**The Milroy Lectures : On epidemic influences; on the epidemiological aspects of yellow fever; on the epidemiological aspects of cholera / by Robert Lawson.**

THE

# MILROY LECTURES.

LAWSON.

A MAP SHEWING THE PROGRESS OF PANDEMIC WAVES, BY ROBERT LAWSON, INSPECTOR GENERAL OF HOSPITALS.

THE

# MILROY LECTURES.



ON

## EPIDEMIC INFLUENCES.

ON THE

## EPIDEMIOLOGICAL ASPECTS OF YELLOW FEVER.

ON THE

## EPIDEMIOLOGICAL ASPECTS OF CHOLERA.

BY

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## ERRATA.

Preface, p. iii., par. 2, line 4, *for* "lecturer" *read* "lecturers."
p. 23, 5th line from bottom, *for* "northern" *read* "north-western."
p. 32, 5th line from top, *for* "become" *read* "became."
p. 36, 2nd line from bottom, *for* "or" *read* "for."
p. 48, 15th line from bottom, *for* "south-east" *read* "south-west."
p. 55, 10th line from bottom, *for* "established" *read* "establish."
p. 60, reference, *for* "Juillonzo" *read* "Giullouzo."
p. 63, 3rd line from bottom, *for* "officer" *read* "officers."
p. 64, 12th line from bottom, *for* "are" *read* "is."
p. 66, 17th line from bottom, *for* "where" *read* "when."
p. 87, 21st line from bottom, *for* "are" *read* "were."
p. 88, 13th line from bottom, *for* "occurred 57" *read* "57 occurred."

# PREFACE.

THE late Dr. Gavin Milroy had for many years taken a deep interest in Epidemiological questions, and his visits to the Colonies, in early life in the Packet Service, and subsequently as Medical Inspector under the Board of Health, had afforded him opportunities of acquiring much information as to the diseases which were met with in these countries, and the measures different communities adopted with the hope of excluding them altogether, or for limiting their diffusion if introduced, or already existing amongst them. The great divergence of arrangements put in practice to meet these requirements in different colonies, even of the same nationality, showed a very imperfect acquaintance with the causes of the diseases for which they were adopted, and he saw clearly that the only way to get rid of this anomaly was to acquire sound information on the natural history of these diseases, from a close observation and minute analysis of the facts connected with their appearance, both locally, and over large areas about the same time, as well as for considerable periods of years in succession.

With the view of promoting this desirable result, Dr. Milroy bequeathed a sufficient sum to the Royal College of Physicians of London, to endow an annual course of lectures on State Medicine and Public Hygiene, and suggested that the selection of lectures should not be limited to members of the College, but might be extended to medical men whether in the public services or in civil life, whose opportunities had enabled them to investigate various forms of disease in different regions of the world.

In the exercise of its authority the Council of the College of Physicians did me the honour to ask me to undertake the delivery of the first course of lectures under Dr. Milroy's bequest. This I was glad to comply with as I had been intimate with him for many years, and was well acquainted with his views. The selection of Epidemic Influences, as the subject for the opening course, was

made under the impression that it would have met with his approval, and that it really constitutes the first step in the investigation he desired. It has not been in my power to do more than indicate some of the factors that have hitherto been included under that term, their recognition for the present, however, will bring under the notice of the medical profession facts having a most important bearing on the spread of epidemics, and their further development must be left for future enquirers.

As the matter in the first three lectures is much in excess of what could be got over in the usual period allotted for delivery, much of the detail was omitted in reading. In the following pages they are given at length as originally written.

ROBT. LAWSON.

LONDON, *March* 14*th*, 1888.

THE

# MILROY LECTURES.

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## LECTURE I.

(21st February, 1888).

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### EPIDEMIC INFLUENCES.

*Dr. Milroy's recommendations for the Study of Epidemic and Endemic Diseases.—Selection of Subjects for present Course.—Circumstances which led to enquiry into Epidemic Influence.—Method followed.—Explanation of lines on Map representing the positions and progress of Pandemic Waves.—Febrile Epidemics usually terminate in second year, sometimes another Epidemic following a declining one appears to prolong the duration to three or four years.—Epidemics in Jamaica and West India Command compared.—Progress of Pandemic Waves illustrated.—Extension of Yellow Fever along East and West Coasts of South America.—These Outbreaks come under the same series of Waves as found elsewhere.*

In opening this, the first series of Lectures under the bequest of the late Dr. Milroy, I have to express my appreciation of the honour the President and Fellows of the Royal College of Physicians have done me in requesting I should undertake them.

I met Dr. Milroy for the first time at Scutari, in 1855, and since 1872, when I retired from the Army, I was on intimate terms with him, and had frequent opportunities of ascertaining the deep interest he took in advancing our knowledge of the causes of disease, and of elucidating questions which have led to extended and embittered controversy, without either party to the contest having taken adequate measures for clearing up the points in

dispute, or, at all events, for narrowing their limits. The following paragraphs from Dr. Milroy's "Suggestions for Consideration by the Council of the Royal College of Physicians in relation to his bequest," embody his opinions on this subject, which cannot be too strongly impressed on every enquirer who ventures on the investigation.

"IX.—Among the unsettled questions of medical doctrine there is none that stands more in need of strict inductive examination than that of determining with accuracy the part which Contagion—the communicability of disease from the sick to the healthy—plays in the development and spread of various maladies. On no single subject has there been, and still continues to be, greater uncertainty and disagreement of opinion among professional men; and on none have the practical issues of this diversity been more perplexing to the general public, as well as, too often, misleading to governmental authorities. The correct solution of this problem thus becomes one of supreme importance in State medicine. This can only be effected by the patient investigation of numerous *verified* and *authenticated* facts in various localities and regions, and under different circumstances and conditions, apart from all previous speculation and any mere traditional or customary beliefs."

"XVIII.—I would express my strong desire that more diligent and continued attention may be paid than has yet been attempted in this country to the study of the accurate *Geography of Diseases*, together with the exact *Chronology* of the appearance and persistence of those diseases, which are of only occasional and temporary occurrence; also the exact date of each epidemic prevalence or extra severity of the ordinary endemic maladies in different countries and localities, together with a brief notice of any exceptional feature or peculiarity characteristic of each aggravated manifestation of the malady in question, so that some record of its varying natural history may be preserved for the benefit of future times."

Dr. Milroy had made considerable contributions to the geography and chronology of diseases himself, first in his analysis of reports on the practice of quarantine in the colonies and foreign countries, and the diseases for which it was imposed, printed as Parliamentary papers, and subsequently in the "British and Foreign Medico-Chirurgical Review." Of late years the state of his health interfered with his activity in this direction, but to the last his interest in such enquiries was unabated, and I never visited him without finding that he had noted several questions as to recent investigations for explanation of their nature and application.

Dr. Milroy's "Suggestions" embrace far too many diseases to be treated of in the limited number of lectures at my disposal, even were there sufficient evidence regarding them available of a character which would have met with his approval; it is necessary, therefore, to make a selection, and I think his wishes will be best fulfilled, on the present occasion, by dealing with Epidemic Influences, a subject which is intimately connected with the geographical and chronological phases of disease, and the epidemiological aspects of yellow fever and cholera, both of which received much of his attention, and which admit of being placed on a more defined basis by the legitimate employment of evidence now at our disposal.

The terms epidemic constitution, epidemic influence, pandemic influence, are merely conventional expressions embracing those factors which lead to the diffusion and intensification of disease, from time to time, which are not referable to the individuals who suffer, or the localities in which they reside. Though the existence of such factors has long been recognised, and their importance in etiological enquiries is manifest, yet wonderfully little has been done to ascertain their nature or to indicate their mode of operation; it is here that the necessity for Dr. Milroy's geographical and chronological records of disease become apparent, as they bring out relations between its occurrence in different localities often widely separated, which are too commonly altogether overlooked in the speculations as to its diffusion. The evidence available for the elucidation of this subject is still very scanty, but limited as it is it permits of some generalisations which will serve as a basis for farther progress.

About thirty years ago, when I was in charge of the Medical Department of the Army in Jamaica, I was anxious to find out how far the severe outbreaks of fever, which had been met with among the troops there, were attributable to local causes at the different stations that admitted of diminution or removal. For this purpose I had the advantage of a personal acquaintance with the barracks and their vicinity at the six principal stations in the island, and of perusing the detailed reports from these and the other small out stations, extending over about forty years. The examination of these records showed that, while at each station there were causes of insalubrity of a more or less permanent character, the severe epidemics of fever appeared at intervals only, leaving the respective stations comparatively healthy during the intermediate years, thus indicating the operation of factors during the epidemic

years which were in abeyance during the intervening periods. Farther investigation showed these factors were not confined to Jamaica, but were active in the surrounding countries, and sometimes even on both sides of the Atlantic about the same time. It became obvious, therefore, that the epidemic factors embraced large portions of the earth's surface at the same time, and that records of disease over an equally extended surface, and for many years in succession, were required to indicate the course these factors pursued.

To obtain evidence bearing on this question I began to collect all the notices of the occurrences of epidemics of fever, and several other diseases, which I met with in the course of reading, and in the periodical press. As this accumulated it became apparent that in the case of fevers these outbreaks, besides embracing a considerable space in longitude, gave rise to epidemics in the respective localities they invaded, for the most part in a year with an even, or odd number.

Thus, at Sierra Leone, there were some cases of yellow fever in 1817, a severe epidemic in 1823, one of remittent fever in 1825, severe epidemics of yellow fever in 1829, 1837, 1847, 1859, and 1865, all of them odd years. In Jamaica there were severe epidemics of yellow fever in 1819, 1825, 1827, 1831, 1837, 1841, 1853, 1856. There was occasionally considerable mortality from fever in the even years, but the excess fell on the odd years. Yellow fever appeared at Gibraltar in 1804, 1810, 1813, and 1828, besides threatening to do so on several other occasions; of the four instances here noticed three were in even years.

