

Original Articles.

SOME ECONOMIC ASPECTS OF BENGAL MALARIA.

By DR. C. A. BENTLEY,

Director of Public Health, Bengal.

ONE hundred and thirty years ago Malthus, an obscure country clergyman stated in his now famous essay that "everything depends on the relative proportions between population and food." Fifty years later Darwin was led to apply this doctrine to the whole animal and vegetable world and the results of his work published long afterwards, laid the foundations of the modern science of biology and produced a revolution in every department of thought. The laws of population enunciated by Malthus and extended by Darwin have thus exerted a profound influence upon nearly every branch of knowledge; and their fundamental importance in connexion with the study of epidemiology and the problem of disease prevention is at last being recognized.

Every organic being naturally increases at so high a rate that if not destroyed, the earth would soon be covered by the progeny of a single pair. There is no exception to the rule; even slow-breeding man has doubled in twenty-five years. But a continual doubling of his numbers every quarter of a century cannot take place. In any long settled country mankind cannot increase at anything like the maximum rate. The fundamental reason of this is to be found in the tendency to diminishing returns from the soil. On any given area that tendency shows itself for all agricultural produce. The tendency towards increase in population must then be counteracted; and it may be counteracted in two ways, to which Malthus gave the names 'positive' and 'preventive checks.' By positive checks he meant those which cut down numbers already brought into the world—starvation, disease, war, misery in all its forms. By preventive checks he meant those which prevent numbers from being brought into the world.

The present paper concerns disease, one of Malthus' positive checks, which operates through a high death-rate or in other words through an excess of deaths.

Bengal is a huge swamp, peopled, as the *Ragubansa* puts it, with eaters of rice and fish and dwellers in boats. "A good rice swamp is a bog at all seasons, and at one season a bog covered with water," says Adam Smith; and he points out, it is "unfit either for corn or pasture and the lands fit for those purposes are not fit for rice." But it has one great advantage: "A rice field produces a much greater quantity of food than the most fertile corn field." Rice itself is an aquatic grass which cannot thrive without ample water and which suffers from deficiency far more

than from excess. It can adapt itself to floods but it cannot stand drought. The long-stemmed varieties will grow 12 inches in 24 hours and withstand submerging for three days; and provided the crop is not drowned outright the greater the depth of water on the fields the better the yield of grain. Besides producing rice, swamps abound in fish, another valuable food of man. Hence rice-swamps supplied with sufficient water tend to become very densely populated. "The numbers of a population," says Darwin, "depend primarily on the means of subsistence and this depends partly on the physical nature of the country but in a much higher degree on the arts which are there practised."

Agriculture is the art most widely practised in Bengal; rice occupies 85 per cent. of the cultivable area, and jute, another swamp crop, a further 10 per cent. and as we shall see later these facts have an important bearing on the density and growth of population, which are by no means uniform throughout the country.

Bengal is divided by its main river systems into four natural divisions, *viz.*, Western, Central, Northern, and Eastern Bengal respectively. Since the first Census of 1872 there have been remarkable variations in the rate of growth of the population in these four divisions as may be seen from the statements quoted.

Increase of Population.

	Population in 1872.	Population in 1921.	1872—1921 increase per cent.
Western Bengal ...	764,661	8,039,704	+ 5·7
Central Bengal ...	8,202,780	9,433,544	+27·1
Northern Bengal ...	8,045,432	10,358,303	+28·8
Eastern Bengal ...	10,980,504	18,650,139	+69·8

Density of Population.

	Density per square mile.		Increase.
	1872	1921	
Western Bengal ...	545	570	+ 25
Central Bengal ...	424	539	+115
Northern Bengal ...	418	538	+120
Eastern Bengal ...	479	815	+336

The extraordinary development of the population in Eastern Bengal is due entirely to natural growth by excess of births over deaths; there are few towns and no important industries to attract immigrants; this natural division also, as a matter of fact, has lost rather than gained by migration. This area affords therefore an example of normal expansion occurring in an agricultural population living under relatively favourable conditions. Conditions are obviously very different in the

other divisions, all of which possess important industries which attract immigrants in large numbers. Western Bengal for example possesses coal, iron and mills, etc. Central Bengal has a number of towns with many mills and factories and Northern Bengal includes nearly 200,000 acres under tea. Estimates of the gain by migration from these and other causes are difficult but the excess of immigrants over emigrants in 1901 and 1911, respectively was found to be about 6.3 and 7.4 per cent. of the population in Northern Bengal and 5.8 and 8.8 per cent. in Central Bengal. Much of the expansion in this latter division is undoubtedly due to immigrants to its many towns. Western Bengal on the other hand lost nearly as much by emigration from certain of its rural areas as it gained by immigration into its towns and industrial tracts.

