Health and Economic History: Lessons from the Study of Famines, Epidemics and Colonial Development in British India, 1871-1920[1]

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Introduction

The period from the beginning of the 1870s to the end of the 1910s can be called 'the Age of Famines and Epidemics' in British India. The population growth rate was very low (0.37%) due to many mortality crises such as famines and epidemics. But after the beginning of the 1920s the population growth rate rose above the 1% level (Table 1).

According to the nationalist interpretation of the post-independence historiography on famines and epidemics, this situation was caused by colonial exploitation and the concomitant agricultural stagnation. Heavy land revenue, forced commercialization of agriculture, the tendency toward monoculture, and the loss of land by peasants led to the amplified damage of famines and epidemics.

But does this description explain the reality? If we look at this period using recent studies, we find in the 1871-1920 period 'growth' rather than 'stagnation'. During this period, the real burden of land revenue was being lessened, commercialization of agriculture did not lead to the decline of food production, and the process of losing land by peasantry did not occur so. Thus, the nationalist interpretation is not successful in explaining the economic historical process.

Why did famines and epidemics occur so often, leaving huge casualties? Were famines and epidemics only natural disasters? Or were these phenomena related to the economic historical process?

By introducing the 'health' factor into the analysis of the economic historical process in British India during the period, this paper will try to

[1] This paper is based on my Japanese book, *Kikin, Ekibyo, Shokuminchi Touchi* (Famines, Epidemics and Colonial Rule: Development and Diseases in British India), Nagoya, 2002.

answer these questions. Firstly, my methodological standpoint will be briefly elucidated. Next we will touch upon the debate about the Indian economy during the 1871-1921 period. Then we will present our hypothesis on the low population growth rate during the period. Finally we will take a case study of malaria and population change in Bengal during the 1871-1931 period.

1 How Should We Examine 'Health' in Economic History?

The main aim of the discipline 'economic history' has been measuring commodities or incomes. Economic history has aimed at investigating the process of economic development, that is, whether or not a society has achieved economic progress. The degree of economic development has generally been measured by quantitative changes in commodities or incomes. While quantitative changes in food production is used as a measure of economic development in the case of agricultural societies, multiple measures, including industrial production and service production, are used in the case of industrial societies. In any case the measures can be reduced to commodities or incomes.

We can ask what the main interest should be in economic history. If we think that the main interest of economic history should be examining the changing nature of human well being, examining quantitative changes of commodities or incomes should not be the ultimate aim. We cannot deny, of course, that quantitative increases of commodities or incomes are one of the most important determinants of human well being. However, increasing commodities or incomes is not an aim, but a step to an aim.

Health is the basic component of human well being. How we can physically act or not is the most important component of human well-being. Therefore it is not unnatural that we set health on the stage of

economic history. It is needless to say that the condition of health varies from person to person. But we put the group aspect of health in question. For example, if there were some people who experienced damage to their health, we can think that their human well-being was reduced.

Amartya Sen has devised a new concept that more properly expresses human well being.[2] His 'capability' concept means the space in which human well-being can be measured. His definition is: 'The life of a person can be seen as a sequence of things the person does, or state of being he or she achieves, and these constitute a collection of "functionings" — doings and beings the person achieves. "Capability" refers to the alternative combinations of functionings from which a person can choose'.[3] There are many functionings, from elementary ones like 'being adequately nourished' to very complex ones like 'being able to take part in the life of the community'. Being healthy or avoiding disease is one of the most elementary functionings.

Economics has generally assumed 'commodities' or 'utility' as the space for measuring human well-being. 'Commodities' have been used as the space by economics because they are easy to measure. On the other hand 'utility' has been used theoretically, following the utilitarian tradition of economics. Look at the following three stages (Figure 1). A person gets 'commodities', then consumes them and attains some 'functionings', and finally (mentally) feels 'utilities'. The implication of the 'capability' approach is to measure human well-being in the middle stage.

The 'commodity' approach has taken precedence because of its easy measurability in economic terms. In contrast, 'capability' is not easy to measure, and has been taken out of consideration. But equating the acquisition of commodities with the attainment of functionings is incorrect.

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[2] Amartya Sen, *Inequality Re-examined*, Oxford, 1992.
[3] Jean Drèze and A. Sen, *India: Economic Development and Social Opportunity*, Oxford, 1995, p.10.

For example, suppose that there are two persons who earn equal incomes. While Mr. A is in good health, Mr. B suffers from a disease. Even though they receive equal incomes, they are not equal in terms of functionings.

Or, suppose that there are two societies whose populations produce the same per capita GDP on average. But if there is a significant difference in public health conditions or disease environment between the two societies, there will be a substantial differential in human well-being in terms of functionings. Getting commodities does not automatically mean achieving functionings. Thus, we should take into account other factors if we assess human well being in the space of capability.

2 The Indian Economy 1871- 1920

(1) Nationalist and Revisionist

How have 'the Age of Famines and Epidemics' been described? We now examine the nationalist view, taking an example from Sumit Sarkar's work.[4]

1. Drain of Wealth: Indian wealth was squeezed through land revenue and other means, and then drained off to England, leaving no surplus in India.
2. Commercialization of Agriculture: Although the commercialization of agriculture was driven by railway construction and the resulting growth in exports, it was a 'forced' process. Peasants were forced to produce commercial crops in order to pay heavy land revenues or rents. The conversion to commercial crops necessarily led to the decrease of food production, worsening the damage of famines. In addition, the commercialization of agriculture intensified the dependence of

[4] S. Sarkar, *Modern India 1885-1947*, Madras, 1983, pp.24-42.

peasants on moneylenders, thereby promoting differentiation of the peasantry.

3. Agricultural Production: Big landlords, moneylenders, and rich peasants who gained much from commercialization of agriculture did not invest much in agricultural production, continuing to depend rather on semi-feudal exploitive relationships. Therefore, agricultural production did not increase, leading to outbreaks of destructive famines.

According to the nationalist view, famines and epidemics were the necessary results of the economic historical process during the period. But recent studies have presented another interpretation. We now call it the revisionist view. Below, we present the revisionist interpretation, using the works of N. Charlesworth, B.R. Tomlinson, and T. Roy.[5]

1 After the 1850s, agricultural prices increased faster than the nominal amount of land revenue. Thus the real burden of land revenue was lightened.

