to be raised when the water would flow over it and find its exit. In three years the whole work came to pieces, when the present mechanism was substituted. But antecedent to this again, from a time beyond recollection, the people were in the habit of bunding up the mouth by earthen mounds which were as often washed away on account of the dead opposition they offered. Thus we find three systems of embankments resorted to at different times. The first

or old system in which a dead barrier was offered and as often washed away. The second improvement consisted of a pucca wall with a sluice to let out occasionally the excess of water. And the third or the last one which had the advantage of a continuous outflow. Now, which of the three offered the most impediment to drainage we need not take time to consider, and yet it was during the operation of the last method (i. e. only 3 years ago) when the flow was so constant and the obstruction so little that the banks never overflowed, that the fever first broke out."

The bunding up of the Kana Nudee at its mouth had a different motive however. Its object was not to retain water in the khal but to prevent its entering and inundating the tract in its vicinity. It allowed the beds of the khals to carry on the drainage uninterruptedly as before, but in the absence of the deepening effect of a running stream the bed of the Kana Nudee became partially filled up. One mouth of the Nudee is open,-that which joins the Saraswati khal and towards which the drainage level inclines. The closure being at its other mouth, it can be presumed that the embankment has not so much injured the locality by depriving it of its draining agency, as by keeping the channel dry in that season of the year when there is no water to be carried away, it has damaged the health of the district by depriving it of a source of its good water-supply. Everywhere in its course the outcry of the villagers is bad water and scarcity of water, but I found very few attribute the fever to the obstruction and insufficient exit of the drainage.

In rainy weather I found the bed of the Kana Nudee containing water to the depth of 5 or 6 feet which had drained into it from the adjacent villages. Since the above was written, the Government has been awakened to the necessity of opening out the channel and turning into it the water of the Damoodah. More than 20 years ago the bed of the Kana Nudee formed the original course of the river, but it was closed up opposite Selimabad to prevent the overflowing of its banks and causing damage to rail-roads that passed through its area. Its bed silted up next year but the force of the current opened out for itself 2 fresh channel. The small stream that communicated with the Damoodah at this portion expanded into a wide river that flowed south-east through Amtah to discharge itself into the Hughli close to the point where the Roopanarain empties itself also. Thus the course of the main channel was turned. Whilst one district was deprived of the agency of a running stream another had the advantage and disadvantage of the same. If the closing of one channel be supposed to give rise to local unhealthiness, the substitution of another with similar conditions in another part of the country ought to be attended with corresponding improvement. But when after 20 years we fail to observe any such beneficial change, we are forced to the conclusion that the unhealthiness of the district forming both the present and past bed of the Damoodah is independent of deficient drainage. However, now that the Kana Nudee has been opened out anew the fact will be proved to demonstration by observing the health of the district next year through which it will flow.

The other cross-dams and weirs are raised for the purpose of fishery or to irrigate the fields in the dry season, but they are never undertaken before September when the water from the village has all drained off, and what remains in the khal is nothing compared to what had been discharged. To attempt to close a stream in the height of the rains with an earthen mound the power of cohesion amongst whose particles is so feeble that the slightest moisture dissolves it, is to under-estimate the hydraulic force of a body of water. For, as yet I have not seen any earthen dam strong enough to oppose the action of a sheet of running-water for any length of time without giving way to the pressure behind. In most of the Kutcha roads recently constructed I have seen water-courses so obstructed, in some instances with an apology for a culvert or none at all, but these roads give way to the continual pressure of water, wide breaches are thus made which have to be crossed over in the rainy season by means of canoes and rafts. Thus the new road which passes from Jehanabad to Bally have five such breaches in the course of two miles. No doubt they did offer some impediment to drainage at the commencement, but if the outbreak of fever be attributed solely to their construction, now that the obstruction has given way, the fever ought to disappear along with the removal of the cause. But its persistence clearly indicates some cause more potent and more constant in its nature.

New roads in the subdivision of Jehanabad, to which district alone my observations are chiefly confined, have not sprung up of late, excepting two or three kutcha roads running for short distances. As I have just remarked, the obstruction offered by them is not so wide-spread as to account for fever all over the country. Besides, the first appearance of the disease was at Kumargunge, a village situated on the southern bank of the Dwarkessur and entirely beyond the influence of the roads that are on its northern side.

As for the agency of rail-roads in the production of the disease, one fact negatives the belief, namely, that the epidemic devastated "Oola" and other places prior to their construction, and that the places that suffered most are far beyond their influence. Thus Jehanabad is about 28 miles from the nearest railway station, and yet it, with all its adjoining villages, suffered most in the late visitation. The unanimous opinions of the Engineers commissioned to report on the matter prove, 'that there was no ponding up of water on the up as compared with the down stream side of embankments, that there is ample water-way through existing culverts; that as a rule, there is no difference in rice crops on the two sides, and lastly that there is no fixed relation between the unhealthiness of villages and their proximity to roads or railway embankments, that, consequently, such works cannot fairly be considered as sources of obstruction to drainage or the causes of local unhealthiness.' However, Dr. Smith takes exception to the succeeding remarks and says-'that although no ponding up of water may be conspicuous, an amount of subsoil stagnation may occur sufficient to be locally prejudicial to health; such an effect might be produced whilst there was but a very slight difference in the levels of surface-water

on the opposite sides of an embankment.' The universal nature of the outbreak in Lower Bengal precludes the idea of its generation in local obstructions to drainage, which can only account for the outbreak in villages under their immediate influence, and certainly not in others, which own altogether different systems of khals and rivers. Nor has the fact been established that all the villages without exception have had their drainage obstructed likewise. This leads us to the discussion of the next heading of causation, viz :=

(g). Alteration in the course of rivers and silting up of their mouths. On referring to the bed of the river Hughly it will be found, that for the last century it has deviated from its original course. Thus villages have been absorbed in its watery bed and new ones have sprung up where heavy laden boats once sailed with impunity. The village of Kanchrapara, which was very severely visited by fever, has its old site in the bed of the river. I am myself a native of the place, and I was told by my parents, that about half a centuary ago our family dwelling house that now stands on the very bank of the river, was the easternmost boundary of the village. Similar reports will be told of Guptipara and Sentipur where at present extensive sandbanks have been left indicative of the encroachment of the water and its subsequent subsidence. Analogous history also will be told of the Bhagirati, the Damudah and the Dwarkessur. In fact the encroachment on one bank and the retiring from the other form the characteristic feature of the rivers in India. This change is more perceptible at the mouth

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of the river than at its origin; hence the places on the former are more liable to change in their physical condition than the latter. Any obstruction at its mouth will necessarily cause the rising of the subsoil water-level in the immediate neighbourhood, which by capillary attraction will pass also to the villages adjacent. Thus year after year more places will come under the influence of dampness and get in their turn desolated by fever. This view of the question gets some countenance from the fact of the slow spread of the Epidemic from one place to another, and to the places, bordering the river side, having been previously and more severely affected than those situated further inland. But the manner of its subsequent subsidence does not lend any further support to this hypothesis. For whilst the country primarily affected begins to improve, new ones continue to be desolated, and this improvement cannot be coexistent when both own a general drainage medium. Besides, the filling up of the mouths of rivers is an hypothesis not supported by actual experiment, --- an hypothesis which is opposed to the fact that in the height of the flood of the Damudah rising from 15 to 20 feet in the course of a night the whole of that immense bulk of water is drained away in the course of 24 or 48 hours.

Whenever the waters recede and leave an extensive sandy tract, any khal that might have discharged its water at that point is partially or entirely obstructed at its point of outlet. Thus the Bagare khal, through which the drainage of Kancharapara finds its exit into the river, has the sandbank just opposite to it, and how far this hinderance or the railways, which have been accredited with the result, are to be blamed for the local unhealthiness is not an easy matter to solve.

But as I have explained that whilst the river recedes from one bank it encroaches upon the land on the other, it may be presumed that the same obstruction does not exist on the opposite side, and yet when both of them are equally affected as Tribeni and Kanchrapara, it makes the subject somewhat mysterious. In the subdivision of Jehanabad, Kumargunge was first affected and it was for some time that this bank had been giving way, yet there was scarcely any difference in the amount of fever between this and Akloky situated on the other side.

It is a recorded fact that some of the rivers have silted up. The Kana Nudee of Jehanabad was once as big a stream as the Dwarkessar which here divided into two branches; one, passing through Chandur, Myapur and Khanakul, was continuous with the Rupnarain at Bukshee, and the other passed through Balee and became a tributary to the Rupnarain some miles below Ghatal. The heavy flooding that took place some 50 years ago, threw up so much sand that its bed was filled up completely and was raised much higher than the original level. The course of the stream was altered and the bed was planted with mango-trees and cultivated for rice crops. The portion beyond the division now carries simply the drainage of the district to the Rupnarain and remains dry in the summer season. Dr. Dutt mentions the extinction of a channel called the Baluka whose course he has traced for a distance of 10 or 15 miles from Burdwan. At Myapur

the Ratnagar khal has dried up for upwards of a century which once kept up the communication between the Dwarkessur and the Moondeshary. Investigation on this point would bring to light a host of other minor channels that have dried up from a period varying from 20 to 100 years. Such a length of time has transpired since then and the outbreak of fever that one hesitates to assign more share to it than that its influence, if any, must be a slow one and not powerfully active. For directly after the closure of one channel the pent-up water makes for it a second outlet and the difficulty is removed. Besides, in absence of any other reliable information if we are to trust to the experience of the ignorant villagers it should be mentioned that their belief is that the water flows in equally strong current and volume as it used to do of old, and that the existing rivers and khals are emptied after inundation as efficiently and quickly as they used

Thus whilst denying to each and all of the foregoing causes the credit of bringing about the present outbreak of fever in an Epidemic form, I admit that they are active enough to engraft it as endemic of the soil. They have been in operation for ages past and the fever has co-existed with them. All investigations to establish some special change in them to account for the extra virulence of the poison have proved disappointing. Some of them no doubt have been acting lately in an aggravated form but they also fail to supply a general explanation. Thus with the advance of years general insanitation has been neglected and more filth accumulated in the villages. The general

to be some years back.

causes of dampness have slowly and gradually increased and the increasing rice cultivation in Lower Bengal has added still more to exaggerate the evil. Yet something more is wanting to explain the explosive way in which the disease showed itself. This will lead us to the consideration of those causes which we have termed as immediate or exciting.