The figures in the statistical reports on the health of the army, since 1817, bear out the same view. In these the deaths from the different diseases are given for each year up to 1836 inclusive, for Jamaica, the West India Command, Ceylon, Mauritius, and the Cape of Good Hope; and to 1846 for Canada, Nova Scotia, and New Brunswick, Bermuda, and the Mediterranean stations: in the United Kingdom the returns embrace the period 1830–46 only. The annual mortality per 1,000 from fevers among the white troops at these stations respectively, arranged under the odd and even years, is given in the following table:—

| Stations, &c. | Period. | Aggregate annual strength. | Deaths from fever per 1,000. | |
|---|---|---|---|---|
| | | | Odd years. | Even years. |
| United Kingdom — Cavalry | 1830–46 | 98,985 | 1·62 | 1·16 |
| United Kingdom — Foot Guards | „ | 74,708 | 2·36 | 1·88 |
| United Kingdom — Infantry | 1830–36 | 23,532 | 3·21 | 2·59 |
| United Kingdom — „ | 1837–46 | 160,103 | 2·14 | 2·81 |
| Canada | 1817–46 | 154,736 | 2·40 | 2·00 |
| Nova Scotia and New Brunswick | „ | 73,248 | 1·71 | 1·02 |
| Bermuda | „ | 22,945 | 25·13 | 2·38 |
| Gibraltar | 1818–46 | 93,400 | 1·51 | 11·51 |
| Malta | 1817–46 | 61,998 | 1·70 | 3·29 |
| Ionian Islands | „ | 96,494 | 12·03 | 9·53 |
| Jamaica | 1817–36 | 51,567 | 122·27 | 80·09 |
| Windward and Leeward Islands, &c. | „ | 86,661 | 36·28 | 37·28 |
| Ceylon | „ | 42,978 | 16·16 | 32·64 |
| Mauritius | 1818-36 | 30,515 | 1·03 | 2·39 |
| Cape of Good Hope | „ | 29,344 | 1·79 | 1·76 |

An inspection of the details in this table shows that, in the United Kingdom, the excess of mortality from fever among the cavalry, foot guards, and infantry up to 1836 (which embraced the depôts of regiments serving in the West Indies only), fell on the odd year; from 1837 onwards the great bulk of the infantry serving at home was included, the numbers were large and fluctuated considerably, but, though the loss from fever was less, its excess fell on the even year. In Canada and Nova Scotia the excess of febrile mortality fell on the odd year, and the same occurred in Bermuda, the high rate at the last-named station was due to the severe epidemics of yellow fever in 1819 and 1843, in which the loss was 229 and 122 per 1,000 respectively, but striking out these two years, the remainder of the odd years give a ratio of 2·86, which still exceeds that of the even years. In the Mediterranean, Gibraltar and Malta had the excess of deaths from fever in the even year; the epidemic of yellow fever at the former in 1828, which caused a mortality of 121 per 1,000, has raised the rate for the even years; but, excluding that year, that for the other even years is 3·03 or twice as great as for the odd years. The Ionian Islands differ materially from Gibraltar and Malta in having a much higher mortality from fever, and from the excess of it occurring in the odd years; the troops were quartered in six islands, from Corfu to Cerigo, extending upwards of 300 miles

along the west coast of Greece, and about 70 per cent. of the deaths were attributed to periodic fever, the remainder being classed as common continued, synochus, and typhus. There was a great reduction in the mortality from fever after 1831, and this embraced both forms. Up to 1830 the excess of both periodic and continued fevers fell on the odd years, after 1831 the periodic forms still showed the excess (though much reduced) in the odd year, but the continued forms were about equally frequent in the even as in the odd. In Jamaica the excess of the febrile mortality in the odd year is very obvious. In the West India Command, which embraces stations extending from Demerara to Antigua, 10° of latitude, the ratio of deaths from fever is slightly higher in the even years than in the odd, but on analysing the records of disease at the individual stations it was found that in six of them, viz.: Demerara, Grenada, St. Vincent, Barbadoes, Dominica, and Antigua, in which the aggregate annual strength was 68,118, the fever death rate was 32·3 per 1,000 in the odd years, and 24·3 only in the even, while in four other stations, viz.: Trinidad, Tobago, St. Lucia, and St. Kitts, distributed among the others, with an aggregate annual strength of 20,213, the death rate in the odd years was 51·8 per 1,000, and in the even years 75·5[1], owing to some severe outbreaks having fallen on the latter; the evidence, therefore, is in favour of considering the odd year as that most subject to fever here as in Jamaica. In Ceylon and Mauritius the excess of deaths falls in the even years, and at the Cape the ratios are so nearly balanced as to leave the question undecided.

From the examination of a large body of evidence on the manifestation of fever in many countries, and extending over many years, it became obvious that epidemics of that form of disease which became developed at various points, from time to time, passed uniformly to the northward until they finally disappeared. The length of the course of individual epidemics varied much, but the disease appeared for far the most part in each locality in the odd or even year which characterised it. From the combination of several details the period occupied in passing from the Cape of Good Hope to this country was found to be about six years, and the factor which determined this movement was evidently one of

[1] The numbers in the general table previously given differ slightly from those employed here. In the original report there is a general return for the whole command from which the former are calculated, and special returns for each station, the totals from which are here employed. The difference between these is too small to affect the conclusions drawn from them.

very general operation, and most likely connected with some of the natural forces. It was of great importance to define the position of this influence from time to time, and, after a good deal of consideration, it was found this might be effected approximately at least by lines of equal magnetic dip. Assuming that the magnetic equator marked off the southern from the northern hemisphere, the isoclinals 30°, 53°, 70°, 80° north, and 30°, 53°, 70° south indicate fairly the different zones, characterised by having their excess of fever in the odd and even years repectively, in both hemispheres; and assuming that the factor proceeded northward like a wave, at a uniform rate between these lines, its advancing edge may be considered as leaving the southern boundary of the zone on 1st January and overspreading it during the year, so as to leave the southern boundary of the next zone on the 1st January of the following one. It would thus become operative in the successive zones in odd and even years respectively, as it proceeded northward. These lines have been placed on the accompanying map, and as regards fever the advancing edge of the wave is assumed to be on 1st January of the

| | Odd Years. | Even Years. |
|---|---|---|
| At isoclinal | 70° south. | 53° south. |
| ,, | 30° south. | 0° |
| ,, | 30° north. | 53° north. |
| ,, | 70° north. | 80° north. |

The lines give the position of the isoclinals for 1840, but as these have a gradual motion to the westward, which specially affects the dip along the west coast of Europe and Africa, it is now, 1888, sensibly reduced along this to the north of the magnetic equator, and about equally increased to the south of it. Thus, in 1840 Sabine found the dip at London 69° 12′ north, and it is in the present year 67° 25′ at Greenwich. At the Cape of Good Hope the dip was 54° 2′ in 1851, and as it had been increasing there about 6′·7 annually for fifty-nine years previously (and at 5′·8 for the last fifteen years), it must now be at the latter rate of increase close on 58°. These alterations indicate a translation of the lines of dip westward about $3\frac{1}{2}$° in longitude from 1840 to 1888, and it is obvious that they affect the west coast of Europe and Africa, and the eastern part of the Atlantic chiefly, and have little influence elsewhere. The effect of this change at London is such that while the advancing edge of the wave would have reached it about 14th December, in 1840, it will do so about 6th November in the present year, and at the Cape, while it would have been experienced about

1st January in 1840, in 1887 it will be experienced there about 21st October.

It will be seen in the map that Mauritius and Ceylon, though appearing in the table already given as having the excess of their fevers in a year with an even number, lie in the northern part of a zone in which they usually occur in an odd one; Bermuda, too, though having its excess in a year with an odd number, is so situated in one in which they occur in an even one, that the advancing wave would reach it about the 22nd September. The explanation of these apparent anomalies is, that Mauritius being in a southern latitude has its febrile period in the early months of the year, and though the wave reached it in the odd year, the local conditions necessary for the production of fever were not developed until the commencement of the following one, and the resulting disease appears in the even year. The wave reaches Colombo, in Ceylon, about 23rd October of the odd year, but the febrile period there commences in January, and after some fluctuation attains its maximum in April and May of the following or even one. In Bermuda in ordinary years the greatest number of fevers occur in June, July, and August, from which they diminish slowly through September and October; on the occurrence of yellow fever, however, August is the month when its greatest force is displayed, though it continues to cause great mortality in September; from this it declines rapidly, though cases are met with in November, or even occasionally in December. In Bermuda, then, as in the other two stations, notwithstanding the advent of the wave, an epidemic does not arise until the local conditions necessary for its development become ready, which, in most instances, postpones the outbreak to the odd year. Sometimes there has been a limited outbreak in the end of the even year which then terminated, without appearing in the following one, as in 1812, when the first case appeared in H.M.S. "Ruby," on 7th October, and the outbreak seems to have terminated early in December. On other occasions a limited outbreak at the end of the even year was preliminary to a much more general one the next year, as in 1818, when the first case presented itself on 2nd September and was succeeded by the very severe epidemic of 1819. In a few instances an epidemic has appeared early in the even year, as in 1864, when the first case occurred on 10th June and the epidemic commenced at various points about 20th July; this, therefore, would be under the second year of the wave which had been experienced in 1863 along the southern coast of the United States, which lies in the same zone as Bermuda.

When the mortality from fever in different commands is examined year by year, it is found to be distributed somewhat differently in those which are tolerably compact from what takes place in others in which the posts occupied cover a larger area; thus, Ceylon, Jamaica, Gibraltar, Malta, and Bermuda have the great force of their epidemics in a single year, while in the West India Command, the Ionian Islands, Canada, and this country, in all which the individual stations are much farther apart, and for that reason subject to a greater variety of local influences, when taken in the aggregate present less violent outbreaks than the former division, but have the mortality more equally divided between the first and following years of the epidemic, though the first year is generally distinguished by a sensible increase of the death rate which subsequently declines. The different character of the epidemics in these two classes of stations will be illustrated by the course of mortality from fever from year to year, in Jamaica and the West India Command, where that disease attained its highest development.

