plenty to eat. Their food, however, generally consisting of rice, vegetables and dried fish, meat they seldom eat, not because their caste prevents them, as the coolies consist almost entirely of very low caste Hindus who can eat meat, but because it is too expensive and too difficult to obtain in the jungle. As a rule also the patients have been living in poorly built houses when out in the jungle—houses built of thatch roofs, matting walls and mud floors; on this floor they frequently sleep without any raised sleeping platform such as the Burman uses. In addition the houses are, as a rule, kept in a filthy condition, and in consequence, even though they are from the nature of their construction well ventilated, they are both insanitary and very damp.

It is thus seen that this class of people exist under conditions which are favourable to acquiring Beri-Beri, *i.e.*, living in damp insanitary houses and eating a diet which contains but few nitrogenous elements, and in confirmation of the view that these are the conditions mainly responsible for the onset of Beri-Beri it may be mentioned that a large majority of the cases when admitted into hospital in a not very advanced state of the disease improve rapidly on being placed in a dry ward and being given a diet containing nitrogenous elements in the form of meat.

Unfortunately the coolies, as a rule, delay coming to hospital until the disease is far advanced, and in consequence a high death-rate is unavoidable. But still most marked improvement is frequently rapidly noticed, more especially so when a diet containing nitrogen in the form of bone marrow or ghee is given. As regards the coolies living in Rangoon they do not, I believe, suffer from Beri-Beri to nearly the same extent as those living in the district, at least this would appear to be the case from the number of cases that seek admission. This, I believe, is largely due to the fact that the Rangoon coolies live under better sanitary conditions, in drier houses with raised or cement floors, though there is no doubt that their houses are often greatly overcrowded. In addition also these coolies are, as a rule, better off, and meat is more easily obtainable in Rangoon. To much the same reasons I am inclined to attribute the comparative immunity of the Mahomedans and Burmans from Beri-Beri; they are, as a rule, a fairly well-to-do community, they live in better houses and eat a more nitrogenous diet. Burmans are still much more loathe than Hindus to come into hospital, but still if the disease was prevalent amongst them in anything like the same proportion that it is amongst the Hindus, one could not help coming across cases amongst the out-patients, whereas it is extremely rare to meet with cases of this nature amongst Burmans, though a large number of this race attend daily for treatment and medicine for various complaints.

There is, therefore, I believe, little doubt that Beri-Beri is endemic in the delta districts of Burma, and it only requires subjects living under suitable conditions for the disease to become prominent and widespread.

ABSTRACT OF A PAPER ON THE RELATIONSHIP OF DRINKING WATER;—WATER-LOGGING AND THE DISTRIBUTION OF ANOPHELES MOSQUITOES, RESPECTIVELY TO THE PREVALENCE OF MALARIA NORTH OF CALCUTTA.

FROM THE PROCEEDINGS OF THE ASIATIC SOCIETY, READ BEFORE THE ASIATIC SOCIETY OF BENGAL, JULY 1900.

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IN February last (1900) I carried out an inquiry into the health of the tract of country just north of Calcutta and extending up along the east bank of the Hooghly as far as Naihati, some 25 miles, with special reference to the prevalence of malaria. The percentage of people with enlarged spleens was taken as the most reliable test, and over 5,000 persons were examined by myself, the degree of enlargement of the organ being noted. The ground water levels were taken in as many wells as possible, as the unhealthiness of this part has for years been considered to be due to water-logging. The drinking water-supply was also noted, and the monthly number of admissions for fever in ten of the principal dispensaries for the last six years was compared with the monthly rainfall in order to ascertain the seasonal influences. Lastly, some observations were made on the distribution of the anopheles mosquito larvæ.

The following table shows the percentage of persons found to suffer from enlargement of the spleen in each municipality. They are arranged in order from above downwards, as they are situated on the map from north to south, while the easternly ones, which lie on the east bank of the Hooghly, are placed in the left, and the easternly ones, which lie at a little distance from the river, are placed in the right hand column, so that the table roughly represents their position on the map.

A glance at the table (which in the full paper is illustrated by a shaded map) shows that the places which are situated on the east bank of the Hooghly river have a much lower spleen rate than those further to the east, although the last five are but from one to two miles from the river. The question arises as to whether

the riverine parts are exceptionally healthy or the inland portions especially unhealthy for this part of Bengal, and in order to settle this I examined several hundred people in Busirhat

TABLE I.

