Cholera in relation to certain physical phenomena : a contribution towards the special enquiry sanctioned by the Right Hon. the Secretaries of State for War and for India / by T.R. Lewis and D.D. Cunningham.

CHOLERA

IN RELATION TO

CERTAIN PHYSICAL PHENOMENA:

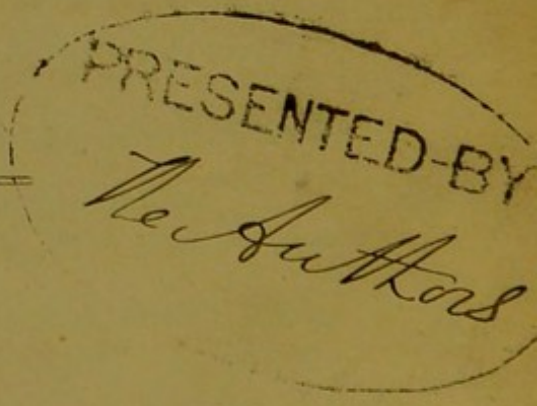
A CONTRIBUTION TOWARDS THE SPECIAL ENQUIRY SANCTIONED
BY THE RIGHT HON. THE SECRETARIES OF STATE
FOR WAR AND FOR INDIA.

BY

T. R. LEWIS, M.B., AND D. D. CUNNINGHAM, M.B.,

SURGEON, BRITISH MEDICAL SERVICE, SURGEON, INDIAN MEDICAL SERVICE,

SPECIAL ASSISTANTS TO THE SANITARY COMMISSIONER WITH THE GOVERNMENT OF INDIA.



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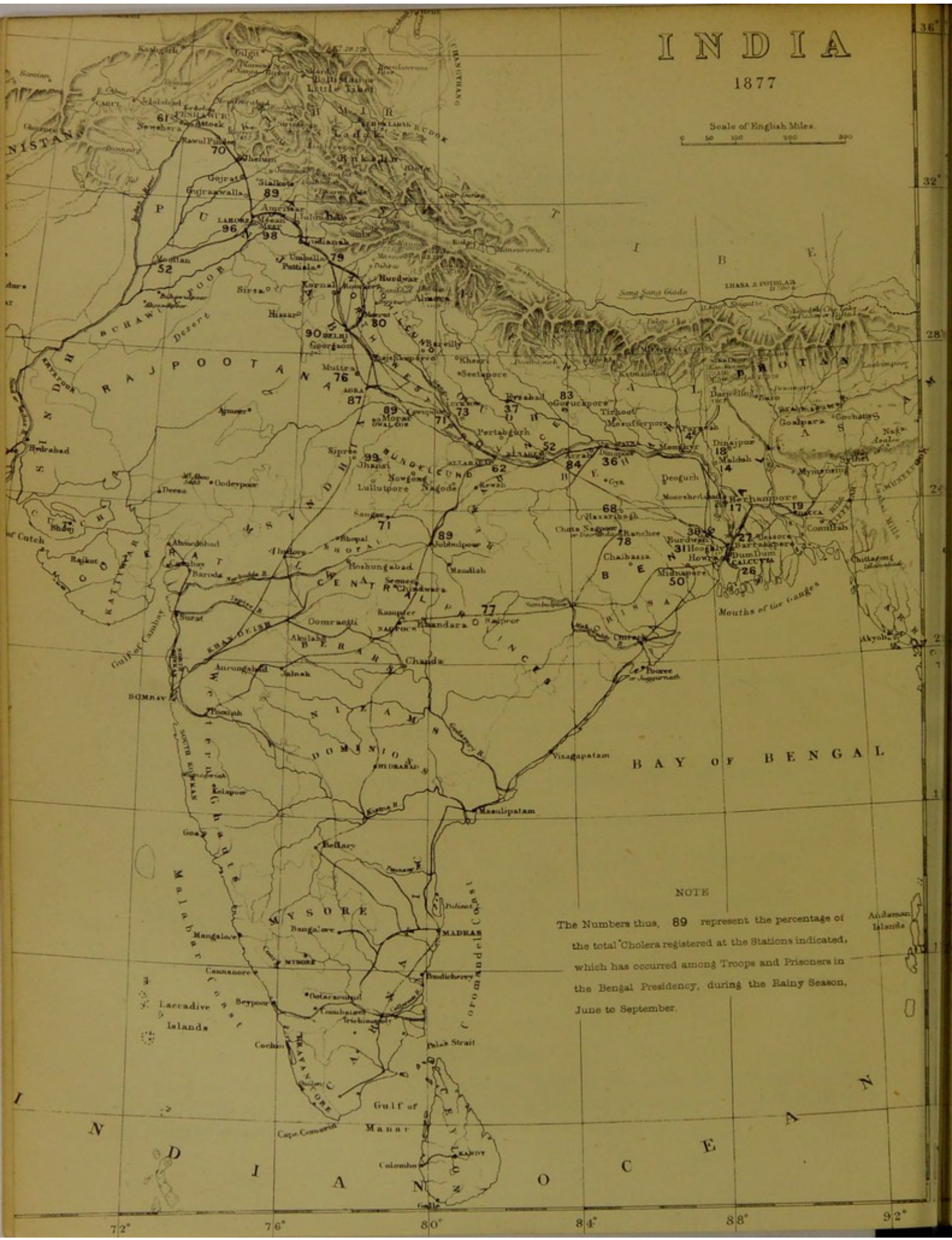
INDIA
1877
Scale of English Miles.
0 50 100 200 300
NOTE
The Numbers thus, 89 represent the percentage of the total Cholera registered at the Stations indicated, which has occurred among Troops and Prisoners in the Bengal Presidency, during the Rainy Season, June to September.
BAY OF BENGAL
INDIAN OCEAN
RAJPOOTANA
MYSORE
BOMBAY
MADRAS
CALCUTTA
Mouths of the Ganges
Laccadive Islands
Andaman Islands
Gulf of Manar
Palk's Strait
Coromandel Coast
Malabar Coast
72°
76°
80°
84°
88°
92°

CHOLERA IN RELATION TO CERTAIN PHYSICAL PHENOMENA:

A CONTRIBUTION TOWARDS THE SPECIAL ENQUIRY SANCTIONED BY THE RIGHT HON. THE SECRETARIES OF STATE FOR WAR AND FOR INDIA.*

INTRODUCTION.

THE RELATION OF SOIL TO DISEASE.

Conditions of soil and cholera.

THE question of the influence of conditions of the soil on the prevalence of cholera has been for some years the subject of special enquiry in this country, and the primary object of the present report is to shew what the results of this investigation have been up to the present time. The varying conditions of the soil are, however, so intimately associated with meteorological conditions in the ordinary sense of the term—the two sets of phenomena acting and re-acting on one another mutually—that, when the subject was entered upon, it was found impossible to leave the latter out of consideration, and the enquiry has, therefore, been made a more or less general one into the physical conditions of localities associated with the seasonal prevalence of cholera in them.

Meteorology and cholera.

That the prevalence of cholera in any locality is more or less affected by the coincident meteorological and other physical conditions is generally admitted by the adherents of all theories regarding the essential cause of the disease, but comparatively little has been done to investigate the actual relation which the phenomena bear to one another. It is true that the special committee for scientific inquiries, appointed by the Board of Health in 1854, included the subject in its

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* Appeared as an Appendix to the *Thirteenth Annual Report of the Sanitary Commissioner with the Government of India.*

meteorological aspect among the matters for investigation, and that more recently the questions of the relation of wind, of soil, and of rainfall to cholera have been discussed by various authorities, such as Drs. von Pettenkofer, Macpherson, Bryden and Macnamara, but in spite of this there is still abundant room for close enquiry. This is in part due to the fact that most of those who have considered the matter at all have, to some extent, only done so in so far as special phenomena have appeared to lend support to special views regarding the cause of the disease, while neglecting to consider others, which either appeared to have no direct bearing on such views, or were even difficult to reconcile with them.

In the following pages an attempt has been made to bring together the scattered data which appear to be of importance in studying the relation which the prevalence of this disease in the province of Bengal may bear to certain conditions of soil and of air, and to incorporate with them such of the new observations as appear to be sufficiently advanced to warrant some conclusions being derived from them.

Observations regarding water-level.

Under the orders of the Government, daily observations have been recorded at numerous stations all over India, in the presidencies of Bombay and Madras, as well in Bengal, regarding the fluctuations which the subsoil water undergo. In the military cantonments these were conducted during 1870 and the greater part of 1871, but in several of the civil stations, the registration has been continued until the present time. In 1875 the observations were limited to four or five stations in each province, as, with the information already acquired, it was considered that these would suffice for the future.

The registration of the water-level was undertaken not only for the purpose of endeavouring to ascertain whether any relation existed between the degree of the prevalence of cholera and the hygrometric state of the soil, but also in the hope that continuous and systematic observations of this character might aid in enabling the profession to come to some definite conclusion with regard to the cause of the various fevers which so frequently recur in certain districts, and cause such terrible devastation.

Dr. von Pettenkofer's views regarding the connection between soil and disease.

As is well known, the credit of drawing attention to these matters in modern times belongs to the distinguished Professor of Hygiene at the Munich University, Dr. Max von Pettenkofer; and their investigation in India was undertaken at the suggestion of the Army Sanitary Commission, in consultation with the late Dr. Parkes

and the other Professors of the Army Medical School.* As some misconception appears not uncommonly to exist even yet as to the object which von Pettenkofer had in view in advocating the system of water-level registration and the method in which the data thus acquired should be interpreted, perhaps it may be advantageous to give a general outline of what we ourselves conceive to be his views on the subject. In his now celebrated lectures on "The Air in relation to Clothing, Dwelling and Soil,"† a lucid description is given of the relation which the air in the soil bears to the air above it: how the air in the pores of the soil is kept constantly moving by the force of the wind passing over the surface of the ground, and by the laws regulating the intermingling of gases—change of temperature, diffusion and so forth.

Soil in relation to decomposition.

As an illustration of the differences which soils present, he points out how experience has shown that in some grave-yards the decomposition of bodies is complete in from six to seven years, whereas in others twenty-five or thirty years are required before this is brought about; so that it has become a matter of practical import to ascertain the quality of the ground in this respect, when selecting sites for cemeteries, as the interval which should elapse before a burying-ground may be used again hinges upon the fact as to whether decomposition takes place rapidly or not; hence it may happen that two cities with an equal population may require cemeteries of very different extent. He mentions that several influences combine to bring this about, but the principal one is the amount of, and the facility for, the interchange of the air in the soil—gravelly and sandy soils acting much more quickly than those of marl and clay.

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* The previous reports which have appeared in connection with the Special Cholera Enquiry sanctioned by the Secretaries of State for War and for India, and which have been published in former Annual Reports of the Sanitary Commissioner with the Government of India, are the following:—

1. Microscopic Appearances of Choleraic Discharges—The Fungus Theory, &c. App. A., *Sixth Annual Report*, pp. 124—178, Calcutta, 1870.

2. Cholera in Madras—Topographical and Microscopic Observations. App. B., *Seventh Annual Report*, pp. 139—236, 1871.

3. Cholera: Microscopical and Physiological Observations—Series I., *Eighth Annual Report*, App. C., pp. 143–203 1872. (Republished in *Indian Annals of Medical Science*, No. 30, vol. XV, 1873.)

4. Microscopic Examinations of Air. *Ninth Annual Report*, App. A., pp. 1—54, 1873.

5. Cholera: Microscopical and Physiological Observations—Series II. *Tenth Annual Report*, App. A., pp. 173—210, 1874. (Republished in *Indian Annals of Medical Science*, No. 35, vol. XVIII, 1876.)

6. The Soil in its relation to Disease. *Eleventh Annual Report*, App. B., pp. 117—143, 1875. (Republished in *Indian Annals of Medical Science*, vol. XVIII, 1876.)

† *Beziehungen der Luft zu Kleidung Wohnung und Boden*, 1872.

Effects of variation of soil-moisture.

Elsewhere this *savant* points out that changes, such as these, are materially expedited by variations in the degree of the soil-moisture: wood is preserved as well in water as in dry air, but it rots when subject to alternations of dryness and moisture.

It is not on the particular degree of soil moisture that Dr. von Pettenkofer lays stress, but on the variations in it, and he suggests the fluctuation of the ground-water as a convenient index of this, especially in Europe. With regard to India, however, he throws out the suggestion that experience may show that the rainfall may serve as a clearer index than the water-level, as the former is not so irregularly distributed throughout the year as in Europe.* Mr. H. F. Blanford, in a work recently published, also points out the marked difference which exists between European and Indian meteorological manifestations, and remarks that "order and regularity are as prominent characteristics of our atmospherical phenomena as are apparent caprice and uncertainty those of their European counterparts."†

Emanations from soil into dwellings.

Granted that certain organic or inorganic processes take place in the soil and give rise to various diseased conditions, it would still be necessary to show how these changes could affect such portions of the community as spend the greater part of their time in-doors. To this von Pettenkofer replies by instancing cases of poisoning from gas which have occurred in houses unconnected directly with gas pipes. The warmer air of the house acting like a heated chimney, having drawn up the soil-air through the ground on which the houses stood and thus conveyed the gas which had escaped from pipes placed in the earth outside the dwelling. Instances are referred to of this having occurred, although the gas had to travel some 20 feet under the street and through the foundation and flooring of the house.

A family poisoned by gas finding its way into a house through the soil of a street.

Quite recently these statements have received marked corroboration from Dr. Cobelli of Roveredo,‡ who gives details regarding a case of the kind where a mother and her two daughters, a dog and a bullfinch in its cage, were one morning found poisoned in a bed-room. The two daughters were already dead and the bird also; the

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* *Verbreitungsart der Cholera in Indien*, 1871, S. 95.

† *The Indian Meteorologist's Vade Mecum*, 1877, p. 144.

‡ *Zeitschrift für Biologie*, Band XII, S. 420.

mother died shortly afterwards; the dog alone recovered. The State ordered an enquiry to be held, as it was scarcely conceivable that the deaths could be attributed to an escape of gas, as no pipes were connected with the house. That gas could get into the room, however, was shown by analysis of the air which it contained, and after minute investigation it turned out that gas was escaping through an imperfectly fitting plug of one of the main pipes which had been sunk about a yard below the surface (in earth of an alluvial nature), and 15 feet 7 inches removed from the room in which the poor people had slept. The gas had been aspired into the room instead of escaping into the street, for the air of the room at night had been warmer than the air outside.

The importance of bearing observations of this kind in mind in connection with attempts at tracing to their source foul emanations from covered sewers and other unwholesome sub-soil recesses and tracts is too obvious to require special note.

It is in this light that, as we understand it, Dr. von Pettenkofer suggests that the relation of soil-influences should be studied, and urges that it is absolutely necessary that each locality should be studied for itself at different times, seeing that constant variations take place not only in the generating power of the soil, but also in its porosity, or, in other words, in its capacity for permitting any noxious elements which it might contain to mingle with the upper air. A layer of asphalt beneath the flooring of that gas-infected house would doubtless have prevented the occurrence of poisoning, as would, possibly equally well, a layer of *wet* clay.

Tables of Water-Level Registers.

With this brief summary of our conception of the learned Professor's views, we pass on to draw attention to the epitome of the Water-Level Registers [Tables I to VII at the end of this paper] which have been kept in Bengal during the last seven years. Some of the returns we have been obliged to leave out of the tables, owing to obvious and irremediable inaccuracies, due, probably in great part, to misconception on the part of the observers as to the precise nature of the information required. Some other returns which were also manifestly incorrect we have been able in some degree to rectify, especially such of them as presented inverse readings of the fluctuations of the water-level. These have been marked with an asterisk in the tables. It will be observed, also, that at some of the stations observations have been made only during very short periods. These have, however, been put on record, as they may, perchance, be of use to future observers

in studying localised outbreaks of disease that may occur at those particular stations.

In the water-level returns for Calcutta, the monthly mean of the daily returns have been calculated for all the years; but with regard to the others, the observation recorded in the middle of each month has been taken as offering sufficiently precise information.

Madras and Bombay returns deferred, as also consideration of relation of the data to fevers, &c.

It was our intention to have analysed the records obtained from Madras and Bombay on the present occasion also, but we found that the task was more than could be accomplished satisfactorily at present. On a future occasion we hope to deal with these also, and to do so, if practicable, not only in connection with the question of cholera, but also with relation to the prevalence of malarial fevers and dysentery.

PART I.

CHOLERA IN CALCUTTA.

CHAPTER I.

THE SEASONAL FLUCTUATIONS IN THE PREVALENCE OF CHOLERA IN AN *ENDEMIC* AREA—CALCUTTA.

Gangetic delta suitable to the study of cholera.

Of all regions where the nature of the influence of seasonal conditions on the prevalence of cholera can be enquired into, the endemic area of the disease, and more especially the endemic area as represented by the lower portion of the Gangetic delta, is perhaps the best adapted to the end in view. In it the constant presence of the disease and the regularity with which the phenomena of fluctuations in its prevalence occur, furnish data which are more readily comparable with those of a physical nature than can be obtained in regions where cholera only occurs occasionally and in epidemic outbursts. The data regarding a typical locality in this area—Calcutta—have therefore been gone into at considerable length and in greater detail than has been attempted in reference to other places; but regarding almost all the localities considered in the report, sufficient data are supplied to allow of their comparison with Calcutta in most important respects.

Sources of data as to cholera in Calcutta.

Our data regarding the varying prevalence of cholera in Calcutta at different times of year are mainly derived from three sources—*1st*, the table published by Dr. John Macpherson in his work on "Cholera in its Home";* *2nd*, that contained in the report of the Health Officer for Calcutta for the year 1876;† and *3rdly*, Dr. Bryden's Statistical Tables regarding the European troops in Fort William and the inmates of the Alipore Jail. Tables shewing the data regarding the occurrence of the disease in the Native troops in Fort William and in Alipore are also included in the following pages, but they are of little value compared with the others, including, as they do, the results of only a very limited number of years.

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* London: John Churchill and Sons, New Burlington Street, 1866.

† Report of the Health Officer for Calcutta, by A. Payne, M.D., Calcutta, 1877.

Dr. Macpherson's Statistics.

The figures furnished by Dr. Macpherson include those contained in the monthly returns of deaths from cholera in Calcutta for a period of 26 years. They are shewn in the following table:—

TABLE VIII.—*Total deaths returned as due to Cholera in Calcutta during each month for a period of 26 years.*

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL.
Deaths ...	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323	8,159	104,295

Dr. Payne's Statistics.

Dr. Payne's table includes the deaths returned during each month from 1865 to 1876, and is as follows:—

TABLE IX.—*Monthly Cholera Deaths in Calcutta from 1865 to 1876.*

Years.	Jan.	Feb.	March.	April.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1865	136	396	508	756	400	131	162	392	496	432	817	452
1866	509	826	1,193	736	616	885	552	491	371	236	203	208
1867	67	142	292	343	315	137	108	56	150	277	243	140
1868	252	328	694	591	360	174	97	395	188	350	405	352
1869	264	428	760	746	698	331	78	53	41	57	78	58
1870	171	259	257	382	165	118	50	40	30	37	22	32
1871	53	96	55	85	29	23	25	41	70	86	128	109
1872	80	81	64	70	66	55	71	79	61	86	181	248
1873	133	189	221	163	153	99	59	31	26	24	28	29
1874	69	182	193	250	217	86	42	39	24	29	67	131
1875	130	73	268	268	119	66	32	35	55	150	358	172
1876	91	226	343	268	168	126	42	32	31	41	259	244
Total ...	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789	2,175

As these tables furnish by far the most important data which we possess in reference to the seasonal prevalence of cholera in Calcutta, it may be well to consider their results alone first, reserving those regarding the more limited communities to be noticed afterwards.

Average monthly mortality: November an average month.

That their results in general agree very closely is evident even on a casual inspection. The first table gives a total of 104,295 for the 26 years' mortality, or an average of 8691·2 per month when the entire period is sub-divided into 12 monthly periods.

The month in which the actual numbers most nearly approach this average is November, the 26 years' deaths of which are 8,323.

The second table for 12 years gives a total mortality of 31,538, or a monthly average of 2628·1. Here again November, with a total mortality of 2,789, is the nearest to the average. We are thus justified in regarding November as a month of average cholera-prevalence—as a month presenting the conditions producing the disease in a state of medium intensity—and consequently in employing it as a starting-point for comparison, and the conditions then existent as bases for the study of those present at other times.

The order, proceeding from minimum to maximum, which the individual months hold in regard to prevalence in the two tables, is shown in the following table, which also includes a third column, showing the order in prevalence since the beginning of 1871:—

TABLE X.—*Months arranged in order of Cholera Prevalence from minimum to maximum.*

Order.	Dr. Macpherson's Table.	Dr. Payne's Table.	Dr. Payne's Table from 1871.
1	August.	July.	August.
2	September.	September.	September.
3	July.	August.	July.
4	October.	October.	October.
5	June.	January.	June.
6	January.	December.	January.
7	December.	June.	February.
8	November.	November.	May.
9	February.	February.	December.
10	May.	May.	November.
11	March.	April.	April.
12	April.	March.	March.

Comparing the first two columns, we find the differences to be as follows: July and September occupy reversed positions, August coming first and July third in the first column, while July comes first and August third in the second one. In both

Cholera-prevalence according to months.

columns October occupies the fourth place, but June, which in the first column precedes, in the second follows, January and December. In both columns the rest of the order is identical, save that in one April, in the other March, comes last.

Next, comparing the first and third columns, we find an entire agreement for the first six months; but after this, December and November change places with February and May, whilst March and April again occur in reversed order. The principal use of the second comparison is to show how, in examining the results of very short periods, whilst we find a general agreement with those of longer ones, minor differences are introduced by the exceptional occurrences of particular years.

Returning now to the consideration of the tables as a whole, it will be found that the agreement between their results may be considerably augmented by removing the figures regarding one great cholera season—that of 1865-66—from the second table. If we do this, starting with September 1865, in which the great rise in prevalence began, and removing the figures of each of the subsequent months up to the following September, we get the following series of figures as the monthly totals for the remaining 11 years:—

1865-66, a season of exceptional prevalence.

TABLE XI.—*Total Cholera Deaths from 1865 to 1876, exclusive of the period between September 1865 and September 1866.*

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Deaths	1,446	2,400	3,655	3,922	2,690	1,346	766	1,193	1,047	1,373	1,927	1,723

The tables now agree, save that June and July change places with October and August. April now appears in both tables as the month of maximum prevalence, and the relation which the figures for November and December bear to one another comes to be closely similar in both cases.

Let us now see what the average annual course of cholera as exhibited in these figures really is. Taking November as most nearly representing the average prevalence of the disease, and therefore as a good starting-point, we find suc-

The average annual course of cholera in Calcutta.

cessive diminutions in prevalence during December and January, a rapid rise in February, continuing to the maximum in March and April, a marked diminution in May, continued through June, to a minimum in July, August and September, and finally a rise in October to reach the average in November. Stating the facts of prevalence in most general terms, it may be said that there are four months in which the prevalence of cholera greatly exceeds the average, three months in which it falls far short of it, and five months in which it ranges round it, the prevalence in November approaching it more nearly than that of any other month.

Such are the results of the more important masses of data at our disposal, and we may next examine those relative to various limited communities in order to see how far they agree with the others.

Cholera in Fort William.

The next two tables contain the deaths from cholera which occurred among the European troops in Fort William from 1826 to 1857, and the admissions from 1826 to 1849 and 1858 to 1876. The figures are those of Dr. Bryden's statistical tables regarding cholera. Deaths have been stated separately from admissions, because they are less liable to suspicion in respect of errors of diagnosis,* and because the previous statistics which we have been considering have referred to deaths alone. The returns of admissions per month in Dr. Bryden's tables cease with the year 1849, after which only deaths are given until 1858, from which date monthly admissions and total annual deaths are recorded, and it is on this account that our two tables do not embrace the same period of years.

TABLE XIII.—*Cholera deaths among European Troops in Fort William, 1826 to 1849 and 1850 to 1857.* [*The figures of latter period refer to deaths of European Troops in "Calcutta".*]

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Deaths ... 1826—49	9	19	37	77	75	16	8	6	9	12	22	7
„ ... 1850—57	2	14	19	28	11	32	3	10	24	10	27	19
TOTAL ...	11	33	56	105	86	48(*a*)	11	16	33(*b*)	22	49	26

(*a*) Thirty-one occurred in June 1857. | (*b*) Twenty-three occurred in September 1856.

* In reference to this point, it is to be noted that some of the returns regarding Fort William are very open to suspicion; for example, we find that in 1838, 126 admissions and only 8 deaths from cholera are recorded

TABLE XIV.—*Cholera admissions among European Troops in Fort William, 1826 to 1876.*
[*Deaths alone registered during the years 1850-55 and 1857.*]

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Admissions ...	51	72	169	274	212(*a*)	107	59	65	84	64	100	62

(*a*) Forty-nine of these admissions occurred in 1826.

giving a rate of mortality very unlike that which is encountered in true cholera at the present time. The numbers of admissions and of deaths, with the percentages of the latter to average strength from 1826 to 1876 are as follows:—

TABLE XII.—*Annual Returns of Cholera among European Troops in Fort William.*

Year.	Cholera.			Year.	Cholera.		
	Admissions.	Deaths.	Percentage of deaths to strength.		Admissions.	Deaths.	Percentage of deaths to strength.
1826 ...	84	46	7·6	1852† ...	...	20	...
1827 ...	40	18	1·9	1853† ...	...	13	...
1828 ...	26	13	1·4	1854† ...	...	6	...
1829 ...	46	14	1·5	1855† ...	...	21	...
1830 ...	57	11	1·0	1856† ...	...	41	...
1831 ...	17	4	0·4	1857† ...	...	73‡	...
1832 ...	19	2	0·2	1858 ...	92	55	7·1
1833 ...	20	5	0·7	1859 ...	14	9	0·6
1834 ...	10	3	0·4	1860 ...	59	40	3·3
1835 ...	15	0	0·0	1861 ...	18	9	0·8
1836 ...	7	0	0·0	1862 ...	16	13	1·4
1837 ...	7	1	0·1	1863 ...	5	4	0·5
1838 ...	126	8	0·8	1864 ...	7	2	0·2
1839 ...	9	2	0·2	1865 ...	0	1	0·1
1840 ...	37	17	2·3	1866 ...	4	2	0·2
1841 ...	69	23	3·3	1867 ...	3	2	0·2
1842 ...	118	59	6·1	1868 ...	5	5	0·5
1843 ...	24	15	1·4	1869 ...	0	0	0·0
1844 ...	15	7	1·3	1870 ...	4	2	0·2
1845 ...	29	14	3·0	1871 ...	0	0	0·0
1846 ...	31	21	4·4	1872 ...	2	1	0·1
1847 ...	5	2	0·3	1873 ...	3	1	0·1
1848 ...	12	9	1·1	1874 ...	1	1	0·1
1849 ...	5	4	0·4	1875 ...	0	0	0·0
1850† ...	...	6	...	1876 ...	5	5	0·4
1851† ...	...	20	...				

† 1850 to 1857 Records of Admissions are incomplete, and the strength not known.
‡ Fort William and Calcutta hospitals (soldiers, sailors, &c., ?).

Comparison between the Military and Civil population.

These tables show results which, in reference to the general phenomena of the fluctuations in the prevalence of cholera, substantially agree with those regarding the population at large. This is specially the case with that referring to deaths, which we have already seen cause to regard as the one more accurately representing the facts. The principal points of difference between the results lie in the greater relative fall in prevalence in December and January among the troops, and in the fact that among them the months of maximum prevalence are April and May, in place of March and April. The general phenomena of the rise of prevalence at the close of the rainy season, followed by a fall during December and January, and of a second great rise in the succeeding months, followed by a great fall during the rains, are exactly those which we met with in the former tables.

The following tables show the number of admissions from cholera among the Native troops in Fort William and in Alipore Cantonment from 1864 to 1876:—

TABLE XV.—*Cholera admissions among Native Troops in Fort William, 1863-4 and 1867 to 1876.*

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Admissions ...	3	6	4	11	19	8	0	0	3	1	5	4

TABLE XVI.—*Cholera admissions among Native Troops in Calcutta [Fort William and Alipore], 1852 to 1876.*

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Admissions ...	14	37	94	97	85	41	34	19	21	15	27	26

The period included is of such short duration that it is remarkable to find how far these tables corroborate the results of the previous ones.

Our last sources of data regarding seasonal prevalence lie in the great Jail at Alipore. Only 39 cases are recorded as having occurred at the Presidency Jail (1872 to 1876). The following table shows the figures regarding cholera

admissions in the Alipore Jail from 1854 to 1876. Like the previous tables, its materials are derived from Dr. Bryden's statistics of cholera.

TABLE XVII.—*Cholera admissions in Alipore Jail, 1854 to 1876.*

Months.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Admissions ...	29	101	284	153	60	114*	133†	35	41	69	77	32

The results in this last table differ from those in the former ones in showing a comparatively high prevalence in June and July. This discrepancy is, however, greatly reduced in importance, when we find that 41 of the total admissions in June occurred in one year, and 53 of those in July in two successive years.

Statistics regarding limited communities must embrace prolonged periods to afford trustworthy indices.

The evidence afforded by this series of minor tables regarding limited communities is confirmatory of the general correctness of the indications afforded by the statistics of the first two, and it is of importance to observe how much data derived from limited communities may furnish trustworthy indices regarding the seasonal prevalence of disease. The great requirement is, that they should embrace a sufficiently prolonged period to do away with the fallacies introduced by exceptional outbreaks; where this condition is fulfilled, such data may be resorted to with tolerable confidence. It is evident that such figures, when thus employed, are in great measure free from the sources of fallacy inherent in them when employed as an index of the general prevalence of cholera among the population at large in one year as compared with another.

CHAPTER II.

A COMPARISON OF THE SEASONAL FLUCTUATIONS IN INDIVIDUAL PHYSICAL CONDITIONS WITH THOSE IN PREVALENCE OF CHOLERA IN CALCUTTA.

Special physical conditions considered.

Having acquired this information regarding the seasonal fluctuations in the prevalence of cholera, we have now to enquire into the meteorological and other physical con-

* Forty-one of these admissions occurred in 1866.

† Nineteen of these admissions occurred in 1858, and 34 in 1859.

ditions coincident with them, in order, if possible, to determine whether any connection be traceable between the two series of phenomena; whether, in fact, there be any series of meteorological and physical constants characterising the various seasons of prevalence when compared with one another.

The conditions which have been selected for consideration are, (1) atmospheric pressure, (2) air-temperature, (3) atmospheric humidity, (4) rainfall, (5) water-level, (6) soil-temperature, and (7) amount of carbonic acid in the soil-air—mainly regarded as an index of soil-ventilation.

The sources from which our data regarding these conditions are derived are the following: (1), the Report on the Meteorology of India in 1875, by Mr. H. F. Blanford, Meteorological Reporter to the Government of India; (2), the Report of the Meteorological Reporter to the Government of Bengal for 1874; (3), the Abstracts of the Meteorological Observations taken at the Surveyor General's Office from the year 1856; (4), the register of water-level kept at the Alipore Jail by Dr. S. Lynch since 1870; (5), our own observations regarding the temperature and carbonic acid of the soil-air.

(a) Atmospheric Pressure.

Atmospheric Pressure.

The accompanying diagram and table show the phenomena of atmospheric pressure compared with cholera prevalence. In the diagram the line of atmospheric pressure is drawn to the second decimal place of the 9 years' averages given in Mr. Blanford's report and reproduced in the table. The cholera line was originally constructed on a scale allowing one graduation to every thousand, and the figures employed are those of the total obtained on adding Drs. Macpherson's and Payne's statistics together. The figures in the table explain themselves.

TABLE XVIII.—*Average monthly Atmospheric Pressure (9 years) compared with Cholera-prevalence.*

		Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Augt.	Sept.	Oct.	Nov.	Year.
Average pressure		29·980	30·030	30·011	29·948	29·856	29·757	29·665	29·550	29·545	29·608	29·689	29·831	29·980	29·787
Cholera.	(Macpherson)	8,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323	104,295
	(Payne) ...	2,989	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789	31,538
	TOTAL ...	11,112	10,334	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112	135,833

It will be observed that in both table and diagram the months are arranged starting from November, in place of from the commencement of the calendar year. The same arrangement has been followed in the subsequent tables and diagrams in connection with Calcutta. The arrangement was adopted because November, as the month of average prevalence, forms a good starting point for comparison; but other advantages also attend it, one of which is that, so far as the phenomena of rainfall are concerned, October makes a more natural termination to the year than December.

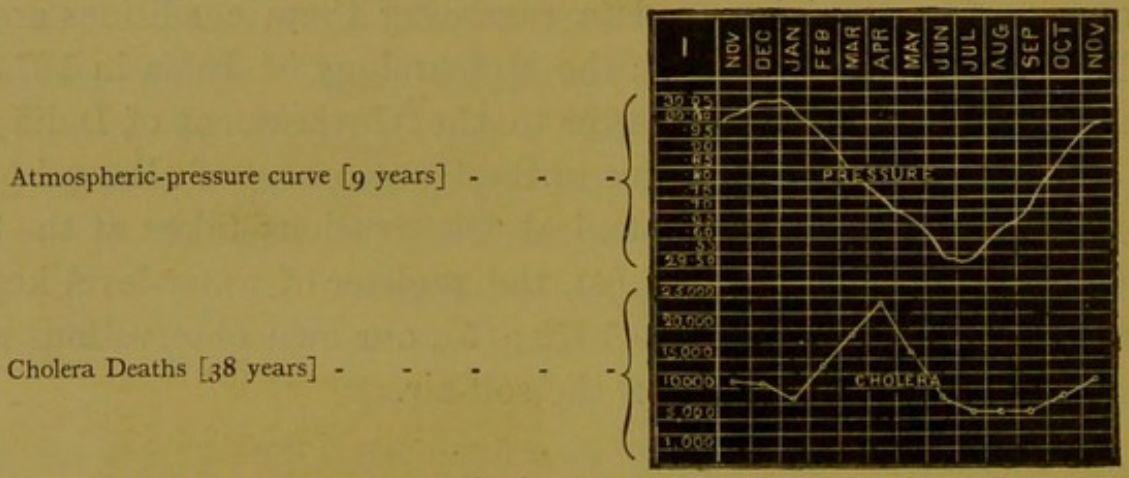


DIAGRAM 1.—Atmospheric-pressure and Cholera-prevalence in Calcutta.

Low pressure coincides with minimum prevalence.

The result of the comparison shows that the season of minimum prevalence is characterised by low atmospheric pressure. Farther than this, however, the coincidence ceases. There is no indication of the existence of any definite relation between degree of atmospheric pressure and prevalence of cholera. December and January, the months of maximum pressure, show less prevalence than November on the one hand, and much less than February, March, April and May on the other. So again June shows lower atmospheric pressure, but much higher prevalence than August and September. Atmospheric pressure, considered in the light of these data, cannot be regarded as exerting any direct influence on the prevalence of cholera. The coincidence of low atmospheric pressure with minimum prevalence must be regarded as such only, or if any influence be exerted by the pressure, it must act through some intermediate agency.

(b) Atmospheric Temperature.

Temperature acts in a subordinate manner.

A mere glance at the table and diagram below renders it evident that temperature, if it exert any influence on the variations in prevalence of cholera in Calcutta, does so only in a

very subordinate way. We find periods of maximum, minimum, and medium prevalence occurring with an almost unaltered temperature. For example, the

TABLE XIX.—*Average monthly Temperature (23 years) compared with Cholera-prevalence.*

		Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Year.
Average temperature ...		74·9	68·1	67·7	73·0	80·5	84·7	86·2	84·9	83·5	83·1	83·3	81·5	74·9	79°·3
Cholera.	(Macpherson)	8,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323	104,295
	(Payne) ...	2,789	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789	31,538
	TOTAL ...	11,112	10,334	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112	135,833

average temperatures of April and July only differ by 1°·2, whilst the former month is one of maximum, the latter one of minimum prevalence. Again, the temperatures of March and October differ only by 1°·0, but March is a month of maximum, October of medium, prevalence :—

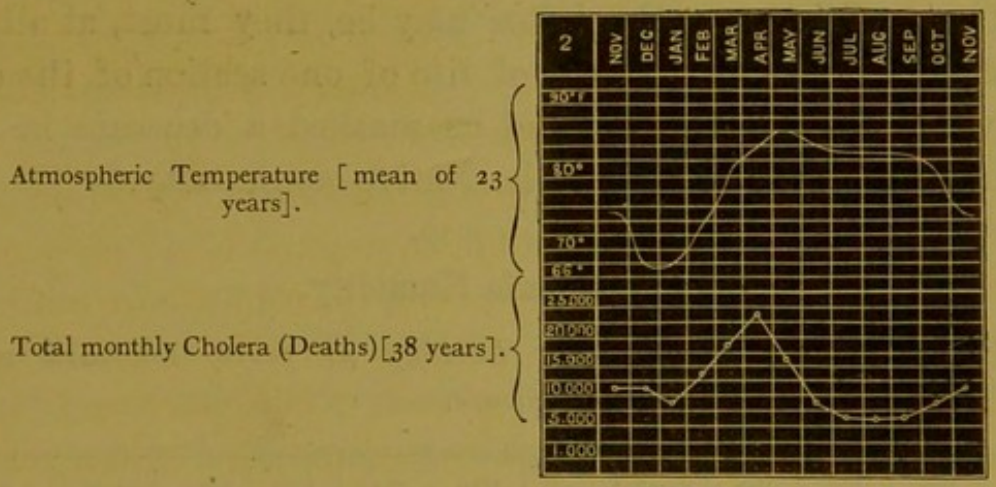


DIAGRAM 2.—Atmospheric Temperature and Cholera-prevalence in Calcutta.

Whilst this is the case, there is at the same time some evidence which seems to be in favour of the temperature exerting a subordinate influence on the prevalence. Taking the months from November to April, we get the following results :—

TABLE XX.—*Temperature and Cholera from November to April.*

	Nov.	Dec.	Jan.	Feb.	March.	April.
Temperature ...	74·9	68·1	67·7	73·0	80·5	84·7
Cholera ...	11,112	10,334	9,105	12,572	19,558	24,040

Starting from November, we have two months of diminishing temperature and prevalence followed by three months of increasing temperature and prevalence. This alone would hardly afford ground for any positive conclusion; but we shall find hereafter, in considering the data regarding other conditions, that some disturbing influence manifests itself during December and January, breaking in on the coincidence between the prevalence of cholera and those conditions which otherwise correspond in their fluctuations most accurately with those of the disease, and there is hardly anything else to which we can ascribe this save the temperature. Taking this into consideration together with the well-established fact of the general tendency to subsidence or even disappearance of the disease during the winter months of periods of its epidemic manifestation in Europe, there appear to be grounds for ascribing some influence to the atmospheric temperature on the prevalence of cholera in Calcutta. The precise method in which it acts remains, however, undetermined. That it acts directly is extremely improbable, but there are many indirect means by which it may produce an effect. Whatever the latter may be, they must, at all events, be entirely independent of peculiar habits of life of one section of the community as compared with another, for we find as marked a decrease in prevalence among the European troops as among the Native community.

(c) Atmospheric Humidity.

TABLE XXI.—*Average monthly Atmospheric Humidity (8 years) compared with Cholera-prevalence.*

		Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Year.
	Humidity ...	71	68	68	68	67	73	75	83	87	88	87	80	71	76
Cholera.	(Macpherson)	18,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323	104,295
	(Payne) ...	2,789	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789	31,538
	TOTAL ...	11,112	10,334	9,105	12,572	19,558	24,40	16,641	8,556	5,297	5,124	5,478	8,016	11,112	135,833

Diminished humidity and increased prevalence.

The diagram differs from the previous ones in its method of construction, the line showing the Relative Humidity representing the reverse and not the direct relation; in other words, the lower the degree of humidity, the higher the scale on the diagram. This plan has been adopted, because there is a certain amount of coincidence between diminished humidity and increased cholera-prevalence in Calcutta, and

the coincidence being of the reverse nature, the amount of it is rendered more clear by arranging the lines accordingly.

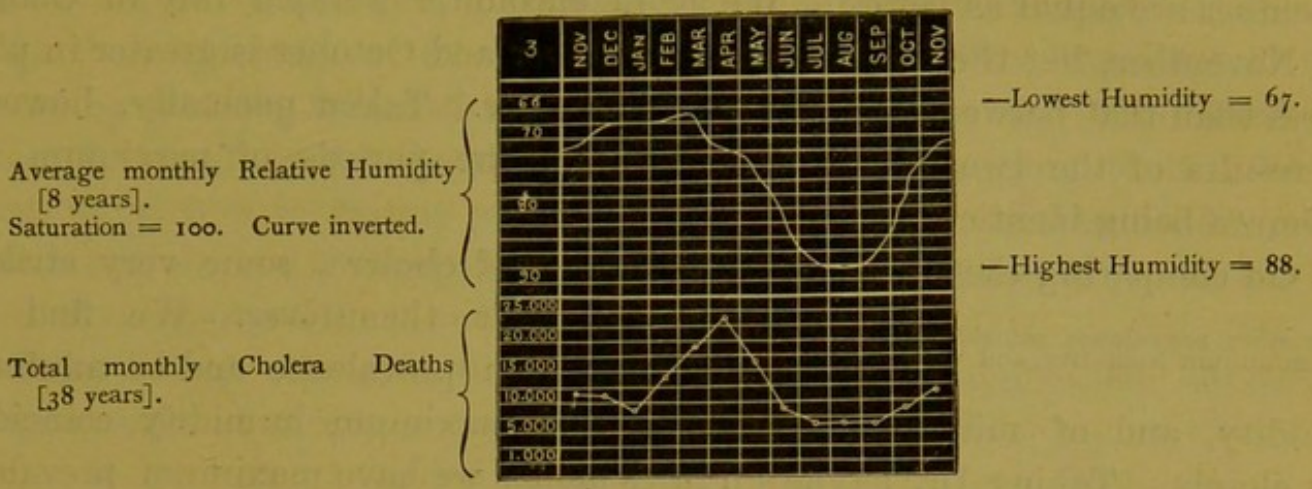


DIAGRAM 3.—Atmospheric Humidity and Cholera-prevalence in Calcutta.

Starting as usual from November, we find a considerable decrease of humidity in December, continuing until February, and followed by a slight fall to the minimum in March. A considerable increase occurs in April, followed by a smaller one in May; next follows a rapid increase through June and July to the maximum in August. This is followed by a slight fall in September, succeeded by a considerable fall in October, and an even greater one in November. The above data refer to the facts of 8 years, but very much the same results are shown in the following table of monthly averages from November 1864 to October 1876, which was specially compiled from the meteorological abstracts of the observations taken at the Surveyor General's Office for comparison with the figures of cholera-prevalence of the same period.

TABLE XXII.—*Average monthly Humidity (November 1864 to October 1876) and average monthly Prevalence (January 1865 to October 1876).*

Month.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
Humidity ...	70	68	69	66	65	68	72	80	85	86	85	77	70
Average cholera	230	175	162	268	404	388	275	185	109	140	128	150	230

Humidity and cholera from 1864 to 1876.

In this table the humidity of November is slightly lower than in the previous table. That of December is the same as in it, but January shows a slight increase, and February a decrease as compared with December. March again gives the

minimum humidity, but the rise between March and April is less than that between April and May. August again gives the maximum, and July and September are equal as before. We again encounter a rapid fall in October and November, but the fall between September and October is greater in place of less than that between October and November. Taken generally, however, the results of the two tables agree closely, the periods of maximum and minimum being identical in both.

Maximum prevalence coincident with minimum humidity, and vice versa.

On comparing these data with the figures of cholera, some very striking coincidences present themselves. We find the periods of maximum prevalence and of minimum humidity, and of minimum prevalence and maximum humidity, coinciding very closely. Taking Dr. Payne's figures alone, we have maximum prevalence and minimum humidity in March, and taking Dr. Macpherson's figures, or the total of both sets, we find minimum prevalence and maximum humidity in August. Not to lay much weight on such details, there can be no doubt of the general coincidence of the phenomena of seasonal prevalence in Calcutta with those of the seasonal fluctuations in atmospheric humidity. The maximum and minimum periods hold a reverse relation; there is a rapid rise in cholera coincident with an equally rapid fall in humidity during October and November, and a similar phenomenon of coincident fall in prevalence and rise in humidity occurs in May and June. The greatest want of coincidence is presented by the phenomena of December and January and of April. In December and January, as compared with November, there is diminished prevalence coincident with diminished humidity, and in April, compared with March, there is increased humidity coincident with a prevalence which our data lead us to regard as increased in place of diminished.

Humidity and temperature in relation to prevalence.

The question of the influence of temperature may here be recurred to in reference to the exceptional relations occupied by the humidity and prevalence of December and January. Assuming that elevation of temperature and depression of humidity favour the prevalence of cholera in Calcutta, and that the opposite conditions produce a reverse effect, let us endeavour to estimate the combined effect of the conditions of temperature and humidity present in each individual month. For convenience of calculation, degrees of temperature and of humidity may be regarded as of equal value in reference to prevalence. We know that November is a month in which prevalence is of nearly average

intensity, and the conditions of the month which favour prevalence must therefore occupy a similar position in respect to those of other months. The humidity of November is 71, its temperature is 74°·9. Passing to December, we have a humidity of 68 and a temperature of 68°·1; that is, we have increased prevalence favoured by 3 degrees of humidity, and diminished prevalence favoured by 6·8 degrees of temperature. According to this there is an excess of 3°·8 in favour of diminished prevalence, and the conditions of December in respect of temperature and humidity in relation to prevalence are as —3°·8, compared with those of November as zero.