The following table shows the ratio per 1,000 of deaths from fever among the white troops each year, from 1817 to 1836, for Jamaica and the West India Command, arranged under the odd and even years.

| Year. | Jamaica. | | West India Command. | |
|---|---|---|---|---|
| | Odd years. | Even years. | Odd years. | Even years. |
| | Ratio per 1,000. | Ratio per 1,000. | Ratio per 1000. | Ratio per 1,000. |
| 1817–18 .. .. | 60·9 | 71·0 | 59·4 | 60·9 |
| 1819–20 .. .. | 273·8 | 134·6 | 39·0 | 78·7 |
| 1821–22 .. .. | 94·4 | 154·6 | 67·1 | 47·0 |
| 1823–24 .. .. | 52·7 | 67·4 | 23·0 | 43·2 |
| 1825–26 .. .. | 287·8 | 69·6 | 38·5 | 30·3 |
| 1827–28 .. .. | 213·6 | 64·3 | 52·2 | 49·0 |
| 1829–30 .. .. | 40·6 | 77·4 | 21·1 | 28·5 |
| 1831–32 .. .. | 106·6 | 91·3 | 30·6 | 10·8 |
| 1833–34 .. .. | 61·1 | 58·4 | 13·3 | 10·0 |
| 1835–36 .. .. | 54·8 | 39·9 | 22·2 | 34·1 |

The epidemics of 1819, 1825, 1827, and 1831, in Jamaica, are all well marked. Those of 1825 and 1827 show a period of recurrence of two years, that of 1831 shows a multiple of twice this unit, or four

years; and comparing the epidemic of 1819 with that of 1825, the interval would be thrice the unit if the occurrences in 1821–22 were considered as merely a prolongation of that outbreak. On examination, however, the period 1819–22, like that of 1825–28, seems to embrace two separate epidemics, the result of one wave following another, while the local conditions were still favourable for a repetition of active disease, the death rate in 1820 was half that of 1819, and though there was a farther fall to 94·4 in 1821, that ratio was still considerably higher than in the second year after a severe outbreak in any other instance in the table, and the increase of the ratio in 1822 to 154·6 per 1,000 showed there was a powerful influence then existing which the experience of other years would indicate to have been independent of that to which the epidemic of 1819 was due. This was partly the introduction of a large number of susceptible subjects from England, the 33rd and 91st Regiments having arrived in the island in February and the following month. These corps lost 171 men up to June inclusive, while the 50th and 92nd Regiments, which had been in Jamaica several years, and had a slightly greater strength, lost 32 men only in the same period, these being the healthiest months in the year at that station. From July to December inclusive, the first named corps lost 43 men, while the other two lost 89. As there were two regiments from England landed in Jamaica early in 1819, and one in 1827, which suffered enormous losses from the epidemics of these years, it may be mentioned here that, after deducting the strength and mortality of the newly arrived corps, the death rate from fever among the regiments which had been some years in the country was 167·4 in 1819 and 184·3 in 1827, which are still largely in excess of the ratio for either the preceding or following even year.

Though one epidemic usually culminates in the first year of the wave, sometimes there may be but sufficient increase of disease in the first year to indicate the commencement of the fresh outbreak, which, owing to local circumstances, does not reach its full development until the following year. The occurrences at Bermuda, described above, show this clearly, and many other examples besides that under consideration might be adduced, the result is that an outbreak that runs over three or four years is usually regarded as one epidemic, instead of being made up of two without an intermediate decline, as in the years 1825–26 and 1827–28. When the sequence observed in 1821–22 is followed by one similar to that of 1819–20, which is to be met with more particularly in civil than

in military life, the obscurity is still more enhanced. Another feature presented by the returns for Jamaica, is that the year preceding one of these severe epidemics generally presents a disposition of the febrile mortality to increase; this was obvious in in 1818, 1824, and 1830, and was due to more frequent deaths at individual stations, those attacked varying in different years, and not to a general rise affecting the whole. A similar feature is met with elsewhere, especially among civil populations; it is also met with in other diseases, of which small pox affords a striking example.

The course of fever in the West India Command presents a marked contrast with that in Jamaica, the mortality from it was much less in the former than in the latter, but the frequency of the disease at the different stations varied to a greater extent. All the stations are subject to epidemics from time to time, but the frequency and severity of these was much greater at some than at others; thus on the average of the 20 years the mortality from fever was, at St. Vincent 11 per 1,000, at Barbadoes 12, while at Demerara and Trinidad, to the south of these, and St. Lucia to the north, the ratios were from 59 to 63, and at Tobago, where the average force during the period was only 170 men, the ratio was 105 for the whole period, and in 1820 alone, with an average strength of 134 men only, 107 died of fever, or 799 per 1,000. Antigua was also remarkable for its low febrile mortality, which, on the average of the 20 years, was 15 per 1,000, while Dominica south of it, and St. Kitts to the west, presented ratios of 50 and 44 respectively. It was shown above that six of the stations, embracing Demerara the southernmost, Grenada, St. Vincent, and Barbadoes in the centre of the group, and Dominica and Antigua to the north of it, with an aggregate annual strength of 68,118 men, had a death rate from fever of 32·3 per 1,000 in the odd years and 24·3 only in the even, while in four others, viz., Trinidad and Tobago, lying between Demerara and Grenada, St. Lucia, between St. Vincent and Dominica, and St. Kitts in the same latitude as Antigua, with an aggregate strength of 20,213, the death rate from fever in the odd years was 51·8 per 1,000, and in the even years 55·5. Thus rather more than three-fourths of the troops occupying the central and extreme stations of the group presented the excess of mortality from fever in the odd year like Jamaica, while in the intermediate stations, with less than one-fourth the strength, owing to local circumstances determining severe outbreaks, sometimes at one, sometimes at another, the excess has

fallen on the even year. It is from the combination of these results that the undecided character of the death rates for the West India Command arises.

In Volume VI of the "Statistical, Sanitary, and Medical Reports for the Army for 1864" (pp. 440–470), a paper of mine on pandemic waves will be found, in which the views given above were developed, with the detailed evidence on which they were based. In some instances these could traced from the Cape of Good Hope to this country and Canada, in others the first indications appeared farther to the northward, or they seemed to lose their force at points short of this country, or their spread to be limited in longitude more at one time than at another, with other variations. It would occupy far too much time to repeat all these details here, but a few instances may be given to show their general character, while those desiring more extended information are referred to the former paper.

In the first instance I will refer to the wave should have been met with at the Cape in 1816, but there is no return available for that station in that year. Its first indication is found in Ceylon in 1818, when the mortality among the troops from fever, chiefly remittent, was 133·8 per 1,000, about four and a half times the previous year's ratio. St. Helena is so situated in the zone between the isoclinals 30° south and 0° that the wave would reach it about 1st June of the odd year, later in the season than the usual period for sickness in the southern hemisphere, consequently on the principle already announced fevers are to be looked for there in the next warm season. There was no return of the sickness among the troops at this station in 1817, but in 1818 the deaths from fever amounted to 6·0 in the 1,000, being more than four times the ratio for 1819. Ascension, to the north-west of St. Helena, came under the advancing wave in the early part of the even year, and fever occurs in the same year as in Ceylon; at Ascension the admissions from fever in 1818 were 12, being six times more than in 1817, and embracing nearly every man on the island; one death occurred, the symptoms, acccording to Burnett, having been those of yellow fever. At Lima, in Peru, where a large body of Spanish troops from Europe was assembled in 1817, a severe epidemic of fever, supposed to have been yellow, broke among them in February 1818. Lima, like Ceylon and St. Helena, lies in the zone to the south of the isoclinal 0°, and would be reached by the advancing edge of the wave about 1st October of the odd year; though, as the active period of the local causes commences

about January, fever due to their influence would not assume the epidemic form before that month in the even one. The disease was not confined to Lima, but was met with as far as Ica in 14° south. In 1819 this wave, extending from Ceylon to Peru, would overspread the next zone to the north, accordingly Pali plague, which had been in the Cutch and Gujerat districts in India for some years, became severely epidemic in 1819. The deaths from fever in the West India Command taken as a whole, were less numerous than in 1818, yet at several of the stations the mortality was high; at Demerara, where the form of fever for years previously had been the ordinary remittent, yellow fever appeared and proved very fatal. In Jamaica there was a terrible epidemic of yellow fever, the mortality among the troops from fever alone having been 273·8 per 1,000. In 1820 among the military stations in the Mediterranean the mortality from fever was much less in the Ionian Islands than in either the previous or succeeding years; at Malta it remained the same as in 1819, but at Gibraltar it increased from 2·5 per 1,000 in 1819 to 3·0, and in the neighbouring parts of Andalusia yellow fever prevailed epidemically, plague was epidemic in Algiers, and typhus severe in the convict hulks at Toulon. There had been an epidemic of yellow fever at New Orleans in 1819 which caused a mortality of 16·2 per 1,000 among the civil population, in 1820 the disease reappeared and the resulting mortality was 14·7 per 1,000; the wave would reach New Orleans about the middle of May, while the period for the occurrence of yellow fever there commences in July, hence the epidemic of this year must be attributed to the wave under consideration.[1] In 1821 the mortality from fever among the troops at

[1] The following remarks will serve to place this conclusion on a more certain basis. In 1818 the mortality from fevers among the troops at Gibraltar was 5·8 per 1,000, and at Malta 5·6, indicating an unusual prevalence of the disease that year in the western part of the Mediterranean. Under the same wave yellow fever appeared at Bermuda late in the year, and caused a mortality among the troops of 16·2 per 1000, which, in 1819, was followed by a severe epidemic and a death rate of 229·4. There were no deaths recorded from yellow fever at New Orleans, or amongst the troops in the Bahama Islands in 1818, but in 1819 when yellow fever, which had already broken out in a more northerly point in the same wave, resumed its activity, an outbreak took place at New Orleans, causing a death rate of 16·2 per 1,000, and about half the small number of white troops in the Bahamas died of the same disease; it also appeared epidemically in Natchez, Mobile, Charlestown, Baltimore, Philadelphia, New York, and Boston. All these were referable to the wave which was experienced in the Mediterranean and at Bermuda in 1818. The epidemic in New Orleans in 1820,

Bermuda rose to 14·3 per 1,000 from 3·0 in 1820, and in Canada it was 2·8 per 1,000, having been 0·6 only in 1820, and yellow fever showed itself at Baltimore, and Norfolk Virginia. In 1821, the second year of the wave in the Mediterranean, there was a severe epidemic of yellow fever at Barcelona, while it continued at other points, and fever among the troops in the Ionian Islands caused a mortality of 24·7 per 1,000. In like manner in 1822 yellow fever was seen at New York, and in Nova Scotia the millesimal rate of deaths from fever among the troops was 1·9, there having been no death from this cause in 1821.