Municipality.	Spleen Percentage.	Municipality.	Spleen Percentage.
Naihati ...	19·9	(Gobardanga) ...	(55·5)
Bhatpara ...	20·0		
Garulia ...	33·8		
North Barrackpur	36·5	(Busirhat) ...	(52·8)
Titagarh	37·8	Baraset ...	52·9
S. Barrackpur, W.	25·2	S. Barrackpur, E	56·0
Kamarhati, West	18·8	Kamarhati, East	34·8
Baranagar ...	17·8	North Dum-Dum	68·1
Chitpur-Cossipur	11·2	South Dum-Dum	32·3
		Maniktolla ...	13·2
Average ...	24·5	Average ...	41·0

and Gobardanga, which are situated some 25 miles further to the east, and found their spleen rates to be over 50 per cent. It is evident, then, that the riverine portions are exceptionally healthy for Lower Bengal, but the reason remains to be found.

One very marked exception will be found to the above rule, namely, that of Maniktolla, which although at some distance from the river, yet has a very low spleen rate, the lowest of all the thirteen areas except Chitpur-Cossipur,—facts which can only be explained as being due to these two municipalities being the only ones of the lot which have a full filtered water-supply. Moreover, this low rate occurs in spite of these two places being the most water-logged in the whole area, their ground water levels being but from four to five feet below the surface in the dry season, and from one to two feet down only during the rains.

This result was somewhat surprising in view of recent work on malaria, so advantage was taken of the fact that certain wards of some of the municipalities were partially supplied with filtered water, from standpipes provided by certain of the mills within them, to examine more closely into the question. The result was ample confirmation of the relationship of the water-supply to the spleen rate, illustrative examples of which are as follows: Naihati is divided up into five wards, beginning from the south. The first three are mainly inhabited near the river, and their spleen rates are 19·5, 10·8 and 19 respectively. The very low rate of Ward II coincides with a partial filtered water-supply from a mill, which is the only difference between them that can account for the figures. The two most northerly wards are mainly inhabited at a distance of about two miles from the river, and their water-supply is mainly from tanks, and although their ground water level is slightly lower than that of Ward III, yet their spleen rates are 22·7 and 27·9. The water-supply of Wards I and III is mainly from the Hooghly. Still more striking are the figures for Garulia, in the northern portion of which is a mill which has been supplying filtered water for two years only, during which time the number of cases of fever treated at the local dispensary has fallen to about one-third of what it was before the filtered water came into use, and the greatest improvement took place in the very year that every other dispensary in this area showed a great increase of fever. As, moreover, the Native inhabitants were very positive that those who drunk the filtered water suffered much less from fever than those who did not, I decided to examine 100 people near the mill, about 80 per cent. of whom had drunk filtered water, and another series at a short distance away, but within one mile of the former, and living under identical conditions, but who differed from the former in not having been accustomed to drink filtered water. The spleen rate was found to be 21·1 per cent. in the former, and 55·5, or more than two and a half times as great in the latter, which strikingly confirms the local opinion as to the relative immunity of filtered water drinkers from malaria.

Titagarh, two out of the four wards of which have a partial filtered water-supply from mills, afforded a good opportunity of putting the matter to a crucial test, so a note was made of the water drunk by nearly all the people examined. The results are shown in the following tables :—

TABLE II.

Area.	Ground Water Level.		Drinking water-supply.	Spleen percentage.
	Feb.	Rains (1899).		
	ft. in.	ft. in.		
Ward IV	10 1	1 3	River and tank water.	48
Ward III	10 6	1 6	One-third drank filtered water.	30
Ward II			82 per cent drank filtered water.	19
Ward I	18 4	6 0	River and tank water.	54·8

The much lower spleen rates in Wards II and III which had a partially filtered water-supply, and that too in proportion to the number of persons examined who had drunk the filtered water, is evident. But this is not all, for it will be seen from Table III below that the spleen rate among 140 filtered water drinkers is 26·4 per cent., that among 179 river water drinkers was 41·8, while out of 55 tank water drinkers (who it should be noted form a minority here), it was no less than 67·2 per cent. Further, only 38 per cent. of filtered water drinkers in which the spleen was enlarged, was it consider-

ably (two fingers, breadth below the ribs) or markedly so, while in 62 per cent. it was only just felt between below the ribs. In river water drinkers it was much enlarged in 67 per cent., and slightly so in 43 per cent., while in tank water drinkers it was much enlarged in 73 per cent., and slightly so in only 27 per cent. Not only, then, is the spleen much more frequently enlarged in river and tank water drinkers than in those who drink filtered water, but the degree of enlargement is also much greater in the former than in the latter.