What would the present populations of Western, Central and Northern Bengal be, respectively, if they had expanded since 1872 by 69.8 per cent., the rate of growth which has actually occurred in Eastern Bengal? Western Bengal would have nearly five million, Central Bengal nearly four million and Northern Bengal over three million more inhabitants; and the province as a whole would possess a population greater by more than twelve millions than it does at present; that is 58,605,420 against 46,481,690. Why is it that this expansion has not occurred? A partial explanation is to be sought in the fact that for a very long period the population of large areas in the several divisions has ceased to expand at a healthy rate; but a factor of even greater importance is the actual decline of population that has taken place in tracts covering many thousands of square miles. The statement below gives particulars of the area in each natural division in which population has shown a decline at each of the last five census enumerations.

Area in square miles in which population has declined.

	1872-81	1881-91	1891-'01	1901-11	1911-21
West Bengal ...	7,149	5,027	1,428	5,339	11,515
Central Bengal ..	2,590	4,444	4,488	5,262	7,126
North Bengal ...	6,534	5,483	3,878	3,175	6,964
East Bengal ...	6,476	1,109	2,180	1,388	465
	22,749	16,063	11,974	15,164	26,070

With the exception of the period 1872-81 the decline of population has affected a relatively small area in Eastern Bengal at each succeeding decade. The cause of the large area found decadent in 1881 was the storm wave of 1876 which affected much of Bakarganj and Chittagong and parts also of Noakhali and Tippera and resulted in an appalling loss of life. The figures for the last decade give the best idea of the relative conditions of the different parts of the

province. They show that 83 per cent. of Western Bengal is decadent, 60 per cent. of the inhabited portion of Central Bengal is in a similar condition, and 36 per cent. of Northern Bengal is affected by decline of population, whereas in Eastern Bengal only 2 per cent. of the total area has shown a reduced number of inhabitants.

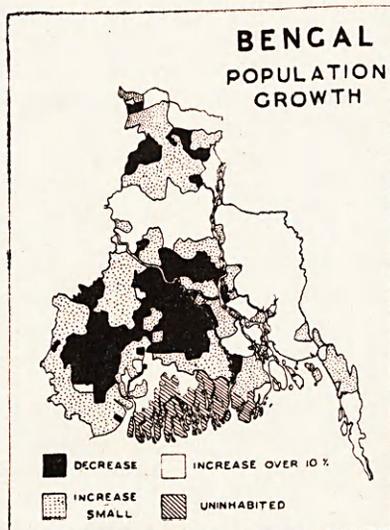
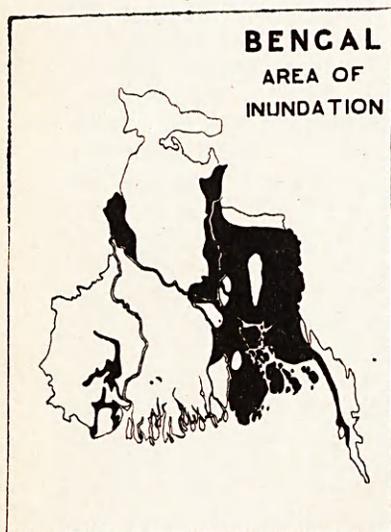
It may be that when population has ceased to expand rapidly it is merely because local circumstances, as for example the food supply, are not specially favourable to expansion. But an actual loss of population means very much more than a lessened rate of expansion. It points to some definite change in the climate or in other conditions vitally affecting the welfare of the population which has made a reduction of their numbers inevitable. The effect of such a change is likely to be very far-reaching, as Darwin has pointed out in his *Origin of Species*. "We shall best understand the probable course of natural selection" he says, "by taking the case of a country undergoing some physical change, for instance, of climate. The proportional numbers of its inhabitants would almost immediately undergo a change, and some species might become extinct. We may conclude" he adds "from what we have seen of the intimate and complex manner in which the inhabitants of each country are bound together, that any change in the numerical proportions of some of the inhabitants, independently of the change of climate itself, would seriously affect many of the others." What Darwin wishes to convey by this passage is that when a change occurs sufficient to affect the numbers or distribution of any living organism animal or vegetable, the other organisms living in the same area are bound to be affected also. When therefore a change of climate or of local conditions has resulted in a decline of the human population living in an area, it is bound to be reflected in the flora and the fauna of the locality also. The history of Cossimbazaar affords a striking example of this and incidentally serves as an illustration of the sort of change to which Darwin refers in the passage just quoted.