The next wave to be noticed can be followed from the Cape to this country. The millesimal ratio of deaths from fever among the troops at Cape Town in 1822 was 2·2, there having been no death from it the previous year; the returns for the frontier, which were rendered in 1822 for the first time, showed a ratio of 4·8, which fell the following year to 1·7. At Mauritius, there was no death from fever among the troops in 1822. I have no information as to the prevalence of fever under this wave south of the equator in 1823, but there was a severe outbreak of yellow fever at Ascension in 1823, under the second year of the preceding one, when that disease was epidemic at Sierra Leone under its first year. In 1824, the wave would pass the isoclinal 0°, and in Ceylon, the deaths among the troops from fever were 104·9 per 1,000. The first Burmese war commenced this year, and the troops in the field there suffered very severely from fever and dysentery, and that form of fever called dengue appeared. The Ashantee war in the vicinity of Cape Coast Castle, which is in the same zone as the Burmese territory, took place in 1824, and here, also, there was excessive mortality from fever and dysentery among those exposed in the field. In 1825, the wave reached the isoclinal 30° north, the fever continued among the troops in the Burmese territory, and dengue spread along the valley of the Ganges, from Calcutta. This year, a considerable force of white

though following immediately on that of the previous year, was evidently due to the extension of the succeeding wave under which the severe outbreak in Jamaica had occurred the previous year. This following up of the outbreaks under one wave by those of the following one is not infrequent in epidemics, masking their true relations, and prolonging the apparent duration of the epidemic to two, three, or four years. Under such circumstances when the more powerful wave is followed by a feebler one the disease culminates in the first period, and diminishes gradually over the second, and on the other hand when the weaker one precedes the stronger the disease seems to rise gradually, attaining its highest point in the third or fourth year.

troops was sent to Sierra Leone and the Gambia, among whom remittent fever broke out and caused excessive mortality. In the West India Command, the millesimal ratio of deaths from fever was 38·3, slightly lower than the previous year; but in Jamaica, there was a death rate from yellow fever of 287·8 per 1,000. In 1826, the mortality at Sierra Leone continued unabated; in the West India Command it was somewhat less, though greatly reduced in Jamaica, but half the white non-commissioned officers at Belize died of fever. The wave would enter the zone to the north of the isoclinal 53° north in 1826; in the Ionian Islands the mortality among the troops rose to 11·0 per 1,000, having been 8·3 in 1825; at Malta, there was little change; but at Gibraltar a rise of a third on the rate for 1825, and Hennen reported several cases of yellow fever. Plague was epidemic at Constantinople. There was no yellow fever at New Orleans in 1826, but one-third of the few white troops in the Bahamas died of it. In 1827, the ratio at Bermuda rose to 4·5 per 1,000, from 1·6 the previous year, and there was a slight outbreak of yellow fever at New Orleans and Charlestown. In 1827 the wave would proceed from the isoclinal 70° north, the ratio per 1,000 of deaths from fever in Nova Scotia rose to 2·7 from 0·9 in 1826, and in Canada, to 4·6 from 3·2. In this country, as shown by the admissions into the fever hospitals in London, Glasgow, and Edinburgh, fever began to increase actively in 1824, the admissions in these in 1826 were: London, 582; Glasgow, 926; Edinburgh, 450; in 1827, the admissions rose to 611 in London, 1,089 in Glasgow, and 1,875 in Edinburgh, increasing to 1,511 at Glasgow, and 2,013 at Edinburgh in 1828; in 1829, the admissions at London fell to 472, at Glasgow to 865, and at Edinburgh to 771. The admissions in the fever hospitals at Cork, and in Dublin, which include those from all cases of acute disease, were most numerous in 1826, at Cork they remained much the same in 1827, but at Dublin were much reduced that year, and this proceeded at both the following years.

The late extension of yellow fever on the Atlantic and Pacific coasts of America from the equator southwards, requires notice. It is generally admitted that the earliest detailed description of yellow fever was given by the Portuguese physician, Ferreyra, from his experience of the disease at Olinda, near Pernambuco, from 1687 to 1694; Humboldt mentions that in 1740 it was prevalent at Guayaquil, near the equator, on the west coast, and in the beginning of the century at Monte Video, in lat. 34° 30′ south, on the east; Humboldt also mentions a febrile affection

peculiar to the Indian race, characterised by profuse bleeding from the nose, and which they designate *matlazahuatl*, this occurs in devastating epidemics at elevations above 7,200 or 7,800 feet, and in the most arid localities with a day temperature not exceeding 10° to 12° Centigrade. Several epidemics of this affection in Mexico are alluded to, the last in 1761–62, and one presenting the same symptoms was met with in South America in 1759, which extended over the country from Potosi and Oruro to Quito and Popayan. As will be shown below a similar sequence took place in 1853–55. Humboldt farther states that yellow fever had not been met with on the Pacific coast of America for fifty years, except at Panama, and there seems to be no evidence of this limit having been passed since he wrote (unless the outbreak at Lima, in 1818, were this disease) until 1842, when a schooner, named "La Reina Victoria," from Panama, with yellow fever on board, arrived at Guayaquil in the beginning of September. The vessel was ballasted with "wet, gravelly mud," and carpenters, labourers, and others, who visited her at Guayaquil, were attacked, as has happened in many other instances; but it was not until after 9th October the disease began to spread on shore there, it culminated in the end of November, and by 8th December its violence was abating.[1] Guayaquil is in the zone between the isoclinals 0° and 30° north, and would be reached by the advancing wave in May in the even year. Yellow fever seems to have recurred at Guayaquil until 1845, from which year nothing has been recorded of its existence on this coast until 1853, when it appeared at Callao and Lima.

In 1808–9, there was a severe outbreak of fever at Rio Janeiro, but whether it was yellow fever, has not been made out, nor has its subsequent progress been recorded; it may be mentioned, however, that, in 1808, the troops at the Cape of Good Hope, all quartered in the vicinity of Cape Town at that time, lost 3·6 per 1,000 of their strength from fever; the mortality from this cause in 1809, was 0·9 per 1,000, and in 1810, 0·7 only, so that the fever in 1808 (the first year embraced in the returns) must have been severely epidemic in South Africa as well as at Rio Janeiro, on the other side of the Atlantic. After this there is no record of yellow fever having shown itself anywhere on the Brazilian coast, until the end of 1849, when the disease sprung up from the equator to 23° south, in the course of a few months. The first cases noted were at the

[1] Dr. A. Smith, "Epidemiological Transactions," vol. i, p. 244.

following places, which have been arranged according to their latitude, the dates of occurrence are added :—

| | | |
|---|---|---|
| Para ... ... | Lat. | 1° south, March, 1850. |
| Paraiba ... ... | „ | 7° south, January, 1850. |
| Pernambuco ... | „ | 8° south, December 25th, 1849. |
| Bahia ... ... | „ | 13° south, November 3rd, 1849. |
| Rio Janeiro ... | „ | 23° south, December 28th, 1849. |
| Porto Allegre ... | „ | 31° south, April, 1850. |

Rio Janeiro lies between the isoclinals 30° south and 0°, in a position the advancing wave would reach about 11th August of the odd year, but in consequence of the fever season in the southern hemisphere being postponed to the end of the year, or commencement of the following one, epidemics of that disease at Rio fell on the early part of the even year, in this instance 1850, as has been shown above to be the case elsewhere under corresponding circumstances. Bahia, the next point to the north, would not come under this wave until 1st March, 1850, so that it and all the other points to the north of it came under the second year of the preceding wave, a view borne out by the fact that the outbreak at Bahia terminated at the end of February, and that at Pernambuco somewhat later. At Porto Allegre, in lat. 31° south, there was a single case in April, 1850, this is in the same wave as Rio Janeiro, and it shows that by that time there was a disposition to yellow fever existing over an extensive line of coast, which would become developed at intermediate points as local circumstances proved favourable. Early in 1851, fever again appeared at Rio Janeiro under the second year of the wave ; it also became frequent at St. Catherines, in lat. 28° south, and as the succeeding wave would reach St. Catherines about 10th April, this outbreak must be referred to the second year of that still active at Rio Janeiro. As with other waves, this overspread the zone beyond the isoclinal 30° north in 1851, during which Demerara, the Antilles, up to St. Thomas, St. Domingo, and Jamaica, as well as the Cape de Verde Islands on the African coast displayed much fever, while from Rio Janeiro northwards, the disease showed itself at various points on that of Brazil. In 1852, this wave passed the isoclinal 53° north, when Charlestown was affected, and in 1853, when it went beyond 70° north, Philadelphia, Baltimore, and Bermuda were attacked with yellow fever.

In 1853, there was an outbreak of fever at Monte Video, which was described as yellow by some, while others regarded this as doubtful, as it was supposed that yellow fever had never been seen

there before; the possibility of its appearing there, however, was placed beyond doubt by the occurrence of a severe epidemic in 1857.

Monte Video is in the northern part of the zone between the isoclinals 53° and 30° south, and the advancing wave would reach it about 10th November in the even year, but as already explained the febrile epidemics are to be looked for in the early part of the following or odd year. In 1853 also yellow fever was frequent along the coast of Brazil. In 1852 a febrile complaint prevailed very generally in Peru which caused little mortality. This seems to have been dengue. At Lima it continued from January to July. This recurred to some extent in 1853 at the same season, and three cases of fever proved fatal at Lima, with black vomit, in April and May; these had had no communication with each other. A few other isolated cases seem to have been observed up to the period of the extinction of the epidemic in July. In the last week of December a few cases of decided yellow fever appeared at Callao (the port of Lima), and early in January, 1854, it sprang up at Lima with extraordinary generality, and continued in force to the end of March; by the middle of April it had nearly exhausted itself. At Arica on the coast, in 18° 28′ south, yellow fever was prevalent in March, April, and May, and there were a few cases at Islay in 17° 0″ south in April and May. Lima is so situated in the zone between the isoclinals 30° south and 0° that the wave would reach it in the first week of October of the odd year, and as with other places in the southern hemisphere, the febrile epidemic is to be expected early the following one; and this epidemic in 1854, following that of 1853 at Monte Video, shows the gradual progression of the fever to the northward, which will be traced still further below. At Lima there was no yellow fever in 1855, but in its stead intermittent was very prevalent, and showed itself in parts of the city where it had seldom been seen previously. The character of the fever in this epidemic differed considerably in different localities; on the coast line and adjacent valleys it was yellow fever; on the table-lands among the Andes, at elevations of 7,000 feet and upwards, where it seems to have prevailed more or less from 1853 to 1857, the black vomit was supplanted by hæmorrhage from the nose, and the form of the disease resembled that of the *matlazahuatl* of Mexico; higher still, above 12,000 feet, the disease was more protracted, and corresponded with the endemic typhus or *tabardillo*, as it is called. The exact date of commencement of the epidemic among the mountains is not given.