Proceeding in the same way with the remaining months, we obtain the following series of figures:—

TABLE XXIII.—*Relations of the various months in respect of combined influence of Humidity and Temperature.*

	Months.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Augus t.	Sept.	October.	Nov.
Combined conditions.	For 8 years	0·0	—3·8	—4·2	+2·1	+9·6	+7·8	+7·3	—2·0	—7·4	—8·4	—7·6	—3·4	0·0
	For 12 years	0·0	—4·5	—6·1	+1·7	+10·3	+11·5	+8·7	—0·2	—6·8	—8·1	—7·0	—0·5	0·0

The relation borne by the combined conditions of temperature and humidity to cholera prevalence is shown in the following diagram of the phenomena for the twelve-year period:—

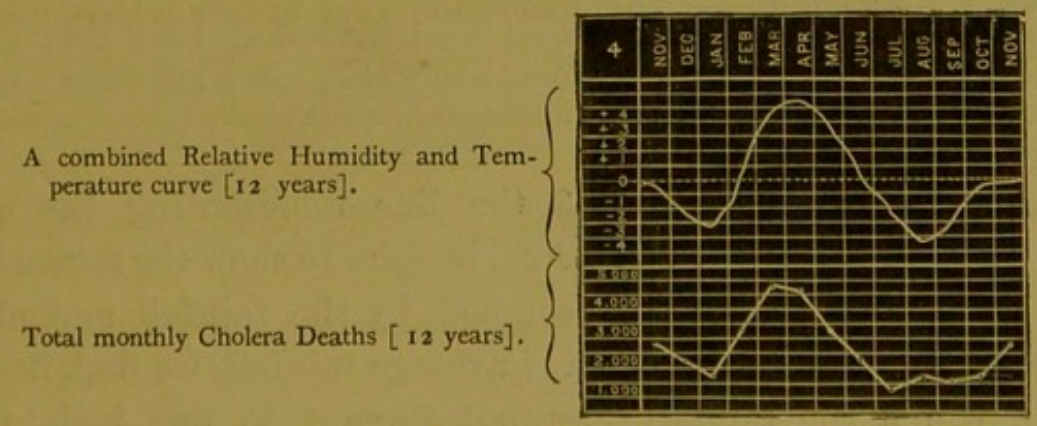


DIAGRAM 4.—Relations of Cholera-prevalence for 12 years to contemporaneous Humidity and Temperature.

It certainly is curious how closely the line representing the aggregate of conditions here assumed to influence the prevalence of cholera corresponds with that representing the actual prevalence.

Relation between diminished humidity and prevalence not so evident on comparison with individual years.

Comparisons of the phenomena of individual years fail to show such close correspondence between conditions of atmospheric humidity and prevalence as is indicated by the present data. It must, however, be borne in mind, that in order to institute accurate comparisons for brief periods, such as individual months, it would be necessary to know the actual distribution of the cholera prevalence throughout their course, and to compare the data with those of the actual humidity coincident with the prevalence at different times, the mere monthly averages of the two phenomena being in this case evidently capable of giving rise to very incorrect conclusions. Moreover, the degree of atmospheric humidity cannot be supposed to act directly in producing prevalence; it can only act by increasing predisposition or by favouring the development, diffusion, or preservation of the agent producing the disease, so that any influence which it possesses may be neutralised by the action of other conditions.

(d) Rainfall.

TABLE XXIV.—*Average monthly Rainfall (47 years) compared with Cholera-prevalence.*

Months.		Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Year.
Rainfall ...		0·66	0·24	0·44	0·83	1·28	2·49	5·46	12·13	12·64	13·71	10·17	5·61	0·66	65·6
Cholera.	(Macpherson)	8,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323	104,295
	(Payne) ...	2,789	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789	31,538
	TOTAL ...	11,112	10,334	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112	135,833

Cholera-prevalence holds an inverse relation to rainfall.

In this diagram, as in Diagram 3, the line representing the rainfall has been inverted, in order to show the somewhat reverse relation occupied by the rainfall and cholera-prevalence. Beginning with the question of average rainfall, we find, first, a period of months in which the rainfall does not amount to one inch, then three months with a fall ranging from 1·28 in March to 5·46 in May. Next follows a second period of four months—that of the rainy season—with averages ranging from 10 to nearly 14 inches, and finally we have October with an

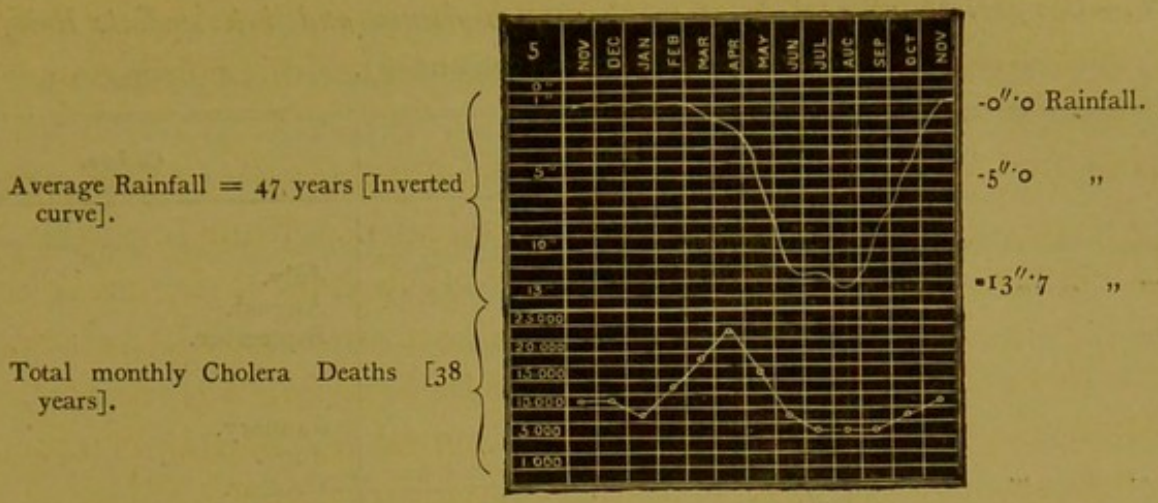


DIAGRAM 5.—Rainfall and Cholera-prevalence in Calcutta. (The Engraver has not kept the curve rigidly to the scale in some parts.)

average of 5·61 inches, which is almost identical with that of May. Stated generally, there are four months of maximum, four months of minimum, and four months of intermediate rainfall; but whilst the months of maximum and minimum form continuous groups, the intermediate months are divided into two unequal sections by the other periods, three of them intervening between the minimum and maximum, and the fourth between the maximum and minimum periods.

On comparing the seasonal rythm of cholera-prevalence with that of rainfall, we find that the months for the former also fall into three groups of maximum, minimum and intermediate prevalence. The groups in this case, however, do not precisely correspond with those of rainfall, for whilst that of maximum includes four months, that of minimum includes three only, and the remaining five months form the intermediate group.

The following table shows the relation which the three groups of months, arranged in reference to rainfall and prevalence, bear to one another:—

TABLE XXV.—*Comparison of periods of maximum, minimum and intermediate Rainfall, and Cholera-prevalence.*

	Rainfall.	Cholera.
Maximum	June. July. August. September.	February. March. April. May.

TABLE XXV.—*Comparison of periods of maximum, minimum and intermediate Rainfall, and Cholera-prevalence.*—(continued).

	Rainfall.	Cholera.
Minimum	November. December. January. February.	July. August. September.
Intermediate	March. April. May. October.	January. June. October. November. December.

The minimum months of prevalence correspond with three of maximum rainfall; the maximum months of prevalence coincide with one of minimum and three of intermediate rainfall; the intermediate months of prevalence coincide with three of minimum, one of intermediate, and one of maximum rainfall. The correspondence between special phenomena of prevalence with special periods of rainfall is much less distinct than that between the phenomena of atmospheric humidity and of prevalence. Beyond the fact that the three months of minimum prevalence correspond with three of the period of maximum rainfall, there is nothing indicating any special relation either direct or inverse between the two phenomena.

The 3 months of minimum cholera coincident with the 3 months of maximum rainfall.

Taking the period of maximum prevalence, we find that it ranges over one month of minimum and three of intermediate rainfall; and if we compare the phenomena of these months more closely, the want of any direct definite relation between them is even more distinctly brought out.

TABLE XXVI.—*Comparison of Rainfall and Cholera-prevalence from February to May.*

Months.	February.	March.	April.	May.
Rainfall	0·83	1·28	2·49	5·46
Cholera	12,612	19,558	24,040	16,641

Taking the data up to April, there might be some grounds for ascribing significance to the correspondence between increased rainfall and increased

prevalence; but when we come to May, we find a continued increase of rainfall—and an increase, too, fairly comparable with those preceding it in amount—coincident with marked decrease in place of increase in prevalence. A similar want of correspondence is manifest in the data of the months of intermediate prevalence.

TABLE XXVII.—*Comparison of the Rainfall with the amount of Cholera in the months of Intermediate Prevalence.*

Months.	June.	October.	November.	December.	January.
Rainfall	12·13	5·61	0·66	0·24	0·44
Cholera	8,556	8,016	11,112	10,334	9,105

Here, on comparing June and October, there is diminished rainfall and diminished prevalence; on comparing October and November, diminished rainfall and greatly increased prevalence; and on comparing November, December and January, what is practically unaltered rainfall with considerable decrease in prevalence.

There are other conditions in reference to rainfall, however, which remain to be considered. As yet the total fall per month alone has been dealt with, but it is also necessary to enquire into the distribution of the fall, into questions relative to the average number of rainy days in each month, the average fall on each of these and the average of the heaviest falls occurring within 24 hours in each month.

The distribution of the rainfall.

The following table, constructed on the data furnished by the observations at the Surveyor General's Office, shows the average number of days on which rain fell in each month of the past 21 years, together with the average per day of fall, and the averages of the heaviest falls in 24 hours.

TABLE XXVIII.—*Average characters of the Rainfall of each month (21 years).*

Month.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.
Average rainfall ...	0·73	0·11	0·46	1·07	1·61	2·07	5·27	12·90	13·02	14·27	10·43	5·88	0·73
Average days of rainfall...	2·6	0·71	2·3	3·1	4·9	7·9	13·4	20·7	25·7	26·0	22·1	9·8	2·6
Average fall per day of rain	2·28	0·015	0·2	0·34	0·32	0·26	0·39	0·62	0·5	0·54	0·47	0·6	0·28
Average of highest falls...	0·97	0·40	0·52	0·91	1·09	0·92	1·52	3·81	2·92	3·32	2·42	1·97	0·97

No coincidence between cholera-prevalence and character of rainfall.

These data regarding the characters of the rainfall in different months fail to show any correspondence between the phenomena of rainfall and prevalence beyond that already indicated by the quantitative data alone. They show the same fact of the coincidence of minimum prevalence with maximum rainfall, but with this all indication of the existence of any definite relation between the two sets of phenomena ceases to present itself. At one time—February and March—there is increase in the average amount of individual falls with increased prevalence; at another —November—there is decrease in the amount of individual falls with increased prevalence, and at a third—May—there is increase in the amount of individual falls with decreased prevalence.

There is nothing in the entire series of data regarding the quantitative and qualitative characters of the rainfall at different times justifying a belief that it exerts any direct action either in producing or diffusing the essential cause of cholera, but, on the other hand, there is some evidence that excessive rainfall exerts a directly opposite action.

(e) Level of soil-water

TABLE XXIX.—*Comparison of Average monthly Water-level (6 years) and Cholera Prevalence.*

Month.		November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.
Average water-level	...	11″·5	12″·9	13″·8	14″·2	14″·4	14″·6	14″·7	14″·0	12″·2	9″·6	8″·2	9″·7	11″·5
Cholera. (Macpherson)	...	8,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323
(Payne)	...	2,789	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789
TOTAL	...	11,112	10,334	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112

Water-level at Alipore.

The above table and the diagram below show the average monthly water-level at the Alipore Jail, where observations on this point have been conducted since 1870. The diagram is constructed on a scale allowing one degree to every 6 inches, and the line showing the fluctuations in level is, as in the diagrams of humidity and rainfall, drawn in a reverse direction, rise on the diagram corresponding to actual fall, and fall to rise of the water.

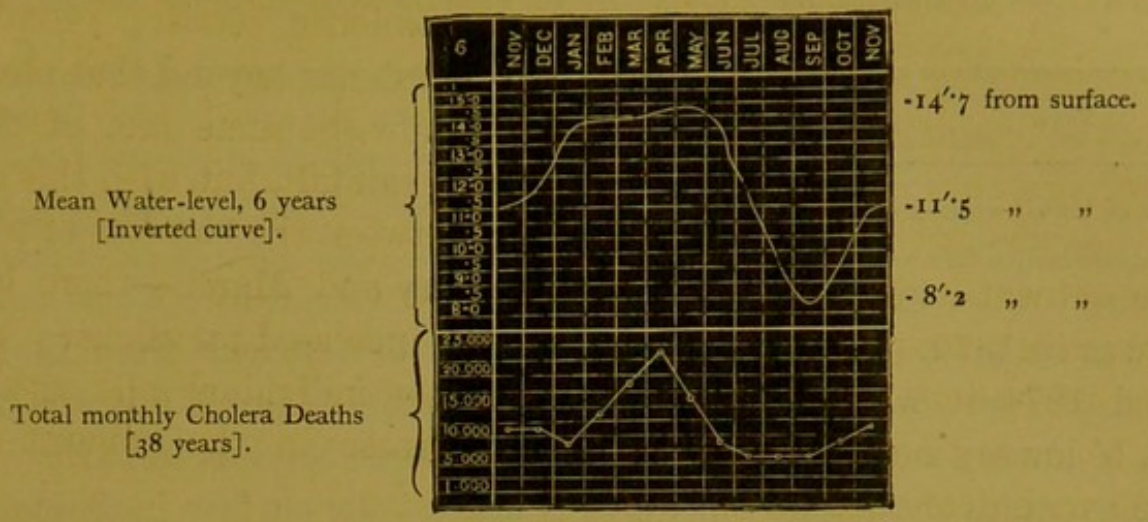


DIAGRAM 6.—Average Water-level and Cholera-prevalence in Calcutta.

The average water-level for the entire year is 12′·4. The average annual fluctuation in level is 6′·4.

The following tables show the amount of rise in each year, the amount of fall from one year to another, and the relations of the lowest water-level of each year to one another, taking that of 1870 as zero.

TABLE XXX.—*Amount of fluctuation from lowest to highest level in each year from 1870 to 1876.*

YEAR.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
Rise in water	7′·0	8′·2	4′·4	5′·0	6′·8	5′·9	7′·9

The greatest rise during the period 8·2 occurred in 1871, the second in order 7·9 in 1876. The minimum rise 4·4 occurred in 1872.

TABLE XXXI.—*Amount of fluctuation from highest level of one year to lowest level of the next.*

YEAR.	1870-71.	1871-72.	1872-73.	1873-74.	1874-75.	1875-76.	1876-77.
Fall in water-level	6′·1	9′·0	4′·6	5′·1	6′·0	6′·7	7′·4

The greatest fall occurred in 1871-72, the next greatest in 1876-77, that is, the greatest falls succeeded the greatest rises. The least falls also followed the least rises.

TABLE XXXII.—*Comparative level of the water when farthest from the surface in each year from 1870 to 1877.**

YEAR.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Comparison of lowest water-level	0·0	+10″	+1″	−3″	−5″	+3″	−5″	0·0

The soil-water in 1871 was about 10″ nearer the surface when at its lowest than it was in 1870. In 1872 it was 1″ nearer the surface than in 1870. In 1873 and 1874 it was 3″ and 5″ lower than in 1870; in 1875 it was 3″ higher; in 1876, 5″ lower; and in 1877 it attained the same level as in 1870.

Maximum cholera coincident with lowest water-level.

The averages show that the water is nearest the surface in September, and thereafter falls steadily, until it reaches a maximum depression in May, from which it again rises rapidly to maximum elevation. There is a considerable amount of coincidence apparent between the lines in the diagram indicating the course of the phenomena of depression of water-level and cholera prevalence. The period of maximum prevalence coincides with part of the period of maximum depression of the water-level, and one of the months of minimum prevalence with the month of minimum depression. When, however, the data are more minutely examined, the coincidence is found to be a general one only, and numerous divergencies between the courses of the two phenomena present themselves. For example, the average maximum depression of water-level occurs in May; but the prevalence of May is much less than that of April. There is, also, a continued fall in water-level in December and January, coincident with the diminution of prevalence occurring at that time. In fact, very much the same failures in coincidence are encountered here as in the comparison of the course of atmospheric humidity with cholera prevalence; and though we may again have recourse to the conditions of temperature as possibly accounting for the phenomena of December and January, we still require a satisfactory explanation for those of May.

Water-level *per se* appears to be of no moment in connection with cholera-prevalence.

Whilst the prevalence of cholera in Calcutta is associated with a low level of the soil-water, the data very clearly show that the absolute water-level, in itself, is of no importance. This cannot be better demonstrated than by comparing the average water-level and prevalence of July, October and November.

* The *plus* sign indicates elevation above the level of 1870; the *minus* sign the reverse.

TABLE XXXIII.—*Comparison of Water-level and Cholera Prevalence in July, October and November.*

	July.	October.	November.
Water-level (average 6 years)	12′·2	9′·7	11′·5
Cholera (26 years)	5,297	8,016	11,112

October and November, whilst showing a prevalence much greater than that of July, have a considerably higher water-level than it has. If, then, the concurrence of low water-level and high prevalence of cholera in Calcutta be more than a mere coincidence,—if any causal relation exist between the two phenomena,—it cannot be a direct simple one, dependent on the mere mass of water in the soil.

Before leaving the subject, it may be well to look into the facts regarding the fluctuations of water-level, compared with those of actual prevalence, during the period in which the observations have been carried on.

The following diagram shows the monthly averages of water-level and rainfall since April 1870, together with the relative annual prevalence of cholera reckoned from the November of one year to the October of the next.

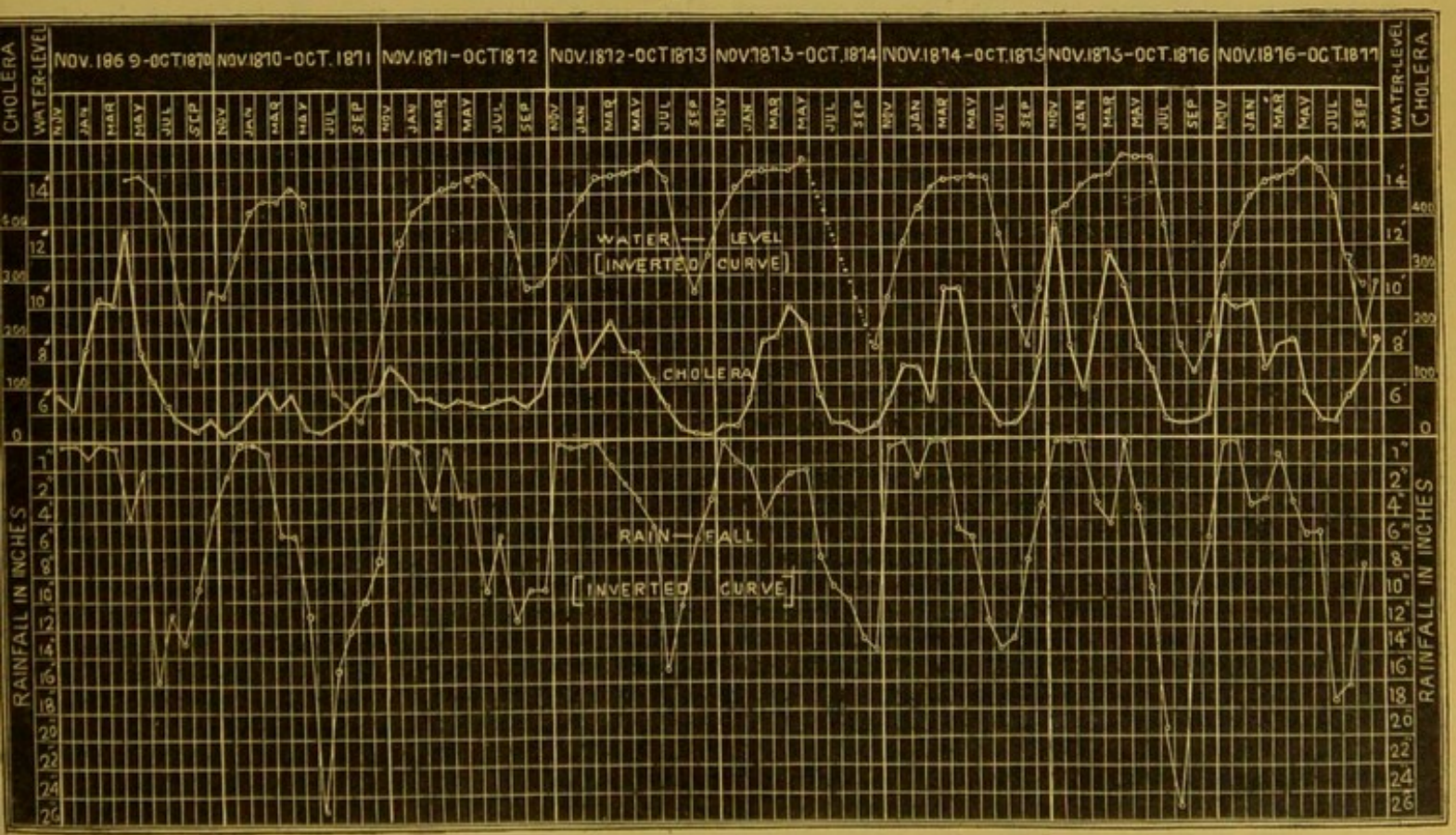


DIAGRAM 7.—The monthly fluctuations in Water-level and Cholera-prevalence in Calcutta, together with the mean monthly Rainfall, since 1870. [The water-level and rainfall-curves inverted.]

Water-level from 1870 to 1877.

The entire period has been sub-divided from November to November, both to render the diagram uniform with those of the general averages, and also because November really forms a more natural beginning of the year in respect to cholera in Calcutta than January does. The prevalence during each annual period has been calculated from the figures in Dr. Payne's table.

Mere diminution in quantity of water is not necessarily coincident with cholera-prevalence.

The only point in the diagram deserving special notice here is, that it shows that the two years of the period which were distinguished by minimum prevalence of cholera, 1871 and 1872, were both years in which there was relatively slight depression of the water-level, succeeding seasons in which there had been excessive elevation of it. The minimum of depression and the maximum of elevation both occurred in 1871: the minimum succeeded a season in which the elevation was the third highest for the period: the maximum preceded one in which the depression was the third smallest. Further than this, however, no special coincidence can be traced between the phenomena of water-level and prevalence; but the fact that the season of 1873-74 was one of low prevalence for the period again shows that mere depression of water-level, mere diminution of the bulk of water in the soil, is insufficient, in itself, to secure prevalence.

Water-level and rainfall do not accurately correspond in Calcutta.

One result of the observations has been to show that the water-level in Calcutta cannot be accurately estimated from the data of rainfall alone, and more especially from those of total annual rainfall. The distribution of the rain throughout the year must be taken into account. This, however, is not all that is required to secure a determination of the relations borne by the water-level in one year to that in another; for it is evident that the variation in the amount of loss by evaporation must importantly modify the effect of the addition by rainfall. Even if the data of temperature and atmospheric humidity be taken into consideration along with those of rainfall, only very unsatisfactory results are obtained, compared with those furnished by direct observation. That this is the case is very distinctly shown by the following table, showing the particulars of rainfall, temperature and humidity, from 1870 to 1876, arranged, as far as possible, in a way to facilitate their application to questions of water-level.

TABLE XXXIV.—*Data of Rainfall, Humidity, Temperature and Water-level, 1870 to 1876.*

Months.	1869-70.						1870-71.						1871-72.					
	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.
	67″·6	″	·	°	′ ″	′ ″	58″·60	′ ″	·	°	′ ″	′ ″	93″·31	″	·	°	′ ″	′ ″
November		0·0	66	73·3				1·22	77	75·9				0·0	71	75·8		
December		0·0	68	68·5				0·0	70	66·5				0·0	70	69·0		
January...		0·77	65	67·9				0·0	67	67·6				0·22	73	68·8		
February		0·0	60	74·2				0·75	67	74·3				2·82	70	72·5		
March ...		0·03	58	81·0				5·41	68	79·4				0·21	65	82·7		
April ...		4·03	64	84·1				5·72	77	82·7	13	11		1·83	65	85·6		
May ...		0·92	70	87·7	14–9			11·08	78	83·3				1·99	72	86·8		
June ...		16·09	80	84·7				25·35	88	82·7				9·45	80	85·1	14–8	
July ...		10·90	85	83·9				15·93	87	82·5				5·55	86	83·1		
August...		12·92	83	82·4				12·11	88	82·9				11·52	88	83·1		
September		9·01	84	83·2		7–10		9·93	87	82·5		5–9		8·42	85	83·1		10–6
October...		3·93	82	82·4				7·03	77	81·6				8·93	81	81·4		

Months.	1872-73.						1873-74.						1874-75.						1875-76.					
	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.	Rainfall of previous season.	Rainfall.	Humidity.	Temperature	Lowest water-level.	Highest water-level.	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.	Rainfall of previous season.	Rainfall.	Humidity.	Temperature.	Lowest water-level.	Highest water-level.
	45″·94	″	·	°	′ ″	′ ″	44″·42	″	·	°	′ ″	′ ″	62″·22	″	·	°	′ ″	′ ″	60″·01	″	·	°	′ ″	′ ″
November		0·02	73	76·3				0·14	67	75·6				0·12	73	74·9				0·0	68	73·7		
December		0·09	73	70·0				0·82	69	69·9				0·0	67	67·1				0·0	69	69·1		
January...		0·0	69	68·0				0·94	71	66·4				1·27	75	66·4				0·0	65	67·8		
February		0·0	64	73·9				3·77	73	72·2				0·0	62	72·0				2·93	60	73·1		
March ...		1·18	64	79·8				1·94	64	78·2				0·0	70	81·7				4·36	70	81·1		
April ...		1·84	72	84·2				1·20	70	85·1				4·18	69	85·4	14–6			0·20	67	86·2	15–2	
May ...		3·78	69	86·6				1·16	72	87·1	15–2			5·24	73	84·3				2·93	73	86·5		
June ...		4·30	75	87·9	15–0			6·89	82	83·7				11·83	84	84·0				9·32	80	85·6		
July ...		14·76	87	83·4				8·89	83	84·0				13·90	86	83·2				19·39	88	82·7		
August...		10·23	86	83·3				10·19	86	82·9				12·64	87	82·7				24·85	86	83·0		
September		5·82	83	84·3		10–1		12·67	86	82·9				7·41	86	82·8		8–7		10·26	86	82·9		7–5
October...		2·40	71	82·0				13·71	82	81·5		8–6		3·42	75	81·3				5·80	79	79·7		

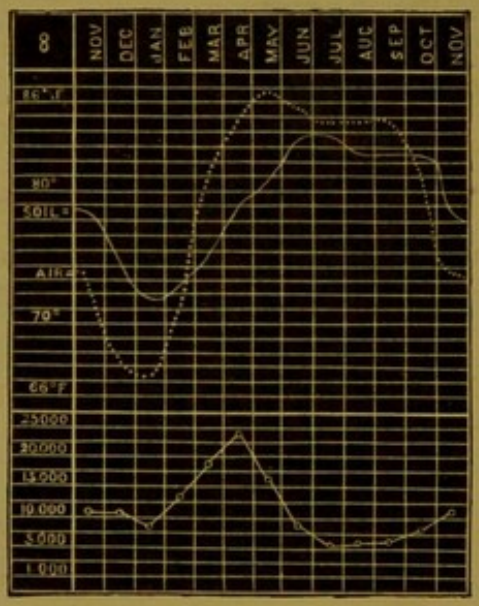
(f) Soil-temperature.

TABLE XXXV.—*Comparison of average Monthly Soil-temperature (3 years) and Cholera Prevalence.*

		Nov.	Dec.	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
Soil-temperature.		78·1	75·4	72·6	73·1	75·4	78·8	80·9	82·3	82·3	81·7	81·4	81·1	78·1
Cholera	(Macpherson) ...	8,323	8,159	7,150	9,346	14,710	19,382	13,335	6,325	3,979	3,440	3,935	6,211	8,323
	(Payne) ...	2,789	2,175	1,955	3,226	4,848	4,658	3,306	2,231	1,318	1,684	1,543	1,805	2,789
	Total ...	11,112	10,334	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112

Soil and atmospheric temperature in regard to ventilation.

The diagram, in addition to the lines indicating soil-temperature and cholera-prevalence, contains a third line of the average atmospheric-temperature, in order to allow of ready comparison of the relations of the air above and within the soil in this respect.



Soil and Atmospheric Temperature curves [average of 3 years].

=Soil Temperature curve.

=Air Temperature curve.

Total monthly Cholera Deaths [38 years].

DIAGRAM 8.—Average Soil-temperature at 6 feet below the surface, and Cholera-prevalence.

The data regarding temperature are those of the soil at a depth of 6 feet from the surface, and therefore represent the conditions of a stratum towards the lower portion of the layer of soil, which lies permanently above the soil-water. The mean temperature for the year is 78·5.* The minimum soil-temperature occurs in January; the maximum in June and July. The temperature exceeds that of the atmospheric-air in the months of November, December and January;

* It may be of interest to compare the figures illustrating the relations of telluric and atmospheric temperature in Calcutta with those of a locality where the temperature is very different. The following table shows the mean

falls far short of it during March, April and May; and is almost equal to it during the remaining months. These facts will receive notice again; but in the meantime it may be pointed out that, in so far as conditions of temperature are concerned, soil-ventilation is favoured during November, December and January; obstructed during March, April and May; and almost in equilibrium during the remaining months.

Comparing the data of soil-temperature and cholera-prevalence, we find that the great maximum of prevalence in April and the minor elevation in November both occur when the soil-temperature is between 78° and 79°, the actual figures being 78°-8, and 78°-1, or at a mean elevation. Here, however, the coincidence ceases; for the increase of soil-temperature after April, and the decrease after November, are both associated with decreased cholera-prevalence. Whether the fact really be of any important significance or not, it is, at all events, worthy of note that such a coincidence should be present in reference to these two months; for in other respects they differ from one another considerably. The only other condition in which they tend to agree is the atmospheric-humidity: the atmospheric-temperature, rainfall and water-level all present important divergencies. The period of minimum prevalence occurs along with that of maximum elevation of temperature; but the

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temperature of the air and of the soil at a depth of 3·02 metres in St Petersburg for each month of 1875. (*Annalen des Physikalischen Central Observatoriums*—Jahrgang, 1875):—

TABLE XXXV*(a)*.—*Mean Monthly Temperature of Air and Soil of St. Petersburg.*

1875.	MEAN TEMPERATURE (FAHRENHEIT).	
Months.	Air: mean =35°·0	Soil: mean =44°·3.
January	6°·5 Fahr.	44°·0 Fahr.
February	17°·0	41°·0
March	18°·5	39°·0
April	30°·2	37°·5
May	47°·5	37°·4
June	59°·7	39°·8
July	65°·7	44°·8
August	58°·8	49°·9
September	48°·0	51°·8
October	35°·0	51°·5
November	24°·0	48°·5
December	8°·6	44°·8

same elevation extends beyond it in both directions, commencing and terminating in June and October, two months of medium prevalence. The fact, that a marked fall in the soil-temperature occurs from November to the minimum in January, is of importance in connection with the questions previously alluded to in the diminished prevalence during the same period. We now see that if temperature really exert any influence, that of the soil must be considered as well as that of the atmosphere above it; and is even, perhaps, in this case of more importance, as the course of the phenomena of soil-temperature in December and January corresponds more closely with the course of the prevalence than that of the atmospheric-temperature does.

(g) Carbonic acid of the Soil-air—Soil-ventilation.

TABLE XXXVI.—*Comparison of the monthly averages of Carbonic Acid [at 6 feet] with Cholera Prevalence.*

		November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.
Relative amount of Co.2 in Soil-air ...		5	5	5	3	1	1	2	2	2	5	6	5	5
Cholera.	(Macpherson) ...	8323	8159	7150	9346	14710	19382	13335	6325	3979	3440	3935	6211	8323
	(Payne) ...	2789	2175	1955	3226	4848	4658	3306	2231	1318	1684	1543	1805	2789
	Total ...	11112	10334	9105	12572	19558	24040	16641	8556	5297	5124	5478	8016	11112

Carbonic Acid in soil-air.

The diagram in this case is constructed from confessedly very imperfect materials. Our data regarding the amount of carbonic acid in the soil-air are as yet very limited, and those employed in the present instance are derived from observations carried out for little more than a year—from July 1873 to August 1874—after which date the observations were unavoidably interrupted until May 1877.* Certain facts have, however, been already ascertained regarding the course of the fluctuations in amount of carbonic acid in the soil-air, so that the data of

* We are indebted to Mr. Henry F. Blanford, Meteorological Reporter to the Government of India, for having made arrangements for the exposure of tubes charged with baryta solution at certain of the larger Meteorological stations. The requisite apparatus has already been provided at Allahabad, Lucknow and Delhi, and observations are now conducted at these places through the assistance of Mr. S. A. Hill, B.Sc., Dr. Bonavia and Assistant-Surgeon Radha Kishen. The tubes charged with the baryta solution are sent by post to the different stations at short intervals, returned after exposure, and the amount of carbonic acid determined.

1873-74 may be employed as illustrating the more general phenomena, although not constituting rigid examples of the precise conditions actually present in individual years.

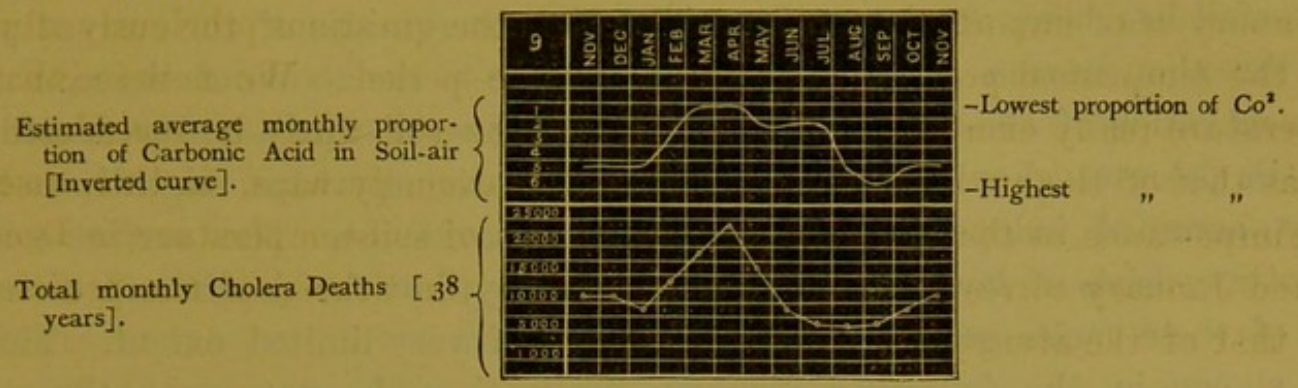


DIAGRAM 9.—Monthly averages of Carbonic Acid in the Soil-air (6 feet below the surface) and Cholera-prevalence.

The line indicating the carbonic acid in the diagram is reversed like those in the diagrams of humidity, rainfall and water-level, and the figures in the table are to be regarded as only representing the relations borne by the amounts of carbonic acid to one another, and not the absolute quantity present.

Taking the data as they stand, we find that, during November, December and January, the amount of carbonic acid is high. In February a considerable decrease occurs, and the minimum for the year is reached in March and April. During May a slight increase occurs, continued through June and July, and followed by a rapid rise in August to the maximum in September, after which a decrease occurs, reducing the average for October to an equality with that for August on the one hand, and for November, December and January on the other.

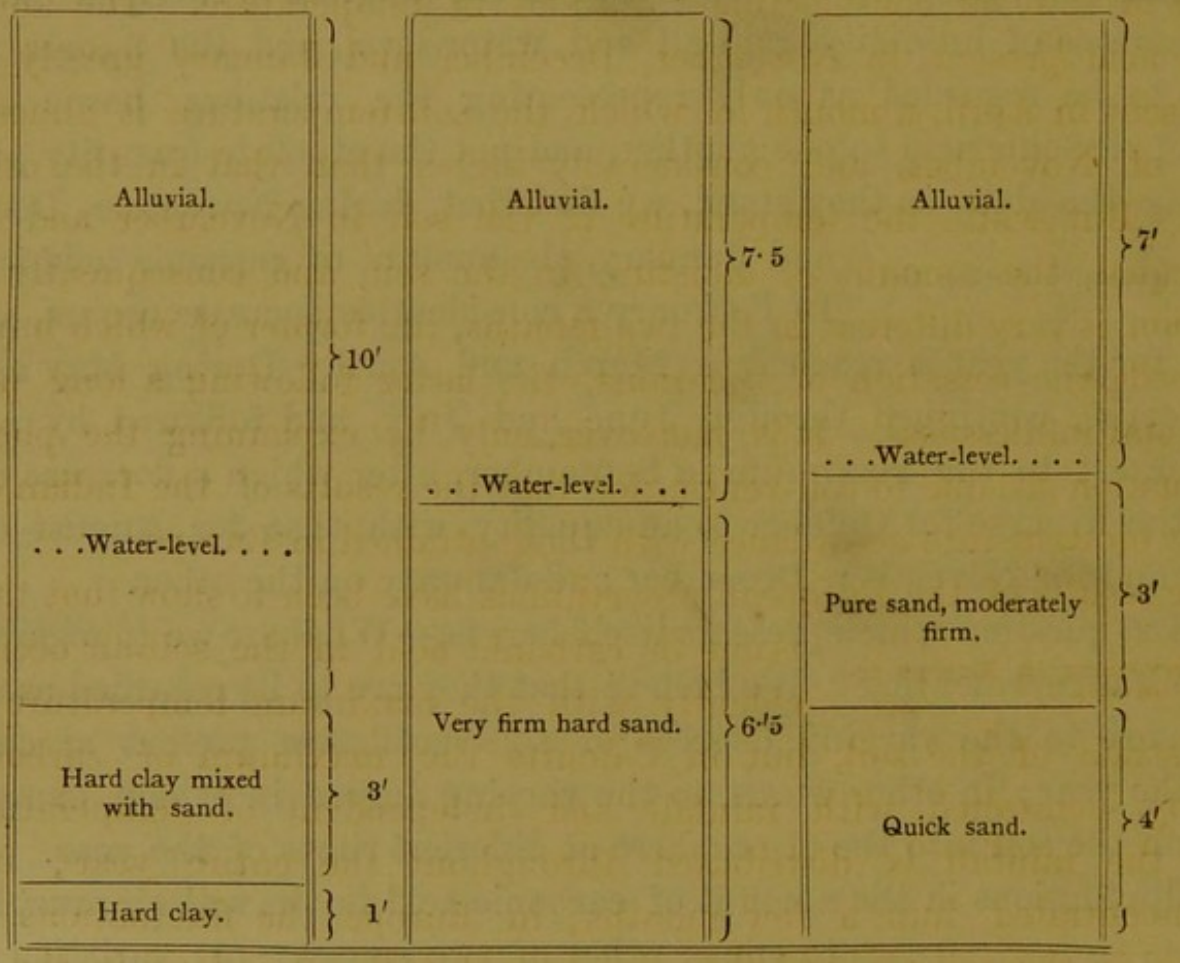
Co^2 in soil, excessive during the rains.

The first question which presents itself here is,—What are we to regard these fluctuations as representing? We believe that they are to be regarded as affording an index to the varying degrees of soil-ventilation present at different times of the year; in other words, to the varying degree in which emanations escape from the soil into the atmosphere at different times of the year.

The fluctuations in the amount of carbonic acid in the soil-air must be due to one or other of two causes: (1) variation in the amount produced at different times; (2) variation in the degree of accumulation of what is formed—variation in the amount retained in the soil. The phenomena of fluctuation in Calcutta appear to be mainly determined by the latter agency. The most conspicuous fluctuations

Causes of fluctuation of Co_2.

during the course of the year are the rapid decrease of carbonic acid during the months of February and March, and the rapid increase during August and September. The coincidence of increased carbonic acid with the occurrence of rainfall has been amply confirmed by the observations of the current year, and the phenomenon is only explicable as due to the action of the rain upon the ventilation of the soil. That rainfall acting on a finely-textured soil like that in Calcutta should produce such an effect, is only what might have been fairly assumed independent of experimental evidence. The surface-soil of Calcutta consists of layers of loam, sand and clay, but the depth and distribution of these varies greatly even within areas of very limited extent. This is well shown in the following diagram illustrating the nature of the strata encountered in three of the borings made in 1875 in the site of the India Museum :—



It is clear that water must tend to close the pores in such a soil so far as it penetrates, and, when added from above as by rainfall, must therefore tend to interpose an impermeable partition between the air of the atmosphere and that contained in the soil beneath the moistened layer.

Water deposited on soil like that in Calcutta takes long to penetrate to any distance from the surface—a fact which must be familiar to all who have had opportunities of observing the sections presented by fresh excavations during the early part of the rainy season—and the increase in amount of carbonic acid begins to occur long ere the water has reached the stratum from which the air containing it is derived. This alone is almost conclusive in favour of the increase at this time being due to accumulation, but there are other grounds for regarding the degree of soil-ventilation as the principal factor regulating the fluctuations in the amount of carbonic acid throughout the year.

Effect of moisture on soil-ventilation.

The temperature of the soil cannot be regarded as the determinant, as we find the amount of carbonic acid on one hand varying at different times independent of corresponding variations in soil-temperature, and on the other hand remaining constant in spite of considerable variations in temperature. The amount of carbonic acid present in November, December and January greatly exceeds that present in April, a month in which the soil-temperature is almost equal to that of November, and considerably higher than that in the other two months. But while the temperature of the soil in November and April is almost equal, the amount of moisture in the soil, and consequently of soil-ventilation, is very different in the two months, the former of which immediately succeeds the cessation of the rains, the latter following a long period of almost total rainlessness. It is, moreover, only by explaining the phenomena of fluctuation as due to soil-ventilation that the results of the Indian observations are brought into accordance with those attained in Europe.

The results of the European observations have been to show that the maximum of carbonic acid in the soil-air occurs coincidently with the maximum temperature of the upper strata of the soil, but in Calcutta the maximum of carbonic acid is clearly connected with rainfall and independent of temperature. In Europe the rainfall is distributed throughout the entire year; in India it is concentrated into a few months; in Europe the fluctuations in carbonic acid in the soil-air probably correspond with variations in the amount formed, but in many parts of India the variations in amount of formation are almost entirely obscured by the effects of the varying degrees of soil-ventilation, although certain phenomena, such as the increase of carbonic acid during May and June in Calcutta, may be a partial indication of their existence.

The observations in Europe regarding Co^2 of soil.

On proceeding to compare the phenomena of cholera-prevalence with those of soil-ventilation as indicated by the carbonic acid of the soil-air, it appears that the maximum of prevalence coincides with the maximum of soil-ventilation and the minimum of prevalence with obstructed soil-ventilation. Taking individual months, however, the correspondence between the course of the two phenomena is not close or uniform, for we find the same degree of soil-ventilation indicated for August, October, November, December and January; whilst the cholera-prevalence of the same months varies widely, and a similar phenomenon is presented in May, June and July.

Maximum cholera in Calcutta coincident with maximum soil-ventilation.

Whether the coincidences between the variations in soil-ventilation and cholera-prevalence indicate any essential connection between the two phenomena or not, there can be no doubt regarding the importance of the observations demonstrating their existence. They show that, in estimating the influence of the rainy season on conditions of health, its action in effecting soil-ventilation cannot be left out of consideration. Until it be conclusively demonstrated that all emanations proceeding from the soil are inert, the presence of any influences obstructing or facilitating their escape deserve careful consideration in any attempts at the explanation of the phenomena of disease as related to season. Hitherto rain has only been regarded as affecting health through the agency of the water-supply, or of its action in washing the surface of the soil, but its relation to soil-ventilation has almost entirely escaped notice. This has, no doubt, arisen from the fact that the subject has been mainly studied in regions with climates like that of Europe, in which the rainfall is uniformly distributed throughout the year, and in which therefore its influence on soil-ventilation is also uniformly distributed. Enough has, however, been shown here to prove that, in tropical climates at all events, the influence of rain on health cannot be regarded as necessarily solely exerted through such channels.

Effect of rainfall on soil-ventilation.

CHAPTER III.

PHYSICAL CHARACTERISTICS OF THE DIFFERENT SEASONS OF CHOLERA-PREVALENCE IN CALCUTTA.

It has been already pointed out that the year may be divided into three seasons, according to the degree of cholera-prevalence. During one of these seasons the preva-

Cholera-seasons in Calcutta.

lence greatly exceeds the average, during another it falls far short of it, and during the third it ranges on either side of it. The season of maximum prevalence includes the months of February, March, April and May; that of minimum prevalence, the months of July, August and September; and that o medium prevalence, the remaining five months of the year. In order to facilitate the comparison of the main meteorological characters of these three seasons, it will be well at first to leave two of the months of the season of medium prevalence out of consideration. These are June and October, when the conditions are greatly complicated by the transitional character of the months as periods ushering in and concluding the rainy season, June partaking of the characters of the hot and rainy seasons, and October of those of the rainy and dry ones. Leaving them out, we find the meteorological characters of the individual cholera seasons to be the following:—

TABLE XXXVII.—*Physical characteristics of the individual months of the seasons of maximum, minimum, and medium Cholera-prevalence in Calcutta.*

SEASONS OF PREVALENCE.	MEDIUM.			MAXIMUM.				MINIMUM.		
Meteorological conditions.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	July.	Aug.	Sept.
Atmospheric Pressure ...	29·980	30·030	30·011	29·948	29·856	29·757	29·665	29·545	29·608	29·689
„ Temperature ...	74°·9F	68°·1	67°·7	73°·0	80°·5	84°·7	86°·2	83°·5	83°·1	83°·3
„ Humidity ...	71	68	68	68	67	63	75	87	88	87
Rainfall	0″·66	0″·24	0″·44	0″·83	1″·28	2″·49	5″·47	12″·64	13″·71	10″·17
Water-level	11′·5	12′·9	13′·8	14′·2	14′·4	14′·6	14·7	12′·2	9′·6	8′·2
Temperature of the soil ...	78°·1F	75°·4	72°·6	73°·1	75°·4	78°·8	80°·9	82°·3	81°·7	81°·4
Carbonic acid in the soil-air ...	5	5	5	3	1	1	2	2	5	6

TABLE XXXVIII.—*Average physical characters of the three seasons of Cholera-prevalence, June and October being excluded from the months of medium prevalence.*

METEOROLOGICAL CONDITIONS.	SEASONS OF CHOLERA-PREVALENCE.		
	Medium.	Maximum.	Minimum.
Atmospheric Pressure	30·007	29·806	29·614
„ Temperature	70° 2F	81°·1	83°·3
„ Humidity	69	70	87
Rainfall	0″·44	2″·51	12″·17
Water-level	13′·1″	14′·4″	10′·0″
Temperature of the soil	75°·3F	77°·0	81°·8
Carbonic acid in the soil-air	5	1	4

Physical characteristics of the three cholera-seasons.