First. Poverty, over-crowding and deficient vital energy. The Government of India, I believe, have partly subscribed to this view, originally promulgated by Col. Haig and supported by Dr. Saunders. It implies that endemic disease has become general not from any increased potency of 'malaria' but from diminished power of resistance in the constitution of the people, brought on by over-crowding, insufficient food and general poverty. To support the existence of this condition in society they had recourse to the doctrine of Malthus. For the benefit of general readers I will quote it as it has been briefly given in Mill's Political Economy.

'The power of multiplication inherent in all organic life may be regarded as infinite. There is no one species of vegetable or animal which, if the earth were entirely abandoned to it and to the things on which it feeds, would not, in a small number of years, overspread every region of the globe of which the climate was compatible with its existence. The degree of possible rapidity is different in different orders of beings, but in all, it is sufficient for the earth to be very speedily filled up. There are many species of vegetables of which a single plant will produce in one year the germs of a thousand. If only two comes to maturity, in 14 years the two will have multiplied to 16,000 and more. It is but a moderate case of fecundity in animals to be capable of quadrupling their numbers in a single year. If they do as much in half a century 10,000 will have swelled within two centuries to upwards of two millions and a half. The capacity of increase is necessarily in a geometrical progression, the numerical ratio alone is different. To this property of organized beings the human species forms no exception. Its power of increase is indefinite and the actual multiplication would be extraordinarily rapid if the power were exercised to the utmost. The capacity of multiplication in the human species exceeds even this where the climate is good and early marriages usual. It is a very low estimate of the capacity of increase if we only assume that in a good sanitary condition of the people, each generation may be double the number of the generation which preceded it.'--- 'Now as to the causes which keep the actual increase of mankind within limit. What prevents the population of hares and rabbits from overstocking the earth ? No want of fecundity but causes very different; many enemies and insufficient subsistence ; not enough to eat and liability to being eaten. In the human race which is not generally subject to the latter inconvenience, the equivalents for it are war and disease. If the multiplication of mankind proceeded only like that of the other animals, from a manner with theirs, the births would be as numerous as the physical constitution of the species admitted of, the population would be kept down by deaths. In a very backward state of society like that of many parts of Asia at present, population is kept down by actual starvation. The starvation does not take place in ordinary years but in seasons of scarcity, which in those states of society, are much more frequent and more extreme than Europe is accustomed to. In these seasons actual want, or the maladies consequent on it, carry off numbers of population which, in a succession of favourable years, again expands to be again cruelly decimated.'

Basing their theory on this fact of political economy they have been led to look upon the fever as a natural sequence brought on by overcrowding and ill nourishment. That just before the epidemic cruelly ravaged the district of Hughly and Burdwan, the population had increased to a considerable extent, having been kept up by early marriage which is a necessary institution of Hindu Society both among the high and low classes and the animal instinct of propagation with which the Hindus look upon the multiplication of species, is a fact which cannot be gainsaid, especially when we take into account the previous salubrity of climate for a great portion of the year for which these districts were famous. Every villager will testify to the crowded population which 'graced' every village before the wholesale illness was threatened. The evil effects of overcrowding show themselves only in families where the sanitary principle is violated, and it is not likely that every family should have been overstocked at the same time. Besides, the well-to-do classes and the European community were free from such culpable neglect. The lower classes spend most part of their time in out-door employments, and phthisis,

which is most common under such conditions, is a rare disease in Bengal. Hence, whatever might be said in its favor as being a predisposing cause, certainly over-population cannot be assumed to have had any more share in its immediate causation and spread. The second part of the doctrine points to gradual introduction of poverty in society on account of increased multiplication of the race without any corresponding increase in its productive resources. It is very true that before the appearance of the Epidemic there was a semblance of prosperity all over the country. But prosperity was limited to the upper few, and was not the lot of the peasant community which form the bulk of village population. The custom of leasing out lands for cultivation with no limited rate of rent, and the exorbitant demand of half its produce by the Zemindars, often leaves a small margin for the benefit of the cultivator who has to cope at the same time with the disadvantage of general increase in the price of all domestic necessaries. Besides, the superceding of some native manufactures, such as cloths, &c., by foreign supply has greatly pauperized the resources of the working classes. It is pitiable to observe the condition to which competition has brought down the weavers that people mostly the district of Jehanabad, and it is to be regretted that no sort of protection has been afforded to that honest body of workmen by the Government by putting a stop to unfair competition in the market. These are the classes of people on whom the brunt of the disease has fallen most severely. The introduction of manufacture in the Jails is another instance of how the income of the working

classes has been encroached upon. The facility of transport, now existing all over the country by the establishment of rail-roads, has raised the price of necessaries with the increasing demand. The combination of all these circumstances more than counterbalances the triffing gain which the peasant class enjoyed from the produce of their labour on account of the increased demand and exportation of rice for foreign supply. The daily nourishment of the poor people has continued the same, consisting of rice, and salt and vegetables. Fish and milk, of which they occasonally partook, have become a rare luxury on account of their increased price, and the wear and tear, to which they were now liable more than before on account of greater labour called for to produce a larger quantity of rice both for home and foreign consumption, must have induced a failing stamina of health. A weak fortress gives way at the first assault, and a weak constitution succumbs under the presence of a poison against which a stronger one maintains its ground for some time with success.

But taking for granted the actual poverty of the people, can it be said that paupurism knows no distinction with reference to any portion of society at large? Do the Zemindars feed less than before, and do the civil European Officers with their princely incomes come under the same category? Yet scarcely one instance can be cited of persons living in and breathing the tainted atmosphere who have been completely free from its influence. All my inquiries on the subject have enabled me to establish one point, namely, that the working classes have suffered most and amongst them

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the greatest mortality has taken place. Out of them again those remain still serviceable for work who command better incomes. I am afraid to give my countenance to a belief which is likely to prove injurious to society, but I must confess that the general opinion is, that those that have recourse to some sort of narcotics as wine, tobacco, or gunjah, have fared better than those who do not. Poverty does not bring about the disease primarily, for the villages in Bengal are at par with reference to the condition of their inhabitants, and yet why should the Burdwan district receive the preference to others claiming similiar disadvantages. But when once the disease is introduced into the system, poverty plays a very important part in retarding convalescence, bringing on repeated relapses after fatigue and exertion, and hurrying on those sequelæ, from the complication of which the patient finds himself impossible to extricate. Thus the greatest mortality has been amongst the poor workingclasses, whilst the rich have escaped with very little suffering, but no party have enjoyed absolute immunity.

The second theory, advanced to explain the immediate spread of the Epidemic, is the superaddition of the element of contagion in the original disease that helps it to spread from village to village through the agency of human intercourse. The facts on which this view is grounded can be briefly summarized. First, that the fever has spread along the railway line. Second, in places beyond the railway the villages more severely 'affected lie on the line of the Grand Trunk Road.' Third, the simultaneous appearance of disease amongst the members of the same family. And Fourth, the spread of disease from one village to that adjacent.

Some facts bearing on the question and brought to light by some Inspecting Staff a year subsequent to the actual disease, gave the theory a shade of importance. He found out in his inquiry that one village in the district of Burdwan succumbed to disease after a few patients from the epidemic-stricken locality had taken their refuge in it with actual fever in their person.

Those, who have any thing to do with any local inquiry, will attest to the difficulty, nay sometimes the impossibility, of getting at truth from the ignorant villagers when dates are concerned, and especially when they extend beyond a year. In several local researches I made about the out-break of Cholera, I found out that unless the history was traced within a few days of its occurrence it was past record and observation. The first appearnce of Cholera always makes a greater noise and creates a greater sensation than Fever which, on account of its very commonness, will pass unobserved and unnoticed. When therefore with regard to Cholera the difficulty to trace its first appearance is so great, a fortiori it amounts to impracticability with regard to other less attractive diseases, especially when the investigation is made a year subsequent to their occurrence. The facts brought forward by contagionists are either not wholly true or may be accounted for in a different way altogether. First, the Fever has not taken the course of the Railway line but has spread from Mugra north, south, and west without observing any definite route. Second,

the mortality has been heaviest in large towns and populous villages, which generally stand on the Grand Trunk Road. Third, the simultaneous appearance of the disease amongst members of the same family previously enjoying freedom from it, is owing to general perversion of the air. Thus, amongst my own household I was first attacked in July. After one week, my eldest girl, who used to sleep in an adjoining room, was next affected, then my wife, and subsequently the servants. In a fortnight every person went through his turn of illness. But it is to be remembered that the appearance of the disease is sudden. The very week, in which myself and my family were the sufferers, brought on universal disaster over the length and breadth of the district. The communicability of a disease cannot be satisfactorily traced when the Epidemic is at its height and when the prevalence of the disease is universal. But during its decline it is not uncommon to meet with sporadic cases of the worst type in individuals who have never imparted the disease to their immediate attendants. I can cite at least one hundred instances under my personal observation, and I seldom observed more than one case of fever amongst the members of the same house from April to July. After July the fever becomes generally wide-spread, and any conclusion arrived at during its height, must be accepted with caution and reserve. The contagious nature of the fever being thus discarded, its fanciful resemblance to typhus or relapsing fever, will at once come to the ground. The difference will be more manifest when we come to treat of the symptoms and progress.