The first case is supposed to have been that of a deserter from Lima, who was taken sick some time in September, 1853, at a point about 300 miles from that city, and near a village named Yurma. The epidemic starting from this place spread up to the end of 1855 to Jaen, 5° 35′ south, 78° 50′ west, and to Carguamayo, a small place in 11° 4′ south, 76° west. In 1855 the wave under consideration would overspread the zone beyond the isoclinal 30° north, and this year the *matlazahuatl* was epidemic in Mexico from May to September, and towards the end of the year yellow fever became active in Jamaica, at Port-au-Prince in Hayti, and at Barbadoes. In 1856 there was a severe epidemic in Jamaica, and the disease was active from Demerara to St. Thomas, and in St. Domingo, Havanna, and Vera Cruz. In 1856, also, under the first part of the wave yellow fever was epidemic at Charlestown, South Carolina, to a slight extent at Bermuda, and there were a few cases at Lisbon in September, which, in 1857, was followed by a severe epidemic there, commencing in July; and there were a few cases met with at Ferrol and Corunna in the autumn.

In 1856 there was another epidemic of yellow fever in Lima of considerable severity at the usual season. A regiment sent from Lima to Tacna in April, 1855, reached that place on 12th, and in about a week after fever showed itself among the men in a violent form. At Cuzco, 13° 30′ south, 72° 20′ west, and 11,350 feet above the sea, fever commenced in October, 1855, and at Sicuani, in 14° 25′ south, 71° 20′ west, and about the same elevation as Cuzco, fever appeared sometime between May and November; and between November and May, 1856, spread over the departments of Cuzco and Puno, causing great mortality. The fresh epidemic of yellow fever at Lima in 1856, succeeding the intermittent of 1855, marks clearly the arrival of a fresh wave, which, as already stated, would reach that place about 1st October. This would reach Cuzco at the same date, and Sicuani about a week earlier, and as the fever in the mountains, unlike that on the coast, seemed to display great activity during the cooler months of the year, the outbreaks at those places may be fairly set down to the same wave. This wave would reach Tacna about 10th July. Whether the outbreak which commenced among the troops there towards the end of April was due to this wave, or was referable, in the first instance, to that which preceded it, the evidence does not admit of being decided. It may be mentioned, however, that the Cuzco battalion which was sent to Truxillo, lat. 8° south, early in 1855 from Lima, at the time intermittent only was prevalent there, was attacked by

yellow fever soon after its arrival at Truxillo, so that early in 1855, while this form of fever was active on the coast at Tacna and Truxillo, Lima between them was suffering from intermittent only. The wave of 1856 at Lima can be traced in the West Indies in 1857, and along the Atlantic coast of the United States in 1858, but it is unnecessary to do more than indicate that, like those previously mentioned, it pursued the same course.[1]

As indicating the interval between successive waves in this part of the world, the yellow fever epidemic at Monte Video in 1857 may be alluded to; this commenced in February, and continued till the end of May, causing 1,800 deaths at that place, and a great increase of mortality at Rio Janeiro and along the Brazilian coast; there were also a few cases at Buenos Ayres in March, and in 1858, under the second year of the wave, a severe epidemic, commencing in March, of which 1,000 are said to have died. In continuation of the wave there was a severe epidemic of yellow fever at Sierra Leone in 1859, embracing Bathurst on the Gambia, and Goree on the African coast; also Trinidad and St. Thomas in in West Indies, and Panama.

The facts detailed above show clearly that there is a factor concerned in the production of fever which determines its appearance at points more and more to the northward in successive years; that this factor revives periodically every second year, or at some multiple of two years, passing like a series of waves over a more or less extensive portion of the earth's surface. These waves can be traced from Buenos Ayres and Cape of Good Hope in 35° south, to northern Europe and Iceland, and in longitude from Ceylon and China to the west coast of America. To distinguish these I have named them pandemic waves. Of their intimate nature nothing is known at present, but as their position from year to year seems defined, approximately at least, by lines of equal magnetic dip, it is inferred they may be dependent in some way on that force. Even should the lines on the map require alteration hereafter, as more extensive and specific information is obtained, for the present they afford epidemiologists a means of arranging the complicated mass of details at their disposal in a much clearer and more manageable form than could be arrived at without their assistance.

[1] The above details of the course of fever in Peru and the Andes are taken from Dr. A. Smith's paper in the "Epidemiological Transactions," vol. i, p. 282, *et seq.* My information as to the prevalence of the matlazahuatl in Mexico in 1855 was obtained in Jamaica in 1857 through a gentleman who had been in that country at the time.

# LECTURE II.

(23RD FEBRUARY, 1888).

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## EPIDEMIC INFLUENCES—CONTINUED.

*Influence of Pandemic Waves on Small Pox in India.—Small Pox Epidemics in Europe and America follow in regular course on those in Hindostan.—Different forms of Fever arise under the same Pandemic Wave in different localities implying the presence and operation of other factors.—Illustrations of this in the case of the "Eclair" and Boa Vista.—This factor in Yellow Fever seems invasive in certain instances, but may be merely quiescent in others.—Ships with a foul hold liable to be infected in same manner as localities on shore.—Outline of the history of recent appearances of Plague.—Connection of Benign Plague with the fully developed disease.—The outbreaks of Plague take place for the most part under the first year of a Pandemic Wave like other Fevers.—The Invasiveness of the Benign Form very marked in some cases.—Whether another factor than that which leads to the Benign Form be required to cause the fully developed Disease requires farther investigation.*

THOUGH fevers alone have been employed to indicate the character and movements of pandemic waves, it would be erroneous to suppose that there are not other diseases similarly affected by them. Small pox for instance, which many are of opinion spreads quite independently of all extraneous influences save the presence of the virus and a sufficient number of susceptible subjects, affords a striking illustration of their operation. From 1869, the first year for which the statistical returns of mortality among the natives in the different provinces in India were published, the progress of small pox in that country in successive years can be traced, and it is found that, like epidemics of fever, those of small pox generally appear in the southern part of the peninsula between the isoclinals 0° and 30°

*Ratios per* 1,000 *of deaths from Small Pox among the Civil Population in the under-mentioned Districts in India from* 1867 *to* 1885.

| Districts. | 1867 | 1868 | 1869 | 1870 | 1871 | 1872 | 1873 | 1874 | 1875 | 1876 | 1877 | 1878 | 1879 | 1880 | 1881 | 1882 | 1883 | 1884 | 1885 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Punjab ... ... ... ... ... ... | ... | ... | 3·05 | 1·55 | 1·46 | 1·36 | 1·47 | ·69 | ·78 | ·59 | ·70 | 2·30 | 2·83 | ·52 | ·38 | ·34 | ·64 | ·87 | ·40 |
| North-west Provinces and Oudh ... ... | ... | ... | 2·73 | ·85 | 1·24 | 1·15 | 2·86 | 2·54 | ·73 | ·94 | ·84 | 3·99 | 1·72 | ·19 | ·39 | ·60 | 3·14 | 4·59 | ·33 |
| Central Provinces ... ... ... ... | ... | ... | 3·47 | ·32 | ·19 | ·57 | 1·37 | 2·38 | 2·73 | ·52 | ·37 | 2·18 | 3·44 | ·69 | ·24 | ·45 | ·53 | ·55 | ·38 |
| Berar ... ... ... ... ... ... | ... | ... | 3·07 | ·64 | ·26 | 3·83 | 3·81 | ·50 | ·42 | ·19 | 2·90 | 2·70 | ·03 | ·02 | ·09 | ·10 | 1·50 | ·20 | ·09 |
| Bombay Presidency[1] ... ... ... ... | ... | ... | ·99 | ·32 | ·66 | 1·83 | ·61 | ·24 | ·21 | ·70 | 1·69 | ·28 | ·07 | ·06 | ·03 | ·10 | ·81 | ·88 | ·16 |
| Madras Presidency ... ... ... ... | 1·20 | 1·30 | ·71 | ·46 | ·84 | 1·30 | 1·70 | 1·50 | ·82 | ·80 | 3·02 | 1·90 | ·60 | ·50 | ·50 | ·60 | 1·30 | 2·10 | 1·20 |
| Mysore and Coorg ... ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ·06 | ·20 | ·60 | 1·92 | 1·18 | ·76 | ·82 |
| | Native troops in Presidency. | | | | | | | | | | | | | | | | | | |
| Bengal proper ... ... ... ... ... | ·15 | ·12 | ·42 | ·13 | ... | ... | ... | ·20 | ·09 | ·18 | ·13 | ·20 | ·38 | ·38 | ·40 | ·20 | ·14 | ·28 | ·14 |
| Assam ... ... ... ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ·38 | ·30 | ·30 | ·37 | ·59 | ·69 | ·71 | 1·36 | 1·05 | ·44 |
| Burma ... ... ... ... ... ... | ... | ... | ... | ·60 | ·63 | ·32 | ·52 | ·43 | ·26 | ·47 | ·41 | ·47 | ·74 | 1·73 | ·48 | ·21 | ·19 | 1·67 | ·58 |

[1] The deaths from Small Pox in Bombay City in 1867 were 1,055; in 1878 1,123; in 1869, 1,725; and in 1870, 556.

The relative positions of these districts will be seen on the accompanying map of India, and the fluctuations in the above table will be rendered clearer by the diagram.