The season of minimum prevalence is, according to these data, characterised by low atmospheric pressure, high atmospheric and soil temperatures, by extreme atmospheric humidity and rainfall, by elevation of the water-level, and by obstructed ventilation of the soil as indicated by the amount of carbonic acid in the soil-air. The season of medium prevalence is characterised by high atmospheric pressure, low atmospheric and soil-temperature, by minimum humidity, and rainfall, by depression of the water level, and by obstructed ventilation of the soil. The season of maximum prevalence shows characters occupying an intermediate position in regard to those of the other two seasons except in so far as its water-level and soil-ventilation are concerned. The former of these is at a maximum of depression, the latter at a maximum of activity. According to these data, the depression of the water-level and the increase of soil-ventilation are the only phenomena which reach a climax during the season of maximum prevalence of cholera.

When June and October are included with the other months of medium prevalence, the results of the comparison are slightly modified.

TABLE XXXIX.—*Average characters of the seasons of Medium, Maximum and Minimum prevalence of Cholera.*

Meteorological conditions.	Seasons of prevalence.		
	Medium.	Maximum.	Minimum.
Atmospheric pressure	29·880	29·806	29·614
„ temperature	75° 4F.	81°·1	83°·3
„ humidity	74	70	87
Rainfall	3″·81	2″·51	12″·17
Water-level	12′·7	14′·4	10′·4
Soil-temperature	77°·9F.	77°·0	81°·8
Carbonic acid in the soil-air	4	1	4

The ventilation of the soil and the depression of the water-level are, as before, shown to be greatest during the season of maximum prevalence, but the latter is now also characterised by the minimum humidity, rainfall and soil-temperature.

Such are the results arrived at on comparing the entire seasons of cholera-prevalence; it remains to be seen how far these are confirmed by the comparison

Comparison of prevalence with the physical characters of typical months.

of typical months selected from the individual seasons. November, April and August are the months indicated by the statistics as those of actual medium, maximum and minimum prevalence during the course of the entire year, and are therefore those selected for comparison.

TABLE XL.—*Comparison of the characters of the months of actual Medium, Maximum and Minimum Cholera-prevalence.*

METEOROLOGICAL CONDITIONS.	November (medium).	April. (maximum).	August (minimum).
Atmospheric pressure	29·980	29·757	29·608
„ temperature	74°·9 F.	84°·7	83°·1
„ humidity	71	73·	88
Rainfall	0″·66	2″·49	13″·71
Water-level	11′·5	14′·6	9′·5
Soil-temperature	78°·1 F.	78°·8	81°·7
Relative amount of carbonic acid in the soil-air ...	5	1	5

Here, again, the period of maximum prevalence is characterised by excessive soil-ventilation and depression of the water-level. The other results agree with those of the Table (XXXVIII) in which June and October are omitted, except that here the atmospheric temperature is higher in the maximum than in the minimum period, and that the amount of carbonic acid in the soil of the minimum period is now equal to, in place of slightly less than, that of the medium period.

Physical conditions characterising Major and Minor cholera-prevalence.

In all the previous comparisons the maximum period has been uniformly distinguished from the others by two characters only—by depressed water-level and excessive soil-ventilation. On leaving the medium period of prevalence out of consideration, and comparing the maximum and minimum periods, it appears that the former is characterised by its higher atmospheric pressure, its lower atmospheric and soil-temperature, humidity and rainfall, and by its greater soil-ventilation and depression of the water-level. When the medium and maximum periods are combined and the year regarded as divided into two seasons, one of major and

one of minor prevalence, the characters of these are as shown in the following table:—

TABLE XLI.—*Comparison of the average monthly characters of the periods of Major and Minor Cholera-prevalence in Calcutta.*

Meteorological conditions.	Period of major prevalence.	Period of minor prevalence.
Atmospheric pressure	29·847	29·614
,, temperature	77°·9 F.	83°·3 F.
,, humidity	72·5	87·
Rainfall	3″·23	12″.17
Water-level	13′·3	10′·0
Temperature of the soil	77°·5	81°·8
Relative amount of the carbonic acid in the soil-air	3	4

Leading results of the series of comparisons.

Here the combined periods of medium and maximum prevalence, as compared with that of minimum, are shown to be characterised by higher atmospheric pressure, by lower atmospheric and soil-temperature, by lower humidity and rainfall, and by greater ventilation of the soil and depression of the water-level. Taking the entire series of comparisons, it would appear that the conditions most closely connected with the seasonal prevalence of cholera in Calcutta are those of water-level and soil-ventilation. Both water-level and soil-ventilation appear, however, to be mainly determined here by the rainfall, so that the conditions of rainfall and prevalence must also be intimately connected. That they actually are so, is indicated by the coincidence of maximum rainfall with minimum cholera; and that the connection between them is not direct has been already shown by the results of the comparison of the data of rainfall and prevalence of individual months. If, then, rainfall exert any influence on the prevalence of cholera in Calcutta, it would appear that it must do so through the medium of its direct action on the conditions of the soil.

Characters of months initiating and terminating prevalence.

When we compare the characters of the months terminating the various seasons of prevalence with those of the months immediately succeeding them and ushering in the following seasons, very similar conclusions are arrived at.

The following table shows the characters of February compared with January, of May compared with June, of June compared with July, and of October compared with September. The month of minor prevalence is placed

after the other throughout the sub-divisions of the table, and the results of the comparisons are separately stated in columns indicating, in regard to the various meteorological conditions, the increase or diminution occurring coincidently with decreased prevalence.

TABLE XLII.—*Comparison of the characters of the months initiating and terminating the various seasons of Cholera-prevalence.*

Meteorological conditions.	Months of maximum and medium.			Months of maximum and medium.			Months of medium and minimum.			Months of medium and minimum.		
	February.	January.	Change with decrease.	May.	June.	Change with decrease.	June.	July.	Change with decrease.	October.	September.	Change with decrease.
Atmospheric pressure ...	29·948	30·011	+	29·665	29·550	−	29·550	29·545	−	29·831	29·689	−
„ temperature ...	73°·0F.	67°·7	= −	86°·2	84°·9	=	84°·9	83°·5	−	81° 5	83°·3	+
„ humidity ...	68	68	=	75	83	+	83	87	+	80	87	+
Rainfall	0″·83	0″·44	−	5″·46	12″·13	+	12″·13	12″·64	+	5″·61	10″·17	+
Water-level	14′·2	13′·8	−	14′·7	14′·0	−	14·0	12′·2	−	9′·7	8′·2	−
Soil-temperature	73°·1 F.	72°·6	−	80°·9	82·3	+	82°·3	82·3	=	81°·1	81″·4	×
Carbonic acid in the soil-air ...	3	5	+	2	2	=	2	2	=	5	6	+

Here we find minor cholera-prevalence invariably associated with relative elevation of the water-level, with either decreased or unaltered soil-ventilation, and with increased or unaltered atmospheric humidity. The remaining meteorological conditions accompanying it sometimes show an increase and at others a decrease, but the close connection of rainfall and prevalence is still very distinctly indicated.

Prevalence of cholera not regulated by any single meteorological condition.

The entire series of data at disposal do not point to any single meteorological condition as the determinant of the phenomena of the seasonal fluctuations in the prevalence of cholera in Calcutta. They indicate depression of the water-level, free ventilation of the soil, and a relatively low degree of atmospheric humidity as the conditions most influential in promoting the prevalence of the disease. When these conditions are simultaneously present, the maximum prevalence occurs, but one or other may be present at other times in very high degree without the prevalence necessarily showing a corresponding elevation. In February, March, April and May, all the favourable conditions are present, and the disease attains its maximum of prevalence; but in November, December and January, when, although the atmospheric humidity is very low, the water-level is relatively high, and the soil-ventilation obstructed, the prevalence does not nearly equal that of the former period. In June, again, as

compared with May, there is a great diminution in prevalence, when our data regarding the carbonic acid in the soil-air do not warrant us in regarding the soil-ventilation as diminished, but at this time the atmospheric humidity is greatly increased, and the water-level undergoes a considerable elevation.

The cholera-prevalence of April and May.

Although the water-level, soil-ventilation and humidity appear to be the most influential conditions in relation to cholera in Calcutta, there are certain phenomena of prevalence which they do not appear to be capable of explaining. During December and January the prevalence ought, in so far as influenced by them, to be higher in place of lower than in November. The question of the causation of the diminution in prevalence at this time has been already alluded to in those sections of this report treating of temperature and humidity, and it was then pointed out that the influence of temperature probably manifested itself in the phenomenon. The phenomena of prevalence presented by April and May are, perhaps, the most difficult of explanation of any throughout the entire course of the year. Here there is diminished prevalence with slight increase in the depression of the water-level, and with only very slight increase of atmospheric humidity or of obstruction to soil-ventilation. It certainly seems improbable that such small alterations in these conditions should be influential in producing such considerable effects. It must at the same time be borne in mind that, in so far as soil-ventilation is concerned, our data are very imperfect. They were obtained from observations conducted during an exceptional year, when the rainfalls of April and May did not stand in their normal relation to one another, that of the former month amounting to 1·20, and that of the latter to only 1·16 inches. There are good grounds for regarding rainfall as calculated to obstruct soil-ventilation, indeed we have experimental proof that it actually does so in Calcutta, so that the average difference between the soil-ventilation in April and May is probably greater than our data would lead us to believe.

Mode in which the physical conditions associated with cholera-prevalence may be supposed to act.

The conditions which we are led to regard as most influential may be supposed to act in two ways in favouring prevalence of the disease. Assuming that cholera is produced by a specific material, or a combination of materials, the conditions of soil-ventilation, of water-level and humidity may influence either the diffusion and preservation of the material, or they may influence its production. The material may be produced either by chemical processes taking place independently of organic influences, or by processes dependent on such influences for their existence. If

the latter be the case, conditions of soil-ventilation, of water-level and humidity, however influential in aiding development and diffusion of the material, may not alone be capable of determining the precise period of maximum production. This may be partially dependent on the intrinsic properties of the bodies in the course of whose organic changes the material is developed, and if so, a precise correspondence between the phenomena of prevalence and of the meteorological conditions favourable to it need not necessarily invariably occur. It is at present, however, premature to speculate more on the matter. The whole subject requires further investigation. All that can be done in the meantime is to suggest a possible explanation of certain of the obscure phenomena of cholera prevalence, and to indicate the extremely complex nature of the questions to be determined.

PART II.

CHOLERA IN THE ENDEMIC AREA GENERALLY.

CHAPTER I.

THE RELATION OF VARIOUS PHYSICAL PHENOMENA TO CHOLERA IN OTHER DISTRICTS OF THE ENDEMIC AREA IN THE BENGAL PRESIDENCY.

(a) Geographical limits and character of the soil of the Endemic area.

Relation of cholera-prevalence to physical phenomena in the endemic area generally.

Having discussed the question of the relation of cholera to certain generally studied physical phenomena in Calcutta as fully as the statistical and other data seemed to warrant, we now purpose applying the same process to such other parts of India as present a cholera-history more or less closely identical with that of Calcutta. It will not be necessary to treat the several stations which belong to this class with the same minuteness as Calcutta; nor indeed, were it desirable to do so, is there sufficiently precise information in existence regarding them to render such a description possible.

In his important work, "Cholera Epidemics of Recent Years," Dr. Bryden defines the region of endemic cholera in the Presidency of Bengal as "the basin having the hill-country east of the Brahmaputra for its eastern margin, and the Rajmahal and Cuttack hills for its western margin. Its northern limit is the terai of the Himalayas from Lower Assam on the east to the terai of the Purneah district on the west, and its southern limit is the sea border of the Bay of Bengal, from Pooree in the west, to beyond the mouth of the Brahmaputra in the east" (page 61).

Similarity of physical characters of endemic areas.

It may be observed at starting that the history of cholera all over India presents one common feature, and that is that it can only be fairly regarded as endemic in such localities as manifest a close resemblance in the more superficial layers of their geological formation. This feature, it will be found, is more conspicuous than any of the other physical characters to which we shall have occasion to refer.

The soil of the Gangetic plains.

We have already indicated generally what characters the surface-soil of Calcutta presents. Mr. Henry F. Blanford in his *Physical Geography* describes it in a few words

as a mixture of firm sand and clay with decayed animal and vegetable matter—loam, very much like the silt that settles from muddy river-water. Below this, at a distance of from 6 to 10 feet, comes a bed of stiff clay, and below this again a layer of peat resting on alternating layers of sand and clay.

Mr. Blanford tells us that many years ago a well was sunk in Calcutta to a depth of 481 feet through successive layers of sand, clay, peat and pebbles; that at 380 feet was a layer of fresh-water shells resting on a bed of decayed wood, indicating that this must at one time have constituted the surface, but that it has since sunk and been covered by a soil formed by deposits from a river.

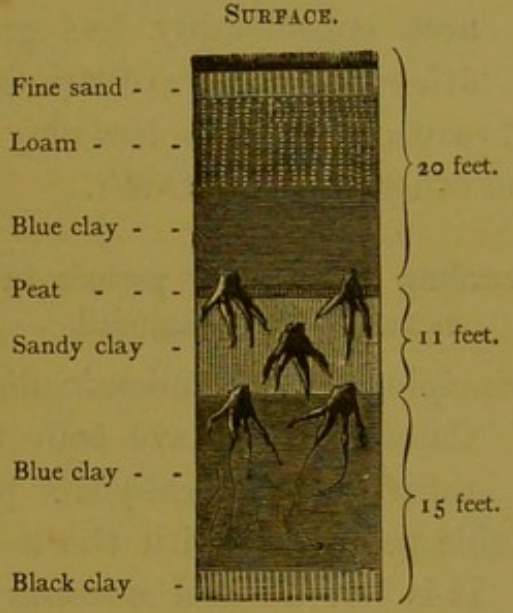


Diagram 10.—A Section of ground exposed in a tank at Sealdah, Calcutta [H. F. Blanford].

Taken generally, it may be stated that the more the soil of a district in India approaches to the character here described, the more likely is it to be one whose inhabitants are more or less constantly liable to be affected with cholera.

And of other alluvial districts in Lower Bengal.

This general statement regarding endemic cholera is not merely applicable to the districts which occupy the Gangetic plains of Lower Bengal, but also to certain parts of Oudh and the North-Western Provinces, as well as to similar plains which have been formed by the silt of the Godavery, the Mahanuddy, the Brahmaputra, and the Cauvery—in all of which areas cholera is more or less distinctly endemic.

The towns and the communities whence data have been derived.

We have selected certain localities of this area in which statistics have been collected for a long series of years from among those sections of the population regarding which

care has been taken to attain fairly accurate particulars—namely, the European and Native troops and the prisoners. The data which these afford, although not sufficient to warrant definite conclusions as to the comparative healthiness of different stations, is yet sufficient to indicate with considerable exactness at what particular seasons of the year cholera is most prevalent.

A glance at the map will show that the area over which these selected stations are distributed is a very wide one, considerably larger than the whole of England and Wales. As there are some districts within the limits of this area considerably less prone to the disease than others, so are there districts in the Bengal Presidency beyond them, in the larger towns of which cholera may also be said to be endemic, as for example Fyzabad and other towns in Oudh.

Calcutta.	Dacca.
Dum-Dum.	Maldah.
Barrackpore.	Dinagepore.
Chinsurah.	Purneah.
Berhampore.	Midnapore.
Burdwan.	Dinapore.

(b) Prevalence of cholera according to Monthly periods in the Endemic area, and the mean monthly Rainfall.

The physical phenomena most closely allied to cholera-prevalence.

Applying the same principle to these endemic districts as was applied to Calcutta, we have collected the monthly cholera returns for several years past and compared them all, so far as the data available permitted, with the several meteorological and allied physical conditions. It is not deemed necessary to submit full details of these comparisons, as, taken together, they yielded closely similar results. As in Calcutta, so in these districts generally, the most characteristic physical phenomena with which the prevalence of cholera is associated all over the endemic area, are indicated by the fact that at most of the stations the disease is less prevalent during the height of the rains, or rather it would be, perhaps, more accurate to say that it attains its maximum when the depression of the sub-soil water is at its maximum, and consequently, in a general way, holds an inverse relation to the proximity of the sub-soil water to the surface, so long, of course, as the sub-soil water under observation is ascertained to lie over the first impermeable layer.

This is completely in accord with what all writers who have studied this subject specially have asserted. Dr. Bryden (op. cit., page 61), after describing the proximity of the water to the surface in the endemic area, and pointing out that vast tracts of land are annually submerged, writes: "It is with the inunda-

tion of these tracts that cholera disappears, and it is with their re-appearance that cholera re-appears."

The monthly records of cholera in the endemic area.

In Table XLIII will be found a monthly statement of rainfall and of all the cholera cases that have been registered among the European and Native troops and the Prisoners in all the principal stations distributed over the area which has just been referred to as furnishing meteorological phenomena and conditions of soil closely resembling those observed in Calcutta.

TABLE XLIII.— *A Monthly Statement of Cholera in the Principal Stations of the Endemic Area among European and Native Troops and Prisoners for periods of from 23 to 51 years, together with the average Monthly Rainfall.*

	Elevation in feet.	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Remarks.
CALCUTTA	18′															
Cholera		38	9,105	12,572	19,558	24,040	16,641	8,556	5,297	5,124	5,478	8,016	11,112	10,334	1,35,833	Total population.
Ditto (Fort William and Alipore)		5·51	94	211	560	525	359	264	240	119	147	152	204	121	2,996	European and Native Troops and Prisoners only.
Rainfall		*48*	*0·43*	*0·87*	*1·35*	*2·39*	*5·40*	*12·08*	*12·78*	*13·94*	*10·18*	*5·61*	*0·55*	*0·23*	*65·81*	
DUM-DUM	20′															
Cholera		51	19	36	65	88	159	67	43	170*	34	47	62	23	813	European and Native Troops and Prisoners.
Rainfall		*48*	*0·43*	*0·87*	*1·35*	*2·39*	*5·40*	*12·08*	*12·78*	*13·94*	*10·18*	*5·61*	*0·55*	*0·23*	*65·81*	Calcutta observations.
BARRACKPORE ...	20′															
Cholera		51	84	100	250	318	375	260	137	150*	120	274	229	152	2,449	European and Native Troops
Rainfall		*48*	*0·43*	*0·87*	*1·35*	*2·39*	*5·40*	*12·08*	*12·78*	*13·94*	*10·18*	*5·61*	*0·55*	*0·23*	*65·81*	Calcutta observations.
CHINSURAH AND HOOGHLY ...																
Cholera		51	81	141	137	342	226	128	120	142	237	222	133	130	2,039	Europeans and Prisoners.
Rainfall		*12*	*0·61*	*1·48*	*2·18*	*3·68*	*5·23*	*10·65*	*11·97*	*12·31*	*7·88*	*3·94*	*0·41*	*0·15*	*60·49*	
BERHAMPORE AND MOORSHEDABAD ...	65′															
Cholera		23	42	69	530	263	84	50	90	58	51	89	52	69	1,447	European and Native Troops and Prisoners.
Rainfall		*18-20*	*0·45*	*0·92*	*1·03*	*2·17*	*3·99*	*9·76*	*9·73*	*9·91*	*9·30*	*5·83*	*0·17*	*0·08*	*53·34*	
BURDWAN ...	102′															
Cholera		23	33	5	21	72	66	53	35	34	35	41	7	8	410	Prisoners.
Rainfall		*14-16*	*0·67*	*1·10*	*1·58*	*2·80*	*4·51*	*11·07*	*12·44*	*11·78*	*8·51*	*5·40*	*0·24*	*0·52*	*60·62*	
DACCA ...	35′															
Cholera		23	11	18	62	60	29	26	20	12	11	28	50	29	356	Native Troops and Prisoners.
Rainfall		*15-16*	*0·64*	*0·74*	*1·51*	*6·33*	*9·40*	*13·46*	*12·70*	*12·05*	*8·52*	*5·02*	*0·71*	*0·04*	*71·12*	
MALDAH ...	160′															
Cholera		23	2	5	2	15	10	2	4	2	0	0	3	11	56	Prisoners.
Rainfall		*18-20*	*0·46*	*0·85*	*0·86*	*1·86*	*3·21*	*9·85*	*10·16*	*9·56*	*10·71*	*4·50*	*0·18*	*0·40*	*52·60*	
DINAGEPORE																
Cholera		23	7	0	17	86	75	32	10	7	3	1	52	6	296	Prisoners.
Rainfall		*14-16*	*0·22*	*0·68*	*0·75*	*2·57*	*7·43*	*18·84*	*16·09*	*13·41*	*12·75*	*5·98*	*0·15*	*0·04*	*78·91*	
PURNEAH ...	125′															
Cholera		23	3	0	220	278	97	22	4	0	0	4	0	0	628	Prisoners.
Rainfall		*6-7*	*0·40*	*0·43*	*0·21*	*1·84*	*2·56*	*12·36*	*14·90*	*13·60*	*10·98*	*3·88*	*0*	*0·05*	*61·21*	
MIDNAPORE ...	108′															
Cholera		23	9	36	146	111	8	287	·35	3	2	4	10	6	657	Prisoners (with Sepoys during three first years).
Rainfall		*11-13*	*0·72*	*0·46*	*1·54*	*1·67*	*5·49*	*11·43*	*11·60*	*10·93*	*8·66*	*6·14*	*0·43*	*0·01*	*59·08*	
DINAPORE ...	180′															
Cholera		23	46	91	346	672	702	355	403	329	182	137	234	55	3,552	
Rainfall		*17-19*	*0·65*	*0·49*	*0 25*	*0·30*	*1·32*	*6·87*	*9·77*	*8·51*	*7·47*	*2·63*	*0·13*	*0·15*	*38·54*	Patna Observatory.

* Of the 170 cases that have occurred at Dum-Dum during 51 years in the month of August, 113 occurred after the cyclone in 1859; and 50 of the Barrackpore cases at the same period.

Cholera returns of official communities only made use of.

It will be noticed that, save in the case of Calcutta itself, no use has been made of the statistics which have been collected among the general population. This has been done because no sufficiently trustworthy records of vital statistics are at present in existence. As the data employed refer solely to communities of average uniform strength from year to year, regarding whom very accurate information is recorded, and as this information extends, in nearly all cases, over a considerable number of years, they suffice to indicate the time of year when cholera is most prevalent, especially when all the stations are taken together.

The maximum cholera of endemic areas in March, April and May.

Taken month by month it will be seen that the dozen stations tabulated present considerable similarity. In nearly all of them it is in March, April or May that cholera prevalence is most marked, more especially in such of the stations as closely approximate to Calcutta in its physiography. When, however, we approach the borders of this territory—as, for example, at Dinapore, a station commonly left out of the "endemic" area in cholera maps—we find a tendency for the disease to push on into June.

Midnapore.—Laterite.

Midnapore, again, deviates somewhat from the other stations in this group, in that it shows a high cholera rate in June, and in other ways. The bulk of the June cases, which constitute this excess, occurred in 1857 and 1860: 103 cases in the former year, and 140 in the latter. It may be remarked in passing, that, unlike the rest of the stations in the list, Midnapore, together with a great portion of the district in which it lies, is situate on laterite soil. Indeed, it is perhaps not quite correct to imply that the disease is endemic in this particular town, as it would appear that occasionally it is absolutely free of it.

There is an idea prevalent that cholera is less liable to occur in lateritic districts than in others in India. We do not know what grounds exist for the supposition, but it is a matter deserving of the attention of those who have opportunities for judging. This peculiar soil—a compound of clay and oxide of iron—is very porous and possesses the property of hardening on exposure to the atmosphere. In some parts of India it is very general, being spread

out in sheets over the surface, from a few inches to many feet in thickness.*

The month of *average* intensity not uniform.

With regard to the particular month in which cholera may be said to manifest itself in its average intensity at these stations, it is found that no marked uniformity exists, the local *entourage* of each station being, as may readily be supposed, sufficiently distinct to modify the seasonal prevalence of the disease to this extent. On the other hand, to attempt to ascertain this by taking the mean of the monthly cases of the stations forming the group could hardly be deemed as sufficiently approximate to the truth to warrant any marked deviation from the usual mode of tabulating seasonal occurrences. Each station would require to be taken by itself, as was undertaken with regard to Calcutta.

The seasonal periods adopted.

Assuming the end of September to correspond with the average termination of the rains, October may be conveniently taken as the commencement of a season; and as more than 50 per cent of the annual rainfall of this group of stations falls within four months, May to September, the year might even be divided into the wet and the, comparatively, dry season. On the whole, however, we have deemed it convenient to adopt the tri-seasonal divisions, commonly adopted by meteorologists in this country, *viz.*, January to May, June to September, and October to December, but taking the last-named division as the first, instead of the third.

Total cholera registered among the official communities furnishing our data.

Omitting the statistics of the general population of Calcutta from our calculations, we find that the dozen stations which form the group under consideration have during the last 20 to 50 years furnished 15,699 cases of cholera,† the monthly distribution of which is as follows:

TABLE XLIV.—*Showing the Monthly prevalence of Cholera among Soldiers, Sepoys and Prisoners in twelve stations in Lower Bengal during varying periods up to 51 years.*

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	TOTAL.
Cholera	999	1,036	610	431	712	2,356	2,836	2,190	1,54	1,141	1,026	822	15,699

* Whilst these pages were passing through the press, we consulted the Civil Surgeon of this station (Dr. R. J. Mathew) regarding what appeared to us to be some inconsistencies in the course taken by the water-level, judging from the returns. The following extract from Dr. Mathew's reply is very interesting: "Midnapore was an unfortunate station to select for such observations, inasmuch as, owing to the porosity of the sub-soil and lower strata, two-thirds of the wells in the place are dry for nearly half the year, and during the rains a well will fill in one night, and in two days after, should there be no rain, will be found half empty."

† Occasionally records of deaths only could be obtained.

In the second and third chapters (of Part I) we have entered with some fullness into the question of the relation which cholera prevalence holds with regard to the pressure, temperature and humidity of the atmosphere in Calcutta, and the remarks there made apply, with more or less force, to this group of stations; for the meteorology of the different places manifest a close resemblance, and data are not available to enable any but general comparisons to be made.

For details of physical phenomena, refer to Calcutta-section.

With regard to the conclusion arrived at, that the minimum of cholera agreed with low pressure, it will be noted that this takes place during the heavy rainfall of the wet season, so that for this and other reasons, as already intimated, it may be inferred that the influence exerted on the prevalence of the disease, if any, by atmospheric pressure, must probably be of an indirect character.

Cholera and atmospheric pressure in endemic area.

The coincidence of the maximum rainfall with the minimum cholera-prevalence is nearly as evident in most of the stations of this group as it was in Calcutta. This is evident whether the stations be studied individually (as may readily be done by the aid of Table XLIII) or be studied as a group. This point will be more fully discussed further on.

Cholera and rainfall in endemic area.

(c) Prevalence of Cholera according to seasons in Endemic area: also the Rainfall.

As might be supposed, no satisfactory comparison can be instituted between data of monthly prevalence of cholera in communities of very different strengths by a mere tabulation of monthly results or even by a comparison of monthly ratios. Satisfactory comparisons may, however, be made by taking the *seasonal* ratios of the total number of cases which have occurred in individual stations. Such ratios are shown in the following table, together with the relation which exists between cholera and rainfall in Lower Bengal when studied by seasons.*

The seasonal prevalence at individual stations.

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* Whilst preparing these seasonal tables of rainfall, Mr. H. F. Blanford very kindly favoured us with a manuscript copy of his table of monthly rainfall, which is to appear in a forthcoming Report on the Meteorology of India, so that the figures represent the latest data available.

TABLE XLV.—*The prevalence of Cholera according to Seasons, together with the Seasonal Rainfall at twelve stations in Lower Bengal.*

STATIONS.	Number of years.	October to December.		January to May.		June to September.		Totals of cholera and of average annual rainfall.
		Cholera and rainfall (3 months).	Percentage of cholera and rainfall to annual totals.	Cholera and rainfall (5 months).	Percentage of cholera and rainfall to annual totals.	Cholera and rainfall (4 months).	Percentage of cholera and rainfall to annual totals.	
CALCUTTA—								
Cholera (General population) ...	38	29,462	**21·7**	81,916	**60·3**	24,455	**18·0**	1,35,833
Ditto (Barracks and Jails) ...	5—51	477	**15·9**	1,749	**58·4**	770	**25·7**	2,996
Rainfall	*48*	*6·39*	*9·7*	*10·44*	*15·8*	*48·98*	*74·5*	*65·81*
DUM-DUM—								
Cholera	51	132	**16·2**	367	**45·2**	314	**38·6***	813
Rainfall	*48*	*6·39*	*9·7*	*10·44*	*15·8*	*48·98*	*74·5*	*65·81*
BARRACKPORE—								
Cholera	51	655	**26·7**	1,127	**46·0**	667	**27·3***	2,449
Rainfall	*48*	*6·39*	*9·7*	*10·44*	*15·8*	*48·98*	*74·5*	*65·81*
CHINSURAH AND HOOGHLY—								
Cholera	51	485	**23·8**	927	**45·5**	627	**30·7**	2,039
Rainfall	*12*	*4·50*	*7·4*	*13·18*	*21·8*	*42·81*	*70·8*	*60·49*
BERHAMPORE AND MOORSHEDABAD—								
Cholera	23	210	**14·5**	988	**68·3**	249	**17·2**	1,447
Rainfall	*18—20*	*6·08*	*11·4*	*8·56*	*16·0*	*38·70*	*72·6*	*53·34*
BURDWAN—								
Cholera	23	56	**13·6**	197	**48·1**	157	**38·3**	410
Rainfall	*14—16*	*6·16*	*10·1*	*10·66*	*17·6*	*43·80*	*72·3*	*60·62*
DACCA—								
Cholera	23	107	**30·0**	180	**50·6**	69	**19·4**	356
Rainfall	*15—16*	*5·77*	*8·1*	*18·62*	*26·2*	*46·73*	*65·7*	*71·12*
MALDAH—								
Cholera	23	14	**25·0**	34	**60·7**	8	**14·3**	56
Rainfall	*18—20*	*5·08*	*9·6*	*7·24*	*13·8*	*40·28*	*76·6*	*52·60*
DINAGEPORE—								
Cholera	23	59	**19·9**	185	**62·5**	52	**17·6**	296
Rainfall	*14—16*	*6·17*	*7·8*	*11·65*	*14·8*	*61·09*	*77·4*	*78·91*
PURNEAH—								
Cholera	23	4	**0·6**	598	**95·2**	26	**4·2**	628
Rainfall	*6—7*	*3·93*	*6·4*	*5·44*	*8·9*	*51·84*	*84·7*	*61·21*
MIDNAPORE—								
Cholera	23	20	**3·0**	310	**47·2**	327	**49·8**	657
Rainfall	*11—13*	*6·58*	*11·1*	*9·88*	*16·8*	*42·62*	*72·1*	*59·08*
DINAPORE—								
Cholera	51	426	**12·0**	1,857	**52·3**	1,269	**35·7**	3,552
Rainfall	*17—19*	*2·91*	*7·6*	*3·01*	*7·8*	*32·62*	*84·6*	*38·54*

* If the 113 cases which occurred after the cyclone in August 1859 be deducted, the proportion during the rainy season for Dum-Dum will be 9·1 per cent.; and were a similar deduction made with regard to the 50 cases which occurred at Barrackpore after the same cyclone, the proportion would be 25·1 per cent.

Explanation of table of seasonal prevalence.

The first column under each seasonal period gives the total number of cholera cases which have been registered in each of the places cited during the months named, and the following column the *proportion* which this number bears to the total number of cases, of which records exist as having occurred during the 23 to 51 years that statistics have been collected. The aggregate figures are given in the last column of the table.

The average rainfall of the seasonal periods have been calculated on the same principle, the proportion to the average of the total annual amount for several years being likewise given in a separate column, and the figures printed in different type for convenience of reference.

To include the Calcutta figures in estimating the seasonal prevalence of cholera would lead to fallacies.

If the same mode of calculation be applied to ascertain the prevalence of cholera according to season to the aggregate number registered in all the stations, the cholera of the official and non-official communities of Calcutta being included, we get figures closely approximating to those furnished by Calcutta itself, as the following statement indicates (Table XLVI).

As, however, the Calcutta figures, which include the cholera mortality of the general population, represent nearly ten times the totals of all the other stations, it will be evident that the proportion arrived at might convey a very erroneous impression as to the seasonal prevalence of cholera at the other stations of the table. That such is the case will be seen at a glance from the accompanying statement.

TABLE XLVI.—*The prevalence of Cholera according to Seasons in twelve selected Stations in Lower Bengal.*

SELECTED STATIONS IN ENDEMIC AREA.	OCTOBER TO DECEMBER.		JANUARY TO MAY.		JUNE TO SEPTEMBER.		CHOLERA GRAND TOTAL.
	CHOLERA.		CHOLERA.		CHOLERA.		
	Total of season.	Proportion to grand total.	Total of season.	Proportion to grand total.	Total of season.	Proportion to grand total.	
		Per cent.		Per cent.		Per cent.	
Twelve stations including statistics of general Population, Calcutta ...	31,630	21·2	88,686	59·9	28,220	18·9	148,536
The same stations, but including only the statistics of official communities, Calcutta ...	2,645	16·9	8,519	54·3	4,535	28·8	15,699

We now find that, whereas the five first months of the year (January to May) furnish 60 per cent. of the total Calcutta cholera and 54 per cent. of the cholera of the endemic area generally, we find that the four months' rainy season (June to September) furnishes 10 per cent. more of the cholera of the selected stations, taken as a group, than that furnished by Calcutta taken alone. We shall see further on that, as we proceed westwards, this discrepancy becomes greater and greater until areas are reached where the cholera of the rains is not only 10 per cent., but 60, 70, and even more per cent. higher than that of Calcutta.

Cholera 10 per cent. less prevalent in Calcutta during rainy season than in the other selected stations taken together.

(d) The Water-level Registers of the Endemic Area.

The water-level returns of the stations forming this group will be found in the alphabetically-arranged tables (I—VII) at pages 117 to 135, together with similar data regarding several other stations situated within the geographical limits under consideration. Unfortunately, an interruption occurred in the observations taken in Lower Bengal during the year 1874, so that, with the exception of Dr. Lynch's observations at the Alipore Jail, the returns for this part of the country are not so satisfactory as those of most other provinces. At several of the stations, however, the fluctuation of the water-level has been recorded with care and for a sufficiently prolonged period to enable a good approximation to be arrived at of the sub-soil changes in adjoining districts. Some of the stations at which the observations have been conducted with special care have no troops, nor have they a jail sufficiently large, or a jail occupied for sufficiently long period, to enable comparisons to be made between the fluctuation of the water-level and the health returns of an accurately registered community. The returns from such stations may, however, prove of much value in future years should the attempts at present being made towards procuring correct statistics from among the general population prove successful.

Water-level returns of endemic area.

We have thrown the returns of most of these stations into chart form and have found the result to be so generally alike, that it has not been deemed necessary to reproduce them all. It has been shown that in Calcutta the water-level is at its lowest about May, and nearest the surface in September. Such is also the case in the adjoining military stations of Dum-Dum and Barrackpore;

The variations of the water-level at different stations of endemic area occur about the same seasons.

also at Hooghly, Midnapore, Moorshedabad, Burdwan, Purneah, Maldah, Dinapore, and other places.

The period occupied in getting from the lowest to the highest level corresponds consequently with the four months' wet season, and having attained its maximum elevation shortly after the end of the rains, the beginning of its gradual decline may be said to correspond with the commencement of the annual periods into which our seasonal tables have been divided.

CHAPTER II.

ANALYSIS OF DATA FURNISHED BY INDIVIDUAL STATIONS SELECTED TO ILLUSTRATE CHOLERA-PREVALENCE AND PHYSICAL PHENOMENA IN THE ENDEMIC AREA.

(a) Military Stations near Calcutta.

Cholera and water-level of military stations near Calcutta.

In order to carry out the comparisons between cholera as it occurs in Calcutta and as it occurs in the endemic area generally, we have carefully gone over the statistical returns of the military stations within short distances of it, and which are, so far as is at present known, identical with it in their physical features. These are Dum-Dum and Barrackpore, situate on the left bank of the Hooghly, and at distances from Calcutta of four and fourteen miles respectively; and one station on the opposite side of the river, about 25 miles from Calcutta—Chinsurah, near Hooghly, where, until recently, a large military depôt was kept up.

Statistics of military population at Calcutta, Dum-Dum, Barrackpore and Chinsurah.

Regarding these stations very accurate data are available, extending over a period of more than fifty years. In order to ascertain whether any striking agreement exist between the seasonal prevalence of cholera among the civil (as recorded at Calcutta) and purely military population, we have excluded all returns which are in existence in connection with these stations except the strictly military. The following table will show the number of cases which have been furnished by the European and Native troops of these stations—those of Fort William and Alipore being joined and given as the military cholera statistics of Calcutta.

TABLE XLVII.—*A Monthly Statement of the Cholera cases that have occurred among the strictly Military population of Calcutta and adjacent Military Stations; also of average Water-level and Rainfall at Chinsurah.*

	Number of years returned.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	REMARKS.
Calcutta ...	51	79	127	88	65	109	263	371	297	148	93	84	105	European and Native Troops.
Dum-Dum ...	25	47	62	23	19	36	65	88	159	67	43	170*	34	Ditto.
Barrackpore ...	51	274	229	152	84	100	250	318	375	260	137	150*	120	Ditto.
Chinsurah (Hooghly)	46	58	63	31	23	50	51	149	166	94	69	74	62	European troops depôt.
Total Cholera ...	...	458	481	294	191	295	629	926	997	569	342	478*	321	
Mean water-level ...	3	4″·4	5″·4	7″·0	9″·0	10″·1	11″·0	11″·4	11″·8	10″·0	7″·2	3″·0	3″·2	At Chinsurah.
Mean rainfall ...	12	3″·94	0″·41	0″·15	0″·61	1″·48	2″·18	3″·68	5″·23	10″·65	11″·97	12″·31	7″·88	Ditto.

It will be observed that the data regarding rainfall and water-level are not those of Calcutta, but of the station farthest removed from it, *viz.*, Chinsurah. This has been done with the intention of making the comparison as complete as possible, and likewise because Chinsurah (or rather Hughli) is one of the meteorological stations from which good water-level returns have been furnished extending over a period of three years.

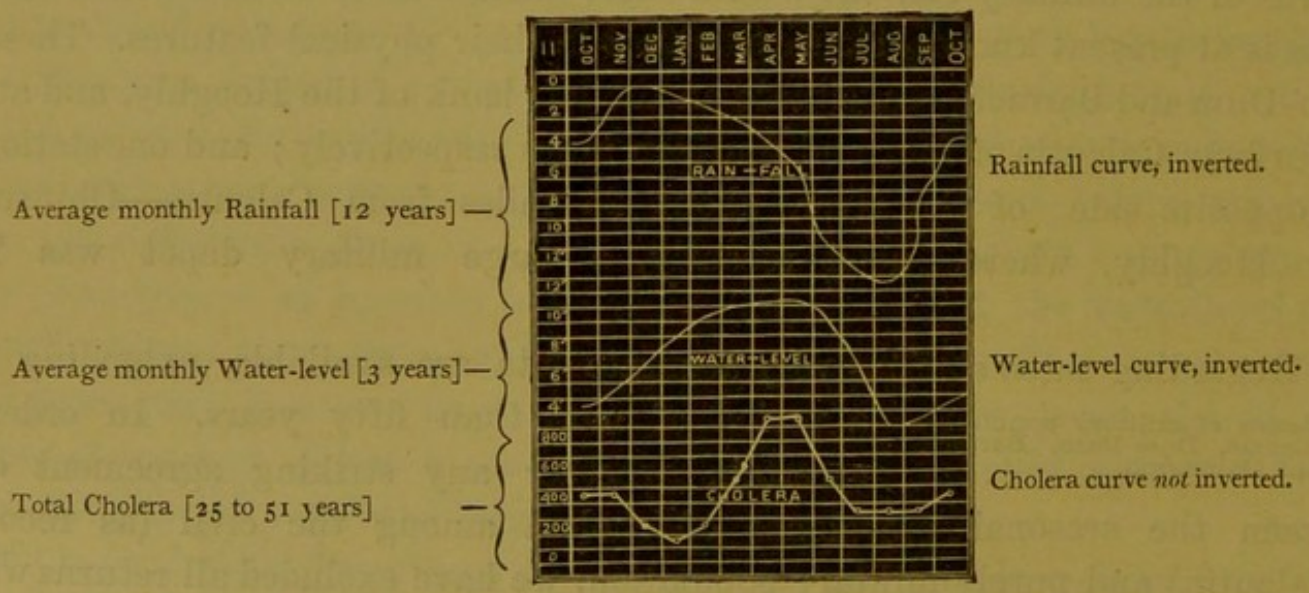

DIAGRAM 11.—Illustrating the average monthly variation in the Water-level at Chinsurah, and the Cholera-prevalence among European and Native Troops at Calcutta and adjacent Military Stations.

* The cases of cholera which occurred in August 1859 after a cyclone (113 in Dum-Dum and 50 at Barrackpore) have been retained in the table, but these were manifestly exceptional cases, and in order to illustrate the *ordinary* seasonal prevalence of cholera, they should be deducted from the total cholera of the four stations. The total would then be [478 — 163 =] 315: this proportion for August has been adopted in the Diagram.

Diagrams of Water-level at Chinsurah and Calcutta.

The above diagram will suffice to illustrate the remarks made in the previous pages regarding the fact that, be the explanation what it may, the prevalence of cholera is at its maximum in Lower Bengal when the water-level is low: not only is this observed in Calcutta itself, nor when judged by data acquired elsewhere from among an indifferently registered civil population, but also when tested by statistics of fairly assured accuracy when they extend over a sufficient number of years.

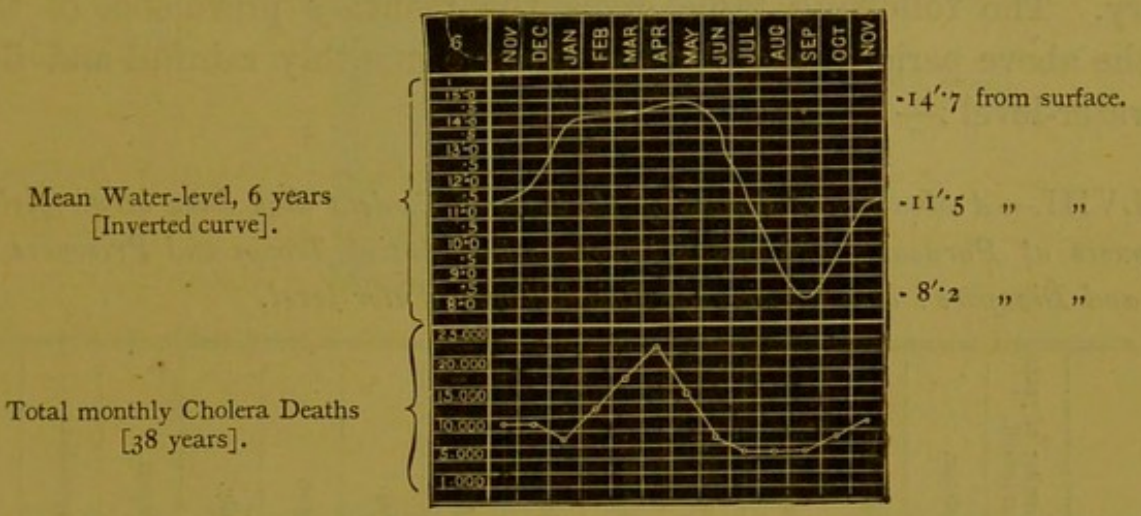

DIAGRAM 11 a.—Average Water-level and Cholera-prevalence in Calcutta.

In order to make this matter more evident, we reproduce the diagram showing the relation which exists between the mean water-level of Calcutta for a period of six years. In both diagrams the water-level is seen to be at its lowest in May and nearest the surface in August and September, and cholera attains its maximum in April and May; as in the case of Calcutta, however, no close connection can be detected between the less marked variations in the cholera-prevalence and water-level.

Water-level and local rainfall.

As the level of the water in the group of stations under consideration is dependent on the local rainfall, it is not considered necessary to refer to the influence of rainfall specially, as the remarks made regarding this factor in the history of cholera-prevalence when speaking of Calcutta apply equally here. It may, however, be mentioned that in some of these stations, especially at Dum-Dum, it has

been ascertained that no relation exists between the height of the river and the level of the water in the well.

(b) The stations of Purneah and Berhampore.

Stations selected to illustrate physical conditions and cholera-prevalence in endemic area.