The theory, which in my opinion satisfactorily accounts for this explosive outburst of disease, is the one by which all visitations of epidemic diseases are generally explained, viz., the assumption of the existence of some climatic change which feeds, as it were, the active principle of the disease and favours its multiplication. The causes I have before enumerated are each and all sufficient to stamp the country with an endemic malarious fever. No one will deny the fact that the three months after the subsidence of the rains throughout India, especially in Bengal, have received the unenviable notoriety of being called the fever-months. The fever, prevalent about this time, though not so general and wide-spread as the present one, is of sufficient virulence to count numbers of victims. Following the close of the rainy season and fixing for its particular habitat, the alluvial soil of Bengal, rich with organic vegetable matter, the fever has been naturally associated with these conditions in the relation of effect to cause. Whatever the term malaria may signify, we understand by it that invisible agent which is generated from moisture and vegetable decomposition. Nor does the idea seem to be based on mere hyphothetical grounds inasmuch as their combination and sequences are so constant that given the two factors, the nonproduction of the disease will form a medical curiosity. In Burdwan this fever has borne such constant relation, in its period of appearance and intensity, to the time of setting in of the rains and the quantity of rainfall, that one would not go far beyond the mark if one were to prognosticate on these data the severity of the fever with which the country might be visited.

Thus, whilst in the preceding years fever commenced early in consequence of the early setting in of the rainy season, this year (1873) the rains having been late, the appearance of the disease has been correspondingly late. In fact it was not till August that it showed itself in the district.

It is in the intensity and gravity of their results that the epidemic disease differs from the endemic. But the former presents some peculiarities which can hardly be explained by the simple endemic theory. Its main feature is, as we have shown already, that it is travelling, slowly indeed, but, as some have remarked, yet travelling. Excluding from our consideration the outbreak in Jessore in 1824, we have found it in our own time to have travelled in 13 years from Nuddea to Hughly, from Hughly to Burdwan, and from Burdwan to Midnapore and Bancoorah in an uninterrupted course. Unlike the sweeping but uncertain marches of cholera and small-pox, its progress has been slow and sure, unmarked by fluctuations indemnifying from its ravages particular tracts of country, but all the contiguous villages within the range of its fell influence, have been one after another absorbed in the general vortex of disaster. The first year of invasion is characterised by an increase of ordinary fever cases, but it subsides completely with the advance of the season ; the second year counts more victims and the duration of disease becomes longer. With the prolonged suffering the complications begin to appear. A little respite is enjoyed in summer by those who are free of complications but only to suffer again in the ensuing rains. In the third year more mortality takes

tions, as it finds the system so reduced from constant suffering that it is ill fitted to sustain an assault. Enlargement of the spleen and the liver, anasarca, anæmia, ascites, cancrum oris now become common sights. In summer, instead of improving, the suffering continues. In the fourth year a slight abatement of its severity is observed, but fatal cases occur amongst chronic patients who succumb under the slight causes of exhaustion. In the fifth year, improvement is more manifest and the temporary abeyance in summer again shows itself. In the sixth year, the majority recover, gaining in flesh and strength, but a permanently enlarged spleen is left behind to indicate the trial through which the locality has recently passed. The insidious way, in which one village after another is attacked, decimated, and restored to its former condition without any apparent change in the habits of the people or the aspect of the country, points to something more than fixed local causes. During the prevalence of the fever, the people become more and more pauperised, sanitary conditions are neglected and the villages wear a deserted appearance. Under such unfavourable conditions an endemic disease is more likely to be intensified than mitigated with the advance of years. We have observed that difference of soil, difference of drainage, and difference of water-supply furnish no explanation of its present intensity. The drainage of the town of Burdwan, I have examined to be as perfect as it can be wished, only there is one Railway feeder that intercepts to some extent the water-course of the neighbourhood. And yet as

regards sufferings and mortality it has become the worst locality in the district. Places on high laterite soil in Beerbhoom have not been exempt, whilst villages that are regularly swamped by inundation of the Damudah, have suffered to a very small extent. The following general facts may be mentioned as the result of my investigation in the villages under my own immediate jurisdiction.

1st. The large populous villages have suffered most.

2nd. Those bordering the river side are worse off than those further inland and more elevated.

3rd. Places with better sanitary arrangements recover before others.

I have not seen perfect restoration to health in any village in the Jehanabad circle, but the standard of health varies according to difference in the sanitary condition.

I have stated my belief that the disease, rendered endemic from the various ordinary and extraordinary causes in operation, has now taken an *Epidemic* character by a peculiar climatic influence. I will now proceed to explain its modus operandi consistent with the facts previously noticed. The climatic agency, the presence of which in the air converts endemic diseases into epidemic, we will for the sake of convenience call the ferment. Small-pox or cholera is known to prove more virulent and more liable to spread one year than another. This excessive mortality cannot be accounted for in any other way than by the supposition of the existence of some toxic agent in the air which feeds, as it were, the active principle of disease, and makes it more potent. The active principle of every disease requires a soil or nidus for its growth, without which it will wither or die out. Small-pox, introduced into a deserted island, will cease to spread. It requires the soil of the human organism for its growth and

the soil of the human organism for its growth and development. In the same way it will die out in a society if there is no susceptible individual to receive it in his system, as it has been stamped out of countries where by the law of the state every individual is protected by vaccination. Given this favourable soil, cases of small-pox will be generated *ad infinitum*. Dengue, when once let loose amongst a community where it was previously unknown, manifested its influence in a wide-spread epidemic, which disappeared as the susceptibility of the individuals wore out and the soil was exhausted.

Malaria differs from these animal poisons in the mode of its generation and multiplication, being independent of human agency. It owns the earth for its habitat. A deserted place, or a jungle, is as deadly as, sometimes more than, an inhabited locality. It may multiply itself ad infinitum in the soil till it is so much intensified as to taint the very air. There are records of armies having got disabled by simply marching through malarious swamps. Thus we have two classes of poisons to deal with, one owning a human soil for its generation and multiplication, the other the earth. The activity of the earth-soil is far inferior to the activity and changes going on in the human system. The greater the activity the more rapid is the reproduction of the poison, and the more rapid the reproduction the more rapid is its spread beyond The affected area. Hence the multiplication of malaria

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being slow, the extension of it is correspondingly slow. Unlike the rapid strides of cholera and small-pox, the influence of malaria is confined within the village where it is generated, and when it does spread, it is limited to places in its immediate vicinity. In a favourable season, the poison of cholera and small-pox will take root, breed, and multiply when wafted across from one place to another if it can find materials to feed upon. But malaria under similar circumstances will just be able to communicate itself to the place adjoining it.

I have observed that every poison requires a favourable soil to be endemic in a country, and it is the addition of a ferment in the air that gives it an increased potency and thus converts it into an epidemic agency. The action of this agent in malaria is akin to that of yeast in a saccharine solution, a particle of which introduced into the latter will so disturb the equilibrium of the particles just surrounding it as to give rise to a fermentative change. This fermenting influence will be gradually communicated to that next to it, and so on, till slowly the change is brought over the whole area as long as there remains a grain of sugar for decomposition. When the boundary is reached, where the solution does not contain ingredients favourable for such changes, the fermentation stops. The larger the quantity of the sugar, the stronger will be the dynamical action. Similarly we have in the soil ingredients for fermentation supplied and kept up by all the causes that we have previously enumerated, viz., dead and decaying vegetable matter and excessive rainfall, bad and insufficient drainage, rice cultivation, retentive nature of clay, silting up of canals

and rivers. By the long continued action of accumulating filth, the ferment is generated,-the spark is supplied to blow up the whole into a flame. This influence is communicated to the adjoining village, till it in its turn affects other contiguous ones. Thus in a series of years, devastation spreads from one village to another. It is thus the disease has travelled from Nuddea to Midnapore. In places, which the ferment has not yet reached, the fever is absent or only endemic according to the nature of the soil. This theory accounts satisfactorily for the causation and spread of the disease. I have gone through the several items of food, habits and clothing of the people as well as the nature of the soil and drainage of the villages, and arrived at such contradictory results that I verily believe that they are of secondary importance, capable of aggravating but not of primarily inducing this perverted state of health.

## 2.—Symptoms.

I have already observed that the fever prevailing in Burdwan does not differ materially from what used to ravage the district towards the end of the rainy season. It is of malarious origin, and varies in type according to the severity of the poison and the constitution of the recipient. The characteristic feature of malarious diseases is their periodicity and tendency to recurrence. The longer intervals of health indicate a system less influenced by malaria, whilst a stronger dose of the same will induce in the same individual less and less of intermission, till the fever will merge into the remittent or continued type. Thus one would pass through the phases of quartan, tertian, quotidian, double quotidian, remittent, or continued, and the danger to life will increase as the climax is reached. All the varieties are changeable from one to the other, and do not in themselves form distinct species. Thus in the first year of the epidemic, cases of the continued and remittent types are observed, which are mentioned by the native Kavirajs as Jwar bikár. As the severity declines it becomes quotidian and ultimately quartan. The last type of fever prevails exclusively in the district of Burdwan, and shows that the poison is wearing itself out. The new cases are observed only in August and September, when the subsidence of water from the face of the earth gives fresh impetus to the generation of malaria.

The mode of attack of the villages one after another is very peculiar. In the first year, the villages adjacent to an epidemic-stricken locality will show at the close of the rains more of ordinary fever cases and greater mortality than usual. But this, being virtually nothing more than what they are accustomed to in some fever season, will not create any alarm or grave apprehension. With the approach of winter, the fever disappears and the people congratulate themselves on the change. The old cases recover and continue their ordinary avocations. The second rainy season brings with it a recurrence of the disease, which this time becomes more general. Nearly every member of every bousehold is affected, and the village is panic-stricken. Deaths from acute fever run high, and those that survive are marked for constant recurrence of the same. With the prolonged suffering, complications begin to appear, such as enlarged spleen, liver, anasarca, &c.