INDIA
Gobi or Shamo Desert
Himalaya Mountains
Mount Everest
TIBET
CHINESE EMPIRE
PERSIA
AFGHANISTAN
BOKHARA
Samarcand
Merv
Meshad
Herat
Balkh
Kandahar
Siah Koh
Hindu Kush Mts
Kashgar
Yarkand
Khotan
Leh
SHINAGAR
KASHMIR
Jamu
PUNJAB
Lahore
Peshawar
Attock
Rawal Pindi
Multan
Bhawalpur
Sukkur
Jaisalmir
Jodhpur
Ajmir
RAJPUTANA
Mt. Abu
Jaipur
Agra
Delhi
Simla
Patiala
Lassa
Brahmaputra R.
Manasarowar L.
Chamdo
Hatang
Sadiya
Bhamo
Mogaung
Mandalay
Amarapoora
Kiang Hung
BURMAH
SIAM
Karenpee
Zimme
Prome
Bassein
Pegu
RANGOON
Martaban
Mouam R.
BANKOK
Gulf of Siam
Malay Peninsula
C. Negrais
Andaman Islands
Nicobar Islands
Mergui Archipelago
BAY OF BENGAL
ARABIAN SEA
Gulf of Cambay
Karachi
Kurrachee
Cutch
Ahmedabad
Baroda
Surat
Dwarka
Kattiawar
Tannah
BOMBAY
Poona
Satarah
Sholapur
HAIDARABAD
Beder
Sawuntwarri
PANGIM on NEW GOA
Karwar
Mangalore
MYSORE
BANGALORE
Seringapatam
Coimbatore
Trichinopoly
Madura
Tuticorin
Cochin
Calicut
Malabar Coast
Coromandel Coast
MADRAS
Cuddapah
Nellore
Karikal
Negapatam
Pondicherry
CEYLON
Trivandrum
Jaffna
Point Pedro
Columbo
Galle
Ootacamund
Nilgiri Hills
Vizianagram
Vizagapatam
Masulipatam
Ellore
Hyderabad
Nagpur
CENTRAL PROVINCES
Berar
Indore
Bhopal
Jabalpur
Nerbudda R.
Godavari R.
Jumna R.
Ganges R.
Allahabad
Benares
Mirzapur
Patna
Gaya
Monghir
Bhagulpur
Calcutta
Hardwar
Lucknow
Cawnpore
Agra
Gwalior
Oude
North West Provinces
Rohilcund
Goruckpur
Nepaul
Khatmandu
Bhotan
Darjeeling
Kuch Behar
Assam
Brahmaputra R.
Lohit R.
Irrawaddy R.
Salween R.
Mekong R.
Yun Nan
Ta li fu
Lake Yung Chang
Lake Tali
Lake Sirhind
Lake Chilka
Lake Manchar
Runn of Cutch
Indus R.
Sutlej R.
Chenab R.
Jhelum R.
Ravee R.
Beas R.
Sutlej R.
Helmund R.
Hurri Rood R.
Oxus R.
Atrak R.
Kizil Arvat
Gok Tepeh
Sarakhs
Maimana
Bamian
Kaferistan
Kohistan
Jalalabad
Ghazni
Kelat
Bela
Gwadur
Sonmeeanee
Kirman
Burjand
Furrah
Seistan
Hamun Swamp
Baluchistan
Persian Gulf
Railways shewn thus
Scale of English Miles
100 0 100 200 300
70° E. Gr.
80°
90°
100°
60°
30°
20°
10°
Stanford's Geog. Estab.t 55 Charing Cross.

north in the first instance, and extend to the portion beyond the isoclinal 30° subsequently, varying in force in different parts of the country invaded in different epidemics, but still presenting an unmistakeable wave-like mode of progression in the same direction. Thus the mortality from small pox among the native population in the Madras Presidency in 1868 was 1·3 per 1,000, and in 1869 ·71. Neither the statistics for the whole Presidency of Bombay nor for the chief districts of Bengal were prepared for 1868, but the deaths from small pox among the natives in the city of Bombay were 1,055 in 1867, 1,123 in 1868, and 1,725 in 1869, a large increase in the last year against an equally striking reduction in the Madras Presidency at the same time, and in the Bengal Presidency the mortality from the same disease among the white troops, the native troops, and the jail population, which in 1868 was 0·0, ·12, and ·04 per 1,000 respectively, rose in 1869 to ·40, ·42, and ·13, showing a very low prevalence of the disease there in 1868 succeeded by a much greater one in 1869. The millesimal ratios of mortality among the natives in the Bombay Presidency, in Berar, and the Central Provinces, which lie to the east of it, and in the North-west Provinces and Oudh, and the Punjab, which extend to the north as far as the Himalayas, were all very high in 1869. In all these there was a very large reduction in 1870 which was smallest in the northernmost district, the Punjab, where it was half the previous year's rate, and that for Madras had also decreased considerably, thus showing this wave to have passed off to the northward.

In 1871 the rates of mortality from small pox showed an increase again in the Madras and Bombay Presidencies and in the North-west Provinces and Oudh, but Berar, the Central Provinces, and Punjab all showed a decrease; in 1872, however, there was a large addition to the rates in the Madras and Bombay Presidencies and Berar, and to a small extent in the Central Provinces, while the North-west Provinces and the Punjab presented a slight reduction of the previous year's ratios. In 1873 the mortality in the Bombay Presidency was but one-third of that of 1872, in Berar it was unchanged, while in the Central and the North-west Provinces and Oudh there was a large increase, and in the Punjab a small one. In 1874 the ratios were much diminished in the Bombay Presidency, Berar, and the Punjab, and to a lesser extent in the Northern Provinces, while it was nearly doubled in the Central Provinces; and, in 1875, it went still higher, while in the Bombay Presidency and Berar the ratios were much the same as the preceding year, and that in the North-west Provinces and Oudh was much reduced, but with a

slight increase in the Punjab. Here, again, was a distinct wave commencing in the Madras Presidency in 1871, and passing off in the Punjab in 1874, but it was complicated by the anomalous epidemic in the Central Provinces in 1874–75 when the prevalence of the disease in the Bombay Presidency and Berar was very slight. The reason seems to be, as was explained with reference to fevers in Jamaica, the peculiar course of small pox in the Madras Presidency from 1871 to 1874 was due to two waves, that of 1871–72 being followed by another in 1873–74, without any reduction of mortality between them to indicate the passing away of the first, or the occurrence of the second. This view is borne out by the fact that the wave of 1871 can be traced to the Punjab where it disappeared in 1874; while the second, commencing in Madras in 1873 developed its force in the Central Provinces in 1874 and 1875, scarcely showing a trace of its passage over the Punjab in 1876.

In 1876 there was again a distinct rise in the death rate in the Bombay Presidency, while in Madras it was stationary, and in Berar and the Central Provinces and Punjab the ratios were low. In 1877 there was a very large increase in the rate in the Madras and Bombay Presidencies and Berar, while in the Central Provinces and in the North-west Provinces and Oudh, the ratios were somewhat lower. In 1878 the ratios were much reduced in the Madras and Bombay Presidencies, slightly so in Berar, while in the Central Provinces, North-west Provinces and Oudh, and Punjab they were very much increased. In 1879 the mortality was much greater in the Central Provinces than the previous year, and in the Punjab it had increased considerably, while everywhere else it was much reduced. In 1880 the very high mortality in the Central Provinces, the North-west Provinces and Oudh, and the Punjab, were replaced by a moderate one and the low rates in all the other districts continued.

The mortality statistics for the Mysore and Coorg became available in 1879; the population of the former is about four millions, and as the latter is but a small district on the western border of the Mysore, and continuous with it, the population of which is something less than two hundred thousand, these two have been classed together in what follows. The Mysore is an elevated plateau, lying to the north-west of the Madras Presidency, between latitude 12° and 15° north, and extending from longitude 78½° east to the Western Ghauts, which separate it from the low land on the Malabar coast. The mortality from small pox registered in this province was ·06 per 1,000 in 1879, ·20 in 1880, and in 1881,

when the death rate from the disease was at its minimum in India generally, it was ·60. In 1882 the mortality in the Mysore from small pox rose to 1·92 per 1,000 and was the first distinct indication of another wave like those already noticed; this year there was a very slight increase of the mortality in the Madras and Bombay Presidencies, and a somewhat greater one in the Central and the North-west Provinces. In 1883 the death rate in the Mysore fell to 1·18 per 1,000, while there was a large increase in those in the Madras and Bombay Presidencies, in Berar, and in the North-west Provinces, and a small one in the Central Provinces and the Punjab. In 1884 while the Mysore showed a farther reduction, there was another large increase of the death rate in the Madras Presidency and in the North-west Provinces, with a considerable one in the Punjab; in the Bombay Presidency and Central Provinces there was little change, and a great reduction in Berar. In 1885 there was a slight rise in the ratio of deaths in the Mysore, but in the Madras Presidency it fell to about half that of the previous year, and in all the other districts above-mentioned there was a large reduction showing much about the same quiescence of the disease as in 1881. This then was the fourth wave which had passed over the peninsula from south to north between 1868 and 1885, besides the more limited one experienced in Madras and the Central Provinces and Punjab from 1873 to 1875. The continuance of considerable death rates in the Madras and Bombay Presidencies in 1884–85, indicate a similar sequence of waves to what occurred in the former in 1873–74, but until the returns for 1886 and 1887 for the other districts become available this point cannot be decided.

These epidemics may be summarised as follows:—

| Epidemic. | In force Madras Presidency. | In force North-west Provinces and Bengal. | Terminated in Punjab. |
|---|---|---|---|
| 1st | 1868 | 1869 | 1870 |
| 2nd | 1872 | 1873 | 1874 |
| 3rd | 1877 | 1878 | 1879 |
| 4th | 1882 (in Mysore) | 1883 | 1884 |

In addition to the details referred to above, the statistics of small pox are given in the Reports of the Sanitary Commissioner with the Government of India for Burma from 1870, for Bengal proper from 1874, and for Assam from 1876, and the relations of

these to those already dealt with may now be indicated. Burma, which lies on the east of the Bay of Bengal, consists of a narrow strip of territory along the coast, between the mountains and the sea, from 10° north to 22°, together with the valleys of the Irawaddy and Salwen from the sea to about 20° north; in latitude it corresponds with the Central Provinces more closely than any other division of the Indian peninsula mentioned hitherto. Bengal proper may be described in general terms as the country extending from the sea to the mountains between the meridians of 85° and 90° east, and Assam as that along the valley of the Bramapootra from 90° east.

From the great extent of Burma, in latitude, the manifestations of small pox there are less marked in their period of occurrence than those in the more compact provinces in Hindostan, and their fluctuations sometimes coincide with those in the more southern districts of the latter, at others with those of the Central, or North-western Provinces. Bengal proper, whether owing to the character of its soil and climate, or to its population being more thoroughly vaccinated, suffered a much smaller loss from small pox on the average of years than any of the other provinces, though the disease fluctuated there as elsewhere under the passing influences; and Assam, to the east of it, enjoyed something of the same immunity up to 1879, but since that date its death rate from the disease has increased very much, though Bengal proper, which lies between it and the Central and North-western Provinces, was less seriously affected.