In order to illustrate still further the relation of cholera prevalence to physical conditions in the endemic area, we select three other stations—*Purneah*, *Berhampore* and *Dinapore*. The cholera history of the first two extends over a period of twenty-three years, and regarding the last, records exist extending over more than half a century. The following table gives the monthly prevalence of the disease during the above periods, and also the average monthly rainfall and fluctuation of the water-level :—

TABLE XLVIII.—*A Monthly Statement of the cases of Cholera that have been registered among Prisoners at Purneah; and among European and Native Troops and Prisoners at Berhampore and Dinapore: also the average Rainfall and Water-level.*

	Number of years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	REMARKS.
PURNEAH.—														
Mean rainfall ...	6—7	3″·88	0″·0	0″·05	0″·40	0″·43	0″·21	1″·84	2″·86	12″·36	14″·90	13″·60	10″·98	
Mean water-level	3—4	2′·2	3′·1	3′·2	4′·0	4′·4	4′·9	5′·1	5′·4	5′·5	4′·4	3′·3	2′·3	
Total cholera ...	23	4	0	0	3	0	220	278	97	22	4	0	0	Prisoners.
BERHAMPORE.—														
Mean rainfall ...	18—20	5″·83	0″·17	0″·08	0″·45	0″·92	1″·03	2″·17	3″·99	9″·76	9″·93	9″·91	9″·30	
Mean water-level	2—3	3′·2	4′·2	5′·8	6′·9	7′·7	8′·5	8′·3	10′·6	10′·4	8′·3	5′·2	3′·9	
Total cholera ...	23	89	52	69	42	69	530	263	84	50	90	58	51	European and Native Troops and Prisoners.
DINAPORE.—														
Mean rainfall ...	17—19	2″·63	0″·13	0″·15	0″·65	0″·49	0″·25	0″·30	1″·32	6″·87	9″·77	8″·51	7″·47	Patna Observatory.
Mean water-level	1-2	8′·2	15′·7	20′·9	22′·6	24′·1	25′·0	25′·8	26′·2	24′·7	14′·5	8′·9	7′·2	
Total cholera ...	51	137	234	55	46	91	346	672	702	355	403	329	182	European and Native Troops and Prisoners.

Purneah.

* The district of Purneah forms a large tract of the alluvial plain lying between the Ganges and the Himalaya, the town itself being about 100 miles to the south of the latter

and about 30 from the river. During the greater part of the rainy season the

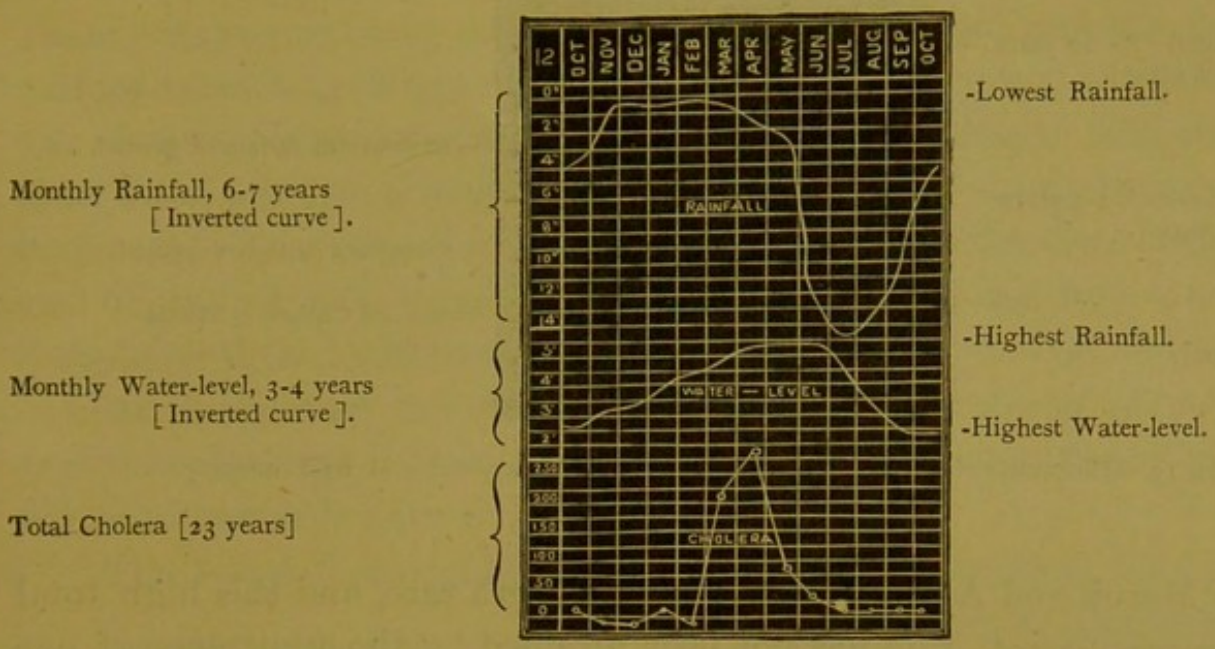

DIAGRAM 12.—Illustrative of the average monthly Rainfall, Water-level, and total monthly Cholera at Purneah.

district is more or less completely under water, and, as may be ascertained by reference to the detailed tables of the water-level registers (pages 117 to 135), the water in the station itself may come within a few inches of the surface. Although the total number of carefully registered cases of cholera in the jail is not sufficiently large to justify any opinion as to the minimum cholera month or season, still the preponderance of the disease in April and May is very marked, the cases having occurred in these months on ten different years. With regard to March, the high numbers may be said to be exceptional, as although cases were registered as occurring in this month during six annual periods, 211 out of 220 occurred in March 1863. We have not, however, been able to ascertain the particulars regarding this evidently terrible outburst of the disease among the prisoners at this station.

Berhampore.

Berhampore was in former years a large Military station, and over 800 of the cases recorded in the Table refer to Europeans. It is within a short distance of the large town of Murshidabad, and the statistics of the jail of that station have been incorporated with those of Berhampore.

Average monthly Rainfall 8--20 years [Inverted curve].

Average monthly Water-level, 2-3 years [Inverted curve].

Total Cholera [51 years],

—10 feet from surface of ground.

—2 feet from surface of ground.

Maximum Cholera in March.

DIAGRAM 13.—Illustrative of the average monthly Rainfall, Water-level, and total monthly Cholera at Berhampore.

Here also March and April present a high cholera rate, and this high total rate has not been attained by the occurrence of one exceptionally severe epidemic, but by repeated severe visitations of the disease. In March 1828, and again in 1829, the European troops suffered terribly, as also did the prisoners in March 1856; so that although, according to the summary-tables and diagram, March is the worst month, yet it appears from a study of the separate annual tables that it is during April that conditions favouring the disease are most commonly present.

The marked cholera-prevalence of March and April at Berhampore not due to exceptional circumstances.

(c) Dinapore—a transition area: Geological and Meteorological features.

Dinapore may be said to furnish an illustration of a station in a district forming a sort of border-land between the endemic area and the parts of the country in which experience has shown that cholera is less prone to be constantly present.

Dinapore—a transition area.

It is situated on the south bank of the Ganges, and geologically may be said to present precisely similar conditions to those of the other alluvial stations to which reference has been made.

In a memorandum regarding the sites of Military stations in India, Dr. Oldham, formerly Superintendent of the Geological Survey, states, with reference to this group, that "the conditions of the several stations on the banks of the Ganges are pretty nearly the same, that is, Calcutta, Dum-Dum, Barrackpore, Berhampore and Dinapore,

Geology of Gangetic stations from Calcutta to Dinapore.

so far as the geological structure of the ground on which they are placed is concerned, may be said to be similar. They are all built on a series of beds of silt, fine sand and clay of immense thickness and varying much in the succession. These beds are generally quite or very nearly horizontal, and the character of the surface varies according as the uppermost bed at the place is sand or clay. Not one of these places do or can afford any natural drainage. Soil will, of course, absorb and drink in a large amount of moisture and of impurities also, but there is no means by which these can pass off, and they therefore accumulate. The ground, in fact, licks up moisture and sewage as a sponge would, and as a sponge it also loses these by evaporation, only overflowing when full, but nothing more."

At this part of the country, however, *the character of the alluvium begins to give evidence of a change*—a transition from the more recent Gangetic to the old alluvium(*vide* page 68).

Rainfall at Dinapore.

The *rainfall* also undergoes a considerable diminution, for instead of being over 60 inches as in Calcutta, Purneah, Berhampore and other stations, an average of only 38·5 inches has been recorded during 14 years at a meteorological station about eight miles from Dinapore, the large town of Patna.

Its distribution over the year also is not quite parallel to that of Calcutta, 84·6 per cent. of its annual total falling in the wet season—June to September—against 74·5 per cent. in Calcutta; but even then the aggregate amount of this season's rainfall remains less than that of Calcutta by 16 inches (*vide* Table XLV, page 54).

17 per cent. more cholera at Dinapore during rainy season than at Calcutta

A comparison of the data regarding Calcutta and Dinapore suggests that conditions of rainfall in a locality (taken in connection with geographical position and geological features) really do exert an important influence on the development and distribution of the cause or causes of cholera. Both stations agree closely in their general physical features, the most important difference lying, as indicated above, in the amount of the rainfall. During the wet season in Dinapore the rainfall is 16 inches less than in Calcutta; this season at Dinapore contributes 35·7 per cent. of the annual cholera, whilst in Calcutta it only gives 18 per cent.

This increase of cholera during the rains becomes more evident further up the Ganges and its tributaries.

As already stated, however, Dinapore may be looked upon as a transition station, for we shall find the contrast becoming more marked as we proceed in a westerly and

north-westerly direction. This important difference cannot be set aside on the ground that the statistics do not comprehend a sufficient number of cases, as may, with perfect justice, be said of some of the endemic-area group of stations which we have been obliged to fall back upon. Here we have a large military station which has been occupied during more than 50 years, and furnishing an aggregate of over 3,500 cases of the disease, among a carefully-registered official population.

Years during which cholera has occurred at Dinapore.

This aggregate, moreover, has not been furnished by some *one* extraordinary epidemic, but is distributed over nearly every year of the period: for example, cases have been recorded during 44 years in April, 43 in May, 42 in August, 40 in June, 38 in March, and in 34 years in September. It is in January that the disease has occurred least often—21 times.

Relative humidity at Dinapore.

The data in connection with the hygrometric condition of the atmosphere at this station are not so accurate as those which are available regarding Calcutta, still they are probably sufficiently near to enable a fair estimate of its monthly variation to be formed. We have combined the data furnished in the Bengal Meteorological Report for 1874 with Mr. Blanford's tables for 1875, and thus obtained a monthly mean extending over nine years.

TABLE XLIX.—*The mean relative Humidity of the atmosphere at Dinapore (Patna observations) during nine years; also the mean monthly Temperature and atmospheric Pressure.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Relative humidity [Saturation = 100]	9	57	50	58	59	50	37	34	49	63	73	79	76
Temperature	7—8	79°·5	70°·1	62·7	61°·0	66°·2	77°·5	85°·8	88°·7	87°·6	84°·6	83·9	83°·3
Atmospheric pressure ...	7—8	29·675	29·834	29·884	29·858	29·801	29·681	29·568	29·470	29·349	29·359	29·429	29·514

As in Calcutta, the relative humidity of the air at Dinapore bears to a certain extent an inverse relation to the degree of cholera-prevalence; this is brought out very clearly in the diagram (No. 14), where the curve, as in the case of the rainfall and water-level curves, is shown inverted so as to convey a

clearer impression of the relation to the cholera and temperature curves forming the lower section of the chart, but which are not reversed.

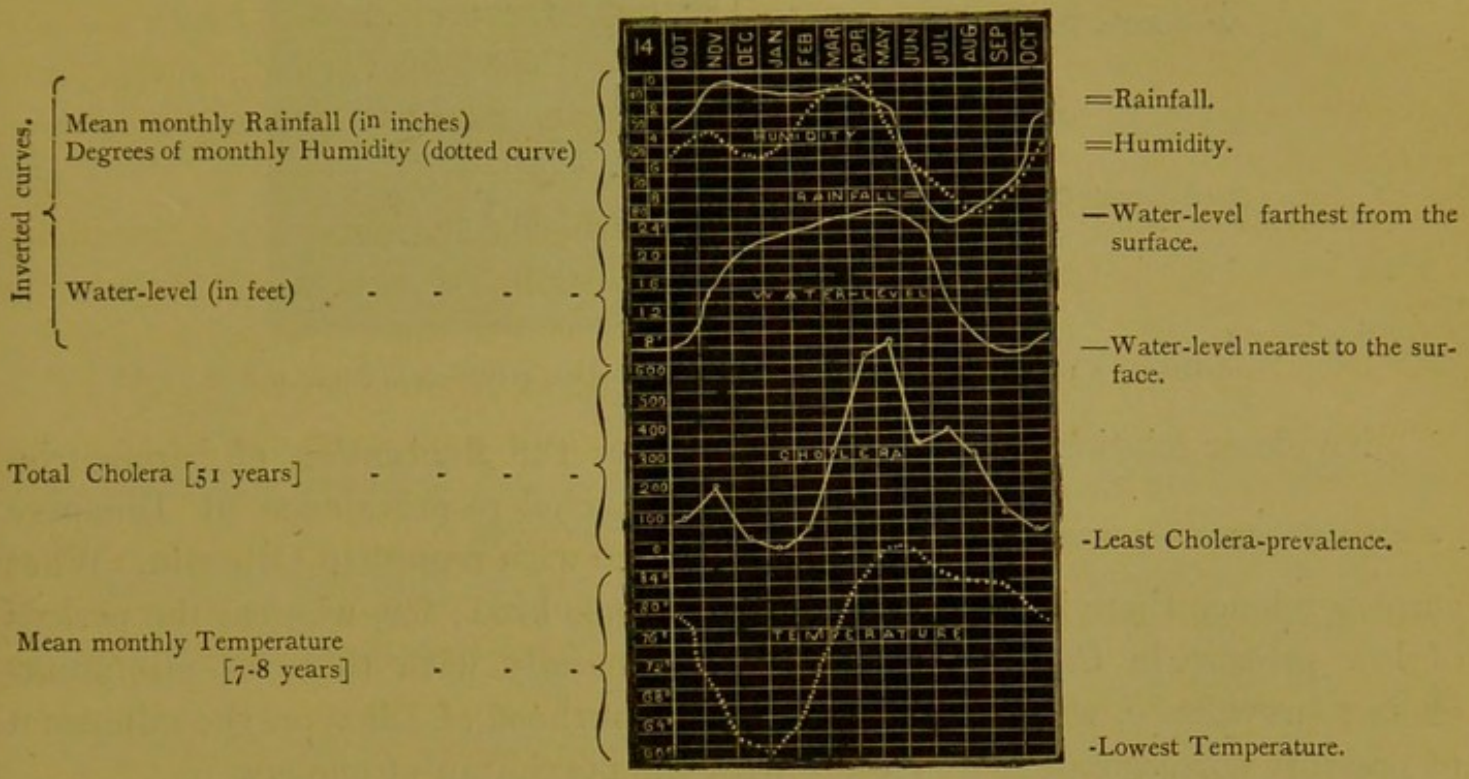

DIAGRAM 14.—Illustrative of average monthly Relative Humidity, Rainfall, Water-level, Temperature, and total Cholera at Dinapore.

The temperature at Dinapore.

The mean monthly *temperature* at Dinapore differs somewhat from that of the stations which are situated further down along the Ganges and its various branches. Taking Calcutta, again, as a standard for comparison, we find that, although the mean temperature of the year does not materially differ, being 79°·3 at Calcutta and 77°·6 at Dinapore, still its distribution over the year presents a marked difference. From April to August the average heat at the latter is greater than at the former by from one to three degrees, but in October the condition becomes reversed, the temperature being from five to six degrees cooler at Dinapore than at Calcutta during the cold season. On comparing the curves in the above diagram, it will be observed that the temperature-curve follows that of the cholera-prevalence curve much more closely than it was observed to do in Calcutta, the minima and maxima of both at Dinapore corresponding with considerable accuracy. The Calcutta temperature diagram (No. 2) is reproduced here, for convenience of comparison.

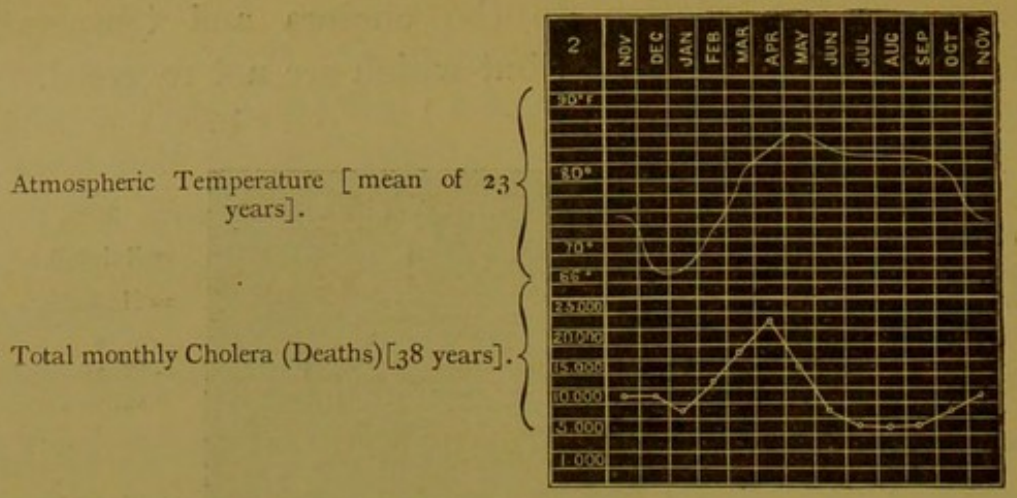

DIAGRAM 14 a.—Atmospheric Temperature and Cholera-prevalence in Calcutta.

Barometric-pressure at Dinapore.

No closer relation can be traced between the fluctuation of barometric-pressure and the cholera-prevalence at Dinapore than could be done with regard to Calcutta. What correspondence there is, however, is of an inverse kind; for, whereas the periods of low pressure in Calcutta corresponded generally with those of minimum-cholera-prevalence, we find that in the neighbourhood of Dinapore the minimum of pressure corresponds more closely with the maximum of cholera.

PART III.

CHOLERA IN THE NON-ENDEMIC AREA OF BENGAL.

CHAPTER I.

THE SEASONAL PREVALENCE OF CHOLERA IN *NON-ENDEMIC* AREAS OF THE RENGAL PRESIDENCY.

(a) The leading Geological features of the 'transition' area, and of the Gangetic plain eastward of 84° East Longitude.

Endemic and non-endemic cholera areas.

In the introductory chapter to his work—'Cholera Epidemics of Recent Years'—Dr. Bryden starts with the proposition that the cholera of the Bengal Presidency has a geography which can be demonstrated, that in Upper India the disease has not a permanent habitation, but that in certain areas of the Lower Provinces cholera has a permanent and perennial abode. Other writers also have directed attention to this fact, and it has seemed expedient to epidemiologists to divide the Presidency into two areas—the endemic and the non-endemic.

In the preceding chapters we have endeavoured to point out the leading physical phenomena which are associated with the maximum and minimum prevalence of the disease in the former of the two areas, and we now come to enquire whether a like combination of physical conditions is associated with the maximum and minimum cholera-periods in the latter.

The data at our disposal for the study of this matter are derived from similar communities, and the sources of our information are mainly the same; but we have in addition availed ourselves of the assistance of the compiled statistical details in Dr. J. M. Cuningham's Report on the Cholera Epidemic of 1872.* In the present chapter we have, however, to deal with physical features, geological and climatic, which not only differ in many districts from those observed in the endemic area, but also differ among themselves.

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* Ninth Annual Report of the Sanitary Commissioner with the Government of India—Section 1, 1873.

The transition area—Dinapore, Benares.

Taking the district of Dinapore as one which presents transitional conditions between the Upper Provinces and Lower Bengal, and between the latter and the Central Provinces, it will perhaps tend to simplify the subject if the physical aspects and cholera-history of those parts of the country which manifest a deviation from the typical cholera-producing area be taken up *seriatim* according to their geographical position.

Reviewing the geological features of the sites upon which the principal military stations above Dinapore have been built, Dr. Oldham, in the memorandum already referred to, states that there are in the Ganges Valley Proper two very distinct deposits of very different ages and probably of very different origin: one being what is described as the old, the other as the Gangetic alluvium (*vide* page 63).

The large city of Benares, some 125 miles higher up the Ganges than Dinapore, may be said to present physical features and a cholera-history closely similar to those of the latter, so that it may be conveniently taken as the starting-point of our description of the leading characters of the physical concomitants of the disease in areas where it appears at irregular intervals. "Below Benares (speaking roughly)," writes Dr. Oldham, "the greater portion of the plain of the Ganges from the foot of the hills to the north, to the hills on the south is composed of the more recent alluvium, chiefly soft incoherent beds of fine sand and silt, while here and there through these beds stand up parts of the older alluvium (possibly a marine deposit) which for the most part consists of a strongly coherent reddish yellow clay, generally abounding in *kunkur*,* and with only occasionally irregular beds of sand through it."

It is evident, therefore, that speaking *generally*, the soil of the Gangetic plain to the westward of, say, 84° east longitude presents physical properties very different from what we have seen it to present from Dinapore downwards.

The modern and the older Alluvium.

Although it is quite true that on looking at a Geological map of India, we find possibly but one tint extending from the mouths of the Ganges to Lahore, bounded on the north by the Himalayas and on the other side by an irregular line of elevated country many miles to the south of the course taken by the Ganges

* *Kunkur* consists of nodular calcareous concretions generally embedded in clay. Mr. W. King states that it derives its origin from decomposed shells and subsequent precipitation of the carbonate of lime derived from them.—*Memoirs of Geological Survey of India*, Vol. IV, page 360.

and its tributaries, with large patches of the same tint in Central India, signifying that the territories over which it is spread is alluvial, nevertheless, as Dr. Oldham says, the essential character of the deposit and the physical conditions of the surface vary very materially.

As we have just seen, there is a marked difference between the alluvium found below and above Benares. Speaking generally, the prevailing character of the deposits constituting the plains of Behar and the North-West Provinces consisting, not as below Dinapore, of inchoherent sand and silt, but of "layers of older and very kunkury clay." This, says Dr. Oldham, is not universal, but it is general, whereas its absence is the general character below Benares. Moreover, the more superficial deposits present every possible variety, from the barren white saline soil on the one hand to the fertile black cotton soil,* which covers such large tracts, especially of the more southerly portion of the area under review, on the other. It is therefore incorrect to suppose that, taken generally, no material difference exists both as to physical and chemical properties between the soil of the endemic and non-endemic areas.

(b) Prevalence of Cholera according to Monthly periods in the Non-endemic area in Bengal, and the mean Monthly Rainfall.

Tabular statement of monthly cholera and rainfall of non-endemic area.

Before proceeding further at present with this subject, it will, perhaps, be well to adopt the plan followed in Part II, and to take a general inventory of the statistical data at our disposal regarding the particular group of stations now under consideration, previous to entering into details concerning individual stations. In a former chapter, a monthly tabular statement was given of the cholera-prevalence in

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* *Regur* or cotton soil has long been a puzzle to Geological and Medical writers. It is generally seen as a surface-soil covering kunkur and gravelly beds; Captain Newbold (*Journal of the Royal Asiatic Society*, Vol. VIII, p. 254) referring to it writes: The best kinds of this extraordinary soil are rarely suffered to be fallow, and never receive manure. It has yielded annually crop after crop for upwards of 2,000 years without receiving any aid from the hand of man except an annual scratching with a small plough. It is irrigated solely by the dews and rains of heaven. It is remarkably retentive of moisture, and it has been ascertained that if exposed to moist air it will absorb 8 per cent. of its own weight. Contracting by the powerful heat of the sun, it is divided like the surface of dried starch by countless and deep fissures, and while the surface for a few inches in depth is dried to an impalpable powder raised in clouds by the wind, darkening the air, the lower portion of the deposit still retains the character of hard black clay. In wet weather the surface is converted into a deep tenacious mud.

Regur or cotton soil.

Mr. W. T. Blanford says that it is extremely adhesive when wetted, and expands and contracts to an unusual extent under the respective influences of moisture and dryness, hence the great cracks by which it is fissured in hot weather. Like all argillaceous soils it retains water, and hence requires less irrigation than more sandy ground.—*Memoirs of the Geological Survey of India*, Vol. VI, p. 235.

a dozen stations of the endemic area, together with the average monthly rainfall. We have compiled a similar table regarding the cholera and rainfall of 25 selected stations in the non-endemic area of the Bengal Presidency, such stations being selected as far as possible, which, in addition to furnishing correct returns regarding their military and jail population, were also capable of furnishing meteorological and other collateral data.

TABLE L.—*A Monthly Statement of Cholera in the principal Stations of the Non-Endemic Area among European and Native Troops and Prisoners for periods of 18 to 51 years, together with the average Monthly Rainfall.*

STATIONS.	Elevation in feet.	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	REMARKS.
HAZAREEBAUGH	2,010															
Cholera ...	...	23	1	1	33	60	61	45	201	80	22	2	3	0	509	Soldiers and prisoners.
Rainfall ...	...	*10—11*	*0·47*	*0·81*	*0·63*	*0·40*	*1·33*	*8·52*	*14·15*	*13·30*	*8·25*	*3·42*	*0·19*	*0·06*	*51·53*	
RANCHEE ...	...															
Cholera ...	...	23	1	1	5	12	16	20	63	43	3	0	2	0	166	
Rainfall ...	...	*16—18*	*0·92*	*1·04*	*1·31*	*0·58*	*1·52*	*7·43*	*12·50*	*10·90*	*7·81*	*3·45*	*0·13*	*0·09*	*47·68*	
ARRAH ...	191															
Cholera ...	...	23	0	2	8	21	15	92	229	60	8	9	20	0	464	Prisoners.
Rainfall ...	...	*17—19*	*0·84*	*0·45*	*0·59*	*0·76*	*1·06*	*7·10*	*12·91*	*10·04*	*9·65*	*2·60*	*0 21*	*0·07*	*46·28*	
BENARES ...	267															
Cholera ...	...	51	31	26	139	245	216	188	187	380	77	52	29	40	1,610	Soldiers, sepoys and prisoners.
Rainfall ...	...	*20—21*	*0·70*	*0·47*	*0·26*	*0·15*	*0·48*	*5·26*	*12·67*	*11·88*	*6·86*	*1·63*	*0·05*	*0 08*	*40·49*	
GORUCKPORE ...	255															
Cholera ..	...	23	0	1	12	10	22	32	249	35	28	5	18	1	413	Prisoners.
Rainfall ...	...	*20*	*0·49*	*0·55*	*0·33*	*0·26*	*1·59*	*6·57*	*13·46*	*11·88*	*8·19*	*2·77*	*0·24*	*0·09*	*46·42*	
FYZABAD ...	400 ?															
Cholera ...	...	18	1	3	4	133	13	6	6	62	69	71	16	1	385	Soldiers, sepoys and prisoners.
Rainfall ...	...	*5—6*	*0·20*	*0·20*	*0·10*	*0*	*0*	*8·70*	*13·90*	*14·30*	*8·60*	*2·50*	*2·10*	*2·30*	*52·90*	
ALLAHABAD ...	306															
Cholera ..	...	50	8	14	105	128	310	213	192	417	146	20	14	5	1,572	Soldiers, sepoys and prisoners.
Rainfall ...	...	*19—20*	*0·75*	*0·57*	*0·23*	*0·18*	*0·38*	*3·43*	*12·04*	*10·67*	*6·62*	*2·47*	*0·09*	*0·15*	*37·58*	
LUCKNOW ...	369															
Cholera ...	...	21	1	4	44	63	43	74	329	321	179	58	111	7	1,234	Soldiers, sepoys and prisoners.
Rainfall ...	...	*11*	*0·99*	*0·16*	*0·25*	*0·19*	*0·56*	*4·66*	*14·10*	*10·93*	*9·90*	*1·27*	*0·*	*0·34*	*43·35*	
CAWNPORE ...	113															
Cholera ...	...	51	42	39	203	287	424	653	834	1,246	441	111	82	75	4,437	Soldiers, sepoys and prisoners.
Rainfall ...	...	*20*	*0·66*	*0·48*	*0·24*	*0·09*	*0·56*	*3·38*	*9·24*	*7·80*	*5·40*	*0·80*	*0·09*	*0·15*	*28·89*	
AGRA ...	555															
Cholera ...	...	51	11	13	70	117	150	832	683	1,391	133	50	32	19	3,501	Soldiers, sepoys and prisoners.
Rainfall ...	...	*22—25*	*0·71*	*0·42*	*0·24*	*0·13*	*0·63*	*2·89*	*8·86*	*7·24*	*4·88*	*0·22*	*0·03*	*0·16*	*26·41*	
MUTTRA ...	550 ?															
Cholera ...	...	51	0	2	3	25	1	6	14	94	6	1	4	1	157	Soldiers, sepoys and prisoners.
Rainfall ...	...	*19*	*0·49*	*0·42*	*0·25*	*0·11*	*0·69*	*2·78*	*9·56*	*7·45*	*4·76*	*0·19*	*0·01*	*0·30*	*27·01*	
MORAR ...	500 ?															
Cholera ...	...	17	1	0	1	41	20	12	108	438	91	11	2	1	726	Soldiers, sepoys and prisoners.
Rainfall ..	...	*9—12*	*1·26*	*0·27*	*0·25*	*0·03*	*0·31*	*3·88*	*12·40*	*9·62*	*5·13*	*1·04*	*0*	*0·21*	*34·40*	
JHANSIE ...	359															
Cholera ...	...	22	0	0	0	0	0	2	21	134	8	0	0	1	166	
Rainfall ...	...	*9—12*	*1·26*	*0·27*	*0·25*	*0·03*	*0·31*	*3·88*	*12·40*	*9·62*	*5·13*	*1·04*	*0*	*0·21*	*34·40*	

TABLE L.—*A Monthly Statement of Cholera in the principal Stations of the Non-Endemic Area among European and Native Troops and Prisoners for periods of 18 to 51 years, together with the average Monthly Rainfall*—(concluded).

STATIONS.	Elevation in feet.	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	REMARKS.
SAUGOR ...	1,766															
Cholera ...	...	23	0	1	1	2	30	11	57	78	33	39	0	0	252	Soldiers, sepoys and prisoners.
Rainfall ...	...	*19—20*	*0·61*	*0·68*	*0·14*	*0·20*	*0·55*	*6·23*	*18·26*	*12·03*	*8·51*	*1·01*	*0·31*	*0·27*	*48·80*	
JUBBULPORE ...	1,351															
Cholera ...	...	21	0	1	3	9	46	68	340	196	13	12	1	1	690	Ditto ditto.
Rainfall ...	...	*32—33*	*0·60*	*0·47*	*0·46*	*0·13*	*0·35*	*7·66*	*18·41*	*14·12*	*8·53*	*1·33*	*0·30*	*0·19*	*52·55*	
RAIPORE ...	960															
Cholera ...	...	22	0	0	6	11	48	52	136	31	0	1	0	0	285	Prisoners.
Rainfall ...	...	*12·14*	*0·26*	*0·23*	*0·49*	*0·48*	*0·57*	*9·22*	*14·49*	*12·21*	*8·05*	*1·76*	*0·90*	*0·10*	*48·76*	
DELHI ...	717															
Cholera ...	...	32	0	2	8	16	9	56	309	99	137	22	8	5	671	Soldiers, sepoys and prisoners.
Rainfall ...	...	*17*	*0·99*	*0·51*	*0·83*	*0·29*	*0·86*	*3·01*	*7·41*	*5·42*	*4·41*	*0·31*	*0·07*	*0·30*	*24·41*	
MEERUT ...	739															
Cholera ...	...	51	19	16	60	132	126	161	407	1,055	450	66	68	36	2,596	Ditto ditto.
Rainfall ...	...	*20*	*0·72*	*0·84*	*0·56*	*0·39*	*0·93*	*3·78*	*9·70*	*6·71*	*4·01*	*0·22*	*0·02*	*0·21*	*28·09*	
UMBALLA ...	902															
Cholera ...	...	34	1	4	9	42	115	49	167	439	303	47	24	5	1,205	Ditto ditto.
Rainfall ...	...	*10*	*0·54*	*1·26*	*1·13*	*0·79*	*1·04*	*4·46*	*12·76*	*7·90*	*5·28*	*0·30*	*0*	*0·32*	*35·78*	
LAHORE ...	739															
Cholera ...	...	31	1	1	3	15	3	12	24	491	235	4	2	2	793	Ditto ditto.
Rainfall ...	...	*10*	*0·50*	*0·91*	*0·91*	*0·27*	*0·92*	*1·20*	*6·29*	*3·89*	*2·54*	*0·60*	*0*	*0·50*	*18·53*	
MEEAN MEER ...	..															
Cholera ...	...	25	2	0	1	2	13	14	76	1,489	238	8	1	1	1,845	Soldiers and sepoys.
Rainfall ...	...	*10*	*0·50*	*0·91*	*0·91*	*0·27*	*0·92*	*1·20*	*6·29*	*3·89*	*2·54*	*0·50*	*0*	*0·50*	*18·53*	
SEALKOTE ...	829															
Cholera ...	...	24	0	*0*	0	3	5	2	2	44	23	0	0	1	80	Soldiers, sepoys and prisoners.
Rainfall ...	...	*9*	*1·10*	*1·70*	*2·30*	*1·30*	*1·10*	*2·80*	*12·30*	*10·60*	*4·00*	*0·30*	*0*	*0·40*	*37·90*	
MOOLTAN ...	420															
Cholera ...	...	25	0	1	1	1	1	1	4	7	1	5	3	0	25	Soldiers and sepoys.
Rainfall ...	...	*9*	*0·3*	*0·1*	*0·7*	*0·5*	*0·4*	*0·1*	*2·2*	*1·1*	*0·4*	*0*	*0*	*0·3*	*6·1*	
RAWUL PINDEE ...	1,650															
Cholera ...	...	28	1	0	0	2	10	13	9	21	10	5	4	1	76	Ditto.
Rainfall ...	...	*10*	*2·05*	*1·81*	*2·75*	*1·63*	*1·18*	*1·99*	*8·28*	*6·15*	*3·73*	*0·64*	*0·33*	*1·00*	*31·54*	
PESHAWUR ...	1,165															
Cholera ...	...	28	3	0	1	5	205	164	131	25	577	343	26	0	1,480	Ditto.
Painfall ...	...	*10*	*1·32*	*1·26*	*1·60*	*1·25*	*0·60*	*0·21*	*1·75*	*2·64*	*1·06*	*0·36*	*0·31*	*0·55*	*12·91*	

The maximum cholera-prevalence in non-endemic area occurs during rainy season.

Now, on comparing this table with the one [Table XLIII, page 50] regarding the monthly prevalence of cholera in the endemic area, attention is at once arrested by the circumstance that the months of maximum prevalence in the two groups of stations do not coincide—July, August and September being the months of maximum in the group of stations which forms the subject of the present chapter, whereas, so far as the cholera-history of Calcutta itself goes, they are the most favourable, and even when the endemic-area stations are taken as a group, furnish a minor proportion of the total.

August the month of maximum prevalence in non-endemic area.

Twenty-five stations have been selected in the different districts of Upper and Central India, and, with a single exception, July or August has furnished the largest number of the registered cases of cholera in every one of them. The exception is Peshawur, which has its maximum of cholera in September. This station will be referred to further on.

The aggregate monthly cholera of the 25 selected stations.

It will be recollected that the dozen stations which we selected for illustrating the seasonal prevalence of the disease in the endemic area furnished 15,699 registered cases of cholera from among the official communities, regarding whom alone, as already explained, it is possible at present to obtain satisfactory statistics. The cholera returns collected from among 25 similar groups of the population in stations situated beyond the bounds of the endemic area amount to 25,338. The aggregate monthly cholera statistics of the selected group of stations in the endemic area were given at page 52 (Table XLIV), and a similar summary regarding the other group is annexed:

TABLE LI.—*The aggregate Monthly prevalence of Cholera among Soldiers, Sepoys and Prisoners at twenty-five Stations in Upper and Central India during periods of from 18 to 51 years.*

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total.
Cholera . .	942	470	203	124	132	720	1,382	1,902	2,778	4,778	8,676	3,231	25,338

A comparison of monthly cholera-prevalence in the two areas.

A comparison of the above summarised statement, with the like summary regarding the endemic group of stations, omitting Calcutta, presents some points of resemblance as well as of contrast. In both tables January is seen to occupy the lowest place as to cholera-prevalence, and in both also there is shewn that a gradual increase of the disease takes place with the progress of the year. In Lower Bengal, however, the maximum culminates in April and declines month by month till September, when a slight rise occurs until November, and it then subsides till the minimum is reached; but in the non-endemic provinces, instead of a remission of the disease taking place in June and the subsequent months, there is unmistakable evidence of its increase, and this continues until the maximum is reached in August—this month furnishing almost twice as many cases as its predecessor and nearly three times as many as September; there is, therefore, overwhelming evidence to show that, be the actual conditions favourable to the manifestation of the disease what they may, they are present to a far greater extent during the month of August in the non-endemic area generally than at any other period of the year. The study of the *proportion* between the cholera-prevalence of the two areas, when compared month by month, will be simplified by a scrutiny of the accompanying table in which the percentages have been calculated.

TABLE LII.—*The Monthly Proportion of Cholera-prevalence to total Cholera in the selected groups of Stations of the Endemic and Non-endemic Areas.*

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Total cholera from which the percentage has been calculated.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
ENDEMIC AREA—													
Calcutta	5·9	8·2	7·6	6·7	9·3	14·4	17·7	12·2	6·3	3·9	3·8	4·0	135,833
Group of 12 stations ...	6·4	6·6	3·9	2·7	4·5	15·0	18·1	14·0	9·8	7·3	6·5	5·2	15,699
NON-ENDEMIC AREA—													
Group of 25 stations ...	3·7	1·8	0·8	0·5	0·5	2·8	5·5	7·5	10·0	18·9	34·2	12·8	25,338

The fact that whereas, taking the whole group of stations in the non-endemic area, 34·2 per cent. of their total cholera occurs in the month of August, while only 6·5 per cent. occurs in the group illustrative of the endemic area and still less, 3·8 per cent., in Calcutta when taken by itself during the same month, cannot but arrest the attention of the student.

(c) Prevalence of Cholera according to Seasons in the Non-endemic area, and the mean Rainfall for the same seasons.

Cholera-prevalence according to 'season' in non-endemic area.

If the principle adopted in a previous chapter of classifying the disease into seasons comparable with the three seasons into which each annual period naturally falls in India, be applied to the group of stations in the non-endemic area also, we shall see that the cholera-prevalence in the two areas presents still greater contrasts than was manifested in the classification by months. The following table (LIII), which has been prepared in the same manner as table XLV (page 54), will enable students to ascertain at a glance what these salient contrasts are. The rainfall has likewise been given here, and the average proportion for each seasonal period calculated out.

TABLE LIII.—*The prevalence of Cholera according to Seasons, together with the seasonal Rainfall at 25 Stations in Central and Upper India.*

STATIONS.	Number of years.	OCTOBER TO DECEMBER.		JANUARY TO MAY.		JUNE TO SEPTEMBER.		Totals of cholera and annual rainfall.
		Cholera and rainfall (3 months).	Percentage to annual totals.	Cholera and rainfall (5 months).	Percentage to annual totals.	Cholera and rainfall (4 months).	Percentage to annual totals.	
HAZARIBAUGH—								
Cholera	23	5	1·0	156	30·7	348	68·3	509
Rainfall	*10—11*	*3·67*	*7·1*	*3·64*	*7·1*	*44·22*	*85·8*	*51·53*
RANCHEE—								
Cholera	23	2	1·2	35	21·1	129	77·7	166
Rainfall	*16—18*	*3·67*	*7·7*	*5·37*	*11·3*	*38·64*	*81·0*	*47·68*
ARRAH—								
Cholera	23	29	6·3	46	9·9	389	83·8	464
Rainfall	*17—19*	*2·88*	*6·3*	*3·70*	*7·9*	*39·70*	*85·8*	*46·28*
BENARES—								
Cholera	51	121	7·5	657	40·8	832	51·7	1,610
Rainfall	*20—21*	*1·76*	*4·4*	*2·06*	*5·0*	*36·67*	*90·6*	*40·49*
GORUCKPORE—								
Cholera	23	24	5·8	45	10·9	344	83·3	413
Rainfall	*20*	*3·10*	*6·7*	*3·22*	*6·9*	*40·10*	*86·4*	*46·42*
FYZABAD—								
Cholera	18	88	22·9	154	40·0	143	37·1	385
Rainfall	*5—6*	*6·9*	*13·1*	*0·5*	*0·9*	*45·5*	*86·0*	*52·90*
ALLAHABAD—								
Cholera	50	39	2·5	565	35·9	968	61·6	1,572
Rainfall	*19—20*	*2·71*	*7·2*	*2·11*	*5·6*	*32·76*	*87·2*	*37·58*
LUCKNOW—								
Cholera	21	176	14·3	155	12·5	903	73·2	1,234
Rainfall	*11*	*1·61*	*3·7*	*2·15*	*4·9*	*39·59*	*91·4*	*43·35*
CAWNPORE—								
Cholera	51	268	6·1	995	22·4	3,174	71·5	4,437
Rainfall	*20*	*1·04*	*3·6*	*2·03*	*7·0*	*25·82*	*89·4*	*28·89*

TABLE LIII.—*The prevalence of Cholera according to Seasons, together with the seasonal Rainfall at 25 Stations in Central and Upper India*—(continued).

STATIONS.	Number of years.	October to December.		January to May.		June to September.		Totals of cholera and annual rainfall.
		Cholera and rainfall (3 months).	Percentage to annual totals.	Cholera and rainfall (5 months).	Percentage to annual totals.	Cholera and rainfall (4 months).	Percentage to annual totals.	
AGRA—								
Cholera	51	101	2·9	361	10·3	3,039	86·8	3,501
Rainfall	*22—25*	*0·41*	*1·5*	*2·13*	*8·1*	*23·87*	*90·4*	*26·41*
MUTTRA—								
Cholera	51	6	3·8	31	19·8	120	76·4	157
Rainfall	*19*	*0·50*	*1·8*	*1·96*	*7·3*	*24·55*	*90·9*	*27·01*
MORAR—								
Cholera	17	14	1·9	63	8·7	649	89·4	726
Rainfall*	*9—12*	*1·25*	*3·6*	*2·12*	*6·2*	*31·03*	*90·2*	*34·40*
JHANSIE—								
Cholera	22	1	0·6	.....	.....	165	99·4	166
Rainfall	*9—12*	*1·25*	*3·6*	*2·12*	*6·2*	*31·03*	*90·2*	*34·40*
SAUGOR—								
Cholera	23	39	15·5	34	13·5	179	71·0	252
Rainfall	*19—20*	*1·59*	*3·2*	*2·18*	*4·5*	*45·03*	*92·3*	*48·80*
JUBBULPORE—								
Cholera	21	14	2·0	59	8·6	617	89·4	690
Rainfall	*32—33*	*1·82*	*3·5*	*2·01*	*3·8*	*48·72*	*92·7*	*52·55*
RAIPUR—								
Cholera	22	1	0·3	65	22·8	219	76·9	285
Rainfall	*12—14*	*2·76*	*5·6*	*2·03*	*4·2*	*43·97*	*90·2*	*48·76*
DELHI—								
Cholera	32	35	5·2	35	5·2	601	89·6	671
Rainfall	*17*	*0·68*	*2·8*	*3·48*	*14·3*	*20·25*	*82·9*	*24·41*
MEERUT—								
Cholera	51	170	6·5	353	13·6	2,073	79·9	2,596
Rainfall	*20*	*0·45*	*1·6*	*3·44*	*12·2*	*24·20*	*86·2*	*28·90*
UMBALLAH—								
Cholera	34	76	6·3	171	14·2	958	79·5	1,205
Rainfall	*10*	*0·62*	*1·8*	*4·76*	*13·3*	*30·40*	*84·9*	*35·78*
LAHORE—								
Cholera	31	8	1·0	23	·29	762	96·1	793
Rainfall	*10*	*1·10*	*5·9*	*3·51*	*18·9*	*13·92*	*75·2*	*18·53*
MEEAN MEER—								
Cholera	25	10	0·6	18	1·0	1,817	98·4	1,845
Rainfall	*10*	*1·10*	*5·9*	*3·51*	*18·9*	*13·92*	*75·2*	*18·53*
SEALKOTE—								
Cholera	24	1	1·2	8	10·0	71	88·8	80
Rainfall	*9*	*0·70*	*1·8*	*7·50*	*19·8*	*29·70*	*78·4*	*37·90*
MOOLTAN—								
Cholera	25	8	32·0	4	16·0	13	52·0	25
Rainfall	*9*	*0·30*	*4·9*	*2·00*	*32·8*	*3·80*	*62·3*	*6·10*
RAWUL PINDEE—								
Cholera	28	10	13·2	13	17·1	53	69·7	76
Rainfall	*10*	*1·97*	*6·2*	*9·42*	*29·9*	*20·15*	*63·9*	*31·54*
PESHAWUR—								
Cholera	28	369	24·9	214	14·5	897	60·6	1,480
Rainfall	*10*	*1·22*	*9·5*	*6·03*	*46·7*	*5·66*	*43·8*	*12·91*

* Jhansie rainfall returns.

Analysis of the seasonal table.

In comparing the two tables, it will be remarked that in the endemic area the first five months of the year furnish in most places more than half of the whole year's cholera—in some of them very considerably more—the average contribution of the stations including Calcutta, being 59·9 per cent., or excluding the statistics of the general population of Calcutta, 54·3. The aggregate cholera of the same season—the 'spring cholera' in the non-endemic group of stations—yields, however, a very different proportion, *viz.*, 16·8 per cent. of the total of the yearly period. Further, if the cholera of the rainy period be compared with the cholera of the rest of the year, we find that whereas in the endemic area the rainy season furnishes only 28·8 per cent. and the dry season (October to May) 71·2 per cent. of the total annual cholera, in the non-endemic area the same seasons respectively furnish 76·8 and 23·2 per cent. These facts will become more evident when arranged in tabular form.