Late in winter a respite is obtained which continues till a third rainy season brings on with it fresh suffering. The mortality this year is heavier, not from acute disease, but amongst chronic patients who succumb under slight depressing causes. The suffering being general, there is seldom any person spared in a family to attend to the sick. Instead of improving in summer, the fever continues, as well as the mortality, which takes place from dysentery, anasarca and cancrum oris. In the fourth year, death from acute fever becomes still less, but the chronic cases swell the list of mortality. Slight abatement in its severity is again observed in summer, when the fever, formerly quotidian, takes on a quartan type. In the fifth year the virulence is much spent. Though the people suffer, they are yet able to attend to their duties and earn their livelihood. Fever with them becomes a natural phenomenon. Unless it be a very strong attack, it never deters them from eating, drinking, and bathing as usual. In this condition some recover their flesh enough to show an apparently healthy appearance. Medication is no longer resorted to, and to all intents and purposes, there is restoration of health, peace and tranquility. A great many yet suffer from quartan fever, but as I have already said, their system gets so accustomed to the suffering that they do not attach much importance to this state. In the majority a permanently enlarged indurated spleen is left, but it becomes a part and parcel of the necessary constituents of their body. Most of them would remain without fever for months or years and yet their spleens remain undiminished in size. The slightest cause however upsets their balance of health, and every now and then cases occur, which are hurled on from bad to worse and ultimately terminate fatally. When this state of thing continues, which is more marked in the sixth year, we pronounce a village as restored or recovered. I have not yet seen a village perfectly regain its former salubrity, though some of those, that were less affected and less populous and possessed better sanitary arrange ments, have approached a condition very near to it. Some villages bordering the line of the epidemic wen only through two stages of illness and have nov rallied.

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Whilst the village affected goes through its stages c desolation, other new ones are absorbed in the vorte: of disaster. The encroachment is slow and goes on extending one year after another till in 12 years' time the epidemic has travelled, before our very eyes, from east to south-west, an extent of territory no less than 70 to 80 miles. I have not met with any village in my jurisdiction which has been completely indemnified from its ravages. But there are certainly some tracts of country to be found here and there, where the visitation has been less disastrous. Their topographical condition and the habits of their inhabitants will form another chapter of our discourse. The extension has taken place more towards west than south and more towards south than north, whilst be it remarked that the drainage level of the district runs from north-west to south-east. Often a river-course has deterred its onward progress for years, nay at places the boundary line of health and disease has been abruptly defined.

This slow but sure travelling of the disease and its invasion of one village after another, have given rise to the suggestion of the epidemic being not of malarious origin, but consisting of some such element that bears the stamp of contagion. Dr. Verchere in Burdwan and Dr. Greene in Serampore sounded the alarm note respectively of the fevers being typhus and typhoid in nature. These epidemics, they assert, leave the system so enfeebled that it becomes an easy. prey to malaria which is endemic to the soil, and from the constant recurrence of which the people suffer off and on. A great many other writers incline to the view of communicability, though they do not differentiate the types.

Dr. Elliot inclines to the belief that the fever in Burdwan possessed decided power of communicability, and the Deputy Inspector-General Dr. Sutherland subscribes to the same opinion. According to him, it appears 'that a fever of a highly infectious character may originate and spread from intensified malarious influences, aided probably by bad ventilation and the emanations from the bodies of the sick. That the fever, described by Dr. Elliot, did assume an infectious character, I do not doubt, and that the excessive mortality in certain localities depended on this is, I think, rendered highly probable, but it is only in certain favourable conditions that such a result would occur, and if the ordinary endemic fever of the place exists at the same time, the fact of there being an intercurrent wave of infectious fever may be easily overlooked. In the long period that has elapsed since the first appearance of epidemic fever in Jessore in 1824 up to the present date, it is very probable that fevers of very different characters prevailed.' That

the disease broke out in all its virulence as contagious. and in two years changed its peculiar characteristics and assumed a milder form, cannot be easily credited, since what is now observed is nothing more than the continuation of the first outbreak which has softened down in its intensity. The apparent show of contagiousness which has misled some observers, arose probably from the fact of the simultaneous appearance of disease amongst the members of the same family. Thus in July, I was the first person attacked in my house, then my eldest girl, who used to sleep in an adjoining room, next my wife, and last of all the servants. But it should be borne in mind that the week, which saw all of us laid up in bed one after another, was the one when universal disturbance was manifest in the district. In Burdwan itself other officers, such as the Magistrate and the District Engineer, suffered also and sickened the same week, though we had no intercommunication. The simultaneous appearance of disease amongst members of the same family or of different ones proves nothing more than general perversion of the air. The period in which the power of communicability can be satisfactorily traced is the one when the fever is on the decline and when the suffering, instead of becoming universal, is confined to a few individuals. It is not uncommon then to find sporadic cases of remittent or continued fevers of the worst type, and I can confidently say that out of numerous instances of that nature brought to my notice and some of them ending fatally, I have never seen a second case of the same type in the same

house and seldom two in one village. At the very height of an epidemic, when the cause is powerfully operative, every one is subject to it alike, and of course those are more liable who undergo bodily and mental strain by waiting on their sick relations. Under such circumstances, it is expected that case after case would take place in the same house without any contagion to account for it. If it had been limited to the members of one house whilst the others enjoyed absolute freedom, as occurs in an outbreak of cholera, the theory of contagion would have been undeniable. But in the present epidemic the suffering is acknowledged to have been universal and no family was spared, the priority of attack being determined by the predisposition which exhaustion and fatigue would lead to.

It has been observed that towards the end of winter and just when the hot summer sets in, a few fresh cases of remittent fever come under treatment. These take place mostly in boys under 15 years of age and take a dangerous turn. They are very obstinate in their course and run on for 10 or 15 days continuously, bringing on great prostration and emaciation. They are essentially in their type analogous to the virulent fever observed at the commencement of the rains, only they are confined to a few individuals and have no tendency to spread. These are the cases that I have mentioned previously as sporadic, and from which II have deduced my conviction of the non-contagious character of the fever. Their per centage of mortality is great, though they generally mark for their victims those that had shaken off their previous illness and had apparently recovered. In the ensuing season from

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the month of March such cases begin to show them. selves, and those that have hitherto been brought to my notice have presented well marked brain complications from the very outset, which have ended fatally in some instances. The cause 'of this sudden manifestation has not been satisfactorily made out. The villagers informed me that such fevers in the summer season were uncommon before the epidemic, at least they were not recognised facts. This fever has been described by many as heat-fever, appearing with the change of season, and attributable to the direct effect of solar heat on the human system. The explanation seems to me not to afford sufficient solution of the fact of the preponderating number of boys suffering as compared with adults, who from the very nature of their occupation are more exposed to this cause than the former. If this secondary period of exacerbation were solely due to the influence of heat, it is unaccountable why the same agency did not operate in previous years before the district fell a prey to malaria? One fact, however, should be mentioned as a coincident circumstance, that from the middle of February to the middle of March, the first ploughing of the land is commenced. After the last harvest is reaped, the water from the fields subsides and the ground is dried up. It becomes in a manner settled, charged as it is with remnants of manure and stumps of rice stalks. The first turning up of the soil liberates a fresh dose of malaria, which, however, is not of sufficient strength to prostrate adults who possess greater powers of resistance, yet potent enough for the constitution of boys, especially those who had shaken off its influence.

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I offer this simply as a suggestion as to how far the two circumstances can be associated in the relation of cause and effect, though I confess sufficient evidence is yet wanting to admit them as proved facts.

The first attack always proves to be of the continued or remittent type, and is looked upon as dangerous. After the prodromata of general languor, lassitude, costiveness, wandering pains, want of appetite, the fever is ushered in by a chill followed by the hot stage of several hours' duration; generally there is complete intermission in the first day, but next morning the attack recurs. The symptoms are no more exaggerated, the face becomes flushed, the thirst is intense, the tongue is thinly furred, and there is headache attended with bilious vomiting and sometimes delirium. The patient feels an intense pain in the limbs as if bruised all over. The hot stage may or may not be followed by sweating, but there is no more that feeling of ease after the lapse of a few hours. The fever remits and yet he feels thirsty, drowsy and heavy in the head. The temperature reaches its maximum and ranges between 100° to 104° with a fluctuation of 2° to 3° between the morning and the evening indications. This state continues for 3 or 4 days when the prostration becomes greater, the tongue is more thickly coated, and delirium supervenes, which takes place more often at night and is of a quiet nature. The bowels remain costive, and active purgation is very badly tolerated. On the 5th or 6th day copious sweating brings the case to a termination. If the strength be not properly supported throughout the illness, the diaphoresis may end in collapse. The skin gets cooled down to 90° or

97°, and if advantage be not taken of this period of quietude to anticipate the coming storm with good doses of quinine, we may expect in the evening a recurrence of the symptoms, and the fever tending to become intermittent, instead of continued, in character. Thus, along with the decline or severity of the disease, we have the different phases of intermittent, remittent, or continued fevers in one and the same individual, the different types being well marked both during the period of invasion and subsidence. The merging of one type of fever into another distinctly observed at its commencement and end, distinguishes it from typhus, which runs its equable course and ends in complete and sudden defervescence. Thus an ordinary case takes 7 or 8 days before convalescence is established, but when once under the influence of malarious fever, the slightest cause, as exposure, fatigue or irregularity of diet, will bring on what is ordinarily called a 'relapse.' This relapse, unlike the relapses of true relapsing fever, does not observe any regularity as to time. It is quotidian, tertian, quartan, weekly, fortnightly, or monthly, according to the capacity of the individual to withstand its effects.

Exceptional instances occur, which are too puzzling for diagnosis, in which instead of the convalescence being established in 8 or 9 days, the attack lasts longer and ultimately takes on a typhoid type. These are generally the results of neglect in seeking for early treatment, or of some peculiar idiosyncrasy in the individual. The cases continue from 2 to 3 weeks, during which a high temperature is kept up with occasional variation, the tongue, at first thickly coated

and moist, gets dry on the surface, and ultimately brown sordes collect on the teeth and lips, and petechial eruptions make their appearance. As a rule, the bowels remain costive, and it is exceptional to find looseness of bowels as a complication. When it does exist, the cases are more obstinate and take longer time to recover. Drastic, hydrogogue cathartics at this period are to be carefully avoided, as too often I have traced the sudden turn of disease from bad to worse to a dose of jalap or salt. Whilst on the one hand listlessness, drowsiness, prostration, delirium, dryness of tongue, and sordes make the case resemble an attack of typhus, on the other hand analogy is equally strong with typhoid when along with the existence of the preceding symptoms, we have a prolonged duration of illness, spots, and diarrhœa. It is no wonder that practitioners, on an imperfect observation of a few cases, should jump at a conclusion, which is so tantalizing, and startle the world with a discovery hitherto unrecognised by the profession. The differential symptoms of both will be treated of under the heading of diagnosis. The looseness, which I have spoken of as an exceptional complication, may be either of the nature of a dysentery or of a bilious flux. As a rule the spleen and the liver both become enlarged and tender. Death takes place in the second week of illness from exhaustion, or it may not take place till the 3rd or 4th week, when it is generally due to complications of the lungs. When it takes place in the first week, it is due to cerebral complication, or to a concentrated dose of the poison acting on an enfeebled constitution and bringing on sudden collapse during the sweating stage.