2 The commercialization of agriculture was not a forced process, but rather driven by the peasants' initiatives. Peasants responded to rising agricultural prices caused by railway construction and the resultant export growth. The process of substitution from food crops to commercial crops did not occur on a large scale. There was an increase in agricultural indebtedness, but it did not lead to a substantial increase in transfers of land ownership to moneylenders.

3 Agricultural production gradually increased from the late 19th century to the First World War. After the First World War agricultural production began to stagnate.

[5] N. Charlesworth, *British Rule and the Indian Economy, 1800*-1914, London, 1982, pp.20-28; B.R. Tomlinson, *The Economy of Modern India, 1860-1970*, Cambridge, 1993, pp.51-67; Tirthankar Roy, *The Economic History of India, 1857-1947*, New Delhi, 2000, pp.51-113.

This interpretation presupposes a picture of the growth of world trade after the 1860s. The transport revolution brought by railways and steamships substantially reduced freight rates, leading to a large increase in low value-added bulk shipments. The opening of the Suez Canal accelerated these processes. The export of cotton, wheat, oilseeds, jute, tea, rice and so on from India substantially increased after the 1870s. This export growth drove the commercialization of agriculture during the 1871-1920 period.

(2)'Tropical Development' and India

Which is more persuasive, the nationalists' view or that of the revisionists? If you consider India in the context of world economic development before the First World War, you naturally get the answer. The revisionist view that the Indian economy grew because of the increased exports of agricultural produce is more reasonable.

According to W.A. Lewis, tropical countries experienced a substantial export growth of primary goods in the last quarter of the 19th century.[6] This was caused by the transportation revolution and 'the growth of demand resulting from the increase in the national incomes of the leading industrial states'.[7] The annual rate of growth of exports from the tropical countries between 1883 and 1913 was 3.4%, which was slightly lower than the annual growth rate of industrial production in the world, 3.7%. The strong export performances of these tropical countries resulted from the peasants' own initiatives.

W.A. Lewis suggested that tropical countries achieved primary-good export-led economic growth between 1880 and 1913. He asserted that this picture does not necessarily call to mind such keywords as

[6] W. Arthur Lewis (ed.), *Tropical Development, 1880-1913: Studies in Economic Progress*, Surrey, 1970.
[7] *Ibid.* p.14.

‘colonialism’, ‘exploitation’, and ‘drain’. But this export-led economic growth faltered after the First World War.

We find the same tendency in the Indian case. India’s export growth rate was 2.8% during the 1883-1913 period. This was low among many tropical countries. It resulted from a land-population ratio that was very low compared with other tropical countries. The peasants could not afford to allocate much land to commercial crops due to the scarcity of land. Nevertheless, there is no doubt that the increase of commercial agricultural exports was a kind of ‘engine of growth’ in the economy as a whole.

Table 2 shows that outputs of both food grains and non-food grains grew at a certain rate, which was driven by export growth. After the First World War, however, output levels started to stagnate due to the fall in the rate of growth of world trade. In addition, Table 3 shows that NDP for both agriculture and the entire national economy grew at about 1 % until the end of 19th century, then slowed down.

The period from the 1870s to the First World War saw a certain measure of economic growth in British India. The improvement of transportation, the development of infrastructure, and the incorporation of the territory into the world economy promoted the export of agricultural products and the commercialization of agriculture. This process probably generated income growth in many rural areas. Therefore, this period was not economically stagnant, although income distribution was possibly becoming more unequal and the standard of living of the lower strata may have become unstable. Why, then, despite modest growth, did this period see many famines and epidemics? This is certainly a paradoxical situation.

3 Famines, Epidemics and Colonial Development

(1) Famine and Income Distribution

There occurred eleven famines in the second half of the 19th century, including three great famines in 1876-78, 1896-97, and 1899-1900. Most of famines resulted from the failure of the southwest monsoon. Drought has been a very common phenomenon in South Asia since ancient times. We should ask why famines caused such extensive damage in this period.

From the 1860s to the end of 1920s India continued to export food grains, with the exceptions of the great famine years. There was not an absolute food scarcity in this period.[8] However, there was certainly very severe local food scarcity when serious droughts occurred. The development of the railways must have prompted a movement of food grains from surplus areas to areas of scarcity.

Famine became a more class-biased phenomenon in this period than earlier. We need to examine changes in the vulnerability of the lower classes to famines. The mortality rates among agricultural labourers, rural artisans and marginal peasants who belonged to lower castes were much higher than in the other classes. A typical case was agricultural labourers who owned no land, usually being employed to work on the land of others. At times of drought, therefore, they lost their employment, and were then unable to purchase food.[9] This is the failure of food entitlement theorized by Amartya Sen.

While there was a certain degree of agricultural growth, the real wages of agricultural labourers hardly increased during the period.[10] It means that agricultural growth did not have a trickle-down effect to the

[8] A.K. Ghose, 'Food Supply and Starvation: A Study of Famines with Reference to the Indian Sub-Continent', *Oxford Economic Papers*, Vol.34, No.2, 1982, pp.374-378.
[9] K. Wakimura, 'Famines, Epidemics and Mortality in Northern India, 1870-1921', in P. Robb, K. Sugihara and H. Yanagisawa (eds.), *Local Agrarian Societies in Colonial India: Japanese Perspectives*, Surrey, 1996, pp.287-288.
[10] T. Roy, *op. cit.*, pp.80-84.

lower classes. The fact to be noted is that the real wage was drastically reduced at the time of famine. Although agricultural growth occurred, the food entitlement of the agricultural labourers and rural artisans may have become unstable during this period.

(2) Famine-Malaria Nexus[11]

We need to analyze the specific causes of death in order to understand why famines brought about huge human mortality. We find that more deaths were due to disease than starvation. Such diseases as cholera, smallpox, diarrhoea, dysentery and malaria combined with famine to produce large-scale mortality. The most important famine disease in South Asia was malaria. We call it 'epidemic malaria'. Epidemic malaria was the worst culprit in raising the famine mortality rate.

Epidemic malaria did not necessarily occur along with famine. However, epidemic malaria most often occurred when the nutritional deficiencies of rural poor after famine coincided with a proliferation of *Anopheles* — vector of malarial parasite — caused by heavy rain. *Plasmodium falciparum* took many lives in conditions of reduced human resistance to disease due to malnutrition along with drastic changes in environmental conditions, including heavy rains.