TABLE LIV.—*A Summary of a portion of tables XLV and LIII giving the percentages of the aggregate seasonal Cholera in the selected group of Stations of the Endemic and Non-endemic areas.*

AREA.	OCTOBER TO DECEMBER.		JANUARY TO MAY.		OCTOBER TO MAY.	JUNE TO SEPTEMBER RAINY SEASON.		The total cholera of group.
	Total cholera of group of stations (3 months).	Percentage to total for the whole annual period.	Total cholera of group of stations (5 months).	Percentage to total for the whole annual period.	Percentage of cholera for 8 months to whole annual period.	Total cholera of group of stations (4 months).	Percentage to total for the whole annual period.	
ENDEMIC AREA—								
Calcutta [General population] ...	29,462	21·7	81,916	60·3	82·0	24,445	18·0	135,833
12 stations [Troops and Prisoners]	2,645	16·9	8,519	54·3	71·2	4,535	28·8	15,699
NON-ENDEMIC AREA—								
25 stations [Troops and Prisoners]	1,615	6·4	4,260	16·8	23·2	19,463	76·8	25,338

Stations which deviate from the average of the group.

Although the impression conveyed by a scrutiny of these tables regarding the seasonal prevalence of cholera in the non-endemic area is clear enough taking the stations as a group, it will nevertheless be observed that there are some half-dozen out of the 25 stations where cholera appears to be more equally distributed over the several seasons, approximates more closely to what is observed

in Lower Bengal, as, for example, instead of furnishing a proportion of 'spring' cholera of about the average, *viz.*, 16·8 per cent., they furnish from 20 to 40—a proportion which, though considerably less than that of the Lower Bengal stations, approximates sufficiently near to command attention. It will, however, be more convenient to consider this question when the cholera-history and physical phenomena of individual stations come under review.

The rainfall of the non-endemic area.

It will be more convenient also to defer the study of the relation which the average monthly and seasonal rainfall may hold to cholera-prevalence. It will be sufficient to observe here that the proportion of rain which falls over the two great areas into which epidemiologists have divided the province of Bengal, not only differs as to amount, but also as to its proportionate distribution over the annual period. For example, if the mean of the rainfall of the wet season—June to September—at the several stations which form our Lower Bengal group, be calculated, it will be found that it is equal to about 75 per cent. of the total fall for the year; but the mean of the rainfall of the selected group of stations in the non-endemic area for the same period exceeds this by 10 per cent.; hence during the winter and 'spring' seasons, the rainfall of the non-endemic area is not only less, because the total annual fall is less, but also because proportionately so much more of it falls during the wet season. There is, as might have been anticipated, some deviations from these results in individual stations in both groups, but taken as representatives of two large tracts of territory, the figures are highly suggestive.

TABLE LV.—*A Summary of a portion of Tables XLV and LIII giving the percentages of Seasonal Rainfall to annual rainfall in the selected group of Stations of the Endemic and Non-endemic areas.*

Area.	October to December.		January to May.		October to May.	June to September.		Total average Annual Rainfall of Group of Stations.
	Average total Rainfall of Group of Stations [3 months].	Percentage to total of average Annual Rainfall.	Average total Rainfall of Group of Stations [5 months].	Percentage to total of average Annual Rainfall.	Percentage to total average Annual Rainfall of Group of Stations.	Average total Rainfall of Group of Stations [4 months].	Percentage to total average Annual Rainfall.	
Endemic Area—								
12 Stations	5″·6	9·1	9″·9	16·3	25·4	45″·6	74·6	61″·1
Non-endemic Area.—								
25 Stations	1″·8	5·1	3″·3	9·4	14·5	30″·1	85·5	35″·2

The water-level registers of non-endemic area.

A summary of the water-level registers which have reached us from the stations situated in the non-endemic area at present under review will be found in the first set of tables, arranged alphabetically (pages 117 to 135). It will be more instructive to consider the possible relation which soil-moisture may bear to cholera-prevalence in connection with the description of the separate stations where the observations were conducted. It will be observed that many of the wells selected for the purpose of registering the fluctuation of the water in them are very deep — far too deep, indeed, to be of material aid in estimating the degree of moisture of the more superficial strata. This was unavoidable in most instances, as no permanent water-supply was attainable nearer to the surface. In such cases we have, in the following illustrative stations, taken the mean rainfall as a more certain index of the hygroscopic condition of the soil. The highest point of the water-level registered in the course of the series has, however, been noted, but when this does not reach to within about 20 feet of the surface, it has not been considered necessary to refer specially to the monthly range.

CHAPTER II.

ANALYSIS OF DATA FURNISHED BY INDIVIDUAL STATIONS SELECTED TO ILLUSTRATE CHOLERA-PREVALENCE AND PHYSICAL PHENOMENA IN *NON-ENDEMIC* AREAS.

(a) Selected Stations—Oudh and the North-Western Provinces.

Representative stations.

Following the plan adopted when referring to the endemic area, we now propose to subdivide the group of stations which have been described collectively in the previous chapter, and which may be said to represent in a general way the physical conditions and predisposition to the occurrence of cholera of those portions of Upper and Central India which have been defined as constituting the non-endemic area of the Presidency.

Owing, however, to the very varied character of the provinces in which the selected stations are located, and to their differences in telluric conditions and climate, especially as regards rainfall and range of temperature, it becomes a matter of some difficulty to classify them satisfactorily. On this account it

seems best to take them according to their geographical position, proceeding in a north and south-westerly direction from Dinapore.

(1) Benares.

Benares.

The first large station of importance is the City of Benares. This can scarcely be said to be beyond the borders of the endemic area, and its monthly cholera chart for the last 51 years would of itself be sufficient almost to imply as much; indeed the disease is seldom absent either from the city or the district. In the previous chapter it was shown that cholera, instead of being diffused so generally over the year as in the endemic area and reaching its maximum in March or April, flourished far more during August and the rainy season generally in the non-endemic area. At this station, this peculiarity is not very marked; though it is true that considerably more cholera has occurred in August than in April, still the history of the cholera of the latter month proves that the conditions which prevail during March, April and May in the more strictly endemic area are also influential during the same periods at Benares.

Table LVI.—*The average Monthly Rainfall, Relative Humidity, Temperature, Atmospheric Pressure, and the total Cholera among European and Native troops and prisoners at Benares.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level	...	Highest registered level of selected well = 28 feet.											
Rainfall [in inches] ...	20—21	1″·63	0″·05	0″·08	0″·70	0″·47	0″·26	0″·15	0″·48	5″·26	12″·67	11″·88	6″·86
Humidity [Sat.=100] ...	7	51	47	50	51	41	29	26	28	53	74	74	72
Temperature [°Fahr.] ...	7—9	78°·8	68°·8	60°·5	59°·3	67°·0	76°·4	86°·8	91°·8	90°·4	85°·4	84°·5	83°·9
Atmospheric pressure ...	7—8	29·59	29·74	29·79	29·77	29·71	29·61	29·48	29·38	29·64	29·71	29·33	29·42
Cholera	51	52	29	40	31	26	139	245	216	188	187	380	77

Meteorology of Benares.

This station gets 28 inches less *rain* than Calcutta, and 20 less than the average of the group of the endemic area stations; but it gets more than Dinapore, although the latter is farther down the Ganges. The months of lowest *temperature* are also the months of minimum cholera; and although the months of mean maximum temperature do not coincide with the maximum cholera-months, there is yet a certain

degree of coincidence between the degree of temperature and cholera-prevalence. The mere fact of a month being warm, however, by no means implies a corresponding increase of cholera; on the contrary, the table shows that, whereas 380 cases have occurred during 51 years in August, only 77 occurred in September, although the mean temperature of the latter month is only half a degree lower than the former. The temperature becomes 2° cooler in January than at Dinapore, but on the other hand is a couple of degrees warmer at its maximum in May.

One of the months of maximum relative *humidity* (August) coincides with the maximum cholera, but the month preceding this has the same mean hygrometric condition with only half the cholera, and the month after it is nearly equally moist and warm, but has only a fifth of the cholera; on the other hand, the driest month of the year (April) furnishes the next highest number of cholera cases.

With regard to the state of the barometer, it will be seen that the highest *pressure* corresponds for the most part with months of minimum cholera, and it so happens that the lowest pressure corresponds with the maximum—the reverse of the general result of the Calcutta analysis,—where the minimum cholera (July and August) and minimum average pressure almost coincided.

(2) Allahabad.

Allahabad.

Following the course of the Ganges, the next important station of which we possess fair data is the City of Allahabad, situated at the angle formed by the junction of the Jumna and the Ganges. We have now followed the latter from Calcutta, a distance of some 600 miles, and observed the gradual transition of the maximum of cholera-prevalence at the several stations of its plains from March and April to July and August.

This station, however, still manifests, to a considerable extent, the tendency to suffer from cholera during the spring season, as nearly 36 per cent. of its total cholera has occurred during the first five months of the year, January to May, the three months, March to May, furnishing nearly the whole of them.

On the other hand, the last three months of the year, October to December, furnish very few, only 2 per cent. of the total, or about 14 per cent. less than the proportion furnished by the group of stations in the endemic area; while

during the rainy season nearly 33 per cent. more occur, so that the contrast is very considerable.

TABLE LVII.—*The average Monthly Rainfall, Relative Humidity, Temperature, and the total Cholera among the European and Native troops and prisoners at Allahabad.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level				Highest registered level in selected well 48 feet.									
Rainfall [in inches] ...	19—20	2″·47	0″·09	0″·15	0·75	0·57	0·23	0·18	0·38	3·43	12·04	10·67	6·62
Humidity [sat.=100] ...	3—6	54	46	55	50	51	35	26	35	55	77	83	77
Temperature [°Fahr.] ...	6—7	77°·6	6°·80	61°·1	60°·2	65°·7	77°·9	86°·9	91°·8	89°·7	83°·9	82°·3	82°·4
Cholera	50	20	14	5	8	14	105	128	310	213	192	417	146

Diminution of rainfall.

Not only does the tendency to cholera decrease as we progress up the Gangetic plains, but so also does the rainfall; for it diminishes from 75 inches at Sagar Island to 65 at Calcutta, 59 at Burdwan, 53 at Berhampore, 40 at Benares, and 37·5 at Allahabad, or only half the amount that falls near the sea coast. As we have already seen, too, a larger and larger proportion of the annual average falls between June and September whilst progressing in the same direction. The month of maximum cholera nearly corresponds with the month of maximum rainfall, the maximum of the latter falling in July and of the former in August.

Humidity and temperature.

The data regarding the average *hygrometric* condition of the atmosphere at this station are very imperfect; the figures obtainable, however, may serve as a rough guide. According to these the month of maximum cholera corresponds with the month of maximum relative humidity, but the humidity of the next maximum cholera month (May) is less than half that of the other, and the month of minimum cholera corresponds to a month of medium humidity. The maximum *temperature* corresponds with the maximum month of spring-cholera (in May), but the temperature of the actual maximum cholera month for the annual period is 9 degrees lower. As usual, the minima of temperature and cholera agree very nearly.

(3) Fyzabad.

Fyzabad.

It was remarked on a former page that cholera was nearly always present in one or other of the cities of Oudh. The ancient capital (Adjudiah, on the banks of the Gogra) is one of these, and is a place much frequented by pilgrims. The adjoining town of Fyzabad (3 miles distant) is also believed to have more or less cholera constantly present; but as our statistics refer only to troops and prisoners in the latter station, no comparisons can be instituted as to relative monthly prevalence in the district beyond what the figures regarding these communities suggest.

Table LVIII.—*The average Monthly Rainfall and total Cholera among European and Native troops and prisoners at Fyzabad.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Rainfall [in inches] ...	6	2″·5	2″·1	2″·3	0″·2	0″·2	0″·1	...	...	8″·7	13″·9	14″·3	8″·6
Cholera	18	71	16	1	1	3	4	133	13	6	6	62	69

Fyzabad approaches in character to stations in endemic area.

The numbers are small, and unfortunately Fyzabad is not a meteorological station, but such information as exists points to the peculiar circumstance that, whilst the district has a reputation for having cholera constantly present in it, the prevalence of the disease among troops and prisoners should approach so closely to what is observed in the endemic area as ordinarily understood, that is to say, getting its largest quantity of cholera, by far, during the dry season. The cases, 133 in April, were not the result of a single year's epidemic, but are the result of a dozen annual visitations out of the 18 years of which we possess records.

The well originally selected for registering the *water-level* appears to have been changed more than once, so that the records are of very subordinate value.

(4) Lucknow.

With regard, however, to the present capital of Oudh, Lucknow, we possess very good data, but these show that the period during which cholera prevails in this city differs from that in Fyzabad, about 80 miles to the east of it.

TABLE LIX.—*The average Monthly Water-level, Rainfall, Relative Humidity, Temperature and the total cholera among the European and Native troops and prisoners at Lucknow.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level [in feet] ...	6	10′·6	11′·6	12′·4	11′·9	12′·2	12′·8	13′·2	13′·9	14′·6	14′·4	12′·1	10′·7
Rainfall [in inches] ...	11	1″·27	...	0″·34	0″·99	0″·16	0″·25	0″·19	0″·56	4″·66	14″·10	10″·93	9″·90
Humidity [sat. =100] ...		52	44	51	56	48	36	29	37	55	76	76	74
Temperatur [°Fahr.] ...	8	78°·5	68°·6	61°·0	59°·9	63°·3	76°·3	86°·7	92°·1	91°·1	86°·1	85°·3	83°·6
Atmospheric pressure ...	8	29·48	29.64	29·69	29·67	29·60	29·50	29·38	29·27	29·14	29·16	29·22	29·32
Cholera	21	58	111	7	1	4	44	63	43	74	329	321	179

Cholera and physical conditions.

According to these data cholera at Lucknow is seen to prevail most during July and August, the number of cases which have occurred in April being less than a fifth of the July and August cases. Here maximum *rainfall* and maximum cholera correspond accurately, as also the monthly maxima of *relative humidity* and cholera. The minima, however, of these do not so closely tally. As usual in the non-endemic area, the minimum *temperature* coincides with the minimum cholera, but the maximum of the latter occurs when the thermometer is on an average six degrees lower than during the hottest month. The maximum of the disease is seen to correspond almost exactly with the minimum pressure, and *vice versâ*.

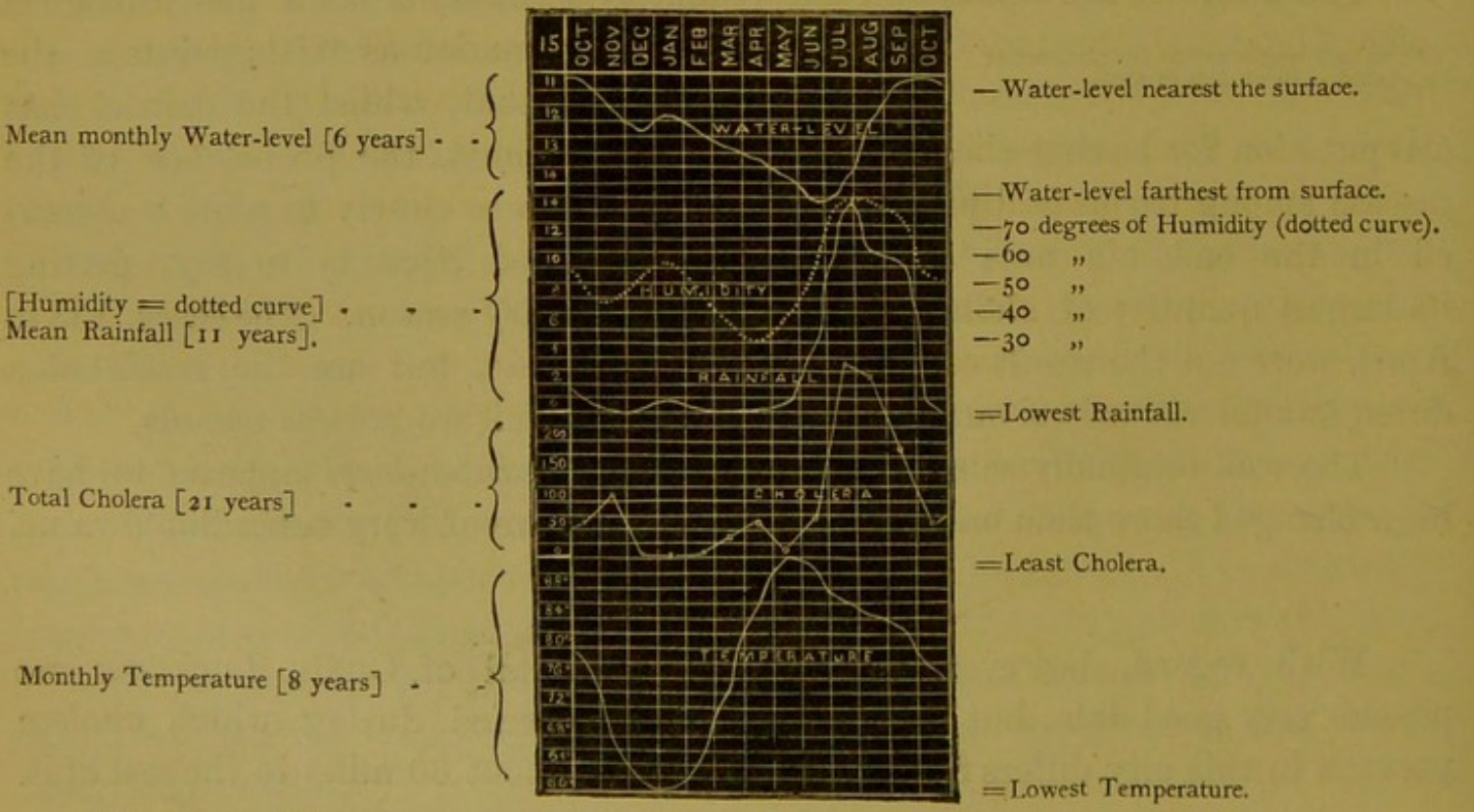


DIAGRAM 15.—The average monthly Water-level, Humidity, Rainfall, Cholera, and Temperature at Lucknow.

The *water-level* has been registered by Dr. Bonavia at the observatory for several years, as also at the central prison some two miles distant, and it has been found that, although a difference of 7 to 8 feet existed between the distance of the water in the two wells from the surface, the fluctuation in the level of the water coincides very closely. It is at its lowest in the month immediately preceding the maximum cholera months, rises on an average about 4 feet between June and October, and then begins to fall again.

The soil within a few feet of the well at the Observatory is sandy, with a few fragments of kunkur, and it appears not improbable that it is under the influence of the adjoining river Goomtee.

(5) Cawnpore.

Cawnpore.

Returning to the banks of the Ganges once more we come to the large civil and military station of Cawnpore, which with the city close by furnishes a population of over 100,000. Records have been kept at this station of the cases of cholera that have occurred among the troops and prisoners for more than half a century, and these now form an aggregate of 4,437. Nearly a fourth of the entire number of cases has occurred during the month of August, although the number of annual visitations of the disease was greater in the month of June, the latter month having furnished 653 cases in the course of 39 annual visitations, and the month of August 1,246 cases in the course of 37. The percentage of spring cholera is still less than at Allahabad, being 35·9 in the latter and 22·4 in the former, and the rainy-season cholera is increased in nearly the same proportion as the spring cholera is diminished.

Table LX.—*The average Monthly Rainfall and the total Cholera among the European and Native troops and prisoners at Cawnpore.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level	...	Highest	register	ed level	of selec	ted well	= 36 fe	et.					
Rainfall	20	0″·80	0″·09	0″·15	0″·66	0″·48	0″·24	0″·09	0″·56	3″·38	9″·24	7″·80	5″·40
Cholera	51	111	82	75	42	39	203	287	424	653	834	1,246	441

(6) Agra.

Agra.

Crossing over to the Jumna, we select as an illustrative station the still larger city of Agra. Here also the cholera statistics of troops and prisoners have been collected over a period of 51 years and now furnish a total of 3,501 cases, 3,039 of which have occurred during the rainy season, and nearly a third during the month of August alone.

The months in which cases of cholera have most frequently occurred are August and May, the former month showing cholera on 39, and the latter on 28 occasions.

The aggregate of cases occurring in May is, however, 9 times lower than that of August.

Table LXI.—*The average Monthly Water-level, Rainfall, Relative Humidity, Temperature Atmospheric Pressure and the total Cholera among European and Native troops and prisoners at Agra.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level	...	Highest	register	ed level	in selec	ted wells	= 52 fe	et.					
Rainfall [in inches] ...	22—25	0″·22	0″·03	0″·16	0″·71	0″·42	0″·24	0″·13	0″·63	2″·89	8″·86	7″·24	4″·88
Humidity [Sat. = 100] ...	7	44	39	48	52	46	37	27	27	46	70	74	70
Temperature [°Fahr.] ...	8—9	78°·5	69°·5	62°·0	59°·1	65°·1	75°·9	86°·5	92°·5	93°·0	85°·8	83°·4	82°·7
Atmospheric pressure ...	8—9	29·30	29·46	29·50	29·49	29·42	29·32	29·21	29·09	28·96	28·97	29·03	29·13
Cholera	51	50	32	19	11	13	70	117	150	832	683	1,391	133

The relation of cholera to the *rainfall* (a still greater quantity of which falls between June and September) is pretty nearly the same as at Cawnpore, and the month of maximum relative *humidity* also coincides with the maximum cholera month. The remarks made regarding the relation to temperature in the two last stations apply equally here.

(7) Meerut.

The only other station which we propose to select in the North-Western Provinces is that of Meerut, a large military and civil station situated between the Jumna and the Ganges, some 30 miles from either. The cholera statistics of this station comprise a long series of years and furnish an aggregate of 2,596 cases registered among troops and prisoners, a large proportion of the former being Europeans.

TABLE LXII.—*The average Monthly Water-level, Rainfall, Relative Humidity, Temperature, Atmospheric Pressure and total Cholera among the European and Native troops and prisoners at Meerut.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level [in feet] ...	6	10′·4	10′·8	11′·1	11′·4	11′·5	11′·6	12′·1	12′·6	12′·7	12′·6	11′·5	10′·7
Rainfall [in inches] ...	20	0″·22	0″·2	0″·21	0″·72	0″·84	0″·56	0″·39	0″·93	3″·78	9″·70	6″·71	4″·01
Humidity [Sat.=100] ...	2	47	44	52	53	46	39	28	36	48	72	72	67
Temperature [°Fahr.] ...	4—5	73°·6	66°·5	59°·3	56°·9	63°·2	73°·9	85°·5	89°·2	92°·3	85°·5	84°·0	82°·5
Atmospheric pressure ...	2	29·17	29·34	29·38	29·35	29·31	29·17	29·07	28·95	29·33	29·35	28·91	29·01
Cholera ...	51	66	68	36	19	16	60	132	126	161	407	1,055	450

Water-level, &c., at Meerut.

The *water-level* registers for Meerut are very complete, and have been conducted by Dr. W. Moir since 1871. The fluctuation coincides very closely with the rainfall. In June the water is at its lowest; it rises a little after the heavy rain of July and August, but scarcely varies two feet during the whole year. It is at its highest level towards the end of October. The data of relative *humidity* are not very satisfactory, but such as they are, they show that, as very generally elsewhere in the non-endemic area, the greatest humidity coincides with the maximum cholera, but the least humidity not with the minimum cholera.

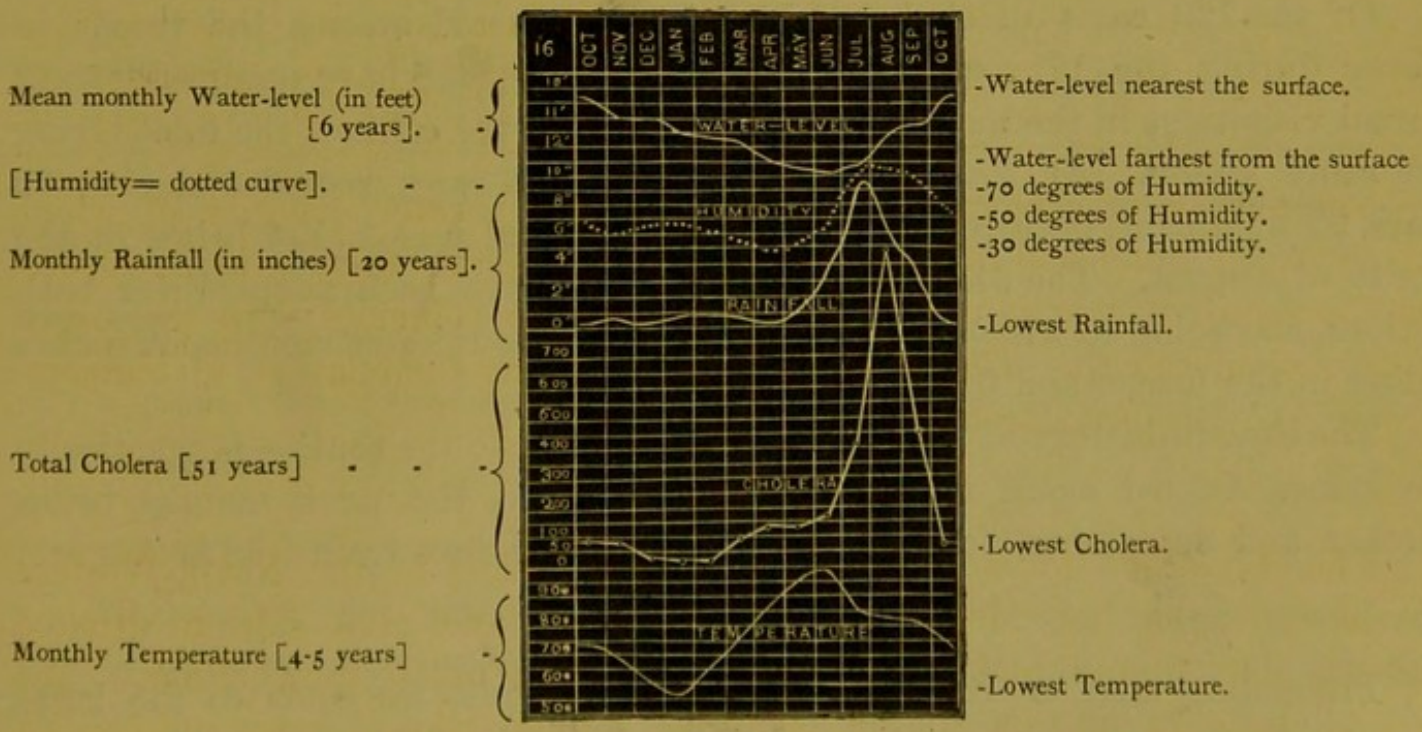


DIAGRAM 16.—The average monthly Water-level, Humidity, Rainfall and Temperature, and the total Cholera at Meerut.

The *temperature* is highest in June, a month later than at the majority of the stations of this area hitherto referred to.

The cholera-history of this station shows that the rainy season—even three months of it July to September—have furnished more than half of the total cholera; 1,055 out of the 2,596 having occurred in August alone. It obtains a larger proportion of its total *rainfall* during the earlier months of the year (January to May) than the stations lower down in the non-endemic area of the Gangetic plain. In other respects no marked deviation is observed. Its mean annual rainfall is the same as that for Cawnpore.

The minimum *temperature* coincides generally with the minimum cholera, but the reverse does not hold good. Here, again, the month of minimum *pressure* corresponds with the maximum of cholera.

(b) Selected stations in Rajputana, Bundelcund and the Central Provinces.

(1) Morar, Jhansie, Saugor.

Stations to south of Agra.

Before pushing up any further towards the north-west a few words may be said regarding some of those stations included in our list, such as Jhansie and Morar, occupying those large alluvial tracts (with black cotton-soil) which spread out from Agra towards Gwalior and southwards.

Of the 726 cases of cholera which have occurred among the troops in *Morar* during the 17 years of which records exist, 438 have occurred during annual visitations in the month of August, and 90·2 per cent. of the total during the rainy season. At *Jhansie*, again, of the 166 cases recorded during 22 years, 99·4 per cent. occurred within the same seasonal period, 134 being in the month of August. The Jhansie rainfall returns have been adopted for both stations, according to which July and August are the rainiest months, 12 inches falling in the former and 9 in the latter.

The cholera-history of *Saugor* also—150 miles to the south—is practically the same, August again taking the foremost place, the next months being October and September, followed by May, with 30 cases against 88 in August.

(2) Jubbulpore.

Jubbulpore.

Proceeding another 100 miles or so southwards, we come to the large station of Jubbulpore in the Central Provinces. Here the month of August loses its place, for out

of 690 cases of the disease recorded among troops and prisoners during the last 21 years, 340, or more than half, occurred in July. By inadvertence the cholera returns which had been furnished regarding the general population with the water-level registers for the last five years, were included in the statistics of this station in the previous tables, but it will be seen that in the accompanying table the troops and prisoners have been shown separate from the general population. In both instances it is July that occupies the first place as to cholera-prevalence.

TABLE LXIII.—*A statement of the average Monthly Water-level, Rainfall, Relative Humidity, Temperature and the total Cholera at Jubbulpore.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level [in feet] ...	6	4′·1	5′·5	7′·7	7′·2	8′·1	8′·8	10′·0	11′·2	12′·5	8′·0	2′·1	2′·1
Rainfall [in inches] ...	32—33	1″·33	0″·30	0″·19	0″·60	0″·47	0″·46	0″·13	0″·35	7″·66	18″·14	14″·12	8″·53
Humidity (Sat.=100) ...	10	63	51	50	55	46	37	55	25	52	79	79	78
Temperature [°Fahr.] ...	7	73°·6	66°·0	62°·0	61°·7	66°·2	75°·1	85°·4	90°·9	86°·7	78°·5	77°·8	78°·5
Atmospheric pressure ...	7	28·50	28·64	28·66	28·62	28·60	28·52	28·42	28·32	28·20	28·20	28·28	28·33
Cholera—troops and prisoners	21	6	1	1	.....	1	3	9	44	68	107	34	8
Cholera—general population	5	6	.....	.....	.....	.....	.....	.....	2	.....	233	162	5
Total ...		12	1	1	.....	1	3	9	46	68	340	196	13

Physical conditions and Cholera-returns regarding troops and prisoners compared.

In looking over the General Table (L), the distinguishing peculiarity that is readily evident is the circumstance that this station gets a heavier mean *rainfall* in July than any of the other stations in the group, its June rainfall also being heavy.

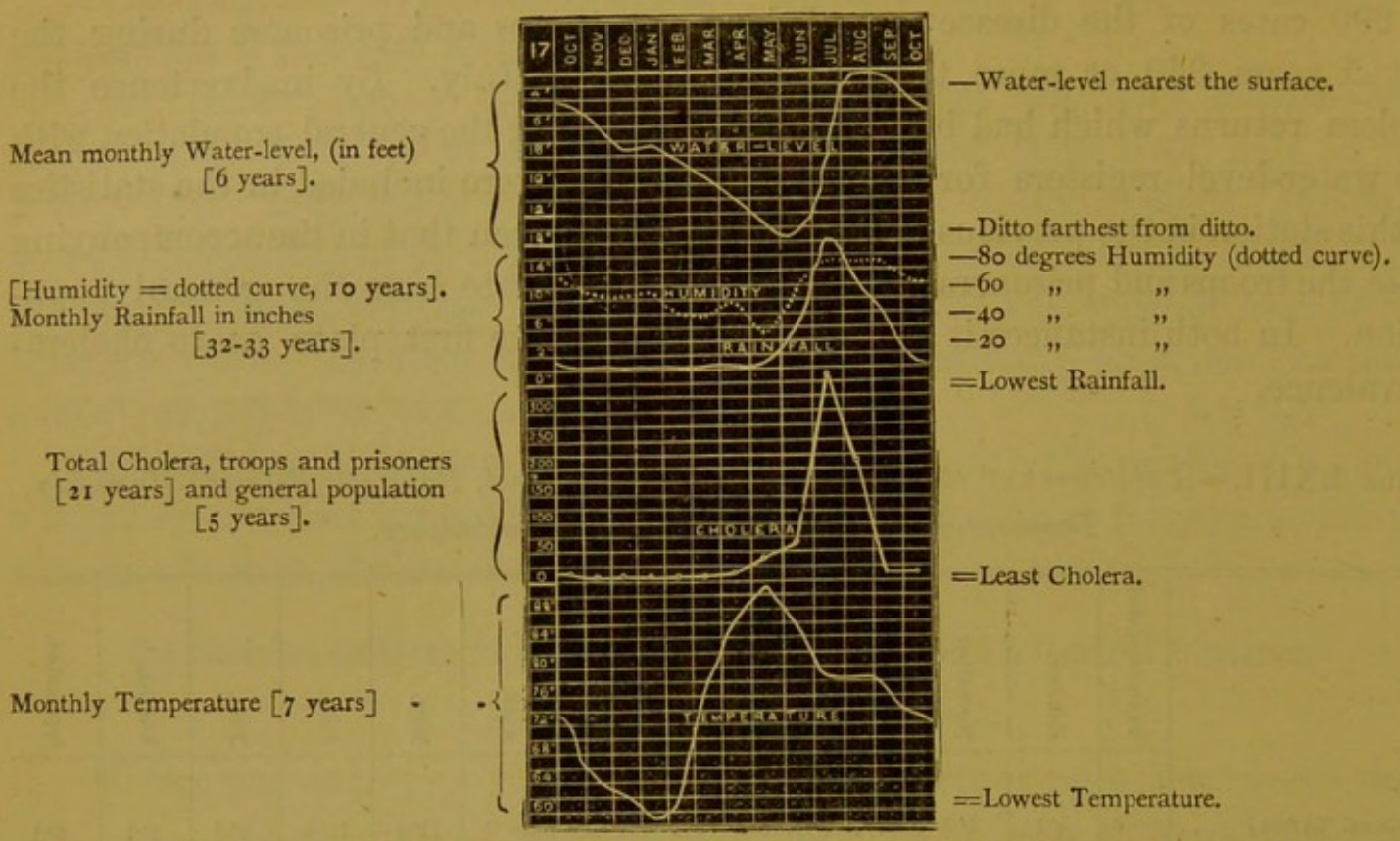


DIAGRAM 17.—The average monthly Water-level, Humidity, Rainfall, and Temperature, and the total monthly Cholera at Jubbulpore.

In this station, also, one of the two months of maximum relative *humidity* corresponds with the maximum cholera month; beyond this, however, no close connection can be traced. The month of maximum cholera-prevalence corresponds with one of the months of lowest *atmospheric pressure*, as it was seen to do in other stations of this area, and the maximum pressure agrees generally with the minimum cholera months. The highest monthly mean *temperature*, however, does not coincide with the maximum cholera month, the average temperature of July being 12 degrees lower than the maximum, which occurs in May. The water-level register at this station has been very regularly kept up by Dr. Rice for six years, the monthly mean of which period will be found in the above table. The level of the well is very rapidly affected by the rainfall, as may be observed from the fact that it rises nearly 4 feet from its lowest level in June; during the course of July and in August it is within 25 inches of the surface. Hence cholera is at its maximum here when the water is in process of rising from its lowest level.

Physical conditions and the cholera returns of General Population during 1875-76 compared.

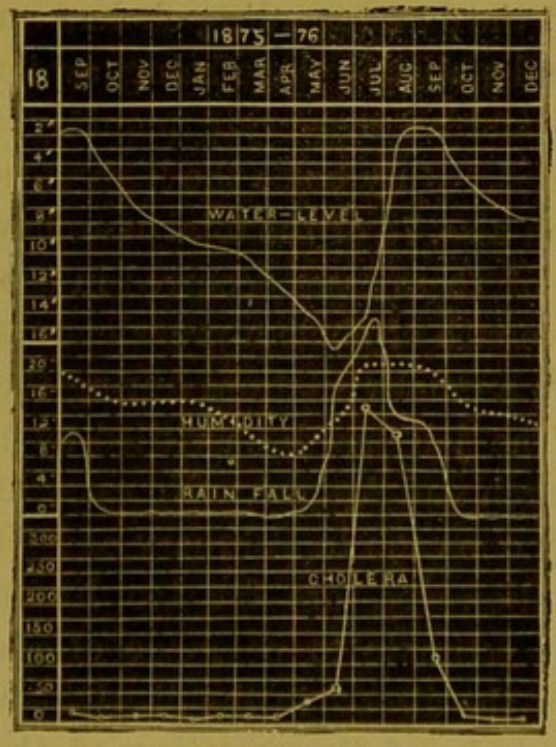
Whilst these pages were passing through the press, Dr. S. C. Townsend very kindly favoured us with a proof copy of his report on the cholera epidemic of 1876 in the Central Pro-

vinces, and we have availed ourselves of the opportunity of reproducing the monthly returns of the deaths from cholera which were registered in the District of Jubbulpore during the epidemic—from September 1875 to December 1876.

TABLE LXIV.—*A Monthly statement of the Water-level, Rainfall, mean Relative Humidity and total Deaths from Cholera among the General Population of the District of Jubbulpore from September 1875 to December 1876.*

	1875–1876.															
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Water-level [in feet]	1′·7	4′·3	6·9	8′·3	9′·1	10′ 0	10′·9	12′·7	14′·1	16′·7	13′·9	2′·0	1′·9	4′·9	6′·7	7′·9
Rainfall [in inches]	11″·5	0″·8	...	...	...	...	...	...	1″·0	3″·2	27″·2	12″·7	12″·3	...	...	...
Humidity (Sat. = 100)	80	67	54	59	57	48	36	22	26	53	84	84	83	64	54	50
Cholera	7	2	...	...	...	...	2	11	48	67	532	492	116	10	...	...

Here also it will be seen that July is the month of maximum cholera, August coming next to it. The monthly water-level rainfall and relative humidity are also given for the same period.



Monthly Water-level (in feet) [16 months].

Humidity [dotted curve].

Monthly Rainfall [16 months].

Total Cholera [16 months].

—Water-level nearest the surface.

——Ditto farthest from the surface.
—80 degrees Humidity.
—60 ,, ,,
—40 ,, ,,
—20 ,, ,,

—Lowest Rainfall.

Lowest Cholera.

DIAGRAM 18.—The monthly Water-level, Humidity, Rainfall and deaths from Cholera, from September 1875 to December 1876, at Jubbulpore.

It will be seen in this illustrative chart, also, that the months of maximum humidity correspond with the maxima of cholera; but it will also be noted that cases occurred when the humidity was at its minimum.

(3) Raipore.

Raipore.

Water-level returns have been received from other stations in the Central Provinces, but the cholera statistics regarding troops and prisoners are of too limited a character to enable any deductions to be made from them as yet. The jail at the station of Raipore, however, towards the eastern part of the province, has during a period of 22 years furnished a total of 285 cases, and these will be found classified in the general tables according to months and seasons. It is interesting to observe that here also August holds the second place only as to cholera-prevalence, whereas July again holds the first. Raipore, however, has a larger proportion of 'spring' cases of cholera (January to May) than Jubbulpore.

(4) Nagpore.

Nagpore—Limited data regarding official communities.

Nagpore, the chief town of the Central Provinces, situated 'on the margin of a broad plain of cotton soil,' has not been included in our general tables, as no water-level observations have been taken there, and the data regarding cholera among official communities are very limited, the jail statistics alone being available. These have been collected during 21 years and an aggregate monthly record of 207 cases of cholera has been accumulated. July holds the highest position as to prevalence of the disease in this station also, 74 of the total cases having occurred then; but it should be noted that 68 of these cases occurred in the July of one year, *viz.*, 1865. The next highest month of cholera-prevalence is March, furnishing 57, 48 of which are due to two annual visitations during the 21 years, 24 cases in 1856, and 24 in 1864. The jail has been visited by cholera six times during July, five times during March and August. No cases have occurred in December and January, and only one each in February and November.

Position of station in regard to monsoon influences.

The foregoing data, however, are far too limited to enable a correct estimate to be made of the seasonal prevalence of the disease in the district—a district which is particularly important in the study of the question of the causation of climatic diseases, seeing that it occupies a somewhat peculiar position as to monsoon

influences. Mr. Blanford describing the rainfall of these parts writes: "All through the Mahratta Country, as far as Nagpore, the annual distribution of rain is the same as at Bombay, *i. e.*, practically restricted to the season of the summer monsoon. But from Nagpore eastwards spring storms are not infrequent, and an appreciable amount of rain falls during the earlier months of the year".*

Cholera of 1875-76.

With the object of still further illustrating the cholera of the Central Provinces according to seasons, we again avail ourselves of the proof-copy of Dr. Townsend's report regarding the epidemic of 1875-76, and incorporate the data regarding the cholera mortality of Nagpore in the same manner as was done regarding Jubbulpore. The prevalence of the disease in the district during the epidemic according to months will be found in the following table, as also the monthly distribution of the disease as it has occurred in the Nagpore Jail during the last 21 years.

TABLE LXV.—*The Monthly prevalence of Cholera at the Nagpore Jail during 21 years, and the Deaths from Cholera which occurred in the District during the Epidemic of 1875-76; Together with the average monthly Rainfall, Humidity, Temperature and Pressure.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Mean rainfall [in inches]	27	2″·55	0″·55	0″·41	0″·58	0″·61	0″·89	0″·36	0″·61	9″·21	11″·84	9″·11	8″·33
Mean humidity	7	54	46	49	44	39	49	21	23	56	76	74	74
Mean temperature [°Fahr.]	6·7	76°·9	70°·9	67°·8	68°·5	73°·8	81°·9	88°·4	93°·3	85°·9	78°·7	78°·7	78°·9
Mean pressure	7	28·80	28·94	28·97	28·94	28·90	28·81	28·71	28·62	28·53	28·54	28·60	28·65
Total cholera, prisoners	21	14	1	...	...	1	57	22	16	5	74	13	4
Ditto, general population	1·2	67	456	30	...	...	...	2	2	1	69	1,642	543
Total Cholera	...	81	457	30	...	1	57	24	18	6	143	1,655	547

Cholera-maximum in August.

According to these combined cholera statistics August again maintains its position, a sudden rise in prevalence of the disease being observed, followed by a more gradual fall. The month of maximum *rainfall* immediately precedes the maximum

* Meteorologist's Vade Mecum, p. 215.

cholera month as also does the maximum *humidity*. The monthly maximum *temperature* however precedes the maximum cholera by 3 months and exceeds the mean temperature of August by nearly 15 degrees. The maximum cholera corresponds nearly with the minimum *pressure*, and the maximum pressure very nearly with the minimum cholera.

(c) Selected Stations in the Punjab.

(1) Mean Meer and Lahore.

Lahore.

We have selected three stations in the Punjab, or rather two—Lahore and Mean Meer having been brought together. Mean Meer is the military station of Lahore about 6 miles to the south-west of it and on higher ground. The cholera returns for the former extend over 25 years and for the latter over 31 and furnish a total of 2,638.

Table LXVI.—*The average Monthly Rainfall, Relative Humidity, Temperature and Pressure at Lahore, together with the total Cholera registered among the European and Native Troops and Prisoners at Lahore and Meean Meer.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level	...		Highest	register	ed level	of select	ed well	(at Meea	n Meer)	— 36 fe	et.		
Rainfall [in inches] ...	10	0″·6	...	0″·50	0″·50	0″·91	0″·91	0″·27	0″·92	1″·20	6″·29	3″·89	2″·54
Humidity [Sat.=100] ...	6	35	39	50	57	52	46	33	24	32	49	53	53
Temperature [°Fahr.] ...	8—10	76°·7	64°·9	55°·3	53°·4	59°·5	69°·0	81°·2	88°·7	93°·0	88°·3	87°·4	83°·5
Atmospheric pressure ...	2—3	29·11	29·33	29·34	29·28	29·26	29·11	29·03	28·90	28·72	28·74	28·83	28·93
Cholera — Lahore	31	4	2	2	1	1	3	15	3	12	24	491	235
Cholera — Mean Meer ...	25	8	1	1	2	0	1	2	13	14	76	1,489	238
Cholera — Total	...	12	3	3	3	0	4	17	16	26	100	1,980	473

Cholera maximum in August.

It will be observed that August again stands prominently forward as the month pre-eminently adapted for cholera in these provinces, nearly 2,000 of the 2,600 odd cases having occurred in this month, the maximum both in Lahore and Mean Meer taking place in the same month.

The proportion of *rainfall* from January to May continues to augment as we proceed towards the frontier. At Meerut it was seen to be 12·2 per cent.

of the total, and here it is 18·9. The proportion of cholera, however, during these months does not appear to augment at the same rate.

The mean relative humidity of the atmosphere at Lahore is all the year round very low, and here it is the highest degree of humidity but one, and not the highest, that corresponds with the maximum cholera months. The highest humidity, so far as our data go, appears to correspond with one of the months of minimum cholera.

The month of lowest mean *pressure* here also corresponds very nearly with the month of maximum cholera, and the high pressure months with the months of minimum cholera. As at Meerut the *temperature* of June is higher than that of May, and is higher than the temperature of the month of maximum cholera by 5°·6.

(2) Peshawur.

We select one more station, that of Peshawur, in the trans-Indus territory of the Punjab. It is a large frontier military station situated in a valley, about 50 miles in length by 40 in breadth, traversed by three tributaries of the Indus.

Table LXVII.—*The average Mouthly Rainfall and the total Cholera registered among European and Native Troops and Prisoners at Peshawur.*

	Years recorded.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
Water-level				Highest	register	ed level	of select	ed well	= 81 fe	et.			
Rainfall [in inches] ...	7	0″·3	0″·3	0″·5	1″·3	1″·2	1″·6	1″·25	0″·6	0″·2	1″·7	2″·6	1″·0
Cholera	28	343	26	...	3	...	1	5	205	164	131	25	577

Peshawur.

Unfortunately we have not been able to obtain any very satisfactory meteorological data regarding this station, so that the table merely gives the mean monthly rainfall, and the monthly cholera—the figures representing the latter extending over a period of 28 years. The total *rainfall* of the year is not

quite 13 inches, and nearly half of the total falls in the earlier months of the year. The cholera statistics also indicate that the disease is not distributed over the annual period in the same proportion as in the non-endemic area generally, for 40 per cent. of the total cholera at Peshawur has occurred at *other* than the ordinary rainy season of the great part of the North-West and Lower Provinces, *viz.*, June to September.

PART IV.

GENERAL CONCLUSIONS.

CHAPTER I.

A COMPARISON OF THE PRINCIPAL PHYSICAL CONDITIONS CHARACTERISING THE VARIOUS SEASONS OF CHOLERA-PREVALENCE IN THE ENDEMIC AND NON-ENDEMIC AREAS.

Comparison of conditions associated with cholera-prevalence throughout the Bengal Presidency.