Death from cerebral complication is more common in villages newly affected, where after a suffering of 4 to 5 days' duration, it is not uncommon to find people struck down as it were with convulsions, coma, and death. In the majority of instances, symptoms of headache, heaviness in the head, drowsiness and delirium precede, but in others the attack is sudden. It takes place in the remittent and continued types and even in the intermittent type during the height of the paroxysm. In children, it is a common and formidable complication, as one or two such fits end in death. In adults, life may be prolonged to two, three or more days in this state of unconsciousness, but recovery is seldom observed. The patient remains on his back with the limbs stretched, rigid or flexed, pupils slightly contracted, pulse over 100 and temperature varying from 100° to 103°. Insensibility from brain complications, and that from exhaustion, can be distinguished by the following characters. The first occurs early in the course of the disease, the second later on. In the former, the insensibility is deep, the patient lies motionless, and the limbs are rigid. The temperature is invariably over 100°. In the latter, there is good deal of restlessness, patients can be roused by loud calls, and temperature is below 100°. Between the insensibility of typhus and that of malarious fever there is this distinction : That the latter is immediately preceded by head symptoms, whilst in typhus, the headache as a rule, disappears, and then coma supervenes (Murchison). Whilst in typhus death begins at the heart; in malaria it begins at the brain. The early feature in typhus is failure of the heart's action, and prostration ;

the early feature in malaria is failure of nervous functions and delirium.

The second mode of death is by exhaustion. To call a fever sthenic or asthenic is as much objectionable as to call ulcerative action healthy or unhealthy. Fever is always debilitating in its nature, more or less. It is specially so in constitutions previously under-fed and kept starving at a time when the vitality is being consumed away by increased pyrexia. This is exactly the condition with most of the poor people in Burdwan, whose time-honoured prejudices will not allow them to have recourse to nourishment as long as the active stage of fever lasts; except one or two sugar bubbles and a mouthful of water to wash them down, the patient is kept literally starving with the view of consuming away the vitiated humours. Want of nourishment brings on more prostration, and want of sufficient fluid in the system causes retention of effete nitrogenous products. These combined may manifest themselves in typhoid symptoms, which have often been mistaken for typhus fever. The rapidity with which these patients recover under simple nourishment is sometimes marvellous, and I have often had the satisfaction of restoring to life, if I may be allowed the expression, patients who were apparently too far gone into the typhoid state, by enforced administration of nourishment. Death from exhaustion seldom takes place within the first week of illness, unless, as I have previously remarked, an officious practitioner brings it about by the administration of an active purge after the 5th or 6th day.

## 3.—DIAGNOSIS.

Acute malarious fevers closely resemble in their

symptoms typhus, typhoid and relapsing fevers, but they have certain main features by which alone they can be distinguished. Without going the length of denying altogether the existence of typhus and typhoid in India, well-marked cases of which have lately come under observation, I give an emphatic denial to the statement that the present epidemic has the characteristics of the one or the other. From typhus it is distinguished by the absence of contagiousness, by the eruption and by peculiarity of temperature. Dr. Murchison states that typhus is contagious in 92 per cent. The unmistakable instances of contagion he enumerates bear no parallel in the history of the present epidemic. The cases from which the advocates of the typhus theory draw their conclusion, were treated in the police hospital of Burdwan, which consists of a hall no bigger than 40  $\times$  30 feet, in which more than 20 beds were crammed in. Indeed, the beds touched each other. The worst case was placed in the centre bed of this hall, surrounded by cases of fever of various degrees of intensity, mostly intermittent. The ventillation of the room was defective owing to the shutting in of the doors, windows and arches with mats on three sides to keep away the draught. Yet the disease was not communicated to a single patient or attendant. The seizure of the several members of the same family at a time when the fever was raging all over the district, gives a fallacious indication of contagiousness. The eruption in typhus, according to the same authority, passes through three stages : 1st, pale, dirty pink or florid ; 2nd, reddish brown or rusty ;

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3rd, livid and petechial. In the first it is slightly elevated and disappears on pressure. In the second it disappears in part and is no longer elevated. In the third it is not affected by pressure. Generally it appears on the 4th day and lasts from seven to ten days. In uncomplicated cases, as a rule, it continues till death or recovery. He lays some importance to the fact that simple petechiæ do not constitute typhus, as they are observed in the course of many other diseases both febrile and non-febrile, but a rubeoloid eruption which often becomes converted into petechia on the 8th or 9th day. These are observed in 93.2 per cent. The spots seen in the course of malarious fever appear on the side of the chest or arm on or about the middle of the 2nd week. They are present in some exceptional instances, and not until grave typhoid symptoms have supervened. It may be stated at a rough estimate that they are absent in 93 per cent. of instances. They are distinct and defined. about the size of a pin's head, and petechial, unpreceded by the stage of rubeoloid effervescence. It may be argued that in dark complexions the primary stage is not well marked. I have often watched the surface of the body for rash of any sort whatever in open daylight, but have never been able to discover either mottling or elevation, though, when we had an outbreak of measles along with it in the district, the eruptions, even in dark skin, were unmistakable. The peculiarities of temperature in malarious and in typhus fevers will at once clench the diagnosis. In typhus it attains its maximum from the fourth to the seventh day, and it is 105°. There is little change for several

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days afterwards. A slight remission is observed between the seventh and the tenth days, but on or about the 14th day it rapidly subsides to its normal standard. After the final fall, it seldom rises above 100°. In malaria, there is complete intermission on the first day. On the 2nd or 3rd day it reaches its maximum and continues with slight variation between the morning and evening indications for four or five days (in bad cases for a longer period without any definite rule) till it begins gradually to decline. From continued or remittent it takes on an intermittent character, and goes on for days unless checked by a sharp dose of quinine. The rise and fall for some days after defervescence show the peculiar termination of malarious remittent into intermittent-a termination which, if it had been typhus, would weaken the theory of specific diseases. The sequelæ from which the majority suffer will further disabuse the mind of the typhus element which was asserted to have been the initiator of the epidemic.

From typhoid fever the diagnosis is easy enough. The peculiarity of temperature in malaria, when contrasted with that of typhoid, will give a valuable clue to diagnosis. Thus, if on the 2nd or 3rd day, the temperature rises so high as 102° or 103° we can at once make up our mind that the case we have to deal with is not enteric fever. Besides, looseness of bowels, a constant element in the latter, is an exceptional attendant on malarious fever. It is a complication only of the bilious remittents, in which, however, its early appearance as a bilious flux, and the bilious vomiting and hepatic tenderness, mark the distinguish-

ing features. Remittent fevers complicated with dysentery have often been mistaken for typhoid, and more than once cases were reported to me as such by native doctors when personal inquiry revealed the true nature of the disease. In these instances, the history of the patient should be carefully sifted. In a case of acute hæmorrhagic dysentery it will require all the tact of the practitioner to differentiate the character. The gripe, the tenesmus, the constant desire to go to stool, and the nature of the stool itself, together with the history of the fever having been simultaneous with the so-called bloody evacuation, will settle the doubtful point. Cases of malaria do now and then occur in which the profuse bloody discharge from the bowels simulates what takes place in the insidious forms of typhoid, but the previous cachectic constitution in the former, the enlarged spleen, scrofulous gums and discharge of blood from other mucous passages, are conditions wanting in the latter disease. Add to these the morbid condition of Peyer's patches in typhoid or enteric fever, and we complete the list of symptoms that would serve as diagnostic between the malarious and typhoid fevers.

The analogy between malarious and relapsing fever is so distant and far that only a very powerful imagination could convert this distant analogy into an identity. I have already expressed my belief that the Burdwan fever is not contagious. Nor do the relapses observe any regularity as to the time of their appearance. The similarity consists merely in the fever being continuous for a few days and then recurring for an indefinite number of times with the least exciting cause. The diagnosis, which one forms at a distance of 70 miles without having a single case under one's direct observation, savours more of fiction than of logical distinction, and therefore does not deserve to be entertained or discussed upon.

We now proceed to describe some of the complications which are the accompaniments of the fever, and from one or other of which the majority of people in the district of Burdwan are suffering. These are what are called the

## 4.—SEQUELÆ.

The first and most frequent in order is enlargement of the spleen. It is found in at least three-fourths of the people affected, and vary considerably in size, from being just perceptible under the costal cartilages, or filling up the whole abdomen. In a female it occupied such an immense bulk that a Sub-Assistant Surgeon mistook it for an enlarged ovarian cyst and suggested operation as the only means of cure. The fixture of the tumor above and its comparative mobility at the lower end convinced him of the error in his diagnosis. In children, indurated, enlarged spleen is very common, and it is this which makes the belly so protuberant. From a distance the pot-bellied feature with distended veins on the surface of the abdomen gives an appearance of dropsy, but palpation will soon decide the question. Abscess of the spleen is a rare termination. A case was shown to me at Jehanabad as such, but on examination I satisfied myself that it was an abscess over the spleen between the layers of the abdominal muscles opposite which the

tail of the organ had contracted adhesion with the peritoneal wall. The absence of any serious symptom helped me much in arriving at the conclusion. In those in whom the organ becomes enlarged to a good size at each febrile accession and diminishes as rapidly after its subsidence, the enlargement is a fluid one from accumulation of blood, but in others it is formed of organized tissue and the feel is tough and indurated. The greater the induration the longer the time it takes in recovering. The indurated organ after the lapse of time becomes a natural constituent of the body and is compatible with health. Such is the case with people in those districts where the influence of malaria after a prolonged continuation has worn out. The enlargement is attributed to a sub-acute inflammation, but in no time of the progress of the fever is any complaint made indicative of an inflammatory action going on. Sometimes an aching pain is felt over it, but never before the organ has assumed a good bulk. The enlargement is made up of tissue that forms the trabeculæ and the investing sheath of the spleen. I consider the thickening as not an inflammatory process, but allied to natural hypertrophy due to constant fulness of the organ from stasis of blood during each paroxysm, when as a diverticulum the blood tends to collect in it. The softening of the spleen is rare, and my experience is borne out fully by the observations of other officers in this endemic district. In the absence of an opportunity for post-mortem examination, I cannot definitely say whether any death from that cause has resulted. In cases of inflammatory deposit the subsequent change of contraction is of frequent occurrence, causing atrophy of the organ. In the liver, as I will presently notice, such changes take place very often. But in the spleen my experience fails to cite one case where atrophy followed enlargement. This would have been the result, at least in some instances, if the process were altogether inflammatory. Congestion of the spleen takes place in all remittent fevers when the organ becomes enlarged and tender.