We examined the change in the crude mortality rate in the United Provinces between 1873 and 1948. We found that there were seven mortality crises before 1920, occurring in 1879, 1894, 1897, 1905, 1908, 1911 and 1918 (Table 4).

Most mortality crises resulted from disease. The most dangerous was epidemic malaria, which often broke out in the United Provinces. Recent Studies by T. Dyson and A. Maharatna have shown that such famine-malaria nexuses were also seen in the other provinces.[12]

[11] K. Wakimura, 'Famines, Epidemics and Mortality'.
[12] T. Dyson, 'On the Demography of South Asian Famines, Part I', *Population Studies*,

(3) Deterioration of Disease Environment

The case of the United Provinces indicates that most of the mortality crises were related to diseases. Famine mortality was worsened by diseases like epidemic malaria. Of course, there were also epidemics independent of famines, like the plague epidemics in 1905 and 1911, and the influenza epidemic in 1918.

We can attribute the basic cause of frequent epidemics in this period to the deterioration of the disease environment. The disease environment refers to an environment in which people are exposed to disease-causing germs, vectors or hosts. The deterioration of the disease environment means that there is a greater possibility of human beings suffering from infectious diseases.[13]

Firstly, as already pointed out, while the development of the railways speeded movements of food grains, it also increased the negative effect of epidemics. The increased movement of people necessarily involved disseminating some infectious diseases over wide areas. For example, the eastern part of the United Provinces was a source of labour supply to industrial cities like Calcutta or Bombay. Many migrant labourers came and went between village and city. This labour movement was the basic cause of the high plague mortality in the eastern United Provinces. Migrant labourers came back to their villages with plague bacillus.[14] This causal relationship can be applied to the cases of cholera, diarrhoea and dysentery.

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vol.45, no.1; do., 'On the Demography of South Asian Famines, Part II', *Population Studies*, vol.45, no.2; A. Maharatna, *The Demography of Famines: An Indian Historical Perspective*, New Delhi, 1996.

[13] I. Klein, 'Population Growth and Mortality in British India, Part □: The Climacteric of Death', *The Indian Economic and Social History Review*, vol.26, no.4, 1989; do., 'Population Growth and Mortality in British India, Part □: The Demographic Revolution', *The Indian Economic and Social History Review*, vol.27, no.1, 1990; I.D. Derbyshire, 'Economic Change and the Railways in North India, 1860-1914', *Modern Asian Studies*, vol.21, no.3, 1987.

[14] I.D. Derbyshire, *op. cit.*, pp.190-191.

Even malaria, a seemingly endemic disease, fits with this causal relationship. During the early decades of the 20th century in India, there was an appreciable increase in labour mobility that was brought about by industrial development and plantation agriculture. The high incidence of malaria on tea plantations should be understood within such a context.[15]

Secondly, urbanization started with the commercialization of agriculture and a certain degree of industrialization in the late 19th century. This made urban hygienic conditions worse, resulting in the prevalence of cholera and plague in the cities.[16]

Thirdly, environmental changes caused by developmental activities like railway, road and canal construction made the disease environment worse. The typical case was the effect of canal irrigation on the prevalence of malaria. The spread of canal irrigation in the western part of United Provinces led to the expansion of waterlogged areas, leading to the proliferation of the *Anopheles* vector. When epidemic malaria occurred, high fever mortality was concentrated in the Doab area, which was the most canal-irrigated area in the United Provinces.[17] In the next chapter we will take up another typical case of malaria epidemics caused by environmental factors.

Human movement, urbanization and environmental changes were among the factors that aggravated the disease environment, worsening the human misery caused by famines and epidemics. These factors were primarily caused by colonial development activities, and the period from the 1870s to the First World War was when colonial development was most intense (Figure 2).

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[15] K. Wakimura, 'Anopheles Factor and Human Factor: Malaria Control under the Colonial Rule, India and Taiwan', in M. Hasan and N. Nakazato (eds.), *The Unfinished Agenda: Nation-Building in South Asia*, New Delhi, 2001.
[16] N. Crook, *India's Industrial Cities: Essays in Economy and Demography*, New Delhi, 1993, pp.8-15; R. Ramachandran, *Urbanization and Urban Systems in India*, New Delhi, 1989, p.67.
[17] K. Wakimura, 'Famines, Epidemics and Mortality', pp.290-292.

4 Malaria and Population Change in Bengal, 1871-1931: A Case Study

We now take a typical case of 'deterioration of disease environment'. It is the series of malaria epidemics in Bengal during1871-1931, which affected the population change in Bengal at that time. Since the middle of the 19th century intense malaria epidemics called 'Burdwan Fever' struck central and western Bengal.[18] Series of malaria epidemics substantially influenced the population change in the second half of 19th century Bengal. Firstly, we will look at a general view of population change in Bengal during that time. Next, we will see the causation analysis on Bengal malaria by British malariologist in the first half of 20th century. Finally we will examine the relevance of this causation analysis.

(1) Population Profile

If we look at the regional comparison of population change in British India during 1871-1931, the average population growth rate of East Zone, 0.63% is higher than any other Zone (Table 5). East Zone includes Bengal Provinces, Bengal States, Bihar and Orissa Province and states, Assam Province and states. The most important factor of this relatively high rate in East Zone was the almost absence of famine in Bengal during this period (There were some famines in Bihar). The non-existence of famine contributed to the higher population growth rate after 1881 also in the South Zone.

The population growth rate was 0.72% during the 1871-1931 period in Bengal. This is the highest ratio among the main provinces. But we need to closely look at the Bengal case. Bengal can be divided into two

[18] Concerning 'Burdwan Fever,' see the following studies. B. Chaudhuri, 'Agricultural Production in Bengal, 1850-1900: Coexistence of Decline and Growth', *Bengal Past and Present*, Vol. 88, Part 2, No. 166, 1969; I. Klein, 'Malaria and Mortality in Bengal, 1840-1921', *Indian Economic and Social History Review*, Vol. 10, No. 2, 1972; and S. Bose, *Peasant Labour and Colonial Capital: Rural Bengal since 1770*, Cambridge, 1993.

types in terms of population growth rate (Table 6). While a very high rate of population growth rate was recorded in east Bengal (12.85%), stagnant growth rates were seen in west Bengal (1.4%), central Bengal (5.4%), and north Bengal (5.2%). This clear difference can be explained mainly by the health factor, particularly the disastrous effects of 'epidemic malaria'. Even in the absence of famines, the population growth was substantially constrained by this disease. Series of malaria epidemics not only raised mortality, but also reduced fertility and promote out-migration.[19] The population growth rate in west Bengal (1.4%) was almost as same as in West and North zones, which were frequently affected by famines during the 1871-1931 period.