The millesimal ratio of deaths from small pox in Burma in 1870 was ·60, and in 1871 ·63, from which it decreased in 1872 to ·32; without the corresponding information for the previous two years it is not clear how these should be allocated. In 1873 the ratio rose to ·52, when there was a large increase both in the Central Provinces and in the North-west Provinces as shown above, in 1874 this fell to ·43, and the following year to ·26, the ratios in Bengal for the corresponding years were ·20 and ·09. As already mentioned the mortality was very high in the Central Provinces in 1875, and was followed by an increase of that in the North-west Provinces in 1876, and this year the rates in Burma and in Bengal were about doubled, and in Assam there was a death rate of ·38 per 1,000. In 1877 there was a sensible reduction in all these districts, accompanying the lower rates in the Central and North-western Provinces the same year; and in 1878, with a great rise in the latter, Bengal and Burma both showed an increase in their death rates;

this continued in 1879 and that of Assam also rose. In 1880 the death rate in Burma was 1·73, and that in Assam was ·59, while in Bengal there was no change. In 1881 the rate in Burma fell to ·48, while that in Assam rose to ·69, and in Bengal it was ·40, showing, as in the case of the North-west Provinces in 1876, the progressive influence of the great activity of the disease the preceding year in Burma. In 1882 the rates both in the Central and North-west Provinces rose again, and with them the previous year's ratio in Assam was sustained, and it was nearly doubled in 1883, along with the same epidemic which then declared itself in the North-west Provinces, though both in Bengal and Burma the ratios had continued to fall. In 1884 the continued high ratios in the North-west Provinces was accompanied by a moderate increase in Bengal, and a high though reduced one in Assam. In this year, too, the death rate in Burma rose to 1·67, but as it was the second year of a severe epidemic in the Madras Presidency, the Burma outbreak may with more reason be associated with that than with those which were now passing off to the north of it. It is obvious from these details that the epidemic fluctuations in the territory to the east of the Bay of Bengal are intimately connecnected with those in Hindostan, and are virtually under the same pandemic waves.

These waves like those of fevers pursue their course to the north-west to variable distances, and they frequently cover very great spaces in longitude. The want of information regarding the course of small pox in Central Asia, to the north of Hindostan, prevents this being demonstrated directly for that part of the continent, but its manifestations in the successive zones elsewhere show, as in the case of fevers, the progressive nature of the wave, and its lateral extension. The wave described above as prevailing in the Madras Presidency in 1868 illustrates several of these points, this was active in the Punjab in 1869, and in the latter part of that year small pox commenced at Marseilles and in the south of France, and early in 1870 became extensively diffused in that country, and towards the end of it raged in Paris. The mortality from small pox in London began to increase in the end of 1870, and in 1871 became developed into a severe epidemic, causing a mortality of 2·42 per 1,000, the highest met with there for many years. In 1872 the remainder of England, as well as Scotland and Ireland, was covered by the epidemic. In 1871 the disease was very prevalent and fatal in Holland, in Germany extending into 1872, and in the latter year Austria and Russia became severely

affected, the disease in Austria having culminated in 1873. In 1870 small pox became epidemic in Teneriffe from August, and at Havanna there was an epidemic which caused a death rate of 3·17 per 1,000, and the following year it increased to 5·77. In the United States Philadelphia had but nine deaths from small pox in 1870, but in 1871 there were 1,879, and in 1872 2,585; the disease was also prevalent in New York, and at Montreal and Ottawa in Canada.

The wave which was experienced in the Madras Presidency in 1872 appeared also on the west coast of Africa among the Ashantee and Yoruaba tribes in the end of the year, and at Old Calabar early in 1873; this year also it was severely epidemic at Sierra Leone. In the West Indies in 1873 it appeared in Kingston, Jamaica, in June, and had been in the country districts earlier. The death rate at Havanna in 1873 was ·24 per 1,000 only, but in 1874 this rose to 3·96, and the following year remained nearly as high. There was a considerable prevalence of small pox all the summer of 1874 at Constantinople and its vicinity, and the epidemic which had prevailed in Austria in 1873 was then decreasing, though still frequent. In Western Europe and the United States small pox does not seem to have shown activity anywhere in 1874, but in 1875 there were indications of an approaching increase of the disease at various points; thus at Paris the death rate rose from ·02 per 1,000 in 1874 to ·14 in 1875, at Berlin from ·02 to ·05, and at Vienna, though there had been a rapidly falling rate since the epidemic of 1872, that for 1875 was little less than in 1874, and still stood at 1·14. In 1876 there was a death rate of ·84 from small pox at Brussels, of ·20 at Paris, of 1·72 in Vienna, and in London of ·21, while in England generally it was ·10. In 1877 the death rate declined at all these points except London, where it rose to ·71, and in England when the rise was to ·17 only; a great fall, however, took place at both next year. In 1878 there was an epidemic at St. Petersburg, causing a mortality of 1·53 per 1,000, this reached 1·93 in 1879 and then declined. In America the deaths from small pox in Philadelphia in 1874 were 16 only, in 1875 there were 56, and 409 in 1876; at Brooklyn there was a death rate of ·58 per 1,000 this year. In 1877 there was a very severe epidemic among the Indians around Lake Winnipeg, and another in Montreal in 1878, causing a mortality of 5·45 per 1,000. This epidemic like that which preceded it passed from south to north, but instead of reaching Berlin and Paris in Europe, and Philadelphia and New York in America, in force in 1874 or 1875, the disease culminated in all these in 1876, and seemed attributable to

another wave following that, the operation of which was manifest in the increased frequency of the disease at Constantinople and in Havanna in 1874. Whether this second fluctuation was simply a continuation of that experienced in the Central Provinces in India in 1874, or a fresh one arising somewhere beyond the isoclinal 53° north, the evidence does not suffice to indicate.

The next wave which appeared in the Madras Presidency in 1877, and was in force in the Bombay Presidency and Berar the same year, embraced the Central Provinces and the Punjab in 1878. In the latter part of 1879 this became sensible at Marseilles where there were 500 deaths from small pox that year, the epidemic continuing into 1880, and the death rate at Paris in 1879 rose to ·48 per 1,000. In 1880 small pox was epidemic in Corsica, the mortality from it at Paris was 1·14 per 1,000, while at Rome it was 1·83, and at Madrid 3·03 per 1,000, falling there to 1·98 the following year. In London the death rate in 1880 was ·12 per 1,000, but in 1881 it rose to ·62; in St. Petersburg this year the death rate from small pox was ·34 only, but it 1882 it rose to ·77, and fell again to ·46 the following year. The disease was also epidemic in Iceland in 1882. While these outbreaks were occurring in Western Europe, there was in 1880 a mortality of ·74 per 1,000 at Alexandria, the rate the previous year having been ·08 only; and at Venice and Trieste, the mortality was ·82 and ·95 respectively, as against ·00 and ·22 the preceding year; in 1881 the disease reached at Buda Pesth 1·19, Vienna 1·22, and Prague ·64, and the rate declined at each the following year. Small pox was frequent at Havanna in 1880, as well as at San Antonio and Matamoras, in Texas; and there was a death rate from it at Philadelphia of ·47 per 1,000. In 1881 the rate at Philadelphia rose to 1·54, at New York the same year it was ·36, and at Chicago 1·70; in Baltimore, which had a rate of ·03 only this year, it rose the following one to 1·35.

The next wave which affected the Mysore in 1882, and became developed in the Madras and Bombay Presidencies, Berar, and North-west Provinces in 1883, underwent a farther increase in the latter in 1884, when also the mortality from small pox in the Punjab reached its highest point at this time. Following the example of previous epidemics some trace of this one was to be looked for in Europe in 1885, and at Venice the mortality per 1,000 from small pox, which was ·63 in 1884, rose to 2·24; at Buda Pesth it rose from ·14 to ·42, and at Vienna from ·12 to 1·13; at Rome the rate in 1884 was ·38, which rose to ·66 in 1885, and

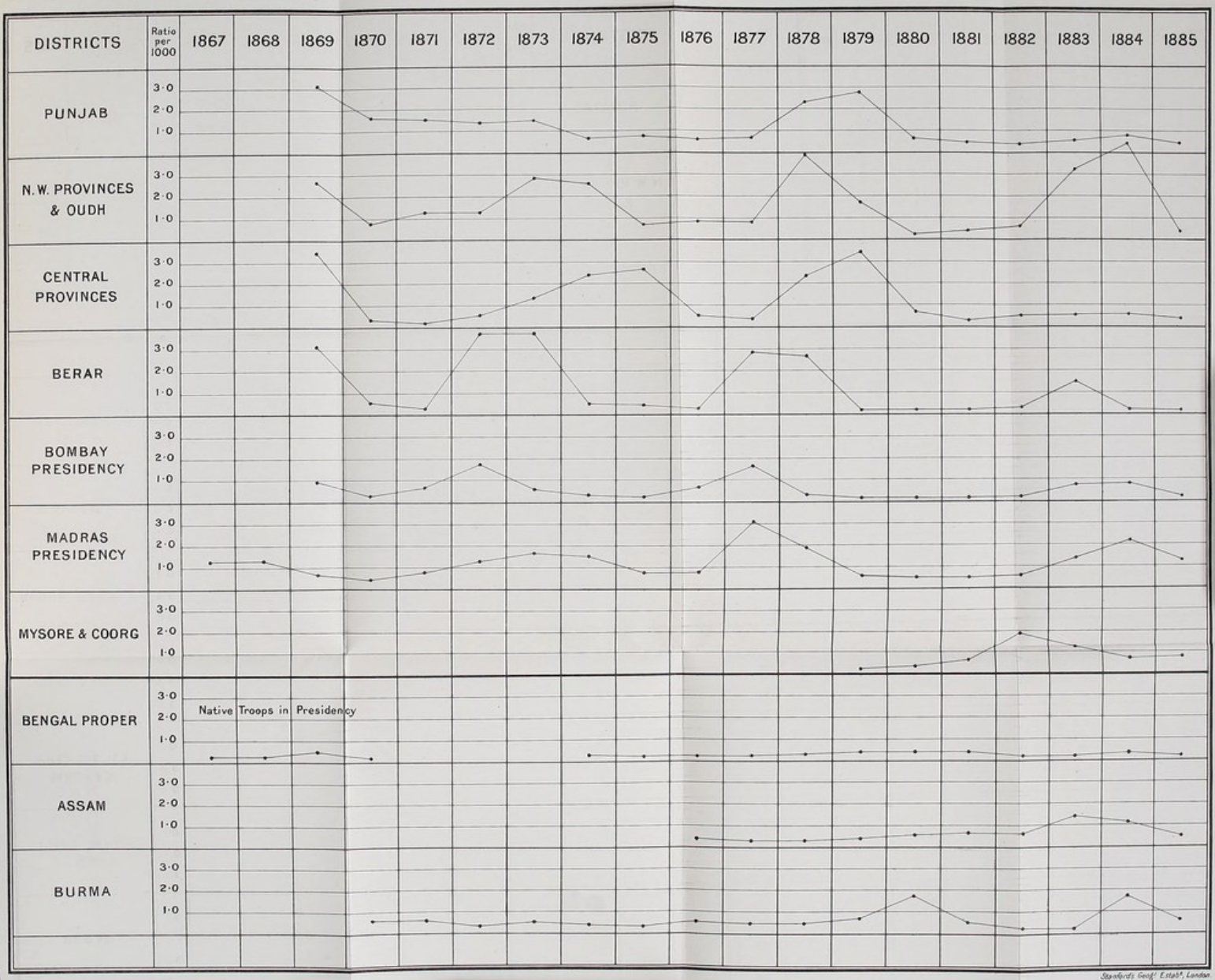
to 1·36 in 1886. In this year too there was a very severe outbreak at Marseilles, with a death rate of 5·45. In Paris the ratio in 1885 was ·03, and in 1886 ·09 only. In London in 1886 the mortality from small pox was too small to be sensible in the second place of decimals.