Enlargement of the liver is not so common and is observed in about twenty per cent. of patients seen. Its enlargement is generally due to sub-acute inflammation of the organ. In size I have never seen it extend below the umbilicus and it is always associated with enlarged spleen. As in all inflammatory process, pain and tenderness over the organ are felt. The inflammation ends in some instances in suppuration, giving rise to large circumscribed abscesses. Intemperate habit has nothing to do with this morbid change, as I have seen as many cases in boys as in adults whose habit was abstemious. In one out of six cases, a previous history of dysentery could be traced. The abscess points externally, with all the characteristic symptoms which it is not our object to describe in detail. Suffice it to say, that in three cases it burst through the lungs. In two of them a favourable result was obtained and the other died from its effects.

Any thickening or enlargement of the margins of the portal fissure through which the vena porte enters the substance of the organ, will lead to obstruction to the portal circulation and end in ascites. The large prominent veins on the surface of the abdomen show the obstruction offered to the venous blood, which obstruction is relieved by the effusion of serum into the peritoneal cavity. The proper secreting structure of the organ not being affected, jaundice is rarely seen.

Dropsy is the sequela with which these cases take a fatal turn. It is dependent on two different causes : 1st, hepatic; and 2nd, general. Hepatic dropsy is the result of enlargement of cirrhosis, and is seldom recovered from. The lean emaciated limbs and haggard countenance set on a bloated trunk give a most unsightly appearance. Nutrition is interfered with from the inability of the individual to take in sufficient quantity of food, and emaciation progresses till death takes place either from the pressure of the fluid inducing imperfect aeration of the blood and bronchitis or from dysentery. In most of these cases the history is, that they had suffered previously from fever with enlargement of the spleen and the liver which, however, left them to enjoy a good interval of health. The collection of fluid in the abdomen was gradual and not attended with very acute symptoms. In some a previous history of dysentery can be traced, but besides these the patients suffer at the time from no other symptoms beyond what is felt by the mechanical distension of the fluid. It is note-worthy that when habitual drunkards become the subject of malarious fever they are more liable to this turn of the disease.

General dropsy is the result of an impoverished condition of the blood. The anæmic appearance, bloated face, œdematous limbs, laxity of tissues, all point to mal-nutrition. Diarrhœa or dysentery sometimes attend these symptoms, and the patient is much reduced in strength. Irritative fever helps to lower him still more, and unless timely treated with tonics and nourishment, cancrum oris makes its appearance and puts an end to his miserable existence. It is remarkable how these patients improve when placed on a liberal and easily digestible diet, as milk and rice. The equilibrium of secretion and absorption is restored, the tissues regain their natural firmness and the œdema and peritoneal fluid are removed if the kidneys are gently acted upon. The majority of these cases are recoverable unless too far advanced. Unlike the other variety, the splenic enlargement is a common complication.

Cancrum oris mostly occurs in boys under the age of fifteen. It generally takes place towards the end of winter or beginning of summer, when after prolonged continued suffering the vitality is reduced to its lowest ebb. In the height of the fever-season other sequelæ are more common than this. It is quite unaccountable why the reduction of vital strength should be indicated by sloughing of a part, which, in the healthy state of the system, is freely supplied with blood and the injuries of which are quickly recovered from. The extent of sloughing varies from a patch of the size of a  $\frac{1}{4}$ rupee to extensive sphacelus involving the whole cheek and inducing necrosis of the superior maxilla. Horrible destruction of tissue takes place producing ghastly features. The orifice of the mouth is supplanted by a wide gap, on the floor of which the tongue moves about with a peculiar wriggling motion. Extensive lesions are seldom recovered from, but a mode-

rate degree of sloughing would heal with thickening and contraction of the surrounding tissues. Atresia oris and difficulty in opening the mouth make the future existence of the patient miserable to the end. No other condition will induce it with greater certainty than when in a broken down constitution, an acute attack of fever supervenes with dysentery. The subjects are always anæmic and possess large indurated spleens. Allied to the ulceration of the cheek, is the peculiar scorbutic condition of the gums and their ulceration. The loose teeth, swollen gums and their tendency to bleed are marked more in some season than in another. The ulceration is superficial and may expose the roots of the teeth by destroying their soft covering when they drope off. From the cheek the ulceration may extend to the hard palate and produce necrosis and perforation. Any ulceration in the cavity of the mouth gives rise to a stinking foctor. It should be borne in mind that in persons of undoubted scorbutic gums, extraction of tooth has been attended with fatal consequences. The constant oozing of blood from the socket proves too obstinate to be checked by any astringent application, and the patient dies in 24 or 48 hours from the effect of slow hæmorrhage.

Dysentery is sometimes an attendant complication of malarious fever. It is most frequent in the month of December and January, when increased cold, greater ranges of variation in hygrometry and temperature render the badly clothed peasants more liable to such attacks. It can be divided into two varieties according to their cause ; the first is due to change of season, and the second to bad and insufficient nutrition.

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The first variety occurs in persons who may or may not. be the regular subjects of fever. They present tolerable health and, as a rule, are free from splenic enlargement. The enlarged spleen acts as a safety-valve in all internal congestions with which each attack of fever is attended. If from toughness of the organ its distensibility is interfered with, the determination take place to the intestines and produce dysentery.\* This is the only explanation I can offer to the frequency of dysentery in malarious localities and which coincides with the fact of its existence mostly in persons whose spleens are not enlarged. Otherwise I deny the existence of any such disease as malarious dysentery which writers like Dr. Maclean maintain. The per centage of dysentery cases amongst hospital attendance seldom rises over five even in the worst season of the year. Such a small number will be found also in places that are not malarious, and their presence should be looked upon rather in the light of coincidence than as an usual accompaniment of mala-

\* It is due to Dr. Sircar to mention here that this is what he long ago insisted upon. In a series of articles published in the Indian Field (now defunct) in review of the "Report of the Committee appointed to inquire into the causes of the Epidemic, its course, and the best means of checking its further progress," which were afterwards published in a pamphlet form, in 1864, gave expression to the following ideas upon the subject :--- "The spleen, in fact, appears to us to act as a safety-valve to the disturbed functions of the alimentary mucous membrane and of the liver. We have accordingly always looked upon the carly enlargement of the spleen as a salutary sign. And we have almost invariably seen that in these fevers, the gastric and the hepatic derangements continue obstinate, so long as there is no perceptible enlargement of the spleen. The first effects, therefore, of the enlargement of the spleen, are to avert the tendency to diarrhœa and dysentery. Again, the assumption, by these fevers, of the remittent type, seems to us to depend upon the want of an adequate safety-valve action of the spleen. And it is a notorious fact, that it is in the intermittent variety of the disease, that this organ is found the earliest and the most frequently enlarged."

ria. In the month of January the eating of new rice is a fruitful cause of bowel complication which may terminate in dysentery. It is a fact that a sharp attack of dysentery will in some instances reduce the size of spleen.

The second variety is observed in emaciated weakly individuals suffering from enlarged spleen and liver and whose constitution is broken down from continued suffering. This form of dysentery is most obstinate and is allied to famine-dysentery. Malaria has nothing more to do with its causation than by inducing broken health, it helps to predispose the system to it, when the blood itself is vitiated for want of proper and sufficient nourishment. Being due to a putrid condition of the blood these cases are difficult of treatment, and often prove fatal. Dysentery might occur with contracted liver as the premonitory stage of ascites.

Pigmentation of the skin was found in four instances only. The complexion of the skin assumed a dark bronzed hue as in Addison's disease. Two of these cases were under my own personal observation. Both of them were free from spleen, and fever in them took place very seldom. In one the change of colour set in just after recovery from an attack of dysentery. The mucous membrane of the mouth was blackened in patches in both instances. Half an ounce of blood was taken from the arm of one of these patients. It yielded 2 grs. of fibrine, on being stirred with a rod. Microscopical examination was unavoidably delayed for a week, when it was seen the blood corpuscles were fewer in number and wanting the dark central spot. Probably it was due to imbibition of fluid and decomposition that was induced in the serum by long keeping.

The change in the blood from malaria can be briefly noted in the following words : a hydræmic or a watery condition, deficiency of red and increase of white corpuscles, and deficiency of fibrine.

From this hydræmic state of the blood much danger is to be apprehended in those conditions of the system which bring on sudden excess of its watery constituents or those which add to the plasticity of fibrine. The liability of pregnant women to embolism of the heart in a malarious district has never before been pointed out by any observer. Four such cases have come under my personal observation, in two of which it came on after parturition, and in two the symptoms were manifest during an acute attack of fever supervening in the eighth month of pregnancy. The hæm orrhage in the two former instances, and fever in the two latter, determined the formation of clot in the heart.

Besides, the watery state of the blood engenders a hæmorrhagic diathesis. Bleeding from the nose or gums is a very common complication. It takes place mostly in children with indurated spleen and sallow complexion. Death from slow persistent hæmorrhage after extraction of a tooth has been reported by previous writers. I had occasion to notice it in only one instance when the bleeding was stopped with some difficulty after 24 hours' slow oozing.