This epidemic malaria started from Jessore district in 1847-48, proceeded to Nadia and 24-Parganas in 1857, spread to Burdwan district in 1868, and then penetrated Birbhum, Midnapur and Hooghly. The 'Burdwan Fever' changed central and western Bengal from a rather healthy region into a very malarious one. Needless to say, we cannot quantitatively confirm this early phase of the history of 'Burdwan Fever' from census data.

But we can confirm the demographic result of malaria epidemics in the negative growth rate of population in the 1870s. The virulence of malaria epidemics continued until the 1880s. The situation began to improve in the 1890s. West Bengal recorded the 7.2% population growth rate due to abatement of malaria. There is no mention on malaria epidemic in the west and central Bengal part of the 1901 census report.

But again malarial epidemics recurred in west and central Bengal during the 1900s. In the 1910s population substantially decreased due to malaria and influenza (Spanish Flu) in some parts of west and central Bengal.

[19] We have not dealt with vital statistics data in this paper. We have omitted the analysis of population migration neither. Of course these are serious defects.

We find that 'Burdwan Fever' continued for a surprisingly long time. Burdwan, Birbhum, Bankura and Midnapore in west Bengal, Nadia, Murshidabad and Jessore are the districts that were most seriously affected by malaria epidemics during the 1871-1931 period. Although we have not mentioned, some districts like Rajshahi, Dinajpur and Rangpur in North Bengal were seriously affected by epidemic malaria.

(2) Socio-Economic Causation of Malaria: Human Factor Approach[20]

We now try to identify the causal factors for this series of outbreaks of epidemic malaria that was called 'Burdwan Fever', basically relying on the work of British malariologists' in the first half of 20th century.[21] British malariologists, S.R. Christophers and C.A. Bentley tried to understand the causal relationship of malaria epidemics in Bengal. They claimed that the human factor approach of malaria epidemiology threw light on the 'Burdwan Fever'.

Malaria and Labour Migration

S.R. Christophers and C.A. Bentley presented a paper entitled 'Human Factor' to the Bombay Medical Congress in 1909.[22] They tried to clarify the causes of heightened malaria prevalence in particular areas. They pointed out that previous research had generally attributed high malaria prevalence only to the anopheles factor and claimed that human factors were more important in certain situations. They paid more attention to parasites in human beings than to vectors in etiology and epidemiology. That is why they emphasized socio-economic conditions in disease causation.

[20] This part is based upon the following my work. Wakimura, 'Anopheles Factor and Human Factor'.
[21] It seems that there have been a few studies on epidemic malaria in Bengal.
[22] S.R. Christophers and C.A. Bentley, 'The Human Factor: An Extension of our Knowledge regarding the Epidemiology of Malarial Disease', in W.E. Jennings (ed.), *Transactions of the Bombay Medical Congress*, Bombay, 1909.

Whenever some virulent malaria prevalence occurred, it probably arose from a situation that could be called ‘tropical aggregation of labour’, referring to places, such as plantations or railway construction sites, where large numbers of labourers lived and congregated. Continuous ‘non-immune immigration’ and ‘physiological poverty and hardship’ in these places increased infection rates. This cause of intensified malaria prevalence was thought to be applicable to wider areas. Thus Christophers and Bentley listed three human factors believed to provoke epidemics: ‘tropical aggregation of labour’, ‘non-immune immigration’, and ‘factor of residual infection’(Figure 3).

It was commonly believed that ‘the factor producing these epidemics has been a change in the natural drainage of the country’. In short, either ‘water-logging of the soil’ or ‘an increase of anopheles mosquitoes’ was cited as the main culprit.[23] However, Christophers and Bentley denied this simple causation theory. They attached more importance to the vicinity of Calcutta, because many labourers went there to work in railway construction, road construction, and factories. They argued that the ‘tropical aggregation of labour’ had been created over this wide area.

Prior to 1860 there is little evidence of the existence in this area of anything like the modern movement towards the immense industrial expansion of recent times; but from about this date commences a period of phenomenal activity and commercial enterprise and an era which saw the inauguration and completion of enormous public works. Within a decade three great canal systems, the great railways, a vast network of

[23] Christophers and Bentley, ‘The Human Factor’, p. 81. During the second half of the 19th century, the miasmatic theory was used to explain malarial epidemics. For example, the one-time civil surgeon of Burdwan pointed out, ‘it has been caused by pent-up sub-soil water, which in a porous soil is, at certain times, subject to high elevations, and rapid retrocession’s. These changes taking place beneath a hot sun appear to be the conditions under which malaria in its most intense or concentrated form is produced’. J.G. French, *Endemic Fever in Lower Bengal, commonly called ‘Burdwan Fever’*, Calcutta, 1875, p. 68.

important roads, together with huge industries like that of coal, cotton, jute and tea, sprang into existence and underwent extraordinary development. Calcutta, the primary centre of this new movement, rapidly increased in size extending in every direction under the stimulus of a growing commercial activity, which necessitated the establishment of docks and the expansion of harbourage, and led to the erection of vast blocks of new buildings both within the city and throughout its widening suburbs.[24]

They concluded that tropical labour aggregation was the main factor causing epidemics of malaria.

Tropical labour aggregation appeared quite typically on the tea plantations of northern Bengal. The Duars was a portion of the 'terai' land that stretched along the eastern Himalayas. This was a 'hyper-endemic' area, meaning that people living there had often suffered from malaria from infancy and had acquired certain degrees of immunity. The problem in this area was not malaria among the indigenous people who had lived there for generations, but rather severe infection among the immigrants to the tea plantations. Intense malaria epidemics sometimes attacked this area, a problem, according to Christophers and Bentley, that resulted from the continuous entry of non-immune immigrants into the tea estates and their poor living conditions.[25] During the early decades of the 20th century in India, there was an appreciable increase of labour mobility and a rise in wages, which was brought about by industrial development and migration. More attention was paid to the availability of labour than ever before; and therefore malaria on tea plantations should be understood within such a context. They argued that this rising demand for labour was the main factor in the high rate of malaria on tea plantations.