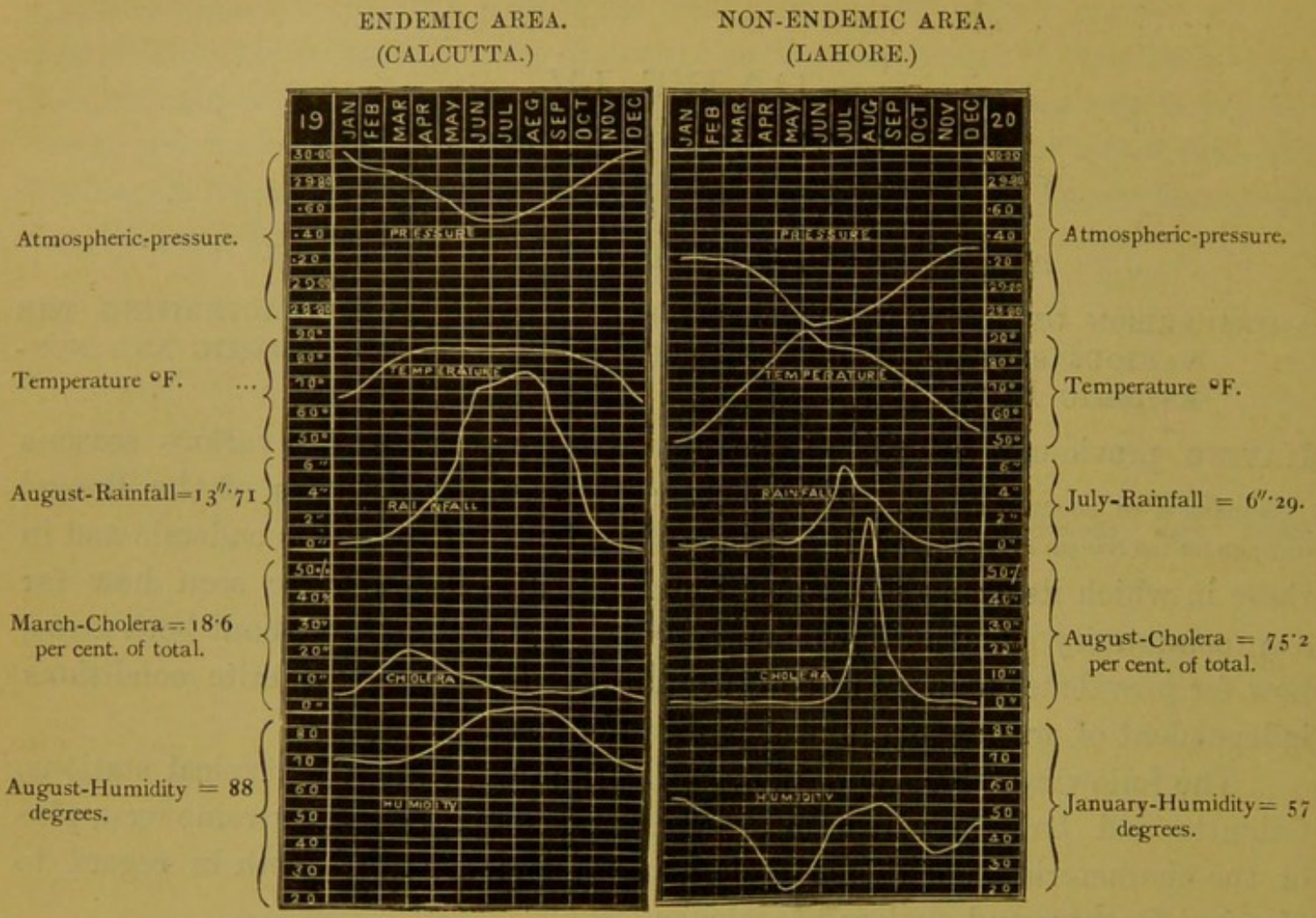
HAVING previously considered the physical features of the various seasons of cholera-prevalence in those parts of the Bengal Presidency in which the disease is endemic and in those in which its occurrence is occasional only, it remains to be seen how far any community of conditions characterises the seasons throughout both areas, how far prevalence appears to be favoured or repressed by definite conditions independent of mere geographical position of locality.

The following table shows the conditions presented by two typical stations, Calcutta and Lahore, which may be regarded as presenting extreme examples of the characteristics of the endemic and non-endemic areas, both in regard to physical features and cholera-prevalence.

TABLE LXVIII.—*Showing the Physical conditions associated with various degrees of Cholera-prevalence in Calcutta and Lahore.*

	Endemic area (Calcutta).												Non-endemic area (Lahore).											
Physical conditions.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Atmospheric pressure ...	30·01	29·94	29·85	29·75	29·66	29·55	29·54	29·60	29·68	29·83	29·98	30·03	29·28	29·26	29·11	29·03	28·90	28·72	28·74	28·83	28·93	29·11	29·33	29·34
Temperature ...	67·7	73·0	80·5	84·7	86·2	84·9	83·5	83·1	83·3	81·5	74·9	68·1	53·4	59·5	69·0	81·2	88·7	93·0	88·3	87·4	83·5	76·7	64·9	55·3
Humidity	68	68	67	73	75	83	87	88	87	80	71	68	57	52	46	33	24	32	49	53	53	35	39	50
Rainfall (inches)...	0·44	0·83	1·28	2·49	5·46	12·13	12·64	13·71	10·17	5·61	0·66	0·24	0·50	0·91	0·91	0·27	0·92	1·20	6·29	3·89	2·54	0·6	0·0	0·50
Water-level	Average lowest, May, 14′·6 Average highest, September, 8′·2												Lowest 37′·0 Highest 36′·0											
Percentage of total cholera(a)	3·13	7·04	18·68	17·52	11·98	8·81	8·01	3·97	4·90	5·07	6·80	4·03	0·07	0·00	0·15	0·65	0·60	0·98	3·80	75·22	17·97	0·45	0·03	0·03

(a) European and Native troops and Prisoners.



DIAGRAMS 19 and 20.—Illustrative of the mean monthly Physical Conditions and the prevalence of Cholera in the Endemic and Non-endemic areas—Calcutta and Lahore. (The Calcutta Cholera-curve has been cut a space too high throughout in the diagram.)

Contrasts presented by Calcutta and Lahore.

Taking these stations as affording indices of the general characters of the areas in which they lie, we find certain marked apparent contrasts between them in regard to the conditions coincident with maximum and minimum prevalence. Maximum prevalence in Calcutta occurs coincidently with relatively high atmospheric pressure and with low humidity and rainfall: whilst in Lahore it is associated with precisely the opposite conditions.

The data in the Bengal Presidency afford no ground for supposing that *atmospheric pressure* exerts *per se* any appreciable influence on prevalence; and the contrasts presented by the endemic and non-endemic areas in this respect must be regarded as entirely subordinate to those of relative humidity and rainfall.

Influence of temperature on prevalence evident in both localities.

With reference to atmospheric *temperature* in place of contrast there is agreement, and it is corroborative of belief in the actual existence of an influence of temperature

on cholera-prevalence to find, that very much in proportion to the increase in the difference between the temperature of the various seasons there is a corresponding increase in the difference of prevalence occurring in them.* In Calcutta the range of temperature between the coldest and warmest month is 18°·5, in Lahore it is 39°·6, or, stated in reference to prevalence, in Calcutta the difference between the temperature of the month of maximum cholera and the coldest month is 13°·8, while in Lahore it is 34°·0. In Calcutta there is a considerable reduction of prevalence in the coldest month as compared with that of the maximum prevalence—the percentages of total cholera being 3·13 and 18·68 ; but this is reduced to insignificance as compared with that exhibited in Lahore, where the respective percentages are 0·07 and 75·22.

Contrast as to conditions is not one of absolute conditions both in regard to humidity

In reference to *humidity* we find apparent contrasts very sharply defined, more sharply even than those exhibited by the conditions of rainfall. It is questionable how much this difference ought not to be regarded as a mere subordinate concomitant of that in regard to rainfall ; but in so far as atmospheric humidity itself can be supposed to exert any influence on prevalence of the disease, it must be remembered that the contrast lies not so much in absolute conditions of humidity as in relative local conditions. The fact is that the conditions of atmospheric humidity of the two localities come to approximate most closely at different seasons—the approximation occurring when the humidity of Calcutta is at its lowest and that of Lahore at its highest. Putting January and February aside as months in which conditions of temperature exert a disturbing influence on prevalence, we find that the conditions of humidity in Lahore, most closely approaching in degree those present in Calcutta during March and April, are those of August and September. The contrast presented by the two localities, then, in reference to conditions of atmospheric humidity and cholera-prevalence is one in regard to relative local conditions only, the absolute humidity of the localities during their seasons of maximum prevalence is comparatively similar. The same final result may be obtained by addition in one case and by subtraction in another, according as the basis of calculation be greater or less.

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* It will be observed that no special notice has been taken of the question of *range* of temperature, as a characteristic of the various seasons. This is not the result of an omission, but as the only thing that could be said regarding it is, that mere range of temperature exerts no appreciable influence on the prevalence of cholera, it has not been deemed necessary to occupy space in giving detailed data leading to no further conclusion.

This must be borne in mind in reference to the next point also—the contrast between the conditions of *rainfall* associated with prevalence of cholera in the two localities.

and rainfall.

In considering the physical conditions of Calcutta we found reason to regard the influence of rainfall as a mediate one, acting through the agency of its direct effects on the soil. In Calcutta, no doubt, the influence of rainfall appears to be mainly exerted through its effects on soil-ventilation, and here there can be no question as to the existence of an apparent contrast between the conditions coincident with maximum prevalence in the two localities. In so far as rainfall acts in obstructing soil-ventilation there is certainly a manifest contrast between the conditions coincident with maximum prevalence in Calcutta and Lahore. The rainfall in the two localities is, however, so very dissimilar, that even were their soils precisely identical in nature, similarity in their effects could not be looked for. The effects on soil-ventilation produced by a fall of 3″·89 which is the average amount for August in Lahore, must patently be very different from that of the contemporaneous fall of 13″·71 in Calcutta.

Direct observations on influence of rainfall on soil-ventilation wanting for stations in Upper India.

Direct observations are still wanting on the effect of the rainfall in the stations of Upper India on conditions of *soil-ventilation*; but the data furnished by the present example are sufficient to show that it is idle to found conclusions on comparisons of local relative conditions, and that it is the absolute conditions, coincident with various seasons of cholera-prevalence, which must be compared with one another. The rainfall and soil of one place may be such that maximum rainfall effectually interferes with soil-ventilation, whilst in another they are so different that little or no effect is produced.

Rainfall influences not only ventilation but moisture of soil.

Rainfall, however, may influence the local prevalence of cholera by means of its influence on the soil in various ways. It does not only act on the ventilation of the soil, it also acts on its conditions of moisture, and, indeed, it is only in doing so that it affects the ventilation. If the development of the cause of cholera in a locality be dependent on local conditions of soil, as there is much reason to believe is the case, it is surely conceivable that one of these conditions is a certain degree of moisture. Granted this, and there can be no difficulty in assuming that given localities may fail to produce cholera either on account of the soil being too damp or too dry, and that the conditions ensuring

development might be provided in one case by diminishing, in the other by increasing, the amount of moisture present. Looked at under this light, the apparently contrasted conditions of rainfall coincident with maximum prevalence of cholera, in stations such as Calcutta and Lahore, practically disappear. As in the case of the humidity, the contrast is one between local relative conditions only, not between the final result of the action of these conditions, or even between the absolute conditions themselves.

In regard to water-level little need be said, as it has been already indicated that, in this country, data of rainfall are more generally applicable as indices of conditions of local soil-moisture than fluctuations in water-level can be.

Remarks regarding Calcutta and Lahore generally applicable to the areas in which they are situated.

Calcutta and Lahore have been selected as typical examples of localities in the endemic and non-endemic areas, regarding which we have relatively satisfactory data for comparison. The remarks made regarding them are, however, generally applicable to the other stations within these areas. Calcutta andLahore are no doubt extreme examples of the characteristics of these areas, both in regard to seasonal distribution of cholera-prevalence and to the coincident physical phenomena, and the phenomena of every locality must be scrutinized in detail for themselves. Lahore is peculiarly distinguished by the smallness of its rainfall, and many other stations within the non-endemic area may be pointed out where the season of maximum cholera is coincident with considerable rainfall. The evidence of the influence of soil-ventilation on prevalence is certainly not so manifest in these cases as in regard to Calcutta. Before any conclusions can be arrived at, however, on this point, data derived from direct observation regarding the actual influence exerted on the soil-ventilation must be acquired, and in the meantime it is well to bear in mind that we have no evidence to show what the effect of the addition of moisture to the soil without coincident obstruction to soil-ventilation might be. We do know how much cholera arises under existing circumstances; we can form no conception as to what the amount might be under the hypothetical ones.

CHAPTER II.

THE PHENOMENA OF SEASONAL FLUCTUATION IN THE PREVALENCE OF CHOLERA CONSIDERED IN REFERENCE TO THE PRINCIPAL THEORIES REGARDING THE ESSENTIAL CAUSE OF THE DISEASE.

(a) As observed in Calcutta.

In the earlier part of this report an attempt has been made to ascertain the character of the local physical conditions coinciding with the various degrees of cholera-prevalence in Calcutta at different times during the course of the year. The information thus obtained has next to be considered in reference to various current theories relative to the essential causation of the disease.

The most important theories are the following:

1st.—That which regards cholera as essentially caused by direct contagion,—by the direct transfer of a poison, manufactured within the human organism, from one person to another: According to it, any fluctuations in the prevalence of cholera must be dependent on corresponding fluctuations, either in opportunity of transfer, or in the susceptibility of human beings to the influence of the poison.

Theories regarding the essential causation of cholera—Contagion and Water theories.

2nd.—The so-called 'water theory:' In this, also, the human organism is regarded as the factory in which a specific poison is produced. By one set of the supporters of the theory, water is regarded merely as one means—although by far the most important and influential means—by which the poison is diffused,—is transferred from one person to another. By other authorities, however, water is not regarded as a mere vehicle, but as the medium in which the material produced within the human organism attains its maximum of virulence. According to this theory, fluctuations in the prevalence of cholera must essentially depend on corresponding fluctuations in conditions determining, or facilitating, the transfer of materials produced within the human organism to the water, and specially to the drinking water.

3rd.—The theory which, while regarding the drinking water of a locality as essentially determining the prevalence of cholera in it, does not regard its influence as necessarily dependent on the introduction of any specific material manufactured within the bodies of those suffering from the disease: It holds that the drinking water

The modified water-theory.

determines prevalence, both by its effect on personal susceptibility, and by being the essential medium in which the specific poison is developed. In any case, the quality of the drinking water of a locality is regarded as the essential determinant of the fluctuations in the prevalence of cholera in it at different periods. Any fluctuations of prevalence in localities in which cholera is endemic are regarded as depending on corresponding fluctuations on the quality of the water, increase and decrease in prevalence being due to increase and decrease in the impurity of the water.

The soil theory.

4th.—The theory which regards the soil as the essential site of the processes resulting in the production of the material inducing cholera: The majority of the adherents of this theory regard the air as the vehicle, by means of which the material produced in the soil is conveyed to human beings, so as to cause the disease in them; but it is obvious, that questions of vehicle are really subordinate here, and that materials manufactured in the soil may reach the human subject by more than one path. According to this view, fluctuations in prevalence of cholera are dependent on corresponding fluctuations in the condition of the soil, which may act either on the manufacture or the diffusion of the specific materials.

We have now to enquire how far each of these theories is capable of accounting for the phenomena of seasonal fluctuations exhibited by the prevalence of cholera in Calcutta.

Theory of direct contagion compared with the data in Calcutta.

1st.—The theory of direct contagion: It may be deemed superfluous, at the present day, to enter into the serious consideration of this doctrine, still as it is yet advocated by some whose opinions are entitled to respect, it is necessary to determine the bearing of our data upon it. The normal course followed by the fluctuations in the prevalence of cholera in Calcutta is not merely inexplicable by this theory, but is strongly opposed to it. If prevalence were dependent on direct contagion, the maximum prevalence should occur at those times of year when the population is most liable to close association. As a fact, the maximum prevalence in Calcutta occurs during a period when there is less crowding together, or close association of the population, than in either of the periods immediately preceding and following it. The native population is more crowded together during the height of the cold weather and of the rains than at any other time of year; for it is then that the people are obliged—by the temperature in the one case, by the rainfall in the other—to pass the nights packed

together in their houses, instead of spending them largely in the open air. According to this theory, the prevalence of cholera ought to attain its maximum in December and January, and in July and August; but, in place of this being the case, these are precisely the periods during which prevalence of the disease is at its lowest ebb.

2nd.—The 'water-theory,' as ordinarily understood: This theory, also, fails to explain the phenomena of seasonal fluctuation in prevalence, or to gain any support from them. According to it, maximum prevalence ought to occur at that period of the year when the meteorological conditions are of a nature calculated to facilitate the entrance into the drinking water of materials derived from the bodies of those suffering from the disease, and specially of the materials of the intestinal excretions. The period during which most material is washed into the tanks and other bodies of water, which, until quite recently, constituted the universal sources of drinking water in Calcutta, is, that of those months in which the rainfall is greatest and characterised by the greatest heaviness of individual falls. These months are June, July, August and September; but the first of these is a month ofl ow medium, while the three others are months of minimum prevalence. With reference to the latter three months, it may be argued, that although the inwash of materials is then great, the inwash of the specific material producing cholera is not so, as it has been in great part removed from the surface of the soil by previous rainfall, and that the influence of what still remains to be introduced is neutralised by the coincident dilution of the sources of drinking water.

The water-theory fails to account for the phenomena of seasonal prevalence in Calcutta.

This argument is, however, quite inapplicable to the phenomena of June. At this time there has been no sufficient previous rainfall to remove the specific material from the soil surface, or to dilute the water-supply; and yet the abundant and violent rainfall of June is accompanied by a great decrease in prevalence. Equally inexplicable on this theory are the phenomena presented by May and November. In May the amount of specific material ready for introduction must be at a maximum, for the preceding months are those in which the number of cases of the disease—the number of assumed factories of the poison—far exceeds that present at any other time of the year. In May, too, both the total rainfall and the heaviness of individual falls are, on an average, higher than in April; and yet at this very time, when everything, according to the theory, provides for excessive increase in prevalence,

there is, on the contrary, a marked decrease. We have here an instance of decrease where the theory requires increase, and the phenomena of November furnish an example of an exactly opposite nature—furnish an instance of meteorological conditions which, according to the water theory, ought to ensure decrease, but which, in fact, coincide with marked increase. When we compare the rainfall of November with that of October, we find that, in so far as provision of means securing inwash of materials are concerned, the latter month occupies a much higher place than the former; and yet the virtually rainless November shows a great increase in prevalence when compared with October.

3rd.—The theory which regards the degree of impurity of the drinking water as the essential determinant of the prevalence of cholera: According to this theory, the periodic fluctuations in the prevalence of cholera in a locality in which the disease is endemic are dependent on corresponding variations in the degree of impurity of the water-supply. In so far as the general physical conditions of locality are concerned, the degree of impurity of the water must depend on the degree to which the entrance of extraneous impurities is facilitated, and on influences determining the relative proportions of the impurities to the mass of water containing them. The conditions favouring the entrance of foreign matters in general into the sources of water-supply are precisely those described previously as favouring the entrance of specific materials; and the conditions favouring concentration of impurity are those under which the general mass of water is reduced to least bulk. Consequently, according to this theory, the maximum prevalence of cholera in Calcutta ought to occur during the hot and dry season, when concentration attains a maximum, and during the commencement of the rains, when there is great inwash of extraneous impurities, without an increase in the mass of the water, calculated to do more than neutralise this addition.

The degree of impurity of water-supply cannot be shown to vary with the prevalence;

The phenomena presented by the cholera-prevalence of the hot and dry months, at first sight, appear to afford strong confirmatory evidence to the theory; for the season of maximum prevalence occurs then, coincidently with the season of lowest water-level. When, however, the phenomena of individual months of the hot and dry season are examined, the results are not so favourable to it. In May the water-level reaches its lowest, the conditions affecting evaporation being, apparently, more than sufficient to neutralise the effect of the slight excess in the rainfall

although certain facts at first sight would appear to show that it does.

over that of April. In May, then, the sources of water-supply are reduced to their smallest bulk, and the concentration of the impurities in them reaches a maximum; and consequently, according to the theory, the cholera-prevalence of the hot and dry season ought to come to a climax then. On the contrary, however, the prevalence in May is much less than in either of the preceding months.

Phenomena of individual months do not accord with the theory.

The phenomena of June do not show any closer agreement with the requirements of the theory. At this time, according to the theory, cholera-prevalence ought to continue at a maximum; for, although the mass of water in the sources of water-supply undergoes considerable increase, the conditions of rainfall are such as to ensure great inwash of materials from the soil, which has not been purified by any great previous rainfall. June is, however, a month of low medium, not of maximum prevalence. November, also, presents great difficulties to the acceptation of any such explanation of the phenomena of periodic fluctuations in prevalence. In November conditions facilitating inwash of extraneous materials are at a minimum, and the mass of water is greater than in either June or July. The prevalence in November ought, therefore, to be lower than that in June and July; but, on the contrary, it is very much higher than in these months.

The soil-theory compared with the data in Calcutta.

4th.—The 'Soil theory': The theories which have been considered hitherto assume that the nature of the specific cause of cholera, or, at all events, that the conditions determining the production of the specific cause, are already definitely ascertained. The soil theory, however, does not go so far; and the difficulty of determining the bearing of our data upon it is proportionately enhanced thereby. All that it definitely affirms is, that the specific cause of cholera is developed in the layer of soil lying above the water-level or first impermeable stratum in a locality; and that, therefore, the development must depend on certain conditions of that layer. These conditions are, admittedly, quite undetermined, but must be supposed to be constantly existent, in greater or less degree, within the areas in which the disease is endemic. According to it, fluctuation in prevalence in any endemic locality must be dependent on corresponding fluctuations either in conditions affecting the development of the poison in the soil, or on conditions determining its diffusion from the soil.

So long as the conditions supposed to secure development of the poison are

Conditions of soil favouring prevalence not accurately determined.

not distinctly defined, it is evident, that an endemic locality affords little field for testing the theory in regard to the relation of prevalence of the disease to influences calculated to favour its production. Attention must, therefore, be mainly directed to prevalence regarded as dependent on diffusion; but even regarding questions of production, there are certain phenomena of prevalence, which admit of comparison with the theory. In any locality, like Calcutta, where the layer of soil above the water-level is always of comparatively little depth, and of tolerably uniform structure throughout, the theory may be supposed to assume, that, other things being equal, the amount of the specific material developed ought to increase with the mass of generating stratum. From this point of view, the maximum and minimum of prevalence ought to coincide with the maximum and minimum depression of the water-level, which is very much what we have previously ascertained to occur in reality.

Two main channels of communication between the soil and the human organism.

In proceeding to consider cholera-prevalence as an expression of the degree of diffusion of the poison, it must be borne in mind that there are two main channels by which materials developed in the soil may reach the human beings in any locality. These are the water and the air occupying the interspaces between the solid constituents of the soil. If the water of the soil be regarded as the means of diffusion of the poison, the phenomena of prevalence in Calcutta present the same difficulties to this theory as they do to those previously considered. This, however, is not the case if the air be regarded as the channel traversed by the poison in passing from the soil to the subjects of the disease. On this hypothesis, maximum and minimum of prevalence ought to coincide with maximum and minimum of soil-ventilation. According to our data, the maximum of soil-ventilation occurs during March and April, coincidently with the maximum of prevalence; and minimum soil-ventilation occurs during the rainy season, the period of minimum prevalence. So far, however, as diffusion alone is regarded as determining prevalence, the phenomena of prevalence in Calcutta do not coincide accurately with the requirements of the theory. The depression of prevalence in December and January, and again in May, remains inexplicable; and all that can be positively affirmed is, that the difficulties opposed by the phenomena of periodic fluctuation in the prevalence of cholera in Calcutta to the soil theory, are less than those encountered by any of the other current doctrines regarding the essential cause of the disease.

It will be observed, that in the previous pages no special notice has been taken of the great and persistent diminution in the prevalence of cholera in Calcutta during the last few years. This has been done designedly, in order to avoid complications, incident on the discussion of two different questions simultaneously. The present report deals with phenomena, which are common both to the period previous to, and to that following, the diminution. To have attempted to combine the discussion of the cause of the diminution in absolute prevalence with one regarding the cause of the variations in relative prevalence characterising different periods of the year, could only have led to confusion and obscurity.

Questions relative to seasonal prevalence alone considered here.

(b) As observed in the localities in the Endemic area other than Calcutta.

The foregoing remarks apply with equal force to the relation which various physical conditions bear to the prevalence of cholera in the other districts in the Bengal Presidency in which the disease may be said to be endemic. It will have been observed that in the stations which have been selected to represent the principal districts of the endemic area taken as a group, the seasonal manifestation of the disease presents a striking resemblance to that in Calcutta—82 per cent. of the total annual cholera taking place during the eight drier months of the year in Calcutta, and 71·2 in the stations taken as a group, the maximum cholera in both occurring during the comparatively dry months of March and April. [*Vide* Table LIV.]

The lessons taught by Calcutta apply to the Endemic area generally.

As, however, the figures available regarding the prevalence of the disease at the individual stations of this group are so small compared with the statistics of Calcutta, which embrace the general population, it is not to be expected that the monthly proportions should accurately agree. Notwithstanding this, however, and the difference in the surroundings of the classes of the population compared, even the monthly statistics, especially when weeded of manifestly casual occurrences, present a marked general similarity. It is therefore obvious that the conclusions derived from the data regarding Calcutta apply generally to this group of stations also.

(c) As observed in the Non-endemic area.

Seeing, however, that in those parts of the Bengal Presidency in which cholera manifests itself at irregular intervals only, it displays a preference for other than the dry

Applicability of these inferences to cholera in the non-endemic area.

months of the year, it will be necessary to consider whether the foregoing remarks concerning the more prominent doctrines regarding the causation of the disease still retain their applicability.

The direct contagion theory.

(1). With regard to *the theory of direct contagion*, it was observed that the fact that cholera-prevalence in the endemic area was at a minimum when, for climatic reasons, the people (during the rainy and cold seasons) are most crowded together, tended to negative the view that personal contact exercised any important element in the extension of the disease.

In the Upper Provinces, notwithstanding the still closer relation which must exist between individuals owing to the greater severity of the cold, cholera falls to its minimum degree of prevalence at the period of minimum temperature, and a sudden diminution from the maximum prevalence of cholera takes place contemporaneously with the setting in of the colder weather. On the other hand, close association of individuals must also be favoured by the crowding incident on the conditions of the rainy months of the year when cholera is most apt to occur. As, however, the heavier and more continuous rainfall of Lower Bengal, with the correspondent increased crowding together of the people, is contemporaneous with a marked diminution of the disease, the general weight of evidence remains opposed to the doctrine of direct contagion.

The water-theory.

(2). Assuming the water-level registers to give a fair general indication of the fluctuation of the water used for domestic purposes in the different stations where observations were conducted, the theory of the spread of the disease through the medium of drinking water gains greater support in the non-endemic area than in Lower Bengal. A glimpse at the diagrams representing the variation in the water-level of different localities in this area will show that the disease undoubtedly attains its maximum shortly after the level of the water in the wells begins to rise; hence, it might be inferred, when sufficient time has elapsed for the choleraic material dispersed over the soil to find its way by percolation into the wells, and when the water, being low, favours the swallowing of the *materies morbi* in a concentrated form. To this, however, it must be added that a considerable proportion of the cholera of a station occurs before the water-level in the wells is affected, especially in some stations where the wells are very deep and where the total annual fluctuation does not exceed a few inches. In such

cases it must be assumed, either that the cause of cholera was present in the water before the percolated impurities could reach the well, or that the earlier cholera of the season was derived from some other source than that furnishing the later cases. With regard to the production of the 'spring' cholera, again, it can hardly be attributed to the percolation of choleraic impurities into the wells; for the ground appears to absorb all the rain that falls at this time, and in scarcely any of the selected stations in the non-endemic area is it observable that the level of the well-water is materially affected by this season's rainfall.

It may, of course, be maintained that while all cases of cholera are not to be referred to the effects of the *percolation* of choleraic impurities into sources of drinking-water, those phenomena which cannot be accounted for in this way are ascribable to the effects of the *direct introduction* of the materials into the water, or other ingesta. But before this can be accepted as a satisfactory explanation of the phenomena, it must be shown that the facilities of introduction at different seasons and in different years vary proportionately to the coincident prevalence of cholera. Until this has been done, the theory seems to assume, that every year in which cholera is generally epidemic, is at the same time a year in which there is an epidemic tendency to the direct introduction of choleraic materials into sources of water-supply.

The streams and rivers must, however, receive a considerable amount of surface impurities by every fall of rain; and if it were true, as some advocates of the 'water-theory' maintain, that an infinitesimal quantity of a choleraic discharge finding its way into a river can multiply to such an extent as to be capable of infecting the population of an entire city, a rapid and general diffusion of cholera would be readily accounted for. If this were actually the case, however, it should follow that the progress of cholera along the water-courses and in the direction of the current would be evident to all. In that case any outbreak of cholera which might occur in the earlier part of the year towards the north-west of the area under consideration, ought to be traceable week by week along the line of the streams and rivers which flow into the Ganges in the North-West Provinces, Oudh, Behar and so on, in a direction towards the sea; but experience shews that, so far as the disease can be tracked in any definite direction—that is to say, so far as the circumstance that the months of maximum cholera-prevalence present a certain ill-defined, progressive arrangement along the stations in the Gangetic plain, can be taken as indicative of the "direction" taken by the disease—this direction is precisely the

reverse of that followed by the numerous streams and rivers: cholera attains its maximum in March and April towards the mouths of the Ganges, but not till August at its sources.

The soil-theory and non-endemic areas.

(3). In so far as the endemic area is concerned, there can be no doubt that the soil theory is more in accordance with the phenomena of the seasonal prevalence of cholera than any of the other theories previously considered. In regard to Upper India the evidence is as yet defective, and detailed data are wanting on many points. There are, however, certain important facts pointing very distinctly to the importance of local soil-conditions in relation to cholera-prevalence in this area also.

It was remarked, in one of the earlier chapters of this paper, that the nearer the soil of a district in India approaches in character that constituting the lower portion of the Gangetic plains, the greater is the likelihood that cholera will be found as an endemic disease in it. It has been seen that the seasonal manifestation of cholera changes gradually as we proceed up the river, the disease manifesting a tendency to be deferred later and later in the year the farther the affluents of the Ganges are followed towards their sources, and the drier the climate and the soil become, so that in the upper part of India and in the Central Provinces the maximum prevalence of the disease occurs just at those periods when the soil-conditions most closely approach those in Calcutta when in its driest state, *viz.*, during and towards the end of the rains, at which period alone the soil-conditions of the former area approximate to those in Lower Bengal during the greater portion of the year. After bestowing the most careful consideration on this matter, and after endeavouring to examine it in all its phases, we have come to the conclusion that the theory which regards conditions of the soil as essentially determining the production of the cause of cholera in a locality is much more in accordance with the phenomena of its seasonal prevalence as manifested throughout the Bengal presidency than any of the other doctrines appear to be.

CHAPTER III.

CONCLUSION.

Influence of soil on disease a recognised fact.

In manifesting a marked partiality for a soil of the character of the Gangetic alluvium, cholera is by no means singular, for it is a well-established fact that malarious fevers

and kindred diseases flourish with most vigour about the deltas of large rivers all over the world.

The connection between soil and malaria, as a connection implying cause and effect, is not seriously questioned, and the apparently capricious manner in which some districts evolve it and others do not is a well-recognised fact: swampy and arid soils alike being capable of producing the miasm during certain seasons.

Malaria and cholera in regard to marshy soils.

In this malaria presents a considerable resemblance to cholera, for, although both affections manifest a marked tendency to become endemic in alluvial districts, there exist, nevertheless, very numerous localities, even in tropical and subtropical climates, where both affections are unknown, such for example as the extensive swampy districts in South Australia. That cholera also is unknown there is commonly attributed to the circumstance that India is too far removed to allow of the transport of infectious material, but no one has as yet attempted to explain the absence of malaria on such grounds.

The Andamans and cholera.

We would not, however, be understood to imply that the causes productive of malarious fevers and cholera are identical, or that localities providing the conditions necessary for the development of the one must, therefore, provide those for the other also.

There are malarious localities of the most pronounced type where cholera has never flourished notwithstanding that cases of the affection have been brought there, and fatal cases too. Of these probably no better example could be cited than the large convict settlement at the Andaman Islands, where cholera has never thriven, notwithstanding the fact that it is within 3 days of India and 24 to 36 hours of Burma, and that during the last twenty years steamers have constantly passed between the two countries and the settlement. A steamer laden with convicts proceeds to Port Blair (the only port in the islands) from Calcutta every four weeks, and cholera cases have on some occasions been imported and have died after landing; but it is only on rare occasions that cases of cholera have been registered as occurring in any part of the settlement.

Dr. Rean, the late Principal Medical Officer to the settlement, however, in his annual report for 1870 (quoted by Dr. C. Macnamara, *op. cit.*, page 236), describes cases of the following character :—

"The patients were generally admitted from some feverish locality or had been employed on works of an unhealthy character. They were taken ill somewhat suddenly; the

most urgent symptoms being frequent purging and vomiting with great prostration. The alvine evacuations bear a resemblance to curds mixed with bloody serum, and the vomited matters were a light-coloured watery fluid; the countenance pinched, voice hoarse and husky, tongue pale, and breath cold, the extremities of the fingers and toes puckered, pulse not perceptible, and the surface of the body cold and clammy. The patients suffered from cramps of the stomach and extremities, and had great thirst; respiration was much restrained, causing extreme anxiety and a presentiment of approaching death; in most cases the urinary secretion was suspended. The only diagnostic sign to distinguish the disease from cholera was the character of the stools, and they sometimes approached the conjee-like character of choleraic evacuations."

During a visit to the Andamans in 1872 one of us had an opportunity of witnessing a case of this kind. In this instance the rice or conjee-water character of the evacuations was very evident, together with every other characteristic symptom of cholera, including suppression of urine. Dr. King, the Surgeon-Major in charge of the hospital, had witnessed several such cases, but had hesitated to return them, whether fatal or otherwise, as cholera, because there was no general diffusion of the disease among the convicts.

The importance of well authenticated records of cases of this character can scarcely be overrated in connection with the etiology of cholera. Questions of possible contagion or of water-contamination by a specific material can hardly be seriously entertained here; there can be no casual importation of cases among an isolated community of this character, as the recent history of every person landed is accurately known. Somewhat similar cases habitually occur in every city in India, as well as every summer in nearly all the large cities of Europe. These, however, excite no special comment unless an epidemic breaks out in any part of the country; on this the previously ignored cases are carefully collated and described as the starting-points of the pestilence: it is not the custom to look upon such cases *then* as due to a localised generation of the disease.

Distribution of Malaria not less inexplicable than that of cholera.

That in the present state of our knowledge of the subject, it may appear difficult or impossible to explain all the phenomena of the distribution of cholera by coincident conditions of the soil must be at once allowed. But at the same time, when we come to enquire into the point, we find that just as many difficulties present themselves in reference to malarial

affections.* Whilst generally associated with moisture of air and soil, they also occur in certain localities, which might have been regarded as quite incapable of furnishing the conditions for their production. In some of these cases, such as the oases in the Sahara, the unfitness may be only apparent, and, on closer enquiry, conditions may be demonstrated, calculated to produce the result. In others, however, no satisfactory explanation can be afforded. The telluric origin of the cause producing the symptoms of malarial poisoning is not, however, on this account doubted, and if this be so there is no sufficient reason for doubting the telluric origin of the cause of cholera in similar exceptional cases.†

Not only do we observe marked parallelisms between cholera and malaria in the capriciousness manifested by the apparently very opposite conditions of soil in which the diseases are sometimes observed, but also in the manner of their diffusion. It is a matter of common experience that removal from a locality in which cholera exists is a remedy against the spreading of the disease, and the Government of this country has, for many years past, acted on this knowledge with regard to its troops and prisoners with the greatest benefit. It is equally a matter of experience to find the population of one part of a district suffering severely from fever, whereas others are practically exempt, without any very evident difference in the localities being observable ; and, just as in the case of an outbreak of cholera, how often has it not been observed that crossing to the other side of a river or shifting a ship

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* "Malaria sometimes breaks loose from its endemic haunts and shows itself in places where it has seldom or never before appeared. It thus loses its endemic character and sweeps over considerable regions of country as an epidemic or over vast sections of the globe as a pandemic. * * * * In view of what has been said before, it does not seem probable that currents of air are capable of carrying the poison which is generated in the breeding places of epidemics to a distance of any considerable number of miles. We believe rather that malarial poison is, in the majority of cases, generated on the spot. * * * It is a still more difficult matter to account for those isolated areas of malarial poison which are often confined to a single street, or to one side of a street, or even to single houses, unless, indeed, supposing them to arise from subterranean swamps and collections of water, the exhalations from which reach the surface through rifts in the ground."—H. Hertz on 'Malarial Diseases' in Ziemssen's *Cyclopædia of Medicine*, 1875, p. 578.

† "No chemist has yet been able to demonstrate the existence of malaria. We assume its existence from certain observed effects on the organism just as we do in the case of other poisons which produce certain specific diseases. Malaria is believed to be the product of organic decomposition in soils, whatever may be their mineral composition ; water is indispensable to the process, and a high temperature, although not absolutely necessary, greatly aids it. * * * It is often found in sandy soils and arid-looking plains, devoid of vegetation ; but in all such cases the soil will be found to contain a considerable portion of organic matter, and water will be found not far from the surface, either in the shape of subterraneous streams, or detained by a bed of clay below the sand. * * Malaria is also generated in hard rocks such as granite and trap, in a disintegrating state. A notable example is the island of Hongkong, which consists entirely of weathered and decaying granite."—W. C. Maclean on 'Malarial Fevers' In Reynolds' *System of Medicine*, 2nd Edit. Vol. I., p. 591.

a few hundred yards from where it had been at anchor, has sufficed to put an end to a regular epidemic of malarious affections? With regard to both affections tracts of country which suffer in one season are exempted in the next, whilst districts formerly exempted are in their turn attacked: at the same time, the two diseases manifest a decided predilection to attack some localities at all seasons.

It is not uncommon to find that cholera is described as passing over large tracts of country, either with the wind or in its teeth, according to the particular views entertained by the writer, leaving the impression on the mind of the reader that some pernicious influence had passed over the land. But is it not a fact that cholera, instead of spreading itself over the country on any systematic, geographical plan, often appears simultaneously in districts perhaps a thousand miles apart? Does it not seem more reasonable to infer that the disease was generated at or near the place of its occurrence in the same manner as outbursts of malarious fevers?

There is nothing more remarkable in the production of an attack of cholera than in the production of an attack of ague: in some respects, indeed, the latter is the more remarkable of the two, seeing that once acquired the symptoms may recur at long periods after the original attack and without subsequent exposure to the influences that originally produced it. It is true that although malarious fevers are not so appallingly fatal as cholera, nevertheless it has not been always so. During periods when cholera was either unknown in Europe or a far milder form alone of it prevailed, malarial fevers almost depopulated whole tracts of country—many parts of England suffered terribly, and Sir Gilbert Blane states that the mortality in London from ague during 1558 was so great that the living could not bury the dead.

We would not for a moment have it supposed that we consider the two affections as mere gradations of the same disease; all that we desire to urge is that cholera has as good a claim as malarial diseases to a telluric origin. What the essential cause may be remains unknown in both cases; but the fact that the production of malaria is so greatly under the control of improvements in local conditions warrants us in looking confidently to similar results with regard to the cause of cholera also.

CALCUTTA,

December 1877.

TABLES I TO VII:

A Summary of the Registers of Observations on Water-level, &c., taken in the Bengal Presidency during 1870-76.

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE I. **1870.**

Number.	STATION.	Elevation above Sea-level [in feet]	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level [in feet].†	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.
1	Agra (Civil) ...	555	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	,, (Military) ...	...	54·5	0	0	55·0	?	0	55·5	0·5	0	56·0	0	0	56·7	0	0	?	?	2
3	Allahabad (Civil) ...	306	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	,, (Military) ...	...	49·8	?	5	50·9	?	24	51·3	0·9	3	52·0	0·7	4	52·6	0	6	53·0	4·4	5
5	Amritsar ...	756	22·0	0	0	22·3	0	0	22·5	1·6	0	22·5	0·2	0	22·3	0	0	23·0	0·7	0
6	Azimgurh ...	756	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	Bareilly ...	568	8·3	?	0	8·2	?	0	7·2	?	0	6·6	?	0	?	?	0	...	...	...
8	Barrackpore ...	20	6·9	0·5	?	8·1	?	0	...	...	...	...	...	...	?	1·4	5	...	...	...
9	Benares (Civil) ...	267	36·7	0	0	36·6	0·3	0	37·5	0·3	64	38·2	1·5	213	28·4	6·7	34	?	4·8	numerous.
10	,, (Military) ...	...	40·4	...	...	40·9	...	...	40·1	...	...	41·0	...	...	44·9	...	...	44·7	...	...
11	Berhampore ...	65	7·4	0	0	8·2	?	0	9·9	?	?	11·0	?	?	11·9	1·8	?	12·8	11·4	1
12	Calcutta (Alipore) ...	16	175	...	...	...	...	...	...	...	...	14·8	4·0	382	14·9	0·9	165	14·5	16·0	118
13	,, (Fort William)	18	10·0	0·7	171	11·4	0	259	12·6	0·3	257	12·9	...	...	13·4	...	...	13·9	...	...
14	Cawnpore ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15	Chindwarra* ...	...	14·9	0	0	18·5	0	0	22·6	3·4	0	23·9	1·3	0	24·9	0	0	26·8	12·9	0
16	Chyebassa ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
17	Delhi ...	717	34·4	0	0	34·1	0	0	35·3	2·3	0	35·4	0·8	1	35·9	0	0	36·1	6·2	?
18	Dinapore ...	180?	22·3	?	?	24·1	0	2	25·1	0·1	0	26·0	0·2	0	26·4	0·4	6	25·7	10·3	38
19	Dum-Dum ...	20	...	...	...	...	...	...	...	...	...	...	...	...	9·0	0·5	0	9·2	6·0	0
20	Ferozepore ...	...	33·1	0	0	32·5	0	0	32·2	1·4	0	32·2	0·3	3	32·0	0·3	0	32·1	1·4	0
21	Fort Attock ...	...	31·5	0·2	0	32·0	0·4	0	32·8	2·8	0	29·3	0·1	0	29·6	0	0	30·0	2·0	0
22	Fyzabad ...	400?	...	...	...	...	...	...	...	...	...	?	1·1	22	28·0	0·3	3	28·1	14·4	1
23	Goorgaon ...	...	15·9	0	0	14·9	0	0	13·7	2·1	0	13·3	0	0	11·6	1·5	0	9·4	3·3	0
24	Goruckpore ...	255	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25	Gujranwalla ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24·0	3·1	0
26	Gujrat ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17·7	2·2	0
27	Hazaribagh ...	2,010	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28	Hissar ...	...	...	...	...	...	...	...	...	...	...	...	...	...	106·7	0	0	106·7	2·6	0
29	Hoshungabad ...	1,020	57·5	0·5	0	58·3	0·1	0	58·9	0·3	0	59·3	0	0	59·9	?	?	Well dry	7·1	0
30	Hughli (Chinsurah) ...	30	8·8	1·0	?	9·9	0	?	10·9	0	?	11·6	2·9	?	12·1	2·9	?	12·7	4·1	?
31	Jessore ...	20	12·1	0·2	?	12·6	0	0	13·0	0·2	0	13·4	6·0	0	13·6	7·6	0	14·0	16·3	?
32	Jhansie* ...	859	...	...	...	12·8	0	0	13·0	0·7	0	13·1	0	0	13·1	0	0	13·1	8·1	0
33	Jhelum ...	...	23·3	?	?	25·0	0·4	0	24·9	1·6	0	23·6	1·0	0	22·5	0	0	21·7	9·7	0
34	Jubbulpore (Civil) ...	1,351	6·6	0·6	0	9·6	0·2	0	12·0	1·4	0	14·6	0	0	18·9	0	1	21·8	14·1	0
35	,, (Military)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
36	Jullundur ...	...	21·3	0	0	21·3	0	0	21·4	?	?	...	...	...	...	...	...	...	...	...