"The decay of Cossimbazaar dates from the beginning of the nineteenth century," states the *Imperial Gazetteer*, "when its climate, which had previously been celebrated for its salubrity, underwent an unexplained change for the worse, so that the margin of cultivation receded and wild beasts increased." Here is an instance in which both the plant and animal life of the locality are noted as having been influenced as the result of a change which affected the human population. The receding cultivation and the increase of wild animals indicate a serious alteration of former conditions.

Knowing what we do of the causes of tropical disease we can safely affirm also that a corresponding change took place in the number and distribution of such lower forms of life as anophelae, mosquitoes and malarial parasites and hence the "unexplained change for the worse"

SOME ECONOMIC ASPECTS OF BENGAL MALARIA.

By DR. C. A. BENTLEY.



AGRICULTURAL CONDITION OF BENGAL

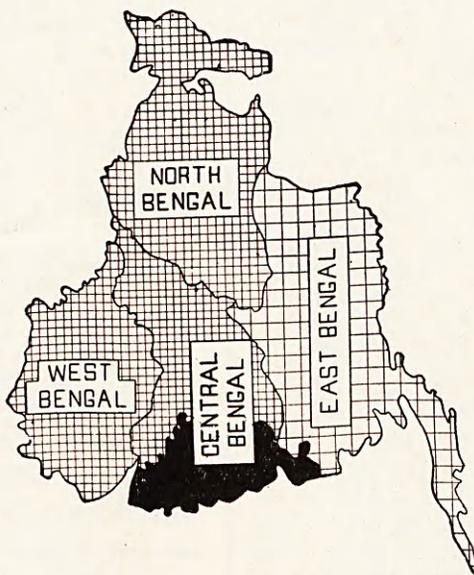
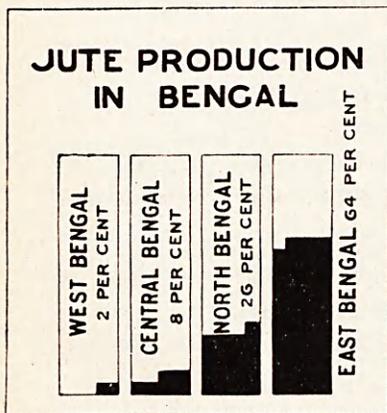
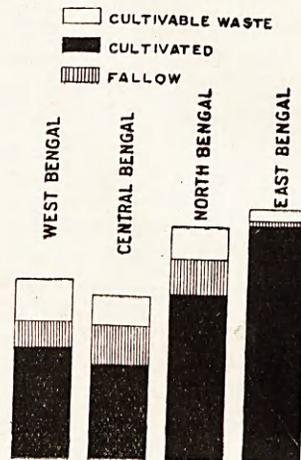
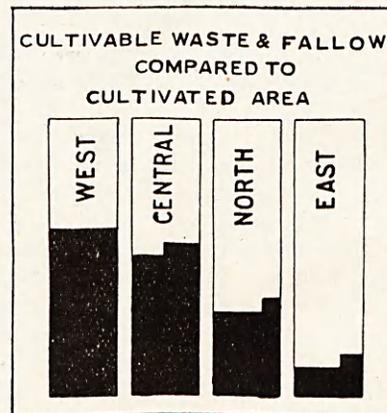


Diagram indicating proportion of roads and railways in each natural division.



of the former salubrious climate. We shall have occasion to refer to the cause of the change of climate at Cossimbazaar a little later. Meanwhile we must return to the discussion of the larger question regarding the more recent serious depopulation of so many portions of Bengal.

Attention has already been called to the fact that a serious decline of population indicates that a definite change has come over the affected area; and as we have seen, the effects of such a change are not limited to man but are certain to exert a very marked influence also on both the flora and fauna of the locality, resulting in an increase of certain species and a decrease of others. This view is borne out by the evidence which shows that both the plant and animal life of the areas undergoing depopulation exhibit an increase in certain directions and a decrease in others, and many of these increases and decreases are of special importance to man from an economic standpoint, affecting as they do the question of available food supply very greatly.