The immigrants came from Chota Nagpur and the Santal Pargannas in Bihar, and also from Nepal and the Darjeeing Hills. The

[24] Christophers and Bentley, 'The Human Factor', p. 82.
[25] S.R. Christophers and C.A. Bentley, *Malaria in the Duars*, Simla, 1911.

labour population in the tea plantations of the Duars was estimated to be 150,000 in the early 20th century, annually receiving approximately 30,000 newcomers. Some of the Duars' newly hired workers were free from malaria but others were infected.

Most of the recruiting localities, if we may judge by the coolies coming from them to the Duars, are comparatively healthy; others are more or less malariaous, and some even apparently intensely so. Thus in the Duars malaria carriers from malarious districts and susceptible people from healthy areas are mingled; and, in the presence of anopheles, we have ready the constituents for an explosion of epidemic malaria.[26]

In addition to the labour migration factor, Chiristophers and Bentley paid attention to the poor living conditions of labourers in tea plantations. The labour conditions in tea plantations of Duars were bad, and nutritional deficiency among labourers was common. 'An inadequate dietary in the case of new coolies leading to the vicious cycle of --- inadequate diet --- physiological poverty --- increased liability to sickness especially to malaria --- less wages earned --- increased hardship and privation with still less adequate diet, and so on' were pointed out in the report on Duars. Not only nutritional conditions, but also housing and sanitary situations were hopeless. These notorious conditions were led to by the '*sardari'* labour system. In any way these disadvantaged economic conditions among labourers were closely connected with epidemic malaria.[27]

Malaria and Environmental Change

C.A. Bentley changed his causal factor of Bengal malaria from 'migration' to 'environmental change' in the 1910s. He made clear a close correlation between the changes of population during the decade of 1901-11 and the prevalence of malaria. He used the spleen index (percentage

[26] *Ibid.*, p. 39.
[27] Christophers and Bentley, *Malaria in the Duars*, p. 89.

of children examined who had enlarged spleen) and the malaria fever index (percentage of malaria cases treated in dispensaries) as a measure of malarial prevalence. For example, according to the dispensary's record in the city of Burdwan, the fever rate, the proportion of malarial patients among total admissions, increased from 10.58% in 1865 to 23.81% in 1868 and to 39.5% in 1870-71.[28] He explained 'Burdwan Fever' in terms of 'agricultural deterioration'.

The epidemic malaria of the Punjab is regarded therefore as arising from the conjunction of conditions favouring an increase of anopheles mosquitoes and the consequent spread of malarial infection with a period of serious scarcity of food among certain classes of the population. And in Bengal epidemic malaria can likewise be shown to be due to the action of the same factors. But unlike the Punjab, which is naturally a dry and comparatively well drained country in which abnormally heavy rainfall encourages the multiplication of anopheles, scanty rain and diminished flooding favours the increase of these mosquitoes in Bengal. And allowing for this difference, the epidemic malaria of the latter province is seen to be due to the operation of causes fundamentally similar to those responsible for its occurrence in the Punjab, viz., an increase of facilities for the spread of malarial infection on the one hand together with abnormal economic stress on the other. In the delta tracts of Bengal short rainfall and scanty inundation favour anopheles mosquitoes, and lead at the same time to agricultural deterioration and poor harvests, the immediate result of this combination of factors being a great intensification of malarial infection, which manifests itself either in the form of acute epidemic outbreaks of the disease or by the more gradual depopulation of the areas affected.[29]

[28] C.A. Bentley, *Report on Malaria in Bengal, Part 1*, Calcutta, 1916, p. 34.
[29] Bentley, *Report on Malaria in Bengal*, *Part* 1, p.73.

What caused this 'agricultural deterioration' in central and western Bengal? According to Bentley, river inundations had given deltaic Bengal a highly fertile soil; but when railways or roads were constructed, the embankments disturbed river inundation, preventing proper silt accumulation. From the middle of the 19th century to the early 20th century, the 'proportion of current fallow and cultivable waste to net cropped area' had increased in central and western Bengal, and the 'percentage by which the outturn of principal food crops fell short of the normal' had also risen.[30] On the other hand, in eastern Bengal agricultural growth was very prominent. And population increased much faster in eastern Bengal.

Obstructions to inundation considerably affected the anopheles factor as well as the human factor. Usually flooding constrained the breeding of anopheles but it is also claimed that inadequate inundation promoted proliferation of anopheles larvae.

The inundation of the country during the monsoon is unfavourable to the multiplication of anopheles mosquitoes, in the first place, because flooding reduces the dangerous 'water-edge' which affords safe cover for mosquito larvae; in the second place, because owing to the large surface exposed to the rays of the sun the temperature of the water tends to rise so as to be exceedingly unfavourable to the life of anopheles larvae; and in the third place, because the physical and possibly the chemical character of river water is inimical to anopheles larvae.[31]

The main vector mosquito *Anopheles philippinesis* preferred 'still water for egg-laying and larval production, not heavily polluted, with rather a low water-table and a moderate (but not light-excluding) growth of aquatic plants'.[32] Interruptions in flooding facilitated the reproduction of

[30] Bentley, *Malaria and Agriculture in Bengal*.
[31] Bentley, *Malaria and Agriculture in Bengal*, pp. 48-49.
[32] Learmonth, *Disease Ecology*, Oxford, 1988, p. 5.

anopheles, leading to the prevalence of malaria. It was concluded that hindrances to inundation affected both anopheles and human factors, resulting in 'Burdwan Fever'. It must be reiterated that this environmental change was brought about by the construction of railways and roads (Figure 4).

(3) Relevance of Human Factor Approach

We will examine the relevance of the above-mentioned causal explanation by Christophers and Bentley. There were two kinds of explanation. The first one, labour migration was supposed to be main cause of malaria epidemics in west and central Bengal. The second one, environmental change, that is obstruction to inundation was assumed to be important. Bentley changed his standpoint from the first one to the second one.

The second explanation is more persuasive.[33]

According to several descriptions in census reports, these areas affected by epidemic malaria were mostly waterlogged because of ill-draining. But these ill-draining conditions were brought about by dams, weirs and embankments. These were constructions for the use of roads, railways, irrigation and flood control.