* Indicate that the Water-level returns have required correction

† Indicates distance of Water-level from surface of ground

PREVALENCE *in various Stations in Bengal for the year 1870.*

1870. **TABLE I.**

JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER.			WATER-LEVEL OBSERVATIONS RECORDED BY	Number.
Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.		
...	...	...	68·4	?	3	68·9	0·5	0	?	?	?	...	...	...	...	...	...	Dr. A. Christison	1
53·8	?	2	52·9	...	...	52·7	...	...	53·1	?	?	53·8	0	0	54·0	?	0	Drs. C. H. J. Godwin, E. White	2
...	...	...	...	...	...	62·0	7·8	0	57·0	9·3	0	56·8	0	0	56·9	0	0	Dr. J. Irving	3
50·6	16·5	2	45·0	16·8	0	43·5	...	...	44·3	10·2	...	46·6	...	...	47·2	..	...	Dr. J. C. Bow	4
22·1	1·2	0	22·0	4·1	0	21·7	5·0	0	21·7	0·4	0	21·6	0	0	21·6	0·5	0	Drs. J. Ferguson, A. Taylor ...	5
...	...	...	15·1	?	?	6·7	3·1	0	12·5	1·0	0	14·1	0	0	16·1	0	0	Dr. R Jameson	6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. H. C. Guinness ...	7
15·0	9·7	1	13·9	9·9	0	7·4	5·7	0	7·5	2·5	0	7·9	4·3	0	?	?	?	Drs. Menzies, Verchere ...	8
?	?	?	?	?	?	28·4	6·7	34	29·0	7·0	14	31·9	0	2	34·0	0	0	Dr. R. Cockburn	9
43·3	31·3	8	?	...	...	?	...	...	37·0	...	...	37·1	...	...	38·9	...	...	Drs. Perkins, Fitzmaurice ...	10
European troops removed from station						...	...	...	...	...	...	...	...	...	...	...	...	Dr. E. R. O'Brien	11
13·0	10·9	50	10·0	11·2	40	7·9	9·0	30	10·5	3·9	37	10·5	1·6	22	12·0	0	32	Dr. S. Lynch	12
13·3	...	...	12·9	...	...	6·7	...	...	8·4	...	...	8·8	...	...	9·9	...	...	Dr. D. H. Daly	13
...	...	...	...	...	...	40·5	11·1	0	39·5	4·7	0	38·7	0	0	38·3	0	0	Dr. J. H. Loch	14
19·4	10·1	0	8·9	4·4	0	7·9	6·2	1	6·2	6·7	0	8·0	0	0	10·8	0	0	Mr. A. G. Price	15
2·8	10·7	?	1·7	11·0	?	0·0	8·2	?	0·0	5·7	?	0·0	...	...	?	1·2	?	S. A. Manook	16
34·4	2·8	?	33·1	11·5	?	32·7	0·5	?	32·7	0	?	33·9	0	?	34·6	0	?	Dr. J. V. Fishbourne ...	17
14·10	8·0	3	10·2	10·9	12	7·4	6·7	2	12·5	9·4	3	15·7	0	0	20·9	0	0	Drs. R. T. Wright, Carmichael	18
7·2	10·0	0	4·0	14·4	0	2·9	9·6	0	3·1	2·3	1	3·9	1·0	1	4·9	0	0	Capt. A. Walker	19
32·1	1·1	0	32·3	8·3	0	32·0	0·1	0	31·6	?	0	31·6	0	0	31·8	1·1	?	Dr. J. Davis	20
29·9	0·5	0	29·5	2·9	0	27·8	0·1	0	28·0	0	0	28·7	0	0	29·9	?	0	Drs. R. Adams, G. Andrew ...	21
26·1	29·7	0	24·6	14·4	0	24·6	13·7	0	24·9	3·2	0	...	...	...	?	?	?	Dr. A. B. Seaman	22
9·0	5·6	0	12·0	2·3	0	13·7	1·6	0	13·8	0	0	13·4	0	0	13·6	0·1	0	Dr. R. Willmot	23
...	...	...	...	...	...	11·0	8·3	0	8·2	3·1	0	9·3	0	0	16·1	0	0	Dr. C. Prentis	24
23·9	3·4	0	23·9	7·8	0	23·7	0	0	23·9	0·6	0	24·0	0	0	24·1	0	0	Dr. Bose	25
17·4	4·8	0	17·4	4·4	0	17·2	2·0	0	17·6	0	0	17·3	0	0	17·4	0	0	Dr. W. P. Dickson	26
20·0	9·4	196	4·5	20·2	50	0·9	7·7	0	1·5	6·5	0	0·9	?	?	?	?	?	Dr. W. H. Corbett	27
106·2	2·5	0	106·4	7·4	0	103·5	0·2	0	103·7	0	0	103·5	0	0	?	?	?	Dr. J. A. Cooper	28
58·7	10·2	0	55·8	9·2	0	55·0	5·1	0	54·9	2·9	0	55·6	0·1	0	56·9	0	0	Dr. P. Cullen	29
11·6	6·8	?	3·7	9·2	?	2·6	10·2	?	4·0	2·7	?	5·3	1·4	?	6·9	0	?	Drs. T. Best, G. E. Dobson ...	30
11·3	13·0	0	8·9	17·0	0	7·2	8·3	0	6·5	7·0	0	8·0	0	0	10·5	0	0	Dr. D. P. Shipton... ...	31
12·3	7·5	0	11·0	13·8	0	10·2	8·3	1	10·6	0·7	0	11·8	0	0	11·9	0	0	Dr. H. W. Spry	32
22·7	14·8	0	21·9	15·6	0	21·9	3·1	0	21·8	0	0	22·2	0	0	22·7	0·9	0	Drs. E. Gardner, J. Clarke ...	33
10·5	27·3	0	2·3	21·1	?	2·7	14·0	0	3·8	5·3	0	4·2	0	0	4·6	0	0	Dr. W. R. Rice	34
12·2	...	...	11·3	...	...	11·0	...	...	?	...	...	?	...	...	...	...	...	Drs. W. Eames, A. Duke ...	35
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. J. H. Oliver	36

owing to the apparatus having been read in the inverse way, &c.

throughout.

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE I. 1870.

Number.	STATION.	Elevation above Sea-level [in feet.]	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet).‡	Rainfall (in inches.)	Cholera.	Distance of Waterl-evel (in feet.)	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet.]	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.
37	Kheree ...	...	...	...	...	...	...	...	...	...	...	30·6	0·5	0	30·9	0·2	0	30·8	12·0	0
38	Kurnal ...	...	24·8	0	0	24·9	0·4	0	25·1	3·5	0	25·0	0·8	0	24·7	0·8	0	25·1	3·0	...
39	Lucknow (Observatory)	369	...	...	...	...	...	...	...	...	...	15·8	0·7	0	16·2	0·2	1	17·2	9·9	0
40	,, (Central prison)	...	...	...	...	...	...	...	...	...	...	24·9	0·4	0	24·9	0·2	1	25·4	7·4	0
41	Ludianah ...	...	28·5	0·1	0	28·4	0·1	0	28·4	2·2	0	28·4	0·1	0	28·5	0·2	0	29·0	4·5	0
42	Lullutpore ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
43	Maldah ...	160	12·1	0·0	7	16·0	0	2	18·0	0·2	1	20·0	0·7	35	23·9	0·8	127	23·2	10·8	58
44	Mean Meer ...	...	37·0	0	0	36·9	0	0	36·9	0·2	0	36·9	0	0	36·8	0	0	36·8	1·3	0
45	Meerut (Civil) ...	739	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
46	,, (Military) ...	...	10·6	0	0	10·9	0	0	10·9	1·9	1	10·9	0·6	1	11·0	0·6	1	11·0	14·1	0
47	Midnapore† ...	108	18·4	0·9	11	21·0	0	10	22·3	0·5	0	22·9	0·3	0	23·6	2·3	0	20·9	10·5	0
48	Monghyr ...	160	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
49	Motiharee ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
50	Mozufferpore ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
51	Mundla ...	...	31·5	0·7	0	32·4	1·7	0	32·9	1·2	0	33·3	0·6	0	33·8	0	0	34·9	8·9	0
52	Murshidabad ...	...	7·8	0	0	8·5	0	?	9·3	0·4	?	11·0	1·1	?	11·9	2·9	?	12·8	11·2	?
53	Muttra* ...	550?	32·8	0	0	32·8	0	0	33·0	2·5	0	33·0	1·1	0	33·5	0	0	33·0	5·2	0
54	Nagode ...	...	...	...	...	8·5	?	0	10·0	0·7	0	11·8	1·2	0	13·6	0	0	15·2	4·7	0
55	Nowgong ...	...	...	...	...	...	...	...	...	...	...	22·9	0·2	?	23·0	0	0	23·9	3·5	0
56	Nowshera ...	...	38·0	0·5	0	38·2	0	0	38·4	1·6	0	?	?	?	...	...	...	...	...	...
57	Pertabgurh ...	...	...	...	...	...	...	...	...	...	...	23·5	0·6	0	24·1	0·7	1	25·6	5·4	0
58	Peshawur ...	1,165	...	...	...	...	...	...	...	...	...	...	...	...	81·7	0·9	0	82·3	0	0
59	Raipur ...	950	16·8	1·0	0	18·4	0	0	20·6	1·3	0	22·0	0·7	0	24·2	0·4	0	27·4	13·2	0
60	Rawulpindee ...	1,650	106·0	0	0	106·3	0·6	0	106·4	4·0	0	?	?	?	...	...	...	...	...	...
61	Roorkee ...	883	31·8	0	0	31·7	2·0	...	31·7	2·0	0	31·8	0·9	0	31·9	0	0	32·2	4·9	0
62	Saugor (Civil) ...	1,763	4·9	0	0	5·4	0	0	6·1	1·2	0	7·8	0·2	0	12·0	0	0	17·6	7·8	0
63	,, (Military)* ...	...	15·5	...	...	16·5	...	...	17·5	...	...	18·0	...	...	20·0	...	...	21·5	...	...
64	Seonee, No. 1 well ...	2,030	8·8	1·3	0	11·3	0	0	13·0	1·6	0	15·0	0·2	0	17·2	0	0	17·9	16·3	7
65	,, ,, 2 ,, ...	...	17·0	1·3	0	20·6	0	0	23·6	1·6	0	25·9	0·2	0	28·0	0	0	29·5	16·3	7
66	Seepree ...	...	..	...	...	...	...	...	...	...	...	5·7	0	0	5·7	0·5	0	5·7	2·7	0
67	Seetapore ...	...	...	...	...	29·8	...	...	29·9	?	0	30·0	?	0	30·9	?	?	30·4	?	0
68	Sialkote* ...	829	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
69	Sirsa ...	...	...	...	...	104·3	0	0	102·9	1·8	0	102·7	0·5	0	102·7	0·2	0	102·9	4·9	0
70	Subathoo ...	5,000?	...	...	...	8·4	1·6	0	8·3	4·0	0	8·2	0·1	0	8·2	?	0	8·3	12·6	0
71	Sylhet ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
72	Umballa ...	902	26·8	0	0	26·8	0·2	0	26·4	2·6	0	26·2	0·8	0	26·1	0	0	26·1	7·1	0

* Indicate that the Water-level returns have required correction

† Rainfall in the district during previous year between 20 and

‡ Indicates distance of Water-level from surface of ground

PREVALENCE *in various Stations in Bengal for the year 1870*—continued.

1870. TABLE I.

July.			August.			September.			October.			November.			December.			WATER-LEVEL OBSERVATIONS RECORDED BY	Number.
Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera.		
28·1	13·6	0	26·8	13·3	0	21·3	8·3	0	21·0	0·4	0	20·4	0	0	20·9	0	0	Dr. W. W. Galloway ...	37
25·2	4·2	0	24·1	4·8	0	24·1	4·0	0	24·5	0	0	23·9	0	0	23·9	0·8	0	Drs. Lethbridge, Metcalfe ...	38
15·5	15·7	0	11·0	20·1	1	6·5	17·1	0	7·6	2·44	0	8·8	0	0	9·9	0	0	Dr. C. Cameron	39
24·3	13·0	0	23·8	20·8	1	19·2	?	0	17·3	4·0	0	17·4	0	0	18·1	0	0	Dr. C. Cameron	40
28·8	4·4	0	27·3	7·5	0	25·2	3·2	0	24·0	0·1	0	24·1	0	0	24·0	0·8	0	Dr. Ince	41
...	...	...	...	...	...	2·9	?	0	3·4	?	0	3·0	?	0	3·7	?	?	Dr. F. W. Sanders... ...	42
14·9	13·2	14	8·7	11·6	0	4·3	8·9	1	5·8	7·1	0	5·7	0	2	7·7	0	2	Civil Surgeon	43
36·8	3·6	0	36·8	7·9	0	36·8	0·1	0	?	?	?	?	?	?	36·7	?	?	Drs. Mantell, Birch ...	44
...	...	...	...	...	...	12·8	4·0	0	13·6	0	0	13·3	0	0	13·7	0	0	Dr. W. Moir	45
10·4	11·7	0	9·8	6·9	1	9·0	4·7	0	8·9	0	0	9·0	0	0	9·3	0·3	0	Drs. Fogo, Clapp	46
10·0	12·5	3	5·6	14·0	0	3·9	5·5	0	6·8	5·5	0	?	?	?	...	...	...	Dr. R. G. Mathew... ...	47
...	...	...	...	...	...	...	...	...	36·9	8·4	?	38·8	0	?	?	?	?	Dr. O'C. Raye	48
...	...	...	...	...	...	4·6	4·6	0	6·9	11·2	0	6·2	0	0	7·3	1·2	0	Dr. J. Cullen	49
...	...	...	12·8	?	?	6·7	14·4	0	5·0	14·0	0	7·0	0	0	11·9	0	0	Dr. E. J. Gayer	50
33·0	15·1	0	27·5	13·6	0	26·6	6·9	...	28·3	1·8	0	29·5	0	0	31·0	0	0	Dr. H. A. Kidd	51
9·7	9·6	?	7·0	10·0	?	6·0	13·5	?	4·4	4·5	?	4·6	0	?	5·4	0	?	Dr. J. White	52
33·1	10·5	0	33·3	7·8	1	33·6	4·0	0	34·0	0	0	33·9	1·5	0	34·0	0	0	Dr. G. Pain	53
15·2	12·0	0	7·8	30 0	0	0·4	6·3	0	1·8	13·3	0	2·4	0	0	2·6	0	0	Captain E. J. V. Holloway ...	54
23·2	4·7	0	21·9	7·5	0	20·9	4·6	0	20	?	?	20·3	...	...	22·9	0	0	Dr. J. E. Fannin	55
38·7	?	?	36·9	8·3	0	36·8	0	0	36·8	0	0	37·0	0	0	37·3	·2	0	Dr. G. Griffith	56
24·2	27·0	0	22·7	13·7	0	20·9	8·8	0	20·0	0·6	...	19·3	0	0	21·0	0	0	Dr. J. Hart	57
82·5	0	0	83·0	3·2	0	83·3	0·6	0	83·6	0	0	83·8	0	0	83·9	0	0	?	58
10·4	18·2	0	5·2	13·8	0	4·8	11·0	...	9·7	2·5	0	11·9	3·6	0	14·9	0	0	Dr. D. W. Trimnell ...	59
...	...	...	...	...	...	...	...	...	106·4	?	0	103·3	0	0	106·4	0·8	0	Drs. Jameson, Fitzgerald ...	60
32·0	14·6	0	31·6	12·5	0	31·0	6·3	0	30·6	0·7	0	30·4	0	0	30·2	0	0	Dr. A. Eteson	61
2·7	20·0	0	2·9	12·3	0	2·9	7·9	0	3·1	3·1	0	3·3	0	0	3·6	0	0	Dr. W. Williamson ...	62
20·8	...	...	11·9	...	...	9·6	...	...	7·0	...	...	8	...	...	9·8	...	...	Dr. G. F. Trimnell ...	63
1·9	23·3	0	1·9	6·2	0	1·9	5·4	0	4·5	4·0	0	4·6	1·7	0	8·5	0	0	Dr. J. Barter	64
11·2	23·3	0	7·5	6·2	0	7·6	5·4	0	10·0	4·0	0	10·0	1·7	9	13·9	0	0	Dr. J. Barter	65
5·7	6·1	...	5·7	7·8	0	5·7	3·0	0	5·7	3·2	0	?	?	?	?	?	?	Drs. J. Supple, G. Corry ...	66
30·7	?	0	30·7	?	0	28·1	?	0	28·4	?	0	27·1	?	0	27·8	?	0	Capt. Beadon, Dr. Townsend...	67
...	...	...	...	...	...	40·0	?	0	40·1	?	0	40·2	0	0	40·3	?	0	Drs. Malcolm, Brown ...	68
102·8	0	0	102·8	2·2	0	102·5	1·1	0	102·7	0	0	102·8	0	0	102·3	0·2	0	Mr. T. Nulty, Mr. J. Rehill ...	69
7·3	8·7	0	7·0	11·3	0	6·9	7·8	0	7·6	0·6	0	7·9	0	0	7·9	?	0	Dr. Roe, Ensign G. Griffiths...	70
...	...	...	...	...	...	...	...	...	2·4	8·0	0	3·1	0·1	...	4·0	0	0	Dr. R. Deacon	71
26·2	4·6	0	26·3	7·7	0	26·3	4·2	0	26·2	0·4	0	26·5	0	0	26·0	1·5	0	Drs. Macnamara, Macmullen	72

owing to the apparatus having been read in the inverse way, &c.
30 inches below the average amount.
throughout.

A Monthly Statement of WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE II. 1871.

Number.	STATION.	Elevation above Sea-level [in feet].	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.
1	Agra (Civil) ...	555	66·6	1·5	0	66·7	0·2	0	66·4	0	0	66·0	0·4	1	65·9	2·4	1	65·9	5·3	3
2	,, (Military) ...	...	54·0	...	...	54·0	...	...	54·1	...	...	54·2	...	...	54·2	...	...	54·0	...	...
	Akolah ...	923	29·6	0	0	29·7	0	0	30·0	0	0	30·6	0	0	31·3	0	0	31·9	?	24
4	Allahabad (Civil) ...	306	57·4	0·4	1	57·9	0·2	1	58·4	0	3	59·0	0	10	59·5	0·7	14	60·0	15·4	8
5	,, (Military) ...	...	47·9	...	...	48·7	...	...	49·0	...	...	50·2	...	...	51·2	...	...	51·1	...	...
6	Amritsar ...	750	21·5	0	0	21·7	2·9	1	20·7	0	0	20·9	0·3	0	20·8	1·3	0	?	5·7	0
7	Azimgurh ...	...	?	0	0	?	0·6	...	16·5	0	0	17·3	0·2	16	17·7	2·0	39	17·7	1·3	90
8	Beerbhoom ...	...	...	...	...	...	...	...	...	...	...	18·8	?	0	20·0	0·7	0	dry	3·5	0
9	Benares (Civil) ...	267	35·0	0	0	36·0	0	0	36·9	0·4	15	38·6	1·2	446	39·6	0·8	298	41·1	9·7	96
10	,, (Military) ...	...	38·5	...	...	39·0	...	...	40·1	...	...	40·6	...	...	42·6	...	...	43·7	...	...
11	Burdwan ...	102	...	...	...	...	...	...	...	...	...	...	...	...	13·3	4·0	7	13·8	8·0	4
12	Burisal ...	...	7·0	?	0	8·7	?	0	8·6	?	0	9·0	?	0	9·2	?	0	0·0	?	0
13	Calcutta (Alipore) ...	16	13·5	0	53	13·9	0·7	96	13·9	5·4	55	14·0	5·7	85	13·9	10·0	29	9 9	25·3	23
14	,, (Fort William)...	18	10·9	...	...	11·7	...	...	12·0	...	...	11·1	...	...	12·3	...	...	11·0	...	...
15	Cawnpore ...	...	38·1	0	0	37·9	0	0	37·7	0	0	38·7	0	2	39·4	1·1	?	39·9	8·2	20
16	Chindwarah ...	...	16·5	1·3	0	19·0	1·0	0	23·4	0	0	25·9	0	0	27·9	0·8	0	29·5	14·1	0
17	Chittagong ...	90	17·2	?	0	18·0	?	0	18·0	3·7	0	19·2	1·5	1	19·8	6·0	0	5·2	35·0	0
18	Comillah ...	717	5·0	0	0	5·8	0	0	6·0	2·3	0	6·6	4·8	0	5·6	18·5	4	2·7	22·8	18
19	Delhi ...	Appa	ratus	bro	ken	29·3	0	0	28·3	0	0	28·6	0·2	0	28·8	3·5	1	28·9	5·0	0
20	Deoghur ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21	Dinapore ...	180	22·9	0	0	24·1	0	0	25·0	0·2	0	25·6	1·2	0	26·0	2·7	3	23·8	12·0	1
22	Dinagepore ...	...	10·1	?	15	10·9	1·0	13	11·1	3·1	14	11·9	2·1	33	12·8	12·5	51	12·8	12·3	8
23	Dum-Dum ...	20	5·6	0	0	6·2	1·6	0	5·5	6·4	0	6·1	3·8	0	6·1	8·4	0	3·8	14·0	1
24	Ferozepore ...	...	32·3	0	0	32·0	2·2	0	32·8	0	0	32·7	0·7	0	32·8	0·8	0	33·0	5·1	0
25	Fort Attock ...	...	30·4	0	0	30·9	4·3	0	29·9	0·2	0	29·7	0·7	0	29·5	0·1	0	28·9	2·9	0
26	Fyzabad ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	New	well	18·0	10·8	0
27	Goalpara ...	386	...	...	...	...	...	...	...	...	...	...	...	...	22·0	21·0	3	16·9	16·5	8
28	Goorgaon ...	...	12·2	0·4	0	11·9	0·4	0	12·1	0	0	11·3	0·2	0	10·8	1·2	0	10·0	1·8	0
29	Goruckpore ...	255	10·9	0·2	0	11·4	0·4	0	11·9	0·1	0	12·6	0·1	0	13·3	5·7	0	13·9	7·4	0
30	Gujranwalla ...	...	24·2	0	0	24·4	1·2	0	24·5	0	0	24·7	0	0	24·9	0	0·8	24·9	3·7	0
31	Gujrat ...	...	17·2	0	0	17·3	2·6	0	17·6	0	0	17·6	0	1	17·8	0·6	0	17·4	11	0
32	Hissar ...	...	97·9	0	0	98·7	1·2	0	98·0	0	0	98·1	0	0	98·3	0·8	0	98·7	4·0	0
33	Hoshungabad ...	1,030	57·9	1·5	0	58·5	0	0	59·7	0	0	dry	0	0	dry	0·9	0	dry	14·2	0
34	Howrah ...	18	5·5	0	3	6·3	0·4	1	6·4	6·0	8	6·4	2·3	12	6·7	10·0	10	4·4	23·4	7
35	Hugli (Chinsurah) ...	30	8·2	0·5	5	9·1	?	6	9·9	3·1	17	10·0	4·0	9	10·6	9·5	4	7·9	15·9	3
36	Jhansie* ...	359	12·0	2·1	0	13·2	0·5	0	13·2	0	0	13·2	0·2	0	13·3	2·9	0	13·7	7·9	0
37	Jhelum ...	...	23·0	0	0	23·2	5·3	0	22·1	0·1	0	22·0	0·1	0	21·6	0·2	0	20·9	2·5	0
38	Jubbulpore (Civil) ...	1,351	4·9	0	0	5·9	0	0	6·9	0	0	7·9	0	0	9·5	7·1	0	9·5	7·1	0
39	,, (Military) ...	...	...	...	...	7·9	...	...	8·2	...	...	8·6	...	...	8·6	...	...	8·6	...	...

* Indicate that the Water-level returns have required correction owing to the

PREVALENCE *in various Stations in Bengal for the year 1871.*

1871. TABLE II.

JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER.			WATER-LEVEL OBSERVATIONS RECORDED BY	NUMBER.
Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.		
66·2	8·9	2	?	10·4	1	?	4·4	0	67·7	0	0	68·5	0	3	68·4	0·7	0	Drs. Christison, Pilcher	1
53·7	...	...	52·9	...	...	53·3	...	...	...	...	...	...	...	...	...	...	...	Dr. C. H. Y. Godwin ...	2
31·9	?	4	32·0	2·1	0	32·4	4·9	0	33·6	0	0	35·9	2·0	0	36·3	0	0	Drs. A. Porter, J. Pitts...	3
58·5	25·1	2	55·8	7·3	0	54·2	11·2	0	52·9	0	0	53·0	0	0	53·6	0	1	Dr. J. Irving ...	4
45·8	...	...	41·3	...	...	40·4	...	...	...	...	...	...	...	...	...	...	...	Dr. J. C. Bow ...	5
?	5·1	0	?	0	0	?	0·4	0	?	0	0	?	0	0	?	0	0	Dr. A. Taylor ...	6
17·2	7·8	18	14·8	4·7	3	14·0	9·0	4	?	?	17	?	?	40	?	?	9	Drs. E. Jameson, A. Wood.	7
14·9	8·3	15	8·4	17·3	13	?	?	?	...	...	...	...	...	...	...	...	...	?	8
35·0	12·9	35	28·4	11·2	154	23·9	10·7	38	25·5	0	0	27·3	0	0	29·6	0	3	Drs. Cockburn, Hooper	9
39·9	...	...	36·0	...	...	33·8	...	...	?	...	...	...	...	...	...	...	...	Drs. Perkins, Donnell...	10
9·9	13·5	3	4·9	16·7	4	3·5	11·9	1	4·0	5·4	0	5·0	0	0	6·0	0	0	Dr. Elliot ...	11
0·0	?	0	0·0	?	0	4·0	?	0	2·0	?	0	3·9	?	0	5·9	?	0	? Civil Surgeon ...	12
6·9	15·9	25	6·0	12·1	41	5·9	9·9	70	7·7	7·0	86	10·3	0	128	12·2	0	109	Dr. Lynch ...	13
4·9	...	...	4·9	...	...	4·7	...	...	...	...	...	...	...	...	...	...	...	Drs. Daly, R. T. Lyons...	14
38·6	15·8	0	37·3	7·5	0	36·8	5·1	0	36·5	0	0	36·7	0	0	37·1	1·6	0	Civil Surgeon ...	15
19·8	8·5	0	6·9	2·8	0	5·2	7·3	0	6·5	0	0	11·2	0·5	0	16·4	0·8	0	Dr. A. G. Price ...	16
2·2	16·5	0	5·2	16·7	0	4·5	7·7	0	6·9	8·4	0	9·5	0	0	12·1	0	28	Dr. Meadows ...	17
1·8	14·6	0	2·0	17·0	0	2·5	18·0	0	2·1	6·5	0	3·5	0	0	?	?	?	Dr. Stock ...	18
27·9	5·4	0	26·2	7·2	0	25·6	0·4	0	...	...	...	...	...	...	...	...	...	Drs. Candy, Hanrahan...	19
27·0	13·6	0	21·0	15·0	0	17·5	6·7	0	19·0	0·3	0	21·0	0	0	23·0	0·1	0	Civil Surgeon ...	20
14·1	10·9	0	7·7	13·4	3	7·0	18·3	0	4·0	...	...	...	...	...	...	...	...	Dr. J. C. Carmichael ...	21
10·0	15·8	22	9·6	12·7	26	7·9	6·2	25	6·9	0·2	15	8·9	0	49	10·0	0·1	71	?	22
2·1	12·0	0	2·1	5·5	0	1·3	9·7	0	...	...	...	...	...	...	...	...	...	Captain A. Walker ...	23
?	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. J. Davis ...	24
27·3	3·4	0	27·4	0·3	0	27·8	0·5	0	...	...	...	...	...	...	...	...	...	Drs. G. Andrew, E. White.	25
17·4	24·7	0	16·5	16·9	0	18·9	19·6	1	7·1	?	?	7·9	0	0	9·0	0·5	0	?	26
9·0	14·2	35	5·2	12·7	6	3·0	10·7	0	6·1	0·8	0	11·9	1·3	3	15·4	0	1	Dr. Briscoe ...	27
9·5	8·1	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. R. Wilmot ...	28
12·4	20·3	0	9·7	21·0	0	2·9	19·0	0	2·3	0	0	6·4	0	0	9·0	0	0	Dr. C. Prentis ...	29
24·9	3·3	0	24·9	1·7	0	25·0	0·6	0	25·0	0	0	25·0	0	0	25·0	0·7	0	Dr. R. C. Bose ...	30
?	4·5	0	15·1	0	0	15·8	0	0	14·4	0	0	14·8	0	0	14·4	0·4	0	Drs. Dickson, Quinnell	31
98·8	2·2	0	99·0	0	0	99·3	1·6	0	99·3	0	0	100·4	0	0	100·4	1·0	0	Dr. J. Cooper ...	32
52·0	15·4	0	51·1	12·8	0	46·5	22·0	0	46·9	0	0	50·3	0·2	0	53·6	0	0	Dr. P. Cullen ...	33
1·8	17·0	7	3·9	12·5	12	5·3	11·4	17	2·4	6·4	47	1·0	0	67	1·4	0	121	Dr. R. Bird ...	34
2·5	13·7	5	1·3	19·2	4	1·7	7·7	36	4·3	4·6	550	4·3	0	2	6·2	0	63	Dr. R. F. Thompson ...	35
12·5	13·2	0	9·4	15·9	0	8·4	7·4	1	10·2	0	0	10·5	...	...	...	...	...	Dr. H. W. Spry ...	36
21·0	4·3	0	21·0	5·0	0	21·2	1·3	0	21·9	0	0	22·1	...	...	...	...	...	Drs. Gardner, Martin ...	37
10·6	?	0	4·4	?	0	2·2	13·1	0	3·5	0	0	4·9	0	0	7·0	0	0	Dr. W. R. Rice ...	38
7·5	...	0	2·0	?	...	0·0	...	0	...	...	...	...	...	...	...	...	...	Dr. G. Carry ...	39

registering apparatus having been read in the inverse way, &c.

A Monthly Statement of WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE II. 1871.

Number.	STATION.	Elevation above Sea-level [in feet].	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.
40	Kheree ...	...	21·3	0·6	0	21·7	1·1	0	21·9	0	0	22·3	0·2	0	22·7	5·7	0	dry	9·8	0
41	Kishnaghur ...	...	...	...	...	...	...	...	...	...	...	...	...	...	3·6	8·0	0	2·7	12·0	0
42	Kurnal ...	...	24·6	0	0	23·9	4·3	0	23·0	0	0	24·0	0·2	1	24·8	1·2	0	25·6	7·4	0
43	Lucknow (Obsty.) ...	369	10·5	1·4	0	11·0	1·1	0	11·4	0	0	11·9	0	1	12·4	3·1	0	12·9	11·5	2
44	„ (Prison) ...	...	18·1	1·0	...	18·4	1·7	...	18·8	0	...	20·0	0	...	20·9	1·7	...	20·9	15·7	...
45	Ludianah ...	900	24·0	0	...	24·0	3·2	0	23·9	0	1	24·1	0·2	0	24·1	0·6	0	23·5	8·6	0
46	Lullutpore ...	...	4·3	?	0	4·6	?	0	4·8	?	0	4·4	?	0	5·1	?	0	6·9	13·7	0
47	Maldah ...	160	12·6	0	8	14·7	0·1	8	16·3	1·5	7	20·0	1·7	1	20·3	4·6	4	21·0	6·6	0
48	Mandla ...	...	32·0	0·2	0	32·1	0·5	0	32·7	0	0	35·3	0·1	0	35·5	1·3	0	36·0	12·1	0
49	Meean Meer ...	...	36·7	0	0	36·6	0·2	0	36·6	0	0	36·6	0·2	0	36·5	2·9	0	36·5	1·9	0
50	Meerut (Civil) ...	739	13·6	0·8	0	13·6	2·2	1	13·5	0	0	13·9	1·0	0	14·2	3·7	0	14·2	6·8	?
51	„ (Military) ...	...	9·4	...	...	9·4	...	...	9·5	...	...	9·8	...	...	10·0	...	...	10·0	...	...
52	Midnapore ...	108	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8·3	8·9	1
53	Monghyr ...	160	41·0	0	0	42·0	0·2	0	42·7	?	?	dry	1·2	0	dry	2·0	14	52·0	10·3	28
54	Motiharee ...	...	8·0	?	5	?	?	?	10·2	?	1	11·0	1·5	0	10·2	7·0	3	6·9	6·4	0
55	Mozufferpore ...	...	14·0	?	2	16·9	0·6	4	18·4	0	0	20·9	0·8	10	22·7	3·4	11	21·7	9·6	40
56	Murshidabad ...	...	6·1	0	0	6·9	0·2	0	7·7	1·3	0	5·7	0·1	0	9·7	7·3	0	9·0	13·0	0
57	Muttra* ...	...	33·9	0	0	33·9	0·7	0	34·0	0	0	34·2	0·5	0	34·3	0·4	0	33·7	8·7	0
58	Mymensing ...	...	...	...	...	7·1		0	7·5	0	0	8·7	?	0	12·7	?	0	6·4	?	0
59	Nagode ...	...	6·2	0	0	7·9	0	0	9·6	0	0	11·5	0	0	13·5	2·0	0	15·2	8·3	0
60	Nowgong ...	...	23·0	0·7	0	23·3	0·4	0	...	...	...	24·6	0·6	0	24·4	2·1	0	24·9	11·4	0
61	Nowshera ...	...	37·6	0	0	37·8	6·9	0	37·9	0	0	?	?	?	?	?	?	?	?	?
62	Oomraotee ...	1,206	23·9	0	0	24·5	0	0	25·1	0	0	26	0	0	28·0	0	0	28·3	0	0
63	Patna ...	179	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7·0	?	?
64	Pertabgurh ...	...	...	...	...	...	...	...	New well			20·0	0	0	21·0	0·8	0	22·4	6·9	0
65	Purneah ...	125	1·9	0	0	2·4	0·3	4	3·0	0·4	0	3·4	3·4	1	3·8	3·1	0	4·0	14·2	0
66	Raipur ...	960	16·6	0	0	18·3	0	0	19·9	0·2	0	22·3	0·1	0	24·9	1·3	0	25·6	13·5	0
67	Rajshahi ...	...	7·9	?	0	9·3	0·1	0	10·3	0·9	0	12·9	0·3	0	15·1	5·6	0	13·5	15·2	0
68	Ranchi ...	...	13·8	?	?	14·4	0	1	14·7	2·1	4	15·8	0·3	7	16·9	3·4	1	8·9	16·6	7
69	Rawulpindi ...	1,650	106·4	0	0	106·0	6·4	0	105·9	?	?	...	...	...	...	...	...	...	...	...
70	Roorkee ...	886	30·0	1·0	0	29·9	3·1	0	29·7	0	0	29·7	0	0	...	...	...	...	...	...
71	Saugor (Civil) ...	1,766	5·5	1·2	0	7·3	0·4	0	9·0	0	0	11·7	0	0	14·7	1·1	0	15·1	14·6	0
72	„ (Military) ...	...	10·4	...	...	12·2	...	...	15·3	...	...	17·0	...	...	15·0	...	...	18·5	...	...
73	Seonee, No. 1 Well ...	...	11·0	0	0	13·7	0·4	0	16·0	0	0	18·3	0	0	17·0	1·4	0	17·2	15·6	0
74	„ „ 2 „ ...	2,030	17·3	...	...	19·9	...	...	22·6	...	...	25·6	...	...	28·2	...	...	31·2	...	...
75	Seetapore ...	...	27·4	?	0	27·2	0	0	27·1	0	0	27·2	0	0	27·8	3·6	0	27·9	?	0
76	Shajehanpore ...	...	20·9	0	0	20·9	?	0	21·2	?	0	21·9	?	0	22·4	5·6	0	22·9	10·5	0
77	Sialkote* ...	829	40·2	2·9	0	40·2	0·1	0	40·2	0·1	0	40·4	0	0	40·3	0·3	0	40·2	7·1	0
78	Sirsa ...	...	102·4	0	0	102·6	1·2	0	102·5	0	0	102·5	0	0	102·6	1·1	0	102·5	3·6	0
79	Sylhet ...	...	4·8	0	0	5·4	1·3	0	5·3	2·5	0	1·9	17·1	0	2·4	20·3	0	1·9	16·3	0
80	Umballa ...	...	25·7	?	?	24·9	1·8	0	25·6	0	0	25·4	0·2	0	24·9	2·4	0	25·0	11·6	0

* Indicate that the Water-level returns have required correction owing to the

PREVALENCE *in various Stations in Bengal for the year 1871*—(continued).

1871. TABLE II.

July.			August.			September.			October.			November.			December.			WATER-LEVEL OBSERVATIONS RECORDED BY	Number.
Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.	Distance of Water-level [in feet].	Rainfall [in inches].	Cholera cases.		
27·4	29·0	0	25·8	11·5	0	22·8	11·3	0	22·6	0	0	23·9	0	0	?	0	0	Dr. J. Hart ...	40
Full	11·9	0	0·0	10·3	0	0·0	4·7	0	0·0	3·0	0	...	...	...	...	...	...	?	41
25·6	5·1	0	25·9	2·9	0	24·2	0·3	0	24·7	0	0	24·4	0	0	23·8	0·6	0	Drs. Metcalfe, Calthrop	42
10·9	20·9	0	8·1	5·3	0	6·7	24·1	0	6·9	0	4	8·3	0	420	9·3	2·1	373	Dr. J. Cameron ...	43
19·9	18·3	...	15·1	..	...	14·2	...	...	Well de	stroye	d by	heavy	rain	...	...	...	...	Dr. C. Cameron ...	44
21·9	0	0	21·4	2·0	0	21·1	0·7	0	20·9	0	0	20·9	0	0	20·7	0·7	0	Dr. J. Ince ...	45
?	12·3	0	4·2	13·4	0	4·2	6·2	0	3·7	0	0	3·0	0	0	4·9	0·3	0	Dr. F. W. Saunders ...	46
14·4	14·9	56	7·2	6·1	17	1·5	20·2	11	1·7	4·5	85	4·4	0	282	8·4	0	170	Dr. Chatterjee ...	47
34·9	25·0	0	26·3	2·3	0	28·8	8·2	0	28·6	0	0	30·8	0	0	31·6	1·4	0	Dr. H. A. Kidd ...	48
36·5	4·6	0	36·5	0	0	36·5	0	0	...	...	...	...	...	...	...	...	...	Drs. Poole, A. Deane ...	49
13·8	9·7	?	12·6	5·8	0	11·9	1·1	0	12·2	0	0	12·5	0	0	12·8	1·6	0	Dr. W. Moir ...	50
9·0	...	...	8·0	...	...	7·0	...	...	7·6	...	...	...	...	...	...	...	...	Drs. Clapp, A. Lewis ...	51
5·6	12·6	2	3·0	12·4	0	0·4	12·1	0	3·1	3·6	0	3·7	0	0	6·0	0	0	? Civil Surgeon ...	52
50·6	18·8	4	45·0	12·0	23	41·9	13·8	3	40·6	0	6	40·0	0	13	40·2	0	2	Dr. Mathew ...	53
5·6	12·4	0	6·1	?	?	5·6	25·6	1	1·9	2·0	7	4·0	0	0	4·6	0	0	? ,, ...	54
16·8	19·4	0	10·8	7·3	2	3·3	36·2	2	5·7	0·3	2	9·0	0·4	0	...	...	...	? ,, ...	55
6·9	14·5	0	3·5	12·14	0·9	?	?	1·1	1·8	0	2·9	...	...	...	4·6	0	1	? ,, ...	56
32·6	8·8	0	33·6	6·7	0	34·6	2·6	0	...	...	...	...	...	...	...	...	...	Drs. G. Pain, C. Smith...	57
5·9	?	0	6·2	?	0	5·6	?	0	3·0	?	0	5·0	?	0	6·0	?	0	? ...	58
13·0	25·5	0	1·0	13·0	0	0·0	18·2	0	...	...	...	...	...	...	...	...	...	Captain F. B. Boone ...	59
24·0	13·1	0	21·7	18·3	0	...	...	...	...	...	...	...	...	...	...	...	...	Drs. Ffolliott, Macnamara.	60
39·0	0·3	0	38·9	0·5	0	38·9	2·0	0	...	...	...	...	...	...	...	...	...	Drs. Griffith, Strachan	61
24·7	7·4	0	21·6	1·5	0	18·6	7·7	0	21·3	0	0	19·9	0·7	0	23·0	0·3	0	Dr. J. S. Howard ...	62
4·4	?	?	0·3	?	?	0·2	?	2	?	?	?	...	...	...	...	...	...	? Civil Surgeon ...	63
21·5	30·0	0	19·0	6·8	0	18·9	18·6	0	16·1	0	0	?	0	2	...	...	...	Dr. Hart ...	64
3·1	17·5	0	0·8	19·2	0	6·0	18·5	2	0·8	0·2	11	2·5	0	5	3·7	0	43	Dr. Picachy ...	65
10·3	15·4	0	6·2	3·3	0	7·1	12·7	0	10·4	0	0	16·2	0	0	18·8	0	0	Dr. D. W. Trimnell ...	66
6·6	22·2	0	2·6	15·7	0	2·0	10·4	0	2·8	1·6	0	5·0	0	0	6·6	0	0	Dr. Hoskins ...	67
6·5	11·8	43	4·6	14·2	33	4·0	13·3	11	7·2	0·3	6	8·7	0	3	13·2	0	3	Dr. Wood ...	68
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. R. E. Fitzgerald ...	69
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. A. Eteson ...	70
1·0	24·1	0	1·3	15·0	0	1·8	11·3	0	2·9	0	0	3·9	0	0	4·7	0·5	0	Drs. Williamson, Cowan	71
14·7	...	...	9·5	...	...	8·9	...	...	8·4	...	...	...	...	...	...	...	...	Dr. G. F. Trimnell ...	72
2·8	11·8	0	2·7	5·6	0	1·9	7·3	0	3·5	0	0	8·2	1·5	0	13·5	1·1	0	Dr. J. Barter ...	73
16·0	...	...	6·9	...	...	6·3	...	...	7·6	...	...	12·9	...	...	20·0	...	...	,, ...	74
27·7	?	0	27·0	10·0	0	27·0	9·5	0	...	...	...	...	...	...	...	...	...	Drs. E. Townsend, A. Hall.	75
21·5	29·7	0	18·6	11·1	0	17·8	8·2	0	17·4	0	0	17·5	...	...	...	...	...	Drs. Harris, Kelsall ...	76
40·1	8·9	0	40·1	2·0	0	40·0	2·7	0	40·0	0	0	...	...	...	...	...	...	Drs. Cherry, Wood ...	77
102·4	0·9	0	102·5	0·5	0	102·7	0·8	0	102·7	0	0	102·8	0	0	102·5	0	0	Mr. J. Rehill ...	78
1·9	24·4	0	1·9	24·0	0	1·4	18·5	0	2·0	18·4	0	3·1	0	0	4·2	0	0	? ...	79
25·0	15·6	0	24·9	9·0	0	24·9	1·8	0	24·9	0	0	...	...	...	...	...	...	Drs. R. Berkeley, Scott...	80

registering apparatus having been read in the inverse way, &c.

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE III. 1872.