These details render it apparent that small pox, like fever, is under the influence of a pandemic factor which determines its development as an epidemic at some point in the first instance, and its subsequent extension to the northward in successive years. The illustrations given above have been mostly taken from the Indian returns, and such notices of its occurrence in Europe and America as gave specific information as to dates of commencement and decline of the disease, or statements of the deaths in particular years. There are many notices of epidemics in southern latitudes, or on the east coast and other parts of Asia, which might have been referred to, but the want of these details prevented their being referred with certainty to their true place in the general arrangement. The isoclinal lines on the map already referred to in connection with fever seem to represent the manifestations of small pox fairly over the space for which it has been examined, from which it may be concluded the waves were every second year for the most part, or at some multiple of two years; and that, as mentioned regarding fevers, one wave sometimes follows on another so as to give the semblance of an epidemic extending over three or four consecutive years.

The existence of the pandemic factor being thus recognised, its nature and mode of action become proper subjects for investigation. Of its intimate nature nothing is known, and there is as yet no explanation of why it should proceed from south to north, nor why it should have a two-yearly period, and lead to a development of disease in some of the zones on the map in a year with an odd number rather than an even one, and *vice versâ*. But there are other directions in which important information may be obtained, some of which may now be enquired into.

It frequently occurs that, in the same year, and under the same wave, there is a great development of fevers over an extensive space in longitude, but the kind of fever may vary much at different points. Thus in 1828, when febrile disease was particularly prevalent throughout the Mediterranean, there was a very severe epidemic of yellow fever at Gibraltar, petechial typhus raged at Naples according to Lanza, remittent fever caused a high mortality among the troops in the Ionian Islands, and plague raged

RATES PER 1000 OF DEATHS FROM SMALL POX AMONG CIVIL POPULATION IN THE UNDERMENTIONED DISTRICTS IN INDIA, FROM 1867 TO 1885.




Stanford's Geogl. Estabt, London.

in Greece, as also in Egypt, Syria, and at Constantinople. There is a similar record from India in 1836–7, when the disease called there Pali plague[1] was active at Pali in Marwar, in the western part of Rajpootana, and the mahamurree in the Himalayan districts of Gurhwal and Kumaon; in the intermediate space ordinary intermittent was rife in Jeypoor, common remittent in Ulwar, and a deadly infecting epidemic prevailed in Rohilkund, the country lying between Ulwar and the foot of the hills where the mahamurree was doing its work. Many other illustrations of this question might be adduced, but these are enough to show that the pandemic wave of itself is insufficient to account for such varied results, and recourse must be had to other factors connected with each locality for the time. With regard to intermittent and remittent fevers the endemic sources of malaria may be all that is requisite in most cases, but with yellow fever and plague, and for other fevers, something else is necessary.

In stations where the common fevers are the ordinary remittent or continued fever, and yellow fever shows itself at intervals only, important information as to its manner of approach may be sometimes obtained. At Sierra Leone the ordinary fever is the remittent, but there were severe epidemics of yellow fever in 1823, 1829, 1837, 1847, continuing in each instance more or less into the following year. In 1825 a number of white troops were sent from England to this station among whom, that and the following year, there was enormous mortality from fever, but altogether from remittent, which continued the sole fever during 1827–28, with the exception of a single fatal case of yellow fever in 1827. In the interval from 1830 to 1836 remittent fever was the only one met with, with the exception of a single case of yellow fever in 1835, in an old officer, which terminated fatally with black vomit on 4th September. In the next interval from 1838 to 1846 the fever was uniformly remittent, except in 1845 when the "Eclair" was affected. This vessel had been at anchor off the Seabar, one of the mouths of the Sherboro River, south of Sierra Leone, from the beginning of March to nearly the end of June with but little intermission, and there her bilge had become foul and gave off excessively offensive exhalations. Boats had been sent up the river on several occasions, and cases of ordinary remittent appeared among their crews in April and May, but on 22nd May a

[1] The Pali plague and the Mahamurree are now generally admitted to be the ordinary bubonic plague.

stoker, who had not been out of the ship, was attacked with fever of which he died after five days' illness; the symptoms were not detailed sufficiently to enable the nature of the case to be recognized with certainty, but it was a very suspicious one. Others followed on 4th and 5th June, in one of which the patient become yellow, and in another incipient black vomit was found in the stomach after death, but these had been up the river from 22nd to 28th May, where of course they were exposed to other influences in addition to those they were subjected to in the ship herself. The "Eclair" returned to Sierra Leone on 4th July; while there her crew had leave, but there seems to have been no fever among them until 19th, from which day, until the 23rd when she sailed, there were four men attacked with fever, which seems to have been ordinary remittent, these men had all been some days on shore; two others were attacked on 29th July, at sea, both of whom died, but without the characterisic symptoms of yellow fever. Before sailing the "Eclair" had taken on board as fuel a large quantity of old wood which had been lying in the mud for years at one of the shipping stations, thus introducing another element of uncertainty in her case. Whether the stoker attacked on 22nd May, or the men who, were seized on the 4th and 5th June, had yellow fever, cannot now be determined, but there seems to have been no fever among the crew from the time the ship started for Sierra Leone, and the 19th July, when she was at Freetown, and none of the cases which occurred up to 29th July inclusive, presented the characters of yellow fever. There was no case of yellow fever on shore before the "Eclair" sailed, but three fatal cases occurred after her departure; one, a resident, was attacked on 6th or 7th August, and died on 16th, yellow with black vomit; the second was the master of an American trader, who arrived in the Colony on 28th July from the Gambia and coast to the northward, who was attacked on 15th August, and died on 19th, with the characteristic symptoms; the third, one of a prize crew, which brought up an empty slaver from the eastward, and arrived on 2nd August; this man was attacked on 16th and died on 20th, also a decided case of the disease. From these facts it cannot be decided whether the "Eclair" first contracted yellow fever while lying off the Seabar, or subsequently to leaving Freetown; there was no case of the disease at the latter place while she was there, and the febrile cases among her crew up to 29th July were all the ordinary remittent; on the other hand she could not have communicated the disease to those on shore, two of whom did not arrive in the Colony until she had left.

From Sierra Leone the "Eclair" proceeded to the Gambia, with the "Albert," one of the vessels employed in the Niger Expedition, and on the way anchored some distance off the coast until 9th August, a portion of her crew being employed clearing out that vessel, which was found in a very foul state from a collection of rubbish and dirt. On 10th the "Eclair" entered the Gambia; thirteen cases of fever (including the two already mentioned) had occurred since 23rd July, six of which terminated fatally; in all these cases the men had been two or three nights on shore at Sierra Leone, and some of them had unequivocal black vomit. The fever continuing, she sailed on 15th for Goree, where she remained in quarantine, coaling, until 17th, when she left for Boa Vista, where she anchored on the morning of the 21st. The "Eclair" left Boa Vista for England on 13th September, 53 cases of fever and 30 deaths having taken place since her arrival. Some Portuguese soldiers and civilians who were much in contact with the "Eclair's" people while on shore, suffered from fever, and it was supposed they were infected by them, and were the means of originating the epidemic which subsequently broke out, but this did not commence until 12th October, the usual sickly season there, and after much rain had fallen. As bearing on this question it is to be observed that in the last quarter of 1845, a corporal of the Infantry of the Marine was attacked with yellow fever at Goree, which proved fatal; no vessel with fever had been at Goree since the "Eclair," and this man had not been away from the island; this case occurred about the time when the disease was at its height at Boa Vista, from which Goree is distant about 300 English miles.

The facts detailed above show that in the course of 1845 the cause of yellow fever was in action on shore at Sierra Leone, and in its neighbourhood on board the "Eclair," and subsequently at Boa Vista, and Goree, finding a suitable locality in the "Eclair," it developed in her causing a severe epidemic, and a similar result followed in Boa Vista in October, as soon as the drying up of the profuse rainfall afforded the requisite conditions, while the comparative immunity of Sierra Leone and Goree, showed these were not favourable there at that time. In 1847, however, the second year after the first indication of the cause, with the advent of a fresh pandemic wave, a severe epidemic sprang up at Sierra Leone, as had been the case in 1829 and 1837 after the appearance of the sporadic cases in 1827 and 1835. The epidemic did not stop at Boa Vista, but was experienced in 1846 at Santa Cruz in Teneriffe, and

the same year the deaths from fever among the troops at Gibraltar, which in none of the preceding five years had exceeded 1·2 per 1,000, rose to 6·7, and one case so closely resembled yellow fever that an epidemic was anticipated; fortunately this did not occur, but the subsequent progress of the wave was obvious by the great development of various forms of fever in this country and Ireland, and in parts of Europe in 1847. It is remarkable how closely the mortality from fever among the troops at Gibraltar has corresponded with its manifestations of the previous year at Sierra Leone, or in the West Indies, though not always resulting from the same kind of fever. Thus the epidemic of yellow fever at Sierra Leone in 1823 was followed in 1824 by a death rate at Gibraltar of 5·3 per 1,000, mostly from what was then designated common continued fever, the rate for the previous year having been 0·7 only; in 1825 Hennen relates there was one sporadic case of yellow fever in Gibraltar, and in 1826 he met with several in persons who had not been out of the garrison the entire season; the death rates among the troops from fever in those years were 3·2 and 4·2 respectively, from common continued fever and typhus, following the much higher rates from yellow fever in the West Indies and Jamaica in 1824 and 1825. The sporadic case of yellow fever at