TABLE III.

SPLEEN PERCENTAGE AND WATER-SUPPLY.

ENLARGEMENT.	Filtered water.	River water.	Tank water.	TOTAL.
Spleen not enlarged	103	105	18	226
Spleen just felt ...	23(62%)	32(43%)	8(27%)	63
Spleen considerably enlarged.	9(24%)	26(36%)	15(40%)	50
Spleen markedly enlarged.	5(13%)	16(21%)	11(33%)	33
Total examined	140	179	55	374
Percentage of enlarged spleens.	26 4	41·8	67·2	39·5

If now the spleen rates for the different municipalities, as shown in Table I and in the map, be examined in the light of the figures just given, it will be evident that the differences in the water-supply will explain all the facts in a way that no other hypothesis will do. Thus, Chitpur-Cossipur has the lowest spleen rates, and it has the double advantage of both a full filtered water-supply and close proximity to the river. The influence of the latter is well illustrated by the fact that the spleen rate of the two riverine wards is only 7 per cent., while that of the other two wards, which are from one to two miles from the river, is 15 per cent., or just about the same as that of Maniktolla, which is similarly situated. The obvious explanation is that those who do not take the trouble to get the filtered water will drink river water in the wards on its bank, while in those at a distance they will drink tank water. The same point is illustrated by the difference between the spleen rates of the western portions of Kamarhati and South Barrackpore and the eastern portions of the same municipalities, the former with a water-supply from the river having just about half the spleen rate as the latter with only tank water for drinking purposes. In short, the much lower rate of the riverine parts is due to the difference in the water-supply; for, as will be shown presently, there is no essential difference in the ground water level which can explain this distribution. The good effect of even a partial water-supply is once more shown by the ward variations of the spleen rate in Baranagar and South Dum-Dum. In the former the lowest spleen rate, namely, 11·6, is met with in the most southernly of the riverine wards, which border on Cossipur; and I found that many of the inhabitants of this small ward were getting their filtered water from Cossipur. Again, the only ward which is at a little distance from the river in this municipality has the highest spleen rate, being dependent on tank water to a great extent.

South Dum-Dum is divided into three wards, and one of these which borders on Cossipur, from which many of the people whom I examined were accustomed to get filtered water, had only a spleen rate of 11 8, against one of 35·4 and 45·3 in the other two wards which had only tank water, although in all other respects I could find no difference between the wards. The very fact of the people taking the trouble to carry filtered water from a distance, and their robust belief that they to a large extent escape fever by so doing, must be allowed some weight in favour of the correctness of their belief. The whole of the evidence, then, points to the water-supply as the determining factor in relationship to the relative amount of malaria in this tract of country, but other possible factors must be considered, the most important of which is water-logging.

WATER-LOGGING AND THE RAILWAY.

It has already been pointed out that Maniktolla and Chitpur-Cossipur are the most water-logged parts of the whole area, and yet they are the least malarious, owing to their filtered water-supply. Further, an examination of the spleen rate and the ground water level ward by ward shows that there is no relationship between the height of the ground water level and the percentage of inhabitants with large spleens, for although at first sight the fact that the bank of the Hooghly river is very slightly higher than the surrounding country, so that the drainage flows away from the river and eventually finds its way back through khals, or runs into the Great Salt Lake to the east of Calcutta, might appear to indicate that the eastern portions of this area must have a higher ground water level than those near the river bank. Measurements in the wells, however, do not bear this out, for there is very little difference in this respect, while what little there is is rather more frequently in favour of the eastern portions than against them. Futher, if different wards of the same municipalities are compared, no definite or constant relationship between the slight variations in the ground water level which are met with and the spleen rate is found, as a study of the tables in the full paper or the map will show.

The Eastern Bengal Railway, which runs from north to south through this area, and, together with the Grand Trunk Road, roughly divides the

western and eastern portions, has frequently been held to be responsible for the unhealthiness of the country, for it lies across the line of drainage. As, however, the drainage flows from west to east, it is obvious that if it materially obstructs the drainage, the part to the west of its course should be the more unhealthy, while precisely the opposite is the case. Moreover, in places in which wells were found on either side of the railway, although not very near it, there was no marked or constant difference in the ground water levels on either side of the railway. The differences in the spleen rates in this tract of country cannot, then, be explained on any theory of water-logging, or interference with drainage by railways or roads, although the natural drainage is certainly bad as in North Dum-Dum.