The most prominent and best recognized change in relation to fauna is to be seen in the great increase of malaria. If we compare a map of the areas suffering from a decline of population with another showing the relative prevalence of malaria we shall see that there is a rough correspondence between them. Depopulation is therefore, generally associated with intense malaria. Evidence points to the fact that in the areas in which the human population is declining, malaria has increased very greatly during the last sixty years.

The relative prevalence of Malaria.

	FEVER INDICES.		
	1868	1912	1920
	per cent.	per cent.	per cent.
Western Bengal ...	21.9	40.9	51.7
Central Bengal ...	17.3	32.3	44.9
Northern Bengal ...	22.3	23.7	33.5
Eastern Bengal ...	9.3	7.5	14.0

Burdwan, Birbhum, Bankura, Midnapur and Hooghly in Western Bengal were at one time relatively free of malaria and were regarded as sanitarium.

Similarly Murshidabad and Nadia and a great portion of Jessore in Central Bengal were formerly healthy, and Pabna and Malda in North Bengal were also relatively salubrious. In Eastern Bengal, Tangail in Mymensingh, Manikganj in Dacca and the Northern portions of the Faridpur district which are now malarious were formerly relatively free of the disease.

This admitted increase of malaria can only be explained on the assumption that there has been a

corresponding increase in the number and distribution of anopheles mosquitoes and malarial parasites in the areas affected. Unfortunately there are no actual observations on this point. But it must be remembered that the malarial parasite was only discovered in 1880, and the part played by anopheles mosquitoes in its transmission as late as 1898, long after this increase of malaria had taken place. Many healthy localities in which population is increasing usually show scanty signs of malaria. But anopheles mosquitoes of species capable of harbouring the malarial parasite are to be found everywhere and often occur in large numbers in these healthy areas. They do not, however, appear to multiply greatly during the wet season, as they do in the unhealthy areas, so that the period of their greatest prevalence does not correspond with that most suitable for the proliferation of malarial parasites. Meanwhile it may be noted that there are grounds for believing that in the decadent areas anopheles mosquitoes are now far more prevalent during the period of July to October than they used to be and that this change is associated with a greatly lessened supply of water.

Other important variations in the fauna of the areas undergoing depopulation, are the notable decrease in fish of all kinds and the great increase in the prevalence of certain mammals, wild hog for example. The decrease of fish is generally recognised and has been reported on by Sir K. C. Gupta, I.C.S., and Mr. K. C. De, C.I.E., I.C.S. The increase of wild hog and other vermin is also generally admitted and is often ascribed to the increase of jungle. Both of these changes are important from an economic standpoint; the reduction in fish, because it means a lessening of the food supply and the increase of wild hog, etc., because it results in greater damage to crops. A further minor change in the fauna of certain of the areas now undergoing depopulation is the reduction in the number of silkworms produced. This is also a matter of economic importance to man.

We have now to consider certain changes that have taken place in the flora of the areas undergoing depopulation. As will be seen, many of these changes are of supreme importance to man from an economic standpoint.

The most noticeable change is the lapsing of cultivated or inhabited areas into jungle. This was previously noticed in the case of Cossimbazaar, but it has become so apparent in later years as frequently to be accepted as a primary cause both of the general increase of malaria and of depopulation. Certain facts require to be noted about this increase of jungle. In the first place it is confined almost entirely to the more elevated and drier localities, the high banks of the rivers and on village sites for instance, and it is especially noticeable in places where population has declined. In the second place, contrary to what is often stated, this growth of jungle, as the Nadia Fever Commission pointed out "is of a kind that

prefers a dry to a damp *habitat*." It is not swamp vegetation that increases, but trees and shrubs whose roots require a soil in which aeration occurs. This fact has a very important bearing upon the nature of the climatic change that has occurred in the areas undergoing depopulation.

Turning to the broad question of cultivated and waste land respectively some idea of the relative distribution of the various classes of land may be got from the following tabular summary which gives the percentages for each natural division.

	Percentage cultivable area cultivated.	Percentage cultivable waste.	Percentage current fallow.
	per cent.	per cent.	per cent.
Western Bengal ..	61	26	12
Central Bengal ...	58	18	24
Northern Bengal ...	71	14	15
Eastern Bengal ...	90	7	3

There is little statistical information regarding changes in the proportions of cultivated and uncultivated land respectively but a few general statements are on record relating to particular areas. For example, it is reported that in Burdwan prior to the epidemic fever seven-eighths of the land was under cultivation, whereas the latest returns show only 47 per cent. of the cultivable area as being cropped. This latter figure compares very unfavourably with Dacca, where during the same season 92 per cent. of the cultivable area was cultivated. A progressive contraction of the cultivated area in Nadia has been reported by successive Collectors. And a loss of fertility and consequent agricultural deterioration has been noted in many other districts of Central and Western Bengal and elsewhere. Take for example the following remark from page 50 of the Settlement Report of Faridpur: "It was impossible for land-lords to enhance rent and to evict tenants * *when the fertility of the soil was declining and land was gradually going out of cultivation.*"