Bleeding may take place from the mouth or rectum (melæna). The profuseness of discharge in such instances is often a subject for grave apprehension. In females an acute attack of fever sometimes brings on untimely the menstrual flux. I have seen four instances of melæna, three of which proved fatal.

Allusion has already been made to the anasarcous condition of the limbs which is the result of water in excess in the blood. Alteration in the quality of the blood renders it unfit for healthy nutrition. Its effect on the nervous system is shown in general languor and mental inaptitude. I have seen several cases of epilepsy both in boys and adults who have had the disease since they became regularly subject to fever, but whether it is to be looked upon as a coinci-. dence or a sequence I am not in a position to decide. Most of the cases entered in the dispensary returns as rheumatism are nothing more than perverted nervous feeling in the limbs. These cases abound in places where malaria is fresh and not deep-rooted. Nyctalopia or night-blindness is as much indicative of deficient nutrition of the system as of alteration or cessation of nervous function of the retinal structures.

Some writers attribute impotency to malaria, but the numerous instances of child-birth in the district negative any such assumption. General debility no doubt represses the procreative tendency, and under this head are to be credited the cases of still births which are not of infrequent occurrence, and which tend materially to keep down the number of the population.

## 5.-TREATMENT.

The treatment varies according to the stage of the disease. It requires thorough discretion and competent judgment to enable the patient to tide over the first

attack, but when once it is got over and merges into a chronic type, any combination of quinine as tonic will be all that will be necessary in the shape of treatment. The reputation which some of the quack medicines have attained in the cure of fever is owing to their containing quinine in fair proportion. In Jamalpore a Pundit made his fortune by selling a mixture of his own composition, and so much as 100 bottles per day were sold in the fever season. D. N. Gupto's mixture received a very encouraging support, but this trade in mixtures fell off when quinine came to be freely supplied from the Endemic Dispensaries and when the people became sensible enough to learn that the recovery was a mere temporary one. The attendance at and reputation of a dispensary in the endemic district depend more upon the quantity of quinine given than upon the skill and attention of its medical officers. Thus the daily attendance in one dispensary rose from 30 to 400 directly quinine was supplied for distribution, although no extra attention was paid in the discrimination of the proper nature of the disease. From 6 to 9 grs. of quinine were given indiscriminately and every patient bore testimony to the marvellous efficacy of the mixture supplied. Wherever arsenic or carbolic acid or any other antiperiodic was substituted, the people lost faith in the medicine and the dispensary suffered in consequence. Thus it shows that quinine is par excellence the best tonic and antiperiodic. In it we have a powerful remedy to check the progress of intermittent fever, and whatever has been said against it to detract its virtue, is not in conformity with the general experience. Even the patients them-

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selves would ask to be supplied with quinine as the best remedy which their experience dictates. But the frequent relapses after recovery, even whilst the patient is under the quinine treatment, shows that it has no curative property. To give quinine as a preventive of malaria is, I consider, a mistaken idea, for it is only powerful in remedying that condition of the system which is induced in every attack of fever by its peculiar effect on the ganglionic system of nerves, and thus restoring temporarily the equilibrium of health. A good dose before an expected paroxysm of fever acts more powerfully as a tonic and counteracts the depressing effect of malaria which is shown in the disturbance to the cutaneous circulation. The paralysis of the vessels and their dilatation form the principal phenomena of the stage of pyrexia. Quinine acts in remedying this condition not only in malaria but in other diseases, such as insolation, in which experiments have confirmed its power of reducing preter-natural heat of skin. In all cases of intermittent fever I content myself in giving a single large dose of it 8 or 4 hours before the expected paroxysm, and prefer it to small doses which, when given at repeated intervals long before the accession of fever, are excreted by the kidneys and do not exert much beneficial influence. After the fever has left,  $\frac{1}{2}$  a grain of it with mineral acids and iron may be administered for some days as a tonic, but should not be continued uninterruptedly for any length of time with a view to ward off any future attack. It should be repeated again and again when the threatening symptoms of fever begin to show themselves. If more than this is expected from this drug, disappointment will be the result.

The other medicines that have been recommneded as antiperiodic, are arsenic, carbolic acid, strychnia, atees, &c.

Arsenic has been in vogue amongst the native Kavirajas as febrifuge from a very ancient date. They use it in acute as well as in chronic fevers complicated with anasarca and when, as they say, the phlegmatic humour preponderates in the system. White arsenic and sulphuret of arsenic are the preparations used ; but according to them if arsenic could be burnt to ashes without volatilisation (?) it would be the panacea for all diseases. Liqr. arsenicalis does not prove as effective as white arsenic, and is everywhere unfavourably spoken of. The number of patients fall off from the dispensaries if arsenic is largely prescribed. Its action being slow, several days' administration is necessary to produce a perceptible effect. In others it brings on irritation and increases the severity of the fever. It is contraindicated in remittent congestive cases-or those in which the liver and spleen or any other internal organs are congested, or those complicated with dysentery or diarrhœa, or in those that are extremely emaciated from chronic suffering and have an irritable disposition. The most favourable cases are the quartan types of fever occurring in able-bodied men without any internal complication, whose system has been saturated with quinine without any benefit. Carbolic acid answered in very few instances. In several cases it increased the febrile symptoms and delayed recovery. It succeeded in very mild cases of the quotidian type in which it is difficult to say how far the good was attributable to the medicine or to the vis medicatrix natura. In irritable and sanguine temperaments it disagrees.

Its nauseous odour is a great drawback to its use. Its power of checking fever is very inferior to that of arsenic.

Strychnia or some preparations of it are very useful in persons whose systems have been saturated with quinine and in whom further administration of quinine acts as an irritant. Other antiperiodics are Atees, Neem, &c., but their effect is too slow and uncertain.

In the remittent type of fever, great care is necessary in its management. A purgative at the outset should be given and debilitating remedies should be withheld. If the bowels be relaxed a dose of Gregory's powder will free the bowels of irritating matters and relieve the tendency to congestion of the internal organs. Quinine in the acute stage acts injuriously, especially when given in large doses. Even when given during the stage of remission, it seldom succeeds in putting a stop to the exacerbation. I never give more than 10 grs., if the case be a favourable one for its use; but the following prescription given every 3 hours for days, with support of the system by nourishing diet, generally brings on remission or intermission.

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Dec. cinchonæ 3i Liqr. amm. acet. 3ii Acid. nitric. dil. mx Spt. ether. nitrosi mxx. Mix. Every 3 hours.

In cases of debility Nitric Acid is replaced by Carbonate of Ammonia, which acts both as stimulant and diaphoretic. Bearing in mind that fever is always debilitating in its nature, the strength should be carefully

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supported throughout the course of illness by proper nourishment as milk and broth. Active purgation after the first week should be withheld. I even allow the bowels to remain loaded for a day or two unless there be very urgent need for interference. Hot sponging should now and then be practised to allow the skin to act freely. I have no experience of Aconite or Veratrum, and cannot say how far they are useful in bringing down the abnormal heat of skin, but I have often used Digitalis with good effect with the above mixture. Too much of medication sometimes helps to keep up the fever. When long continued quotidian fever merges into remittent, active medication should not be practised unless there be urgent need for it. When the head is affected, cold water is an invaluable application. Other symptoms should be treated as they appear. The treatment of pneumonia should be always stimulating, with mild counter-irritants to the chest.

When intermission or full remission is obtained quinine can then be administered in 5 grs. doses. In chronic cases quinine with iron and mineral acids is very beneficial as tonic. Although it seldom helps to bring on complete recovery it has been found that those that use medicine constantly have suffered less in health, and the sequelæ of fever in them are insignificant in proportion. Attention should be paid to the state of the bowels, and any tendency to diarrhœa should be checked by opiates. Inasmuch as cancrum oris is always indicative of a low state of vitality, good wholesome diet should be secured with tonics, stimulants and wine. Iron and Carbonate of Ammonia should be given with caution for fear of their inducing irritability of the bowels.

Ascites due to a watery condition of the blood is very amenable to treatment. Quinine, iron and diuretics with milk-diet would soon bring on convalescence. It seems to be the revival of the old practice amongst the Hindus of keeping all anasarcous patients with looseness of bowels chiefly and solely under milk-diet treatment. The good nourishment gives tone to the tissues and insufficiency of water in the blood makes it seek for that fluid amongst structures where it is redundant. Ascites due to liver disease is most difficult of treatment. The fluid must be let out through the way of the secreting and excreting organs, the kidneys and the bowels, by means of saline purgatives and diuretics. Salines should not be given freely in the other form of ascites where it will deteriorate the condition of the blood and retard convalescence and recovery. Purgatives are to be administered with caution as there is a great tendency to dysentery from which most of these cases prove fatal. I have never seen a case recover after paracentesis, and I have to speak of it only in condemnation as a method of treatment that hastens death. Iodide of Potassium with Digitalis and Nitric Ether will form a good combination.

The best treatment to effect reduction of the size of the spleen is to ward off as much as possible each attack of fever or shorten its duration. A counterirritant over the splenic region helps to make the organ soft and gradually smaller. Ung. Hydrarg. Biniodid. is the best counter-irritant in these cases. It should not be applied however in weak emaciated patients, or in those suffering from constant febrile heat, or in little children, or in ascitic cases, as the irritation of the blister makes the case worse. The skin ulcerates and is apt to take on an unhealthy action.

The Spleen simply enlarged and unaccompanied by fever sometimes becomes a natural organ of the body and cannot be reduced. Preparations of Iodine may help to cause its diminution in size. Chloride of Ammonium was once much spoken of but it has not satisfied the expectation of practitioners who have given it a trial on the recommendation of continental physicians.

The native way of treating an enlarged spleen is by applying the actual cautery over it. This practice is very extensively resorted to, so that in a malarious village one scarcely walks out but meets with persons with scars over the abdomen. From one to as many as thirty of them have been applied at a time, and cases have been brought to my notice where persons have died in consequence of irritation, sloughing and exhaustion from the discharge from the cauterised surfaces or from hæmorrhage.