Again, it might be thought that the lower rate in the western parts might be due to greater density of population, and consequently less few breeding grounds for the anopheles mosquitoes. With regard to the former it may be pointed out that there was practically no difference in the spleen rate of the densely populated western portion of Maniktolla and the very sparsely populated and somewhat more water-logged eastern part of the same place, both having a filtered water-supply, and other similar instances could be given. Further, the great differences in the spleen rates of the contiguous wards of the same municipalities in which every condition except the water-supply are precisely similar, which have already been detailed, cannot be explained on any theory of varying density of population, or of mosquito breeding grounds.

DISTRIBUTION OF THE ANOPHELES MOSQUITOES.

The question of the relationship of the anopheles mosquitoes to the prevalence of malaria remains to be considered. It must now be taken as proved that malaria may be communicated to man through the bites of mosquitoes which have some days previously bitten another case of malaria, but it still remains to be proved whether this is the only or even the most common cause by which this protean disease is communicated. The point is one of the utmost importance to Bengal, one of the principal homes of malaria, for if the disease is only communicated by the bites of these tiny pests, and they only breed in certain small pools, namely, those which are too small to harbour fish, yet not so small as to dry up in a day or two, as Major Ross states is the case, then by searching out these breeding grounds and destroying the larvæ in the pools, we may hope with Ross to at least rid towns or small areas of malaria. Unfortunately I have not been able to confirm these last statements of Ross, for both at Gobardanga and at Maniktolla, which are at the extreme of this tract of country under observation, I easily found numerous anopheles larvæ both in tanks and in smaller pools, all of which contained very numerous fish. As it was impossible to minutely examine 100 square miles or so of this area, I determined to map out and closely search all the pools and tanks in a small area of the Maniktolla Municipality. The results which were obtained are as interesting as they were unexpected. I much regret that I have not been able to confirm Major Ross' observations as to the very localised and small number of the breeding places of anopheles mosquitoes. On the contrary, I found them very commonly in large tanks, and that too in spite of most of them swarming with fish. In fact, in the dry season, when small pools are few in number, the tanks are the common breeding place. Further, although I found them in two out of three very small pools (from two to five yards in diameter), and with but some two inches of water in them, these pools also contained small fish, which during some time that I watched them did not touch one of the anopheles larvæ which floated temptingly past their noses, although they eat several small beetles, which they appeared to prefer. If, then, the larvae can survive in spite of fish in such tiny pools, is it any cause for wonder that they live in tanks?

The question then arises as to whether there is any relationship between the number of anopheles and the amount of fever, in order to test which I resolved to make a monthly examination of the some thirty tanks, together with any pools near them in a small area of Maniktolla. These observations will have to be continued for a year, but it may be mentioned here that during the dry season, when malarial fevers were at a minimum, from one-third to two-thirds of the tanks have been found to harbour the anopheles larvæ, and that too at a time when three visits to the local dispensary, after having given notice that all fever cases were to be kept for me to see, I failed to obtain a single case. Yet some of the tanks were estimated to have contained over one million larvæ, so thickly were they lying near the leeward bank in particular. In short, it would have taken a very large number of the small pools to harbour as many larvæ as one of these tanks, so that in this area, at any rate, the tanks form the principal breeding ground in the dry season at any rate. It will be very interesting to see what happens in the rainy season, but I may mention that after the recent heavy rain the larvæ nearly disappeared from the tanks, and were enormously reduced in numbers in spite of several new small infected pools having appeared, so that further observations promise to be of interest.

The importance of the above observations lies in the impossibility of destroying all the anopheles larvæ in even a very small area in Bengal, for the thirty tanks mentioned above all lay within

an area of one-sixteenth of a square mile, and formed but a small fraction of these of the very small municipality of Maniktolla, so that unless some very much more potent method of destroying mosquitoes is discovered, I fear that Bengal will not have its malaria much reduced by Ross' ingenious suggestions. If, too, all malaria is due to the bites of these mosquitoes, and they are present in such great numbers in the minimal fever season, how many will be found in the maximal fever period, and how great will be the difficulty of destroying them?