Number.	STATION.	Elevation above sea-level [in feet].	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.
1	Agra ...	555	68·9	·5	0	69·0	·1	2	68·9	0	0	68·6	0	3	68·0	1·8	6	67·9	1·5	29
2	Akola ...	923	37·1	0	0	37·6	0	0	38·1	0	0	38·9	1·7	0	39·2	0	0	40·3	0	0
3	Allahabad ...	306	52·8	2·1	0	53·0	0·2	6	53·6	0	1	54·2	0	8	55·0	0·3	6	56·8	2·7	4
4	Amritsar ...	756	22·6	·6	0	21·8	·7	0	21·0	1·0	0	20·9	·4	0	20·8	·6	0	20·9	1.4	0
5	Benares ...	267	30·8	1·6	0	31·5	0·4	0	32·5	0	0	34·3	0	596	36·6	·3	189	37·9	5·0	404
6	Burdwan ...	102	...	...	...	...	...	...	...	...	...	...	...	...	13·3	5·8	7	13·8	10·3	4
7	Calcutta (Alipore)	16	13·3	0·2	80	13·9	2·8	8·1	14·1	0 2	64	14·5	1·8	70	14·7	1·9	66	14·8	9·4	55
8	Cawnpore * ...	...	36·4	·5	0	36·3	0	0	36·8	0	0	38·0	0·2	3	39·5	·5	178	40·9	2·5	44
9	Chindwara ...	...	20·9	0	0	24·2	0	0	26·3	0·7	0	28·4	0·6	0	29·6	·1	0	30·7	9·2	0
10	Chittagong ...	90	17·0	·4	0	16·8	1·1	0	18·2	0	0	19·6	5·1	...	18·0	4·9	0	16·5	10·8	0
11	Deoghur ...	...	24 3	0	0	25·4	2·3	0	26·2	0·1	0	26·9	0·3	0	28·5	1·3	0	28·9	2·9	0
12	Dinajpore ...	...	10·8	·9	0	11·1	·8	0	11·4	·1	0	11·8	0	0	12·8	4·0	0	13·0	14·0	0
13	Fyzabad ...	...	10·7	·1	0	11·3	·5	0	12·0	0	0	12·8	·3	15	13·7	?	2	14·9	4·4	1
14	Goruckpore ...	255	10·0	2·0	0	10·9	·5	0	11·5	·3	0	12·3	·4	0	13·0	2·5	3	13·8	4·3	4
15	Gujranwalla ...	...	25·0	2·6	0	25·0	1·5	0	24·0	2·5	0	25·0	·3	0	25·0	·3	0	25·0	0	0
16	Gujrat ...	...	14·5	0	0	14·3	1·1	0	14·6	3·9	0	14·7	6·0	0	15·1	4·7	0	15·6	5·4	0
17	Hissar ...	...	Appar	atus	un	der re	pair	...	...	...	...	92·9	0·5	0	93·2	1·2	0	93·4	2·7	0
18	Hoshungabad ...	1,030	55·5	0	0	56·6	0	2	57·3	·1	0	58·1	·1	0	59·1	·1	0	...	...	...
19	Jubbulpore ...	1,351	7·8	2·7	0	...	...	...	7·7	·6	0	8·5	·6	0	9·5	0	0	10·5	5·4	0
20	Kheree ...	...	25·9	1·2	0	?	1·1	0	?	?	?	?	?	?	28·2	·4	0	28·8	3·0	0
21	Kurna ...	...	23·1	2·9	0	23·1	·1	1	23·5	·6	0	23·8	0	1	23·9	·4	3	25·4	6·1	0
22	Lucknow (Observatory) ...	360	9·8	1·6	0	10·0	·5	0	10·8	0	1	11·1	·5	0	12·5	·6	2)	13·1	1·7	22
23	Lucknow (prison)	...	10·2	...	...	10·6	...	...	12·5	...	...	15·3	...	...	20·9	...	...	21·2	...	0
24	Ludiana ...	900	21·7	1·9	0	21·6	·2	0	22·1	·4	0	22·1	1·3	2	22·0	·3	0	22·0	4·2	0
25	Lullutpore ...	...	8·1	·3	0	7·4	0	0	6·4	0	0	7·9	·2	0	9·9	·1	0	11·5	1·2	0
26	Mandla ...	...	32·9	0	0	33·4	0	0	34·7	·1	0	35·1	·1	0	36·3	0	0	36·8	11·6	0
27	Meerut ...	739	12·3	·3	0	12·1	·1	0	12·1	0	0	12·6	·4	0	13·0	·2	0	13·4	3·1	...
28	Moorshedabad ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29	Mymensing ...	...	7·0	0	0	7·9	·8	0	8·8	0	0	10·1	4·8	0	9.6	6·5	0	...	16·6	0
30	Oomraotee ...	1,206	26·0	0	0	27·1	0	0	28·8	·1	0	30·8	1·6	0	31·9	0	0	34·6	6·0	?
31	Pertabgurh ...	...	?	0	0	?	0	0	?	?	?	?	?	?	?	?	?	?	?	0
32	Raipur ...	960	20·8	0	0	22·9	0	0	25·0	·1	0	27·5	1·5	0	29·8	0	0	31·3	11·8	0
33	Rajshahye ...	...	7·7	0	0	8·6	2·3	0	9·9	0	0	11·6	1·0	0	14·0	2·7	2	14·9	6·7	0
34	Saugor ...	1,766	5·5	·1	0	6·4	·1	0	8·6	·1	0	12·0	1·3	0	16·1	0	0	20·3	3·4	0
35	Seonee (No. 1 well)	2,030	15·0	0	0	16·7	0	0	18·2	·2	0	19·7	0	0	20·8	·4	0	19·2	15·5	0
36	„ (No. 2 „)	...	21·6	...	...	23·9	...	...	26·4	...	...	32·9	...	...	37·8	...	...	42·9	...	...
37	Sirsa ...	...	102·5	1·2	0	102·6	0	0	102·8	·1	0	102·6	·1	0	102·8	·3	0	102·6	·2	0

* Indicate that the water-level returns have required correction

PREVALENCE *in various Stations in Bengal for the year 1872.*

1872. TABLE III.

JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER.			WATER-LEVEL OBSERVATIONS RECORDED BY	NUMBER.
Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.		
68·0	5·0	83	68·3	8·5	71	68·9	4·6	5	68·9	0	1	68·6	0	0	68·5	0	0	Dr. A. Christison ...	1
37·2	13·3	0	32·9	3·6	0	...	...	...	16·1	7·1	0	19·0	0	0	23·0	·1	0	Dr. A. Porter ...	2
56·4	11·1	12	55·0	25·9	43	52·1	5·3	10	51·6	0	0	52·8	0	0	53·9	?	0	Dr. J. Jones ...	3
20·9	7·0	0	20·2	8·8	0	20·2	4·4	0	20·7	0	0	17·2	0	0	17·2	0	0	Dr. F. M. Mackenzie ...	4
35·0	11·9	188	33·4	9·6	176	28·3	4·0	151	30·0	0	74	34·7	0	38	38·0	0	21	Drs. Cockburn, Hooper	5
9·9	8·4	3	4·9	17·7	4	3·5	11·9	3	4·0	5·1	0	5·0	0	0	6·0	0	0	Dr. Elliot ...	6
14·0	5·5	71	12·5	11·5	79	10·6	8·4	61	10·8	8·9	86	11·7	0·2	181	13·0	·06	248	Dr. S. Lynch ...	7
40·0	4·8	11	38·9	12·7	7	36·3	1·2	0	36·1	0	2	36·7	0	0	36·8	0	0	Drs. Condon, Cleghorn	8
29·1	11·4	0	16·8	10·9	0	3·9	10·3	0	5·4	0·6	0	8·5	0·8	0	12·6	0·5	0	Dr. A. G. Price ...	9
4·1	30·8	0	6·0	15·9	0	6·0	14·9	0	8·7	4·7	0	9·8	0	0	12·2	·7	0	Dr. Meadows ...	10
...	7·6	...	28·5	9·2	0	28·0	7·1	0	27·5	10·3	0	26·7	0	0	26·1	0	0	Dr. S. N. Sing ...	11
11·9	17·6	0	8·4	16·7	0	6·4	10·9	0	6·9	10·6	0	7·8	0	0	...	0	0	Dr. Webber ...	12
...	...	...	...	...	...	12·3	8·6	47	12·5	0	62	12·9	0	5	13·7	0	0	Civil Surgeon ...	13
12·7	23·2	0	8·4	16·1	0	3·0	15·0	0	5·3	0	0	7·9	0	2	9·4	0	0	Dr. Prentis ...	14
25·0	6·5	0	25·0	7·6	126	25·0	4·5	71	24·8	0	2	24·9	0	0	24·9	·2	0	Dr. R. C. Bose ...	15
14·4	8·3	0	?	5·9	80	?	1·9	0	?	1·6	0	19·6	0	0	?	·4	0	Dr. R. C. Quinnell ...	16
93·4	12·2	0	93·1	9·3	2	93·0	·1	0	93·0	...	0	93·0	0	0	92·6	1·3	0	Dr. J. W. Cooper ...	17
...	12·6	0	55·9	14·1	59	50·9	7·7	0	51·9	1·5	0	53·0	0	0	55·4	·2	0	Dr. P. Cullen ...	18
5·0	28·6	35	1·0	21·9	10	2·2	5·7	0	2·5	1·4	0	4·4	0	0	5·0	·4	0	Dr. W. R. Rice ...	19
27·7	7·0	0	26·9	15·4	0	23·5	10·6	1	22·2	0	0	23·4	0	0	24·7	0	0	Civil Surgeon ...	20
22·4	8·8	24	22·6	1·7	40	22·5	2·5	0	22·8	0	0	22·9	0	0	22·6	·6	0	Dr. A. Calthrop ...	21
12·8	9·8	29	11·0	22·7	56	9·2	3·2	20	10·0	0	16	10·9	0	20	11·7	0	18	Dr. E. Bonavia ...	22
19·9	...	...	16·0	...	26	13·2	...	26	14·5	0	16	16·2	...	...	16·4	...	...	Dr. Cameron ...	23
21·5	14·6	0	20·1	10·3	295	20·2	4·0	27	20·6	...	...	20·8	0	0	20·6	·6	0	Dr. J. Ince ...	24
9·9	5·3	0	8·0	11·1	0	7·0	4·3	0	5·5	0	0	6·9	0	0	7·9	0	0	Dr. J. M. Saunders ...	25
32·5	18·1	0	27·7	17·3	0	25·1	9·1	0	25·0	0	0	28·8	0	0	30·4	1·7	0	Dr. H. A. Kidd ...	26
13·1	8·6	0	12·3	8·7	80	12·9	4·4	356	12·1	0	22	12·2	0	0	12·2	2·2	0	Dr. W. Moir ...	27
...	...	...	...	...	...	...	...	...	2·0	5·9	0	3·8	0	0	7·4	0	0	Dr. Coates ...	28
3·2	15·5	0	2·8	15·6	0	3·0	22·3	0	3·3	3·8	0	4·9	0	0	6·0	0	0	Dr. Cowen ...	29
27·9	13·8	0	19·8	3·7	0	19·0	7·9	0	18·9	1·2	0	21·2	0	0	22·3	0	0	Dr. J. S. Howard ...	30
...	14·3	0	...	12·0	...	...	3·8	0	...	...	...	...	...	...	...	...	...	? ...	31
3·9	17·5	0	4·9	12·4	0	5·4	7·0	0	5·8	3·1	0	13·6	0	0	16·0	·1	0	Dr. D. W. Trimnell ...	32
11·0	10·3	0	10·5	4·9	0	?	15·4	0	?	10·4	0	6·0	0	0	7·0	0	0	Civil Surgeon ...	33
7·7	20·1	0	1·2	13·0	?	...	...	...	3·1	0	0	4·1	0	0	4·8	0	0	Dr. W. Williamson ...	34
8·5	14·4	0	1·2	16·1	0	1·2	8·2	0	2·5	·9	0	7·5	0	0	10·7	0	0	Dr. J. Barter ...	35
39·0	,,	,,	15·0	,,	,,	6·6	,,	,,	6·4	,,	,,	13·8	,,	,,	20·0	,,	,,	Ditto ...	36
102·4	8·8	0	102·3	3·4	0	102·5	2·0	0	102·5	0	0	102·7	0	0	102·6	1·4	0	Dr. J. Rehill ...	37

owing to the apparatus having been read in the inverse way, &c.

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE IV. 1873.

Number.	STATION.	Elevation above sea level (in feet.)	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.	Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.	Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.	Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.	Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.	Distance of Water-level (in feet.)	Rainfall (in inches.)	Cholera cases.
1	Akola ...	923	25·8	0	0	27·7	·3	0	28·9	0·1	0	29·9	0	0	31·0	·2	0	31·5	5·0	0
2	Allahabad ...	306	54·8	0·1	0	55·4	0·5	3	56·0	0·5	2	56·9	0	11	57·9	0	16	57·9	0	5
3	Amritsar ...	756	13·0	0·1	0	12·3	0	0	12·6	0·2	0	12·7	0	0	13·0	1·4	0	13·1	0	0
4	Arrah ...	191	13·1	·3	2	14·6	0	1	15·3	1·2	1	16·0	0	0	16·8	·7	14	17·4	1·9	127
5	Benares ...	262	39·0	0	8	40·0	0	33	41·1	0·2	46	42·1	0	257	...	...	...	...	...	...
6	Burdwan ...	102	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	Calcutta (Alipore)	16	13·9	0	133	14·5	0	189	14·7	1·1	221	14·9	1·8	163	15·0	3·7	153	15·0	4·3	99
8	Cawnpore* ...	...	36·9	0	0	36·9	0	0	36·9	1·2	0	37·9	...	0	39·2	1·1	0	40·9	0	0
9	Chindwara ...	...	17·0	0	0	20·6	·7	0	23·0	·4	0	26·1	0	0	28·3	1·1	0	28·6	7·6	0
10	Chittagong ...	90	14·6	·3	3	16·8	0	0	...	...	...	19·0	5·1	0	11·0	5·2	3	3·7	21·1	0
11	Commillah ...	...	3·3	0	11	4·0	·5	0	4·4	1·5	5	6·6	5·5	23	4·2	8·3	23	4·8	17·5	0
12	Dnaj pore ...	...	10·6	0	129	11·5	·5	58	12·0	·2	56	12·1	·6	207	14·5	·3	56	13·6	18·2	0
13	Fyzabad* ...	...	14·6	0	0	15·4	0	6	16·0	·9	0	16·7	0	0	17·5	0	0	18 3	1·1	0
14	Goruckpore ...	255	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15	Gujranwalla ...	...	25·0	·1	0	25·0	·1	0	25·0	·8	0	25·0	0	0	25·0	2·3	0	25 0	·1	0
16	Gujrat ...	...	19·9	1·0	0	20·5	0	0	21·3	·6	0	22·4	0	0	22·6	1·4	0	22·9	·1	0
17	Hissar ...	...	91·3	0	0	91·7	0	0	90·7	0	0	92·4	0	0	92·0	1 8	0	93·0	0	0
18	Hughli (Chinsura)	30	10·3	0	12	11·4	0	21	12·2	·9	15	12·6	2·3	22	12·8	4·5	...	9·6?	4·4	...
19	Hoshungabad ...	1,020	56·5	·6	0	57·10	0	0	59·0	0	0	Well	dry.	...	...	...	...	...	...	...
20	Jubbulpore ...	1,351	6·0	0	0	7·2	·4	0	8 0	2·4	0	8·7	0	0	9·6	·7	0	10·6	·3	0
21	Kurnal ...	...	22·7	·6	0	22·4	0	0	22·3	0	0	22·9	0	0	24·5	3·8	3	24·8	·1	1
22	Lucknow (observatory) ...	369	12·0	·2	1	12·1	·3	0	12·9	1·1	0	13·2	0	0	13·8	·9	1	14·5	·5	0
23	Lucknow (prison)	...	17·9	...	...	19·9	...	...	21·1	...	...	22·0	0	0	22·9	...	...	23·5	...	...
24	Ludianah ...	900	20·7	0	0	22·9	0	0	23·5	·8	0	26·2	0	0	23·4	2·3	0	23·8	·5	0
25	Lullutpore ...	...	8·10	·6	0	8·11	0	0	10·2	0	0	10·11	0	0	11·8	0	0	12·5	·9	0
26	Maldah ...	160	15·0	·4	20	16·5	0	102	19·2	·2	324	20·9	1·1	824	22·6	0	202	23·6	4·3	50
27	Mandla ...	...	31·8	0	0	32·5	·1	0	33·6	·7	0	34·8	0	0	35·3	1·2	0	35·4	6·3	0
28	Meerut ...	739	12·5	·4	0	12·6	0	0	12·8	·9	0	13·0	0	0	13 7	1·3	0	14·0	·2	0
29	Midnapore ...	108	5·7	1·1	110	7·3	0	2	9·8	·7	5	12·5	1·9	12	11·3	9·2	27	10·8	7·1	1
30	Mozufferpore ...	...	16·2	2·2	0	18·9	0	0	18·3	2·2	0	18·2	·6	4	19·9	0	0	19·9	4·0	12
31	Mymensing ...	...	6·9	·1	0	7·9	0	0	8·5	...	...	Well	dry.	...	...	...	...	...	...	...
32	Oomraotee ...	1,206	23·2	·1	0	23·8	·7	0	24·5	0	0	26·0	0	0	27·2	1·3	0	27·0	6·9	0
33	Pertabgurh ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
34	Purneah ...	125	4·1	·2	0	4·6	0	0	4·9	·8	6)	5·3	2 5	617	5·8	·4	69	6·3	7·8	6
35	Raipur ...	900	17·5	0	0	19·2	0	0	21 0	1·4	0	23·1	0	0	26·1	1·9	0	24·9	5·3	0
36	Rajshahye ...	...	7·9	·4	15	9·3	·1	15	10·9	1·4	54	12·3	1·0	108	14·8	·2	68	17·0	6·9	19
37	Ranchi ...	...	12·9	0	0	15·0	0	1	15·9	2·5	5	17·6	·5	3	18·9	1·2	16	19·6	2·2	22
38	Saugor ...	1,766	5·7	1·0	0	6·2	0	0	7·10	·1	0	11·8	0	0	16·6	·2	0	21·9	1·1	0
39	Seonee (No. 1 well)	2,030	12·6	0	0	14·5	·9	0	16·1	1·1	0	17 9	·6	0	18·3	1·2	0	18·9	2·7	...
40	„ (No. 2 „)	...	26·0	...	...	31·5	...	...	36·6	...	...	40·1	...	...	40·3	...	...	40·0	...	0
41	Sirsa ...	...	102·4	...	0	102·1	0	0	101·9	0	0	101·9	0	0	162·2	0	0	102·5	1·3	0

* Indicate that the water-level returns have required correction

PREVALENCE *in various Stations in Bengal for the year 1873.*

1873. TABLE IV.

JULY.			AUGUST			SEPTEMBER			OCTOBER.			NOVEMBER.			DECEMBER.			WATER-LEVEL OBSERVATIONS RECOVERED BY	NUMBER.
Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.		
31·1	5·7	0	32·1	7·5	0	28·0	4·6	0	28·8	0	0	31·3	·5	0	32·4	0	0	Drs. Laing, Porter ...	1
58·3	16·4	0	55·7	7·2	23	54·0	7·9	19	52·9	0	0	53·9	0	0	54·9	0	0	Drs. J. Irving, J. Jones	2
13·2	3·8	0	12·4	7·9	0	12·2	4·6	0	12·1	0·5	0	12·2	0	0	12·4	0	0·8	Dr. F. M. Mackenzie ...	3
17·3	19·7	632	7·3	10·9	149	9·2	3·0	6	10·7	...	...	...	...	...	13·1	·1	0	Dr. J. H. Thornton ...	4
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Civil Surgeon ...	5
...	...	...	4·4	...	...	5·	...	?	6·0	?	?	7·2	?	?	8·3	?	?	Dr. J. G. French ...	6
14·5	14·7	59	11·6	10·2	31	10·1	5·8	26	11·9	2·4	24	13·0	0·1	28	14·0	·8	29	Dr. S. Lynch ...	7
?	12·9	0	?	12·0	2	?	4·6	0	?	0	0	?	0	0	?	0	0	Dr. J. H. Condon ...	8
26·6	6·4	0	26·3	3·9	...	24·9	11·1	0	16·6	0	0	15·7	·2	0	21·0	·4	0	Dr. A. G. Price ...	9
8·5	19·3	0	2·2	18·9	0	5·9	11·1	0	4·0	4·7	2	...	...	...	13·9	·7	6	Dr. Meadows ...	10
1·8	8·7	0	1·2	25·6	0	2·7	4·6	0	2·9	·7	1	...	...	...	2·7	·7	50	Dr. W. Cowan ...	11
13·4	8·2	2	12·6	12·6	0	12·2	2·0	0	12·7	0	1	...	...	...	14·0	·3	6	Civil Surgeon ...	12
20·9	12·8	0	?	22·0	0	?	4·7	0	?	0	0	?	0	0	?	0	0	Dr. Cameron ...	13
...	...	...	...	...	...	...	...	...	12·4	0	0	15·0	0	0	15·4	0	0	Dr. Prentis ...	14
24·9	3·7	0	24·5	10·5	0	24·4	5·4	0	24·2	7	0	24·5	0	0	24·7	0	0	Dr. R. C. Bose ...	15
23·4	3·0	0	22·9	15·1	0	22·2	·5	0	22·8	0	0	22·9	0	0	23·4	·1	0	Dr. R. C. Quinnell ...	16
92·1	5·1	0	91·6	2·3	0	91·6	1·3	0	91·4	·8	0	91·4	0	0	91·4	·2	0	Dr. J. H. Cooper ...	17
7·7	15·3	...	4·0	6·7	65	3·3	3·7	80	4·9	·6	71	6·6	·1	113	7·8	·7	117	Dr. Thompson ...	18
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. P. Cullen ...	19
7·4	16·8	0	2·3	12·9	1	1·6	14·2	4	3·7	0	2	5·0	0	0	6·0	0	0	Dr. W. R. Rice ...	20
24·8	17·2	0	23·9	5·7	0	24·0	4·8	0	22·4	0	0	22·8	0	0	22·0	0	0	Dr. H. Cookson ...	21
15·2	13·4	3	12·0	8·6	5	11·6	11·0	14	11·0	·0	33	12·2	0	56	13·0	0	6	Dr. E. Bonavia ...	22
22·9	...	...	...	...	..	21·5	...	...	21·6	...	33	21·1	...	...	21·9	...	...	Dr. Cameron ...	23
23·9	8·2	0	23·1	5·4	0	22·7	2·9	0	...	...	...	...	...	...	...	...	...	Dr. R. Rouse ...	24
11·4	21·7	0	8·3	19·1	0	3·1	17·7	0	2·7	0	0	4·7	0	0	7·1	0	0	Dr. F. W. Saunders ...	25
23·0	7·0	3	16·2	7·7	7	14·3	4·8	2	...	...	...	...	...	...	20·5	2	23	Dr. Chatterjee ...	26
33·6	19·7	0	28·9	12·4	0	28·0	8·1	0	30·4	0	0	31·3	0	0	32·8	1·5	0	Dr. H. A. Kidd ...	27
13·8	11·3	0	12·9	6·2	0	12·3	7·8	3	11·8	·9	0	11·9	0	0	12·3	·5	0	Dr. W. Moir ...	28
9·7	13·9	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Civil Surgeon ...	29
20·1	11·5	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Civil Surgeon ...	30
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Civil Surgeon ...	31
25·1	7·6	0	23·1	11·2	0	18·9	8·9	0	20·0	0	0	23·0	0	0	24·0	0	0	Dr. J. S. Howard ...	32
15·0	10·8	0	13·1	11·6	0	12·5	6·6	0	12·9	0	0	12·9	0	0	13·5	0	0	? ...	33
6·0	10·9	1	5·9	10·6	0	4·9	6·7	0	4·9	0	0	...	...	...	5·5	·3	0	Dr. J. Picachy ...	34
22·6	12·4	0	6·3	11·5	0	4·9	8·1	0	11·7	0	0	17·4	0	0	20·0	·1	0	Dr. D. W. Trimnell ...	35
16·3	6·7	3	12·5	11·2	...	10·1	3·1	1	9·8	·3	0	...	...	...	13·3	0	114	Civil Surgeon ...	36
...	17·5	95	3·3	12·9	124	3·2	12·2	36	6·8	·6	0	...	...	...	13·9		1	Dr. E. J. Hoskins ...	37
23·3	9·8	0	2·7	11·0	0	·9	17·7	0	3·1	0	0	5·2	0	0	5·7	0	0	Dr. A. F. Renton ...	38
18·9	11·6	0	13·4	7·8	0	3·9	14·4	0	4·0	0	0	8·5	0	0	12·4	1·0	0	Dr. J. Barter ...	39
37·4	...	...	32·9	...	...	14·0	...	...	12·9	...	...	17·0	...	...	23·0	...	...	„ „ ...	40
102·4	2·6	0	102·3	1·3	0	102·7	1·2	0	102·8	·5	0	102·8	0	0	102·5	·2	0	Dr. J. Rehill ...	41

owing to the apparatus having been read in the inverse way, &c.

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE V. **1874.**

Number.	STATION.	Elevation above sea-level (in feet).	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.
1	Akola ...	923	33·6	0	0	33·8	0	0	33·9	0	0	33·7	0	0	32·4	0	0	33·3	12·4	0
2	Allahabad ...	306	55·6	0	0	56·0	0	2	...	0·5	...	57·1	0	2	58·3	0	1	58·8	6·6	0
3	Amritsar ...	756	12·3	0	0	12·2	0	0	12·3	0	0	12·6	0	0	12·8	0	0	12·9	0	0
4	Burdwan ...	102	9·2	?	?	9·1	?	?	10·0	?	?	10·8	?	?	11·9	?	?	12·8	?	?
5	Calcutta (Alipore)	16	14·8	·9	69	14·9	3·7	182	15·0	1·9	193	15·0	1·2	250	15·2	1·1	217	15·2	6·8	86
6	Cawnpore ...	...	?	0	0	38·4	0	0	...	0	0	...	0	0	39·4	0	0	38·7	5·3	0
7	Chindwara ...	...	24·5	0	0	26·4	·6	0	27·5	·4	0	29·5	0·4	0	31·9	·5	0	31·8	14·5	0
8	Fyzabad ...	...	22·4	0	0	23·0	0·8	0	23·1	0	0	23·2	0	0	Dry	0·3	0	Dry	20·7	0
9	Goruckpore ...	255	15·9	0	0	16·4	1·0	0	16·8	0·1	0	17·1	0	0	15·8	0	0	16·0	11·3	0
10	Gujranwalla ...	...	24·5	1·8	0	24·7	1·6	0	24·8	2·4	0	24·9	0·1	0	25·0	0·7	0	25·0	2·7	0
11	Gujrat ...	...	23·4	3	0	22·9	1·7	0	23·0	2·1	0	23·0	1·3	0	22·8	0	0	22·9	2·9	0
12	Hissar ...	...	91·5	0	0	91·5	0	0	91·7	3·9	0	91·7	0	0	91·8	0	0	91·8	1·3	0
13	Jubbulpore ...	1,351	6·8	·3	0	7·5	·1	0	8·6	0	0	10·0	0	0	10·6	·9	0	10·9	18·5	0
14	Kurnal ...	...	?	0	0	22·2	0·4	0	22·7	1·2	0	22·8	0	0	22·7	0·6	0	22·6	6·5	0
15	Lucknow(observatory).	360	13·5	0	0	13·9	0·2	1	14·4	0·1	1	14·8	0	1	15·4	0	1	16·2	12·1	1
16	Lucknow (prison)	...	22·1	...	...	21·6	....	1	21·9	...	...	22·4	...	1	23·0	...	...	23·7	...	...
17	Lullutpore ...	...	9·2	·1	0	10·9	0	0	12·8	0	0	13·3	0	0	14·6	·4	0	16·0	6	0
18	Mandla ...	...	33·0	·7	0	33·7	·8	0	34·0	0	0	34·9	0	0	35·8	2·2	0	35·7	23·6	0
19	Meerut ...	736	12·0	·2	0	11·9	·1	0	14·4	0	0	12·4	0	0	15·4	0	0	13·1	·8	0
20	Oomraotee ...	1,206	24·9	0	0	25·9	0	0	26·9	0	0	27·9	·6	0	29·1	·9	0	28·9	9·6	0
21	Pertabgurh ...	...	13·8	0	0	13·8	0	0	13·9	0	0	14·1	0	0	14·4	0	0	14·8	3·9	0
22	Raipur ...	960	22·1	1·4	0	24·0	0·4	0	26·3	0·4	0	29·1	0	0	31·5	·9	0	32·9	20·3	0
23	Saugor ...	1,766	5·9	1·0	0	6·4	0	0	8·1	0	0	11·2	0	0	15·0	1·3	0	17·2	15·6	0
24	Seonee (No.1 well)	2,030	14·9	·2	0	18·4	0	0	19·2	0	0	...	0	0	...	·5	0	19·1	11·9	0
25	Ditto (,, 2 do.)	...	26·6	...	...	30·9	...	...	33·4	....	...	38·4	...	...	41·5	...	...	39·8	...	...
26	Sirsa ...	...	102·7	0·8	0	102·3	0	0	102·0	2·7	0	102·3	0	0	101·9	0	0	101·9	0·5	0

PREVALENCE *in various Stations in Bengal for the year 1874.*

1874. TABLE V.

July.			August.			September.			October.			November.			December.			WATER-LEVEL OBSERVATIONS RECORDED BY	NUMBER.
Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Raiofall (in inches).	Cholera cases.		
32·0	10·7	0	29·2	5·7	0	29·5	6·8	0	29·3	0·2	0	31·9	0·5	0	33·0	0	0	Drs. A. Porter, Laing ...	1
58·2	12·9	0	55·4	8·9	0	57·1	8·5	0	54·9	0·2	0	53·5	0	0	53·3	0	0	Dr. J. Irving ...	2
12·8	0	0	12·6	0	0	12·8	0	0	12·9	0	0	13·0	0	0	12·9	0	0	Drs. Mackenzie, Whitwell	3
7·1	?	?	6·7	?	?	5·5	?	?	5·9	?	?	5·0	?	?	5·8	?	?	Dr. J. G. French ...	4
?	8·8	4	?	10·1	39	?	12·6	24	8·6	4·5	29	10·0	0·1	67	12·2	0	131	Dr. S. Lynch ...	5
40·4	6·7	0	41·3	4·7	0	42·5	4·5	0	42·6	0	0	41·9	0	0	41·9	0	0	Dr. J. H. Condon ...	6
27·9	17·2	0	12·9	5·4	0	5·0	7·4	0	6·3	0·1	0	10·0	0	0	12·7	·1	0	Dr. A. G. Price ...	7
20·9	17·9	0	20·3	7·7	0	19·2	8·6	0	18·8	0	2	18·1	0	1	18·1	0	0	Civil Surgeon ...	8
16·4	23·2	0	13·6	11·8	4	8·0	8·9	68	7·9	3·3	72	9·0	0	34	10·3	0	0	Dr. Prentis ...	9
24·9	4·3	0	24·9	4·3	0	24·9	3·5	0	25·0	0	0	25·0	0	0	25·0	0	0	Dr. R. C. Bose ...	10
22·8	3·3	0	22·6	2·1	0	22·0	4·1	0	21·7	0	0	22·2	0	0	22·8	0	0	Drs. Quinnell, Fergusson	11
91·8	4·1	0	91·9	1·4	0	91·9	·5	0	91·8	0	0	91·9	0	0	91·9	0	0	Dr. J. W. Cooper ...	12
2·6	25·3	0	2·0	36·9	0	3·0	4·3	0	5·5	·2	0	7·0	0	0	7·9	·1	0	Dr. W. R. Rice ...	13
22·8	12·7	0	22·9	1·9	0	23·9	2·8	0	22·8	0	0	22·9	0	0	23·9	0	0	Dr. H. Cookson ...	14
15·3	12·8	0	11·8	17·6	1	9·0	7·4	0	10·2	0·3	1	11·6	0	1	12·4	0	1	Dr. E. Bonavia ...	15
23·3	...	...	22·0	...	...	18·4	...	0	16·0	...	1	16·2	...	...	0·9	0	...	Dr. Cameron ...	16
12·2	19·2	0	9·4	16·6	0	8·8	1·4	0	2·7	0	1	4·6	0	0	6·0	0	0	Dr. F. M. Saunders ...	17
31·0	13·8	0	26·0	18·3	0	23·2	7·1	0	24·9	1	0	27·7	0	0	30·1	0	0	Dr. H. A. Kidd ...	18
12·4	12	0	10·9	7	0	9·2	4	0	9·5	0	0	9·7	0	0	10·0	0	0	Dr. W. Moir ...	19
27·0	11·0	0	23·9	6·6	0	23·7	9·5	0	23·9	·7	0	24·1	0	0	24·7	·1	0	Dr. J. S. Howard ...	20
14·0	8·2	0	13·8	7·8	0	12·7	4·7	0	12·9	0	0	...	...	0	13·2	0	0	? ...	21
9·2	24·1	0	3·6	20·1	0	5·9	8·9	0	8·6	0·9	0	10·0	0	0	15·6	0	0	Dr. T. W. Trimnell ...	22
1·9	23·7	0	1·9	21·4	0	2·2	5·6	0	3·6	0	0	4·6	0	0	5·8	0	0	Dr. R. A. F. Renton ...	23
4·0	18·6	0	2·0	16·2	0	2·0	13·3	0	4·0	0	0	6·6	0	0	9·10	·1	0	Dr. J. Barter ...	24
23·0	...	...	13·0	...	...	5·9	...	...	10·0	...	...	15·8	...	...	19·8	...	...	Ditto ...	25
101·7	2·9	0	101·5	3·5	0	101·3	1·3	0	101·0	0	0	100·7	0	0	100·4	0	0	Dr. Rehill ...	26

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE VI 1875.

NUMBER.	STATION.	Elevation above sea-level (in feet).	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.
1	Akola ...	923	35·0	0	0	34·9	0	0	33·9	0	0	34·1	0	0	34·9	·3	0	34·9	7·6	0
2	Allahabad ...	306	54·3	0	0	55·0	0	0	55·6	0	5	56·3	0	13	57·1	0	11	57·9	?	?
3	Amritsar ...	756	12·9	0	0	12·9	1·0	0	12·9	·1	0	12·9	·1	0	12·8	1·1	0	12·8	·9	0
4	Arrah ...	191	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	Bhandara ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		...	...	...
6	Burdwan ...	102	0·8	?	?	7·3	?	?	8·3	?	?	8·9	?	?	8·2	?	?	7·9	?	?
7	Calcutta (Alipore)	16	13·3	1·2	130	14·0	0	73	14·4	0	268	14·6	4·1	268	14·6	5·2	119	14·5	11·8	66
8	Cawnpore ...	...	42·0	0	0	42·0	1·0	0	41·7	0	1	40·3	0	41	38·9	0	25	37·7	·5	12
9	Chanda ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10	Chindwara ...	...	18·2	·1	0	21·8	·7	0	24·2	0	0	26·6	·3	0	...	...	...	...	...	...
11	Commillah ...	...	1·5	4·4	0	1·9	0	0	2·3	5	0	1·8	1·9	0	2·3	5·9	0	...	25·3	0
12	Fyzabad ...	...	18·5	0	0	18·9	·4	0	19·2	0	14	19·9	0	108	20·4	0	8	...	15·4	3
13	Goruckpore ...	255	10·9	0	0	11·6	·2	0	12·2	0	0	13·0	0	11	13·9	1·7	2	14·8	5·9	0
14	Gujranwalla ...	...	25·0	0	0	25·0	0	0	25·0	0	0	25·0	0	0	25·0	0	0	25·0	1·2	0
15	Gujrat ...	...	23·0	·2	0	23·3	1·4	0	23·2	·2	0	24·0	0	0	24·3	·8	0	24·7	·9	0
16	Hissar ...	...	91·9	·1	0	91·9	1·9	0	...	...	...	...	...	...	...	...	...	...	...	...
17	Jubbulpore ...	1,351	8·9	·2	0	9·9	0	0	10·8	0	0	12·5	·1	0	13·9	0	2	15·9	·4	0
18	Kurnal ...	...	23·9	0	0	23·9	2·1	0	23·1	0	0	...	...	0	...	...	...	...	0	0
19	Lucknow (observatory).	369	12·9	·1	0	13·1	·4	2	13·5	0	1	13·9	0	345	14·8	0	74	15·7	·5	1
20	Lucknow (prison) ...		18·4	·1	0	19·1	·4	2	19·9	0	1	20·8	0	345	21·8	0	74	22·0	·5	1
21	Lullutpore ...	...	6·1	0	0	6·5	·6	0	6·9	0	0	7·7	1	0	...	...	...	...	...	...
21	Maldah ...	160	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22	Mandla ...	...	30·6	·9	0	30·9	·1	0	31·3	0	0	31·9	0	0	...	...	...	...	...	...
23	Meerut ...	739	10·4	0	0	10·6	·7	0	10·6	0	0	11·2	0	0	12·0	1·5	0	11·0	·2	0
24	Oomraotee ...	1,206	25·3	0	0	26·5	·8	0	27·6	0	0	29·2	0	0	31·0	0	0	32·1	6·5	0
25	Pertabgurh ...	...	13·7	0	0	13·9	1·1	0	14·2	0	0	14·5	0	0	14·8	0	0	15·0	5·7	0
26	Purneah ...	125	...	...	...	14·0	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27	Raipur ...	900	17·1	1·2	0	18·0	0	0	19·9	0	0	22·2	·1	...	...	...	...	...	...	...
28	Ranchi ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29	Saugor ...	...	6·5	0	0	8·0	0	0	10·6	0	0	12·9	0	0	...	...	...	...	...	...
30	Seonee (No. 2 well)	2,030	22·5	·7	0	25·1	·3	0	16·3	0	0	19·7	·1	0	...	...	...	...	...	...
31	Ditto („ 1 do.)	...	12·7	·7	0	14·4	·3	0	27·1	0	0	...	...	...	...	...	...	...	...	...
32	Sirsa ...	...	100·1	0	0	99·9	·9	0	100·0	0	0	104·0	0	0	100·6	0	0	100·8	·5	0

PREVALENCE *in various Stations in Bengal for the year 1875.*

1875. TABLE VI.

July.			August.			September.			October.			November.			December.			WATER-LEVEL OBSERVATIONS RECORDED BY	Number.
Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.		
...	...	...	...	...	...	...	...	...	22·9	1·3	0	25·5	0	0	28·9	0·1	0	Dr. J. A. Laing ...	1
55·6	26·3	0	60·0	12·6	0	52·1	7·7	0	51·4	?	?	51·0	0	0	52·4	0	0	Dr. H. S. Smith ...	2
12·8	10·4	97	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. H. Whitwell ...	3
...	...	...	12·3	12·1	61	11·5	3·8	11	11·1	0	0	12·8	0	0	...	0	0	? ...	4
...	...	..	...	...	...	3·6	9·4	0	5·9	1·8	1	8·0	0	0	9·5	0	1	Dr. W. Aylen ...	5
6·9	?	?	5·9	?	?	4·2	?	?	4·9	?	?	6·0	?	?	7·1	?	?	Dr. C. H. Sonbert ...	6
12·3	13·9	32	10·0	12·6	35	8·7	7·4	55	10·3	3·4	150	13·0	0	358	13·3	0	72	Dr. S. Lynch ...	7
37·0	5·7	14	...	9·1	6	39·8	7·6	3	40·9	0	0	...	0	0	...	0	0	Drs. Condon, Saunders...	8
...	...	...	...	...	...	7·0	7·9	0	9·4	4·2	0	9·9	0	0	10·9	0	0	Dr. M. Craggs ...	9
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. A. G. Price ...	10
0·6	21·6	0	0	21·1	0	·4	5·6	0	1·8	0·4	0	2·8	0	6	3·6	0	21	.....	11
21·3	9·7	46	20·1	21·7	43	20·6	·4	6	...	...	...	20·0	0	48	20·6	0	21	.....	12
14·6	8·2	0	13·8	15·9	0	11·9	3·3	0	12·4	0	0	12·5	0	0	12·5	0	0	Dr. P. Prentis ...	13
25·0	21·2	0	23·2	15·2	0	23·9	3·1	0	23·9	1·9	0	24·1	5	0	24·2	·6	0	Dr. R. C. Bose ...	14
24·9	7·4	0	23·4	12·0	0	20·2	7·0	0	18·0	0	0	17·9	0	0	17·9	1·2	0	Dr. J. Fergusson ...	15
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·2	...	Dr. J. W. Cooper ...	16
14·9	25·1	0	2·5	8·3	0	1·7	11·5	0	4·3	·8	2	6·9	0	0	8·3	0	0	Dr. W. R. Rice ...	17
23·6	2·9	0	23·8	7·7	0	23·9	9·3	0	23·8	0	0	23·8	0	0	23·9	0	0	Dr. Cookson ...	18
16·1	7·5	6	14·3	19·4	78	11·6	13·9	401	10·8	0	40	...	0	7	...	...	...	Dr. Bonavia ...	19
22·6	7·5	6	22·2	19·4	78	20·9	13·9	401	18·0	0	40	17·7	?	7	18·0	0	...	? ...	20
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	Dr. F. M. Saunders ...	21
...	...	...	10·6	16·1	52	4·6	8·2	15	6·3	0	7	11·0	0	133	14·8	0	21	.....	21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. H. A. Kidd ...	22
11·5	5·8	0	9·9	9·1	6	8·4	15·9	108	5·9	·1	8	7·0	0	2	7·7	0	0	Dr. W. Moir ...	23
27·3	10·6	40	22·8	8·1	12	19·2	5·4	5	18·5	3·1	0	21·5	0	0	23·9	0	0	Dr. J. S. Howard ...	24
15·0	5·4	0	14·6	17·1	0	13·4	10·4	40	13·3	0	2	13·9	0	0	14·1	0	0	? ...	25
...	...	...	4·8	14·9	0	3·7	5·0	0	3·8	0	0	4·6	0	0	5·0	0	0	Dr. Picachy ...	26
1·5	17·9	8	1·6	10·6	41	4·0	8·4	0	7·0	2·7	0	11·3	0	0	14·7	0	0	Dr. T. W. Trimnell ...	27
...	...	...	...	...	...	...	8·7	2	·1	1·0	1	...	0	0	...	0	0	.....	28
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. E. Fawcett ...	29
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Dr. B. Evers ...	30
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Ditto ...	31
100·6	5·7	0	100·6	2·5	0	101·1	9·5	0	101·1	·7	0	101·0	0	0	100·9	0	0	Dr. J. Rehill ...	32

A Monthly Statement of the WATER-LEVEL, RAINFALL, *and* CHOLERA-

TABLE VII. 1876.

Number.	STATION.	Elevation above sea-level (in feet).	JANUARY.			FEBRUARY.			MARCH.			APRIL.			MAY.			JUNE.		
			Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.
1	Akola ...	923	30·5	0	0	32·1	0	0	33·1	0	0	34·5	0	0	33·5	0	0	34·0	2·2	0
2	Allahabad ...	306	53·4	0	0	54·3	0	0	55·0	0	3	56·2	0	10	56·5	0	18	58·3	3·0	8
3	Arrah ...	191	13·9	·2	0	14·5	0	0	15·1	·7	0	15·9	0	68	16·7	1·5	827	17·0	8·2	358
4	Bhandara ...	...	10·9	0	0	12·1	0	0	13·2	·4	0	14·9	0	0	18·0	·4	0	19·3	6·2	0
5	Calcutta (Alipore)	16	14·0	0	19	14·6	2·9	226	14·8	4·3	343	15·2	·2	268	15·1	2·9	168	15·9	9·3	126
6	Chanda ...	...	11·8	0	0	12·9	0	0	13·9	·3	0	15·1	0	0	16·6	·6	0	17·2	1·2	5
7	Commillah ...	...	5·0	0	10	5·5	·7	17	5·0	2·1	74	4·3	4·9	53	4·9	10·7	0	2·9	16·8	1
8	Fyzabad ...	...	20·9	0	0	21·0	0	3	21·2	0	3	21·6	0	42	22·1	0	90	22·7	0	38
9	Goruckpore ...	255	12·7	·7	0	13·0	0	0	15·4	·2	0	14·1	1·3	0	14·7	·8	0	15·1	0·4	1
10	Gujrat ...	...	17·9	·6	0	17·9	1·4	0	17·9	3·3	0	19·3	2·8	0	20·0	2·0	0	20·2	·7	0
11	Gujranwalla ...	...	24·3	·2	0	...	...	...	24·4	2·2	0	24·5	1·5	0	24·7	1·3	0	24·9	0·4	0
12	Jubbulpore ...	1,351	9·1	0	0	10·0	0	0	10·9	0	0	12·7	0	0	14·1	1·0	0	16·7	3·2	0
13	Kurnai ...	...	23·6	0	0	23·7	0	0	23·7	1·7	0	23·5	·7	0	23·6	1·3	0	23·6	5·5	0
14	Lucknow (observatory).	369	12·9	·1	0	13·2	0	0	13·9	·7	0	14·4	0	6	14·9	0	6	15·4	3·6	137
15	Lucknow (prison)	...	18·5	0	0	18·8	0	0	19·5	0	0	20·5	0	0	21·3	0	2	22·5	0	5
16	Maldah ...	160	17·0	0	10	19·5	0	3	21·8	0	20	23·8	2·6	53	24·0	3·0	40	...	11·6	5
17	Meerut ...	739	8·9	0	0	8·6	0	0	8·9	1·5	0	9·7	1·8	0	10·2	·1	0	10·9	·1	0
18	Oomraotee ...	1,206	25·0	0	0	26·0	0	0	26·8	0	0	28·0	0	0	29·8	0·4	0	30·9	4·2	0
19	Pertabgurh ...	...	14·5	0	0	14·9	0	0	15·1	0	0	15·5	0	0	15·7	0	0	16·0	1·2	0
20	Purneah ...	125	5·6	·1	0	6·0	0	0	6·7	0	0	6·9	·7	0	7·2	4·4	2	7·4	16·5	0
21	Raipur ...	900	16·9	0	0	16·8	0	0	19·0	1·0	0	27·5	0	0	35·7	·5	0	36·2	6·1	0
22	Ranchee ...	...	...	0	0	15·2	0	0	16·8	·2	5	17·5	0	2	18·4	·9	29	17·4	8·5	19
23	Sirsa ...	...	100·9	0	0	101·2	0	0	101·3	0·6	0	101·3	0·2	0	101·6	0·9	0	101·5	1·1	0

PREVALENCE *in various Stations in Bengal for the year 1876.*

1876. TABLE VII

JULY.			AUGUST.			SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER.			WATER-LEVEL OBSERVATIONS RECORDED BY	NUMBER.
Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.	Distance of Water-level (in feet).	Rainfall (in inches).	Cholera cases.		
34·2	6·2	0	33·5	6·9	0	28·6	3·2	0	29·7	0	29	32·2	0	57	33·7	0	0	Dr. C. Little ...	1
59·0	10·0	2	52·7	10·7	9	54·0	0	7	52·8	0	4	52·7	0	3	...	...	...	Dr. H. S. Smith ...	2
15·4	3·2	176	13·8	10·5	380	12·7	5·3	64	12·0	5·3	...	11·5	0	0	...	0	0	.....	3
18·9	10·5	3	14·5	13·4	50	7·5	7·7	5	8·9	·2	0	11·3	0	1	12·5	0	0	Drs. Aylen, Leckler ...	4
12·9	19·3	42	8·3	24·8	32	7·5	10·2	31	8·9	5·8	41	11·3	·1	259	12·9	0	24	Dr. Lynch ...	5
17·5	10·4	107	16·5	11·7	241	13·9	6·2	25	13·0	·1	0	14·3	0	0	15·1	0	0	Dr. M. Craggs ...	6
0	23·2	0	·1	20·7	0	·7	11·5	0	1·4	2·5	0	1·4	6·4	8	1·7	0	3	.....	7
23·0	4·6	13	22·4	3·3	4	22·7	9·7	13	22·5	0	14	22·5	0	4	22·9	0	0	.....	8
15·3	5·0	0	15·0	10·7	0	14·6	15·3	0	12·5	3·5	0	12·3	0	0	...	...	...	Civil Surgeon ...	9
18·8	22·3	0	16·3	0	84	16·2	0	76	16·1	2·6	0	16·3	·3	0	16·7	0	0	Dr. J. Fergusson ...	10
...	...	...	...	...	...	...	...	...	...	...	...	...	0	...	...	...	...	.....	11
13·9	27·2	198	2·0	12·7	151	1·9	12·3	1	4·9	0	0	6·7	0	0	7·9	0	0	Dr. W. R. Rice ...	12
23·7	16·2	0	23·7	10·0	0	23·7	14·0	0	23·7	1·3	0	23·6	0	0	23·6	0	0	Dr. G. Ross ...	13
16·2	7·0	109	14·7	7·5	379	14·6	3·2	181	14·7	1·0	20	15·4	0	10	16·0	0	1	Dr. Bonavia ...	14
23·3	0	13	23·0	0	13	23·0	0	8	23·9	0	0	22·1	0	1	21·5	0	4	? ...	15
16·9	11·6	0	7·6	0	0	6·8	10·0	0	5·7	3·6	0	9·5	0	2	13·9	0	71	? ...	16
11·5	7·7	0	10·4	10·5	0	10·8	2·7	0	11·1	·6	0	11·5	0	0	11·9	0	0	Drs. Moir, Harris ...	17
28·1	9·1	0	25·5	7·2	6	16·9	8·6	67	20·3	0	17	21·9	0	5	23·0	0	0	Dr. J. S. Howard ...	18
16·2	10·0	0	15·4	10·0	0	15·6	9·0	0	14·7	4·0	0	14·9	0	0	15·3	0	0	? ...	19
4·3	16·5	0	1·9	13·3	1	2·0	10·7	0	1·2	4·1	0	2·8	0	0	3·8	0	0	Dr. Picachy ...	20
20·5	13·1	0	3·2	9·8	0	1·2	13·6	0	8·1	0	0	14·7	0	0	17·6	0	0	Dr. T. W. Trimnell ...	21
7·6	14·7	74	4·1	13·1	48	6·6	6·6	3	5·9	7·0	0	8·9	0	0	11·4	0	0	.....	22
101·2	2·6	0	100·9	0	0	100·9	3·2	0	100·9	3·2	0	100·7	0	0	100·7	0	0	Dr. J. Rehill ...	23