This strip of country, ill-drained and liable to floods the effect of which are accentuated by dams and weirs placed across the rivers and creeks for irrigation purposes, is the most malarious part of Bengal. [34] (Bankura district)

The effect of the embankments and the sand-hills is to impede the drainage of the interior. [35] (Midnapore district)

[33] William Willcoks, *Lectures on the Ancient System of Irrigation in Bengal and its Application to Modern Problems*, Calcutta , 1930; R. Mukerjee, *The Changing Face of Bengal: A Study in Riverine Economy*, Calcutta, 1938.
[34] *Census of India, Bengal, 1921*, p.46.
[35] *Census of India, Bengal, 1921*, p.47.

In the 1870s these fever epidemics were assumed to be contagious diseases. The reason was as follows.

In support of this belief it is urged that the advance of the epidemic followed the main roads and the chief lines of traffic, and that it did not spread in any direction where means of communications did not exist.[36]

Of course malaria is not contagious disease. From this statement we can now guess that constructions of roads and lines of traffic led to ill-draining and water logging, which brought malaria. And these constructions might have led to the obstruction to inundation (flush irrigation). This is what Bentley claimed. There is no contradiction between water logging and obstruction to inundation. These two phenomenons were both results of constructions of dams, weirs and embankments.

Some parts of west Bengal and central Bengal are alluvial delta, but they were moribund delta or becoming moribund delta.

The Ganges found its way in to the Meghna the tendency has been for less and less of its waters to leave the main channel and find their way independently to the sea. The distributaries have become a network of moribund channels, and the subsoil water level seems to have fallen.[37]

This is a well-known eastward march of Bengal rivers. This movement has made West Bengal moribund delta for a long time.[38]

In its turn, the presence of so much water in the villages is due, in part, to the carelessness and ignorance of the inhabitants, and in part to the want of natural drainage in the country, owing to its position in a deltaic tract, where the process of land-building is still going on. The rivers are gradually heightening their banks and beds, until the drainage is away from instead of towards them. The subsoil water is unable to

[36] *Census of India, Bengal, 1881*, p.57
[37] *Census of India, Bengal, 1921*, p,55.
[38] Mukerjee, *The Changing Face of Bengal*, pp.110-140.

drain away rapidly, remains long at high level after the wet season, and prevents the soaking in of rain-water resulting in casual collections of water remaining for long periods in every hollow, natural and artificial. It is the combination of these two factors, the high subsoil water and the jungly and unsanitary condition of the villages, that results in so high a malaria rate.[39]

In the moribund delta the subsoil water was raised and water logging often happened. Constructions of dams, weirs and embankments greatly aggravated ill-draining. At the same time stoppage of inundation (flush irrigation) brought no silt to the moribund delta, resulting in the deterioration of soil fertility. William Willcocks pointed out that there was an ancient system of canal in West and Central Bengal. Countless canals made overflow irrigation possible, reproducing the soil fertility.[40] Bentley's 'Agricultural Deterioration' process was brought about by decay of the ancient canal system. Then a vicious circle between agricultural deterioration and malaria worked.

In the middle of 19th century intense development such as industrial activities and constructions of roads, railways, bridges, dams and embankments started in West and Central Bengal, especially in the areas of vicinity to Calcutta. How labour migration factor pointed out by Christophers and Bentley worked during the period remains to be examined. But we have confirmed that environmental change factor greatly worked.

Concluding Remarks

Massimo Livi-Bacci, a historical demographer pointed out that Malthus model could not explain many facts in European demographic

[39] *Census of India, Bengal, 1911*, p.70.
[40] Willcoks, *Lectures on the Ancient System of Irrigation in Bengal*.

history between the Black Death and the beginning of the Industrial Revolution. Many mortality crises were brought about by environmental factors rather than nutritional factors. The Malthus model suggested that famines and epidemics occurred because of imbalances between population and food. The evidence from European demographic history showed that the damage wrought by famines and epidemics derived mostly from epidemiological factors.[41]

This suggestion applies to the Indian case. 'The Age of Famines and Epidemics' can be best explained not by changes in food production or income alone, but by changes of environmental factors.

While the rate of population growth was very low due to repeated outbreaks of famines and epidemics, there was also economic growth during the period. Recent studies have recognized that there was slight per capita economic growth, and there were various developmental activities, including the building of railways and irrigation canals. We can call this period 'the Age of Development'. However, the results of colonial development such as increased human movement, urbanization and environmental changes may have aggravated the disease environment.

Even if the well being of the people may have risen in terms of commodities or incomes, the well being of the people must have declined in terms of health (one of elementary capabilities). This is the reason why we have emphasized the need to introduce the health factor into the analysis of economic history.

[41] M. Livi-Bacci, *Population and Nutrition: An Essay on European Demographic History*, Cambridge, 1991.

Table 1: Two Periods of Population Change in British India

1871 - 1920	Population Growth Rate 0.37% Many Mortality Crises (Famines and Epidemics)
1921 - 1941	Population Growth Rate 1.22% Disappearance of Mortality Crises

Sources: L. Visaria and P. Visaria, 'Population (1754-1947)', in D. Kumar (ed.), *The Cambridge Economic History of India, Vol.2: 1757-1970,*, Cambridge, 1982, p.490.

Figure 1: How Can We Measure Human Well-Being?

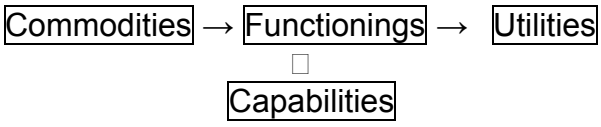

Table 2: Growth Rates of Agricultural Output and Population in British India, 1891-1946 (per cent per annum)

	1891-1916	1921-1946
Population	0.44	1.12
All crops	0.84	0.34
Foodgrain	0.61	0.03
Non-foodgrain	1.66	1.08

Source: Tirthankar Roy, *The Economic History of India, 1857-1947*, New Delhi, 2000, p.57. This table is originally based on George Blyn's study. See G. Blyn, *Agricultural Trends in India, 1891-1947: Output, Availability, and Productivity*, Philadelphia, 1966.

Table 3: Growth Rates of Net Domestic Product, Total and Agriculture, 1868-9 &1946-7 (annual trends in growth rates in per cent)

	Agriculture	Total	Population	Per capita NDP
1868 ~ 98	1.01	0.99	0.40	0.59
1882 ~ 98	1.08	1.29	0.51	0.78
1900 ~ 46	0.31	0.86	0.87	-0.01

Source: Tirthankar Roy, *op. cit.*, p.52. This table is based on the following studies: A. Heston, 'National Income', in D. Kumar (ed.), *The Cambridge Economic History of India Vol.2: c1757-c.1970*, Cambridge, 1983; S. Sivasubramonian, 'Revised Estimates of the National Income of India, 1900-01 to 1946-47', *Indian Economic and Social History Review*, vol. 32, no. 2, 1997.