It may be objected that many of the anopheles found by me in the tanks were varieties which do not carry malaria, but until we know which are harmless and can easily distinguish them at a glance, this will not lessen the difficulty of destroying the really dangerous ones, if indeed any of them are harmless.

The importance of the action of a filtered water-supply in greatly reducing the amount of malaria, which has been demonstrated in this paper, is enhanced by the great difficulty of destroying the malaria-bearing mosquito, and also raises the question as to whether these insects may not carry the infection from cases of fever back to the water of tanks, etc., and the disease may not commonly be obtained by drinking such infected water, which has for centuries been considered to be a frequent method or medium through which the disease may be obtained. This important question can only be settled by experiment, which I hope shortly to be able to undertake.

Lastly, many charts have been made showing the monthly number of fever cases treated in the dispensaries of this area together with the monthly rainfall. It appears from these that the conditions which influence the amount of fever in different years is a general one, for all the dispensaries show very similar curves in the same year (except when the water-supply has been materially altered as in the case of Garulia) so that some general cause must have been in operation. On the other hand, there is no definite relationship between low or heavy annual rainfall, and the amount of fever, as I have shown elsewhere,* is the case of laterite soil with rapid ground water variations. There does, however, seem to be some relationship between the daily distribution of the rain and the amount of fever, but my observations on this point are not sufficiently advanced to allow of any definite statement on the subject at present.

The broad result of the present inquiry, then, is simply that there is a very definite relationship between the drinking water and the amount of malaria, as judged by the spleen rate in this alluvial area.

* *Lancet*, March 12th, 1898.

A CASE OF CONTINUED FEVER (REMITTENT FEVER? ENTERIC FEVER?)

By D. B. SPENCER,
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SEPOY TORA KHAN, of the Hongkong Regiment, a stalwart Punjabi, was brought to hospital in a doolie about midnight of 30th December 1899, suffering from fever.

History.—He was on four months' furlough at his home (*Chănki*) in the district of Shahpur, Punjab, and as it was about to expire he left his home and arrived at Calcutta on 17th December to sail for Hongkong to rejoin his regiment. He was perfectly well so far, the last illness being a year and-a half ago at Hongkong, when he had about a week's fever. From 17th December, the date of his arrival at Calcutta, to the 30th December he was living under canvas in the Native Infantry Lines in Alipore, preparatory to his embarkation. He stated that the fever was of three days' duration, and that it was ushered in with a rigor lasting from three to four hours; further that he did not come to hospital earlier, being in hopes, till the last moment, that he would be able to go with his other comrades to Hongkong.

Condition on Admission.—About midnight of 30th December when he was brought to hospital his temperature was 103·4°F. in the axilla, pulse 120, great restlessness with severe headache and general aching pains, but beyond these symptoms, there was nothing to indicate the nature of the fever.

31*st December* 1899.—Morning temperature, normal; evening temperature, 102·4°; no fresh symptoms; the case was diagnosed as ague; treatment: quinine mixture (10 grains to the ounce) to be given four times in the twenty-four hours, equal to 40 grains per day.

1*st January* 1900.—Morning temperature, 99°; evening temperature, 102·8°; no fresh symptoms; continue treatment.

2*nd January* 1900.—Morning temperature, 102°; evening temperature, 103·4°; continue treatment.

3*rd January* 1900.—Morning temperature, 101°; evening temperature, 103°; constipation marked; spleen and liver normal in size; heart's sounds normal, its action very excited; respiratory murmur harsh in places; urine scanty, high-coloured, sp. gr. 1022; no blood or albumen; continue treatment. Ordered also tepid sponging.

4*th January* 1900.—Morning temperature, 100·4°; evening temperature, 103·4.° Bowels opened once by enema; continue treatment.

5*th January* 1900.—Morning temperature, 103·2°; evening temperature, 101·6°; the fever is high and persistent; vomited four times, the vomited matter being bilious in character; the tongue is thickly coated, and the smell from the mouth somewhat unpleasant; ordered quinine to be increased from ten to twenty grains per dose, to be given three times with a drachm of nitric ether in each dose.

6*th January* 1900.—Morning temperature, 102·2°; evening temperature, 101·8°; the disease was changed to-day from "ague" to "Remittent fever." Has had troublesome cough as a new feature, expectoration being scanty and free from blood; vomited twice; bowels opened twice by an enema; complains of pain and burning sensations in the umbilical region; is groaning continuously; there is no eruption of any kind; mental