Taking into consideration the broad fact that only 58 and 60 per cent. of the cultivable area is under cultivation in Central and Western Bengal respectively, compared with 90 per cent. in Eastern Bengal, it would appear, in view of the marked decay of population that has taken place in the former areas, that some climatic change has occurred which has affected the flora of these areas to such an extent as to diminish very seriously the food supply of the people.

When we come to examine in some detail the crops grown, certain very significant facts are brought to light. Take the character of the rice grown in different parts of the country. There are three main varieties of rice, *Aman* or

Winter rice, *Aus* or Autumn rice and *Boro* or Summer rice. These different classes of rice flourish best in different situations and differ in the amount of water they require. *Aus* paddy grows on relatively high land and requires least water; *Aman* requires abundant water and grows best along the edges of rivers or permanent swamps. The proportions of these three kinds of rice grown in different localities vary very greatly and depend primarily on the water supply. *Boro* paddy gives the most abundant yield, *Aman* paddy the finest grain and *Aus* paddy the smallest outturn and the coarsest rice. In spite of this fact *Aus* paddy is gradually replacing *Aman* in certain areas.

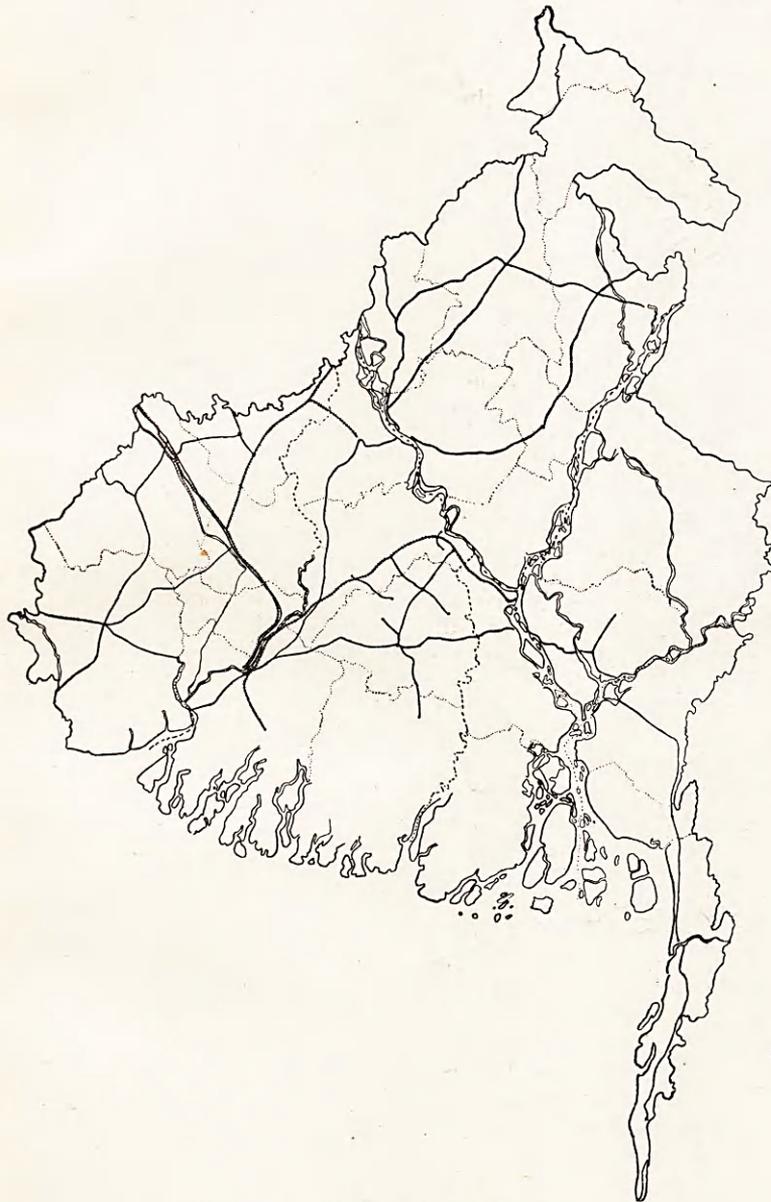
The *Gazetteer* of the Jessore district for example, states that the area under *Aman* rice is contracting owing to deficient floods; and a comparison of the agricultural statistics of 1920-21 with those of 1906 shows that in Jessore the normal area under *Aus* has been increased by 10 per cent. and in Nadia by 50 per cent. Wherever the supply of water is scanty *Aus* paddy tends to replace *Aman*. The figures for individual *thanas* in the Faridpur district are very instructive in this respect, showing as they do that the extraordinary variation in the growth of *Aus* paddy in different parts of the district bears a relation to the water supply. "In the north of the district" says the Settlement Report, "water for drinking and other purposes has become very scarce." The north of the district is malarious and in the malarious northern *thanas*, of Pangsa, Bhushna, Balia-kandi, Goalundo and Faridpur the proportion of *Aus* paddy grown is from 34 to 46 per cent. of the total, whereas in the non-malarious more southern *thanas* it is very small, ranging from 6.3 per cent. in Kotwalpara to 7.5 and 7.9 and 9.6 per cent. respectively, in Madaripur, Gopalganj and Muksudpur. The outturn of *Aman* rice varies greatly according to the supply of water. The yield of *Aman* rice grown in the south of Faridpur is very heavy, says the Settlement Report, "but in the north of the district it is ordinarily much poorer and only becomes good when inundations come early and are widespread."

Jute comes next in importance to rice. As in the case of rice, so for jute also, ample water is necessary, largely governing the distribution of the plant and the character of the crop. Abundant water is also required for the retting of the fibre. "It is necessary to have water conveniently near" says the Settlement Report of the Faridpur district, "in which the jute can be steeped. This limits the amount of jute that can be grown in the north of the district, considerably, but in the Madaripur subdivision the limit, owing to the abundance of small rivers and streams, has not been reached." The figures for jute cultivation in the province as a whole show that 64 per cent. is grown in Eastern Bengal, 26 per cent. in Northern Bengal and

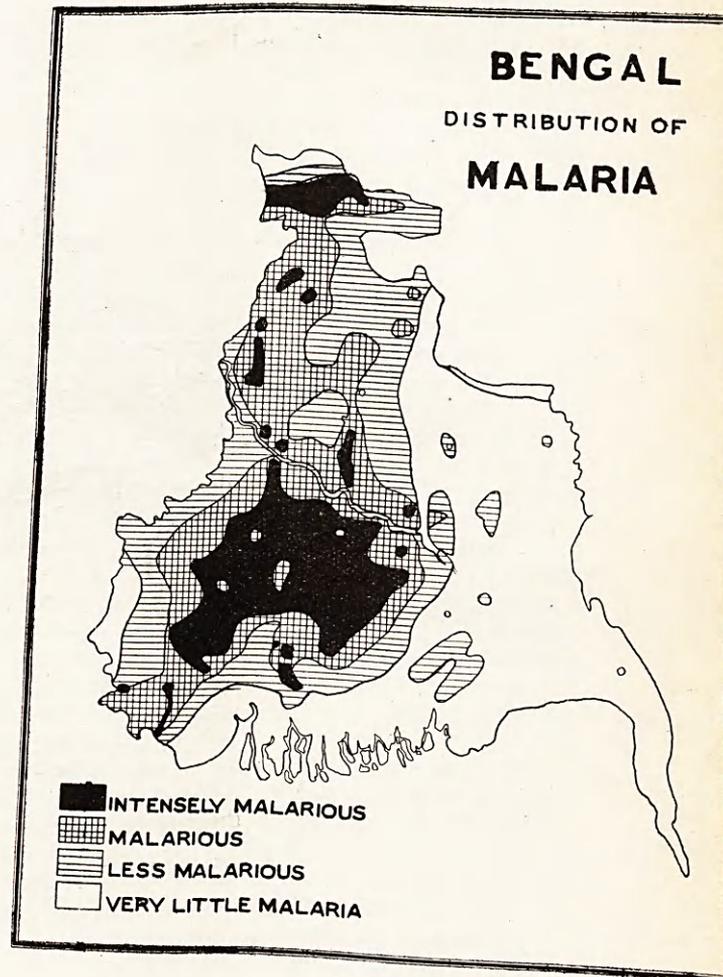
* The italics are mine.—C. A. B.

SOME ECONOMIC ASPECTS OF BENGAL MALARIA.

By DR. C. A. BENTLEY.



Roads and railways in Bengal in 1870.



**SOME ECONOMIC ASPECTS OF BENGAL
MALARIA.**

By DR. C. A. BENTLEY.



Roads and railways in Bengal in 1920.

only 8 and 2 per cent. in Central and Western Bengal respectively. And a comparison of data regarding the relative abundance of water indicates a close relationship between the supply of water and the yield of jute. Generally speaking also a rapid increase of population occurs in areas where jute is largely grown, whereas a reduction in the cultivation of jute is often followed by decline of population.

Among other minor changes in the flora of areas that are losing population the disappearance of indigo and the reduction of mulberry may be mentioned. Indigo was formerly cultivated very widely, especially in Western and Central Bengal and in parts of Faridpur and Dacca; but it is no longer grown in any quantity and the indigo factories are all in ruins. Mulberry too has already undergone a very marked reduction in consequence of the decline in sericulture. Another change is the practical disappearance of cotton as a cultivated crop in the greater majority of the districts within the last century. But this latter change appears to have occurred long before the great increase of malaria and the rapid decline of population with which we are now concerned and it is only therefore mentioned in passing.

Putting aside for a moment the increase of malaria and the loss of population, it will be seen that the other changes that have been noted as occurring among the fauna and the flora respectively of the decadent areas we have been discussing, point the conclusion that a reduction in the water supply is the origin of the trouble. First of all there is the receding margin of cultivation. This is invariably associated with a lack of water. It is always the drier and more elevated lands that go out of cultivation. Then there is the increase of jungle which is largely confined to the relatively high banks of rivers and old village sites, showing that the type of vegetation is one which prefers a dry situation rather than a damp water-logged one. The tendency for *Aus* paddy to displace the *Aman* variety is also an indication of diminished moisture. The decreasing supply of fish affords further evidence of a lessened supply of water; and the increase of wild hog and other animals which has followed the increase of jungle points in the same direction. The only fact therefore, which appears to militate against this view of the situation is the very great increase of malaria which has taken place along with these other changes and which at first sight appears to preclude the possibility of a diminished supply of water being the cause of the trouble.

But we have only to recall two well-known facts in regard to malaria in order to realise that this difficulty is only an apparent one. Ever since Empedocles flooded the marshes surrounding Selinos in Sicily by a canal constructed for the purpose, and in this way freed the city from malaria, it has been known that swampy low-lying localities cease to be unhealthy when

temporarily submerged; and in the old days flooding was often deliberately applied both in Italy and Holland for ameliorating malaria, with most excellent results. But while the flooding of swamps has long been resorted to for checking malaria the partial removal of water from a marshy area has always been regarded as a most dangerous proceeding, calculated to produce a serious intensification of the disease; this belief being justified by the numerous occasions in which the reclamation of swamps has led to severe outbreaks of malaria. Three well-known instances of this kind are the case of the Grand Chartreuse Swamp in France, the low-lands of Biensten and de Wonner in Holland and the Whittlesea Mere in England. Such outbreaks were formerly ascribed to miasma given off from the exposed bottom of the marsh. But now-a-days the accepted explanation is the great increase of anopheles that takes place when by partial drying up, a large expanse of water is converted into many small shallow pools.

We see therefore that all the important changes which can be shown to have occurred in association with the loss of population that has taken place in so many areas in Bengal are consistent with a reduction in the water supply of the affected localities. This naturally prompts the question: Is there any direct evidence of such a diminution having taken place? In reply it may be stated that for many years the complaint has been general throughout the areas afflicted with severe malaria and undergoing depopulation, that water supplies have diminished. In 1867 for example the Revd. G. Schurr, of Kaspadanga in Nadia reported in a letter to the Magistrate: "During the twenty years I have been in this district I have observed a gradual diminution of water supply in old tanks and *khalls* as well as in the rivers."

The following year Dr. Sutherland observed of the same district: "The district is becoming more and more arid, tanks and other reservoirs of water dry up even before the hot weather, tanks full to over-flowing in the rains rapidly dry up—facts which prove that there has been of late no increase or excess of moisture in the soil." Similar complaints have been put on record at various times in regard to every malarious district. As late as 1912 for example Mr. Bhola Nath Banerji, Executive Engineer, in charge of the Special Drainage Division, while at work in Jessore reported: "If we draw a line from Pultia on the Ichamatty to Jhikergacha on the Kabadak, the country lying to the north of this line may be generally taken as suffering from a scarcity of good drinking water." "It is reported," he adds "that tanks in those parts do not hold water but dry up with the subsidence of the rivers." And he concludes by pointing out that most of the Jhenida subdivision and parts of Magura where people suffer from want of water are the most malarious parts of the district. Quite apart from

general statements of the kind quoted, there is a certain amount of direct evidence pointing to the abnormal dryness of many localities that have long been suffering from increased malaria and depopulation. The Nadia Fever Commission for example state that: "Observations in December of the water level in wells showed it to be from 15 to 24 feet from the general soil surface level in the west and north-west of the district." A few years earlier similar observations were placed on record for Birbhum district by Dr. Jackson, the Sanitary Commissioner. Recent observations in Burdwan, Nadia, Jessore, Pabna and Murshidabad have shown very similar results and have proved that, contrary to commonly accepted ideas, the areas in which the level of the subsoil water is specially low are far more malarious and unhealthy than those in which it approaches within three to five feet of the ground surface. In Burdwan which is one of the worst districts for malaria and depopulation the mean level of the subsoil water taken in twenty-eight wells in different parts of the district is 26 feet in the dry weather and 9 feet in the rains; whereas in healthy parts of Howrah, Dacca and Mymensingh it varies from 3 to 5 feet in the dry weather and is level with the ground surface in the rains. Apart from the moisture that is stored in the subsoil and which as we have seen is subject to very great variations in different parts of the province, the unhealthy, malarious and decadent tracts possess the lowest supply. The sources from which the country derives its supplies of water are the rainfall and the overflow from the rivers in the flood season. Although the rainfall fluctuates from year to year there is no reason to suppose that the average amount precipitated has undergone any marked diminution. On the other hand there is plenty of evidence to show that the embankments that have been constructed along the margin of the rivers and for the purpose of roads and railways have had the effect of shutting out from the surface of the country a large amount of water which found access to it in former times. There are now many thousands of miles of embankments which cover the country with a net-work extending in almost every direction. And there is no doubt that their effect has been to deprive the country of much of the moisture it formerly enjoyed. Time and again it has been suggested that these embankments have obstructed drainage and led to water-logging which has resulted in an increase of malaria. But repeated investigations have only served to show that except in a very few places the country within the influence of the embankments instead of being damper than formerly, is actually much drier than it used to be. And in the light of the facts brought forward in this paper the explanation is a simple one. It is in the main to the construction of these embankments that we must look for the cause of the increase of malaria and the depopulation that

has accompanied that increase. The decay of Cossimbazaar which has already been referred to, followed the construction of an embanked pucca road from Berhampur Cantonment to Murshidabad city. That decay was as we have seen accompanied by a decline of agriculture and a change in the climate. And the same sequence of events can be traced in the history of almost every decadent tract in Bengal at the present time. I hope to show, in a subsequent paper, the remedy for this condition of things.

THE PROBLEM OF KALA-AZAR.

By F. P. MACKIE,

MAJOR, I.M.S., M.D., M.Sc., F.R.C.S., F.R.C.P., O.B.E.,

Director of the Pasteur Institute, Shillong, and of the kala-azar enquiry in Assam.

I FEEL that no more fitting place than Madras could have been chosen for reviewing our advances towards the solution of the kala-azar problem, for it is here that so many of the most important investigations have been carried out.

It is nearly 19 years ago since Donovan made his epoch making discovery of the relationship of the parasite (then just discovered by Leishman) to the disease known as kala-azar. Since then he has contributed much of importance to the various aspects of the problem.

Shortly after that Christophers carried out his investigations into the morbid histology of the disease and so thoroughly did he do his work that little of importance has been added to this part of the problem in the seventeen years that have elapsed.

Then Patton began his series of painstaking researches into the rôle of the bed bug in the transmission of the disease and has carried them out with that infinite capacity for taking pains that amounts to genius. The recent observations made by Mrs. Adie on this subject may result in the coping stone being placed on the monumental work with which Patton's name will always be associated in Madras.

Further investigations into the same aspect of the problem have been carried out by Cornwall and his associates, though they have not led him to see eye to eye with Patton in the matter of bug transmission.

These, and others might be mentioned, are sufficient to shew what a great part Madras has played in the elucidation of the kala-azar problem.

Let us now review some of the more recent advances in the subject. THE MORPHOLOGY OF THE PARASITE AND ITS ZOOLOGICAL POSITION. Our knowledge of the morphology of the parasite as it appears in the tissues of man and of experimental animals has not advanced

* A paper read at the Medical Research Section of the Indian Science Congress, 1922.