Table 4: Mortality Crises in the United Provinces

1879 Famine+ Epidemic Malaria (Famine-Malaria Nexus)
1894 Cholera + Epidemic Malaria
1897 Famine + Epidemic Malaria (Famine-Malaria Nexus)
1905 Plague
1908 Famine + Epidemic Malaria (Famine-Malaria Nexus)
1911 Plague
1918 Influenza

Sources: K. Wakimura, 'Famines, Epidemics and Mortality in Northern India, 1870-1921', in P. Robb, K. Sugihara and H. Yanagisawa (eds.), *Local Agrarian Societies in Colonial India: Japanese Perspectives*, Surrey, 1996.

Figure 2: Deterioration of Disease Environment

Human Movement

Development → Urbanization → Deterioration of Disease Environment → Epidemics

Environmental Change

Figure 3: Causal Relationship of Epidemic Malaria in S.R. Christophers and C.A. Bentley, 'The Human Factor'(1909) and S.R. Christophers and C.A. Bentley, *Malaria in the Duars* (1911)

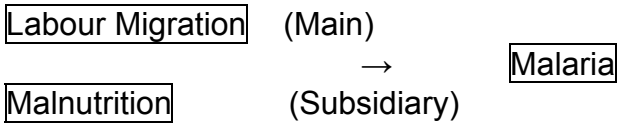

Figure 4: Causal Relationship of Epidemic Malaria in C.A. Bentley, *Report on Malaria in* Bengal (1916) and C.A. Bentley, *Malaria and Agriculture in Bengal* (1925)

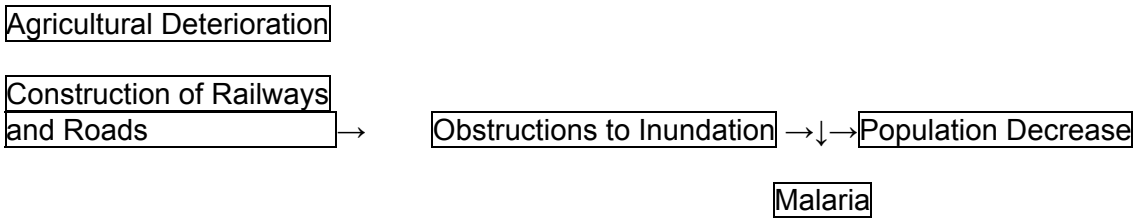

Table 5 Population of the Indian Sub-continent and Average Annual Growth Rate, 1871-1941

	East Zone	West Zone	Central Zone	North Zone	South Zone	All India
Population (million)						
1871	72.07	26.94	29.8	77.96	42.67	249.44
1881	76.42	25.96	32.87	80.2	39.06	254.51
1891	79.83	29.33	37.7	85.38	44.45	276.69
1901	85.62	27.38	33.26	86.48	48.12	280.86
1911	91.8	29.07	38.77	86.37	52.2	298.21
1921	93.54	28.83	37.64	85.7	53.92	299.63
1931	102.67	32.71	42.58	94.11	60.22	332.29
1941	121.47	37.39	48.71	110.16	64.83	382.56
Average annual growth-rate (per cent)						
1871-1881	0.59	-0.37	0.98	0.28	-0.88	0.2
1881-1891	0.61	1.24	0.81	0.76	1.29	0.89
1891-1901	0.58	-0.73	-1.04	0.09	0.78	0.11
1901-1911	0.75	0.66	1.54	0.11	0.8	0.65
1911-1921	0.26	-0.02	-0.25	-0.06	0.35	0.09
1921-1931	1	1.27	1.25	0.95	1.11	1.05
1931-1941	1.68	1.34	1.35	1.58	0.74	1.41
1871-1921	0.52	0.14	0.47	0.19	0.47	0.37
1921-1941	1.37	1.3	1.29	1.25	0.92	1.22
1871-1931	0.63	0.34	0.55	0.35	0.57	0.5
1871-1941	0.75	0.47	0.7	0.49	0.6	0.61

Notes:
East Zone (Bengal Province, Bengal States, Bihar and Orissa Province and states, Assam Province and states);
West Zone (Bombay Province excluding Aden, Bombay states, Baroda state and Western States Agency);
Central Zone (Central India Agency, Gwalior State, Central Provinces and states and Berar and Hyderabad state);
North Zone (United Provinces of Agra and Oudh, United Provinces states, Rajputana Agency, Ajmer-Merwara, Punjab Province, Delhi, Punjab States Agency and Jammu and Kashmir state);
South Zone (Madras Province, Madras states, Travancore and Cochin states, Mysore state and Coorg)

Source: L. Visaria and P. Visaria, 'Population', in D. Kumar (ed.),
The Cambridge Economic History of India Vol.2: c1757-c.1970, Cambridge, 1983.