Various methods are followed of which the following is mostly in vogue in the district of Jehanabad.

The surface of the abdomen corresponding to the tail of the spleen is daubed with oil to the size of one Rupee and a dried palm leaf is applied over this, covering the oiled mark. The burning end of a stick of pith is then rubbed over and over till the leaf is charred. The operator constantly blows on it to prevent it from setting fire to the leaf. The charring heats it to a degree to produce a singing effect on the corresponding portin of the skin beneath. The patients give expression to their suffering in loud cries and restlessness. The whole operation is over in a minute's time.

All these treatments are ineffective or partially successful as long as the patients remain in the tainted locality. Early removal from such to a better or more salubrious place offers the only chance of restoration to health.

## 6.-PREVENTIVE MEASURES.

In proceeding to treat of the preventive measures, one might well breathe a desponding sigh at the hopelessness of the task. It is said that to know the disease is half the cure, and when we have fixed definitely on some cause out of the numerous factors that bear some share in the origin of the disaster, it might appear that the amelioration of the evil is not much beyond our power, but the cost it would entail to set the likely remedy to action seems at first an overwhelming obstacle in the way. Virtually, the physical aspect of the country will have to be changed and the habits and mode of living of the people will have to be altered, before any amelioration can be expected; for so long the Hindu remains a Hindu with his peculiar filthy habits, always acting in opposition to all sanitary laws, so long woud the permanent improvement of the health of the people remain a mere phantom. The Government have shown their backwardness in undertaking the necessary operations on the score of the uncertainty that may await the result, but it may be safely declared that the capital, sunk in the land for its general improvement, is sure to be productive of benefit in the end

Before describing the methods of prevention we will compare the actual condition of those villages within the affected area where the visitation of the epidemic has been milder and less fatal, and try to deduce therefrom our plan of action. I have before mentioned that complete indemnity from illness has been no where observed within the area of my inspection. But the places I am going to narrate fared so well in comparison with the others that it will not be far from the truth to call them as having escaped the ravages of the epidemic. Three of them, Sankta, Dhamuaree, and Soobulda, lie on the western side of the Damudah, in that tract of the country in Mauah Roynah which is annually inundated by the overflow of the river during the rains. They stretch along the western side of the Bachoordah khal. Since the northern side of the Damudah has been secured by embankment to give protection to the railway line, the southern has been opened out at Hijulnah, Bago, and Sreekristpore to give exit to the periodical overflow. This part of the country therefore has been recently subjected to flooding. The body of water rushing in through the breach at several places above mentioned spreads over fields and villages, and washing an extent of land no less than 3 miles in breadth, flows due south to discharge itself again into the river further down in its course. The bulk of this water subsides within 48 or 72 hours, but the fields remain submerged for 3 months. The amount of sand thrown up has rendered the ground unproductive except at places where silts of an alluvial nature have enriched the land with manure rendered it fit for a profitable cultivation of melons, pumpkins and tobacco. This is undertaken immediately

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after December and is over in May. Rice fields have deteriorated and its cultivation abandoned. It is pitiable to see what an immense tract of land has thus been rendered fallow and has been overgrown with long grasses and reeds. From July to September the whole of it is under water to the depth of 2 to 3 ft., so that the people ply across in canoes and rafts. The Bachoordah khals which consist of several distinct channels in communication with the main stream carry strong currents of water and are deep enough to allow boats of 100 mds. capacity to pass with impunity. Remaining under water for the whole of the rainy season the tract of country has received the name of jullah or marsh. After September the water begins to subside from the face of the fields but the deeper channels of the khal continue full though fordable. Most of them dry up in December and the whole then presents a dry sandy soil where the grasses grow luxuriantly. The delay in the subsidence of water is attributed by the villagers with some truth to the gradual filling up of the bed of the khal opposite Jotseram where indeed scarcely a channel is left, but the force of the inundation makes for itself each year a fresh passage. The inundated fields have risen in their level by each year's increment and the encroachment of the water has become wider spread. Yet with all this they dry up sooner than the neighbouring rice fields which remain wet till February. Lying within this circle of inundation are several scattered villages where the inhabitants have been struggling against nature to maintain a precarious footing. For the protection of property and person, they have year after year raised

the level of their villages and of the floors of their houses by addition and deposition of earth. Thus in the villages of Dhamuaree and Soobulda the floors of huts are no less than 10 or 12 ft. high from the level of the surrounding fields. The construction of huts is by no means peculiar excepting that the majority of them are isolated. All these are small and thinly populated though the number of inmates in each house will not fall short of that in other populous villages. They are peopled by the farmer class and their condition is anything but thriving, owing to the deterioration of the productive powers of their land, notwithstanding which they have to pay to their Zemindars unmitigated rent of the year. Their mode of living is not different from their brethren of other villages except that during the period of flood they have to live as they say from hand to mouth.

Whilst the inundation has brought upon them these distresses, it has improved the appearance of their villages by its general effect of scouring. It cannot be denied that these villages look neater and more tidy. Everywhere vegetation and filth are washed away and the filling up of the tanks replenishes their water and clears them of aquatic weeds. In some of these places I tasted of the best water that I have ever drunk. Thus the overflow of the river acts indirectly in promoting the sanitary condition of the villages through which its water flows. I have premised that the villages bordering on this line are, as a rule, healthier and have presented less mortality than those in their immediate neighbourhood. But amongst them again various shades of gradation are observed. Thus Goonore, a village removed only a mile from Sankta, presented an opposite state of health. It scarcely differed in any material way in the local advantages it enjoyed, excepting that it was larger and more populated, and situated more on the bed of the khal than on its side.

There are other villages in this neighbourhood, situated between this khal and the river Damudah, which are older, larger and more populous, such as Sreekristopore, Jotseram, Rajarampore, Shadepore, &c., but the amount of sickness and mortality in them exceeded much in proportion. Most of them are also under water in the flood season, but the water rises in them by a process of slow filling up and it as slowly subsides. The result is therefore totally different. The water of the tanks is simply undrinkable and full of aquatic vegetation. The soil is most jungly, and shrubs and under-woods abound. A more uncleanly state of villages cannot be imagined.

Besides, the drainage of these villages is obstructed. The body of inundation water passing in at Hijulnah is met by another of greater force and velocity that finds its way in at Bago. The striking of the two at right angles to each other neutralises the current and causes stagnation higher up the stream. The fulness of the stream in its turn prevents other minor khals from draining themselves into it freely and thus surcharges the villages with moisture of which they are the drainage media. The cultivation of pumpkins, melons, &c., I have previously referred to, is undertaken only at this portion where the stagnation of water favors deposition of silts. The resulting force of

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opposition turns the course of water more towards the west when it resumes its natural direction a mile or two below the spot. Where the current is strong the bed is deepened year after year and thus the height of the villages contrasted with the level of the fields becomes more marked.

In the Mungulcote circle Dr. B. Gupta has come across a tract bordering the Adjye where similar conditions are obtained. The overflow of the river, the drainage of the surplus water by a khal runing parallel to it and the immunity of villages on its inland side are too significant facts to be overlooked. In the newly affected area on the S. W. district of Burdwan I found out a small village Ramkantpore where out of a population of 50 or 60 not one was a regular subject of fever. They were living on a high elevated soil which sloped towards a running stream.

From the foregoing facts the following conclusions may be drawn.

1st. The main distinctive condition of villages that have been less threatened with malaria and death is their newness and scanty population.

2nd. All of them are seated on an elevated soil, either natural, or made artificially so to subserve a special object. The greater the difference between the elevation and the general surrounding level, the more striking is the improvement.

3rd. They are more tidy in their appearance, present less jungles and enjoy better sanitary conditions.

Having the foregoing facts in view, we should attempt to improve the sanitary condition of villages as well as of their surroundings. Any improvement in

the dwelling of the people will indicate improvement in their social condition which in the present state of society is well nigh impracticable. Jungles should be cut down and growth of bamboo in thick clusters prohibited. Small honey-combed pits should be filled up and the existing large tanks cleared and deepened. Those, that are used for drinking purposes, should be surrounded with high mounds to prevent them from being defiled with ground washings. Surface drains should be cut in every locality with a good outfall, leading into a deep one on the farthest boundary of the village towards which the drainage inclines. These drains or khals joined with similar others in the neighbourhood should have their ultimate fall into a navigable stream. The dead should be buried or burnt out of the limits of human habitations.

Outside the villages the fields should be looked after. A country prosperous with rice cultivation cannot be healthy. If water be allowed to collect in every patch of ground, it will necessarily impregnate the soil with dampness. But rice is the staple article of food and there is no alternative in the production of the crop. A thorough system of irrigation should be introduced which will render it unnecessary for the present to attempt to keep water in the fields. Rice cultivation within the heart of a village should be prohibited.

Any existing obstruction to drainage by bunding a canal either for fishery or agricultural purposes should be put a stop to on penalty of a fine, and the existing bund opposite Selimabad should be opened out to restore the flow of water into the Kana Nudee. The ( 92 )

mouths of small khals are to be kept open, otherwise once obstructed they will fill up gradually and turn the flow of water in a different channel.

Deep khals should be cut in jullahs to convey the stagpant water, and some sort of cultivation introduced.

The habits of the people must be altered. A better standard of living is an indispensable necessity. Better clothing and better food will enable them to bear against malaria or any vicissitude of temperature with greater power of resistance than before. The habit of defæcating on the pond side should be discontinued; grounds should be allotted outside the village for such purposes, and the dry earth system of conservancy adopted. The refuse in time should be carted away to the neighbouring fields to supply manure to the soil. The custom of early marriage giving rise to a generation of paupers, whom their parents are not able to sustain, should be discouraged as much as possible.

If all these measures could be followed out, my conviction is strong on the point that we will reduce the chance of disease and mortality to a minium. Yet some degree of unhealthiness will remain in operation which is the result of causes beyond human control. Thus, the nature of the soil will remain unaltered which is sure to be acted upon in the rainy season with the immense quantity of rainfall which is natural in the tropics.