Table 6 Population Change in Bengal, 1872-1931

	District	Population							Decennial Change						Average of Decennial
		1872	1881	1891	1901	1911	1921	1931	1881	1891	1901	1911	1921	1931	
West Bengal	Burdwan	1,482,439	1,390,459	1,388,118	1,528,290	1,533,874	1,434,771	1,575,699	-6.2%	-0.2%	10.1%	0.4%	-6.5%	2.7%	0.1%
	Birbhum	855,603	796,172	802,398	906,891	940,162	851,725	947,554	-6.9%	0.8%	13.0%	3.7%	-9.4%	0.8%	0.3%
	Bankura	968,597	1,041,752	1,069,668	1,116,411	1,138,670	1,019,941	1,111,721	7.6%	2.7%	4.4%	2.0%	-10.4%	-2.4%	0.6%
	Midnapore	2,542,920	2,515,565	2,631,466	2,789,114	2,821,201	2,666,660	2,799,093	-1.1%	4.6%	6.0%	1.2%	-5.5%	-0.8%	0.7%
	Hooghly	1,119,397	974,773	1,034,077	1,049,041	1,090,097	1,080,142	1,114,255	-12.9%	6.1%	1.4%	3.9%	-0.9%	2.2%	0.0%
	Howrah	635,878	675,394	763,625	850,514	943,502	997,403	1,098,867	6.2%	13.1%	11.4%	10.9%	5.7%	16.5%	10.6%
	BURDWAN DIVISION	7,604,834	7,394,115	7,689,352	8,240,261	8,467,506	8,050,642	8,647,189	-2.8%	4.0%	7.2%	2.8%	-4.9%	2.1%	1.4%
Central Bengal	24-Parganas	1,492,829	1,603,896	1,803,780	1,977,011	2,286,864	2,458,792	2,713,874	7.4%	12.5%	9.6%	15.7%	7.5%	18.7%	11.9%
	Calcutta	721,628	699,182	769,813	949,144	1,043,307	1,077,264	1,196,734	-3.1%	10.1%	23.3%	9.9%	3.3%	14.7%	9.7%
	Nadia	1,498,988	1,660,644	1,641,410	1,665,322	1,624,861	1,494,698	1,529,632	10.8%	-1.2%	1.5%	-2.4%	-8.0%	-5.9%	-0.9%
	Murshidabad	1,204,621	1,217,099	1,240,852	1,322,486	1,345,073	1,224,181	1,370,677	1.0%	2.0%	6.6%	1.7%	-9.0%	1.9%	0.7%
	Jessore	1,439,249	1,922,916	1,872,803	1,797,794	1,743,371	1,722,219	1,671,164	33.6%	-2.6%	-4.0%	-3.0%	-1.2%	-4.1%	3.1%
	Khulna	1,054,990	1,088,097	1,186,910	1,262,881	1,377,220	1,468,970	1,626,148	3.1%	9.1%	6.4%	9.1%	6.7%	18.1%	8.7%
	PRESIDENCY DIVISION	7,412,305	8,191,834	8,515,568	8,974,638	9,420,696	9,446,124	10,108,229	10.5%	4.0%	5.4%	5.0%	0.3%	7.3%	5.4%
North Bengal	Rajshahi	1,417,629	1,444,351	1,433,275	1,456,028	1,482,308	1,497,338	1,429,018	1.9%	-0.8%	1.6%	1.8%	1.0%	-3.6%	0.3%
	Dinajpur	1,435,309	1,447,749	1,487,915	1,572,707	1,694,296	1,711,895	1,755,432	0.9%	2.8%	5.7%	7.7%	1.0%	3.6%	3.6%
	Jalpaiguri	416,781	579,373	679,623	786,326	902,660	936,269	983,357	39.0%	17.3%	15.7%	14.8%	3.7%	8.9%	16.6%
	Darjeeling	94,996	155,645	223,314	249,117	265,550	282,748	319,635	63.8%	43.5%	11.6%	6.6%	6.5%	20.4%	25.4%
	Rangpur	2,149,119	2,093,658	2,061,341	2,150,012	2,880,831	2,503,215	2,594,785	-2.6%	-1.5%	4.3%	34.0%	-13.1%	-9.9%	1.9%
	Bogra	641,863	686,745	764,155	854,129	984,254	1,049,322	1,086,419	7.0%	11.3%	11.8%	15.2%	6.6%	10.4%	10.4%
	Pubna	1,215,118	1,315,479	1,366,261	1,425,608	1,432,935	1,393,850	1,445,654	8.3%	3.9%	4.3%	0.5%	-2.7%	0.9%	2.5%
	Malda	684,537	719,638	823,510	892,993	1,025,707	1,012,409	1,053,766	5.1%	14.4%	8.4%	14.9%	-1.3%	2.7%	7.4%
	RAJSHAHI DIVISION	8,055,352	8,442,638	8,839,394	9,386,920	10,668,541	10,387,046	10,668,066	4.8%	4.7%	6.2%	13.7%	-2.6%	0.0%	4.5%
	COOCH BEHAR STATE	532,565	602,624	578,868	566,974	592,952	592,489	590,886	13.2%	-3.9%	-2.1%	4.6%	-0.1%	-0.3%	1.9%
EAST BENGAL	Dacca	1,798,883	2,056,842	2,355,845	2,605,389	2,916,381	3,156,936	3,432,577	14.3%	14.5%	10.6%	11.9%	8.2%	17.7%	12.9%
	Mymensingh	2,354,575	3,058,059	3,474,850	3,917,724	4,525,972	4,837,219	5,130,262	29.9%	13.6%	12.7%	15.5%	6.9%	13.4%	15.3%
	Faridpur	1,541,369	1,675,315	1,837,904	1,949,550	2,117,068	2,219,250	2,362,215	8.7%	9.7%	6.1%	8.6%	4.8%	11.6%	8.2%
	Bakarganj	1,869,693	1,882,545	2,133,362	2,269,779	2,405,252	2,602,779	2,939,050	0.7%	13.3%	6.4%	6.0%	8.2%	22.2%	9.5%
	DACCA DIVISION	7,564,520	8,672,761	9,801,961	11,309,416	12,557,625	12,816,184	13,864,104	14.7%	13.0%	15.4%	11.0%	2.1%	10.4%	11.1%
	Tippera	1,448,705	1,565,393	1,841,387	2,182,710	2,502,577	2,744,860	3,109,735	8.1%	17.6%	18.5%	14.7%	9.7%	24.3%	15.5%
	Noakhali	841,247	821,623	1,010,740	1,142,912	1,303,441	1,472,786	1,706,719	-2.3%	23.0%	13.1%	14.0%	13.0%	30.9%	15.3%
	Chittagong	1,127,402	1,132,341	1,290,167	1,353,250	1,508,433	1,611,422	1,797,038	0.4%	13.9%	4.9%	11.5%	6.8%	19.1%	9.4%
	Chittagong Hill Tract	69,607	101,597	107,286	124,762	153,830	173,243	212,922	46.0%	5.6%	16.3%	23.3%	12.6%	38.4%	23.7%
	CHITTAGONG DIVISION	3,486,961	3,620,954	4,249,580	4,803,634	5,468,281	6,002,311	6,826,414	3.8%	17.4%	13.0%	13.8%	9.8%	24.8%	13.8%
	TRIPURA STATE	35,262	95,637	137,442	173,325	229,613	304,437	382,450	171.2%	43.7%	26.1%	32.5%	32.6%	66.6%	62.1%
BENGAL		34,691,799	37,020,563	39,812,165	43,455,168	47,405,214	47,599,233	51,087,338	6.7%	7.5%	9.2%	9.1%	0.4%	7.8%	6.8%

Source: *Census of India, Bengal, 1881, 1891, 1901, 1911, 1921, 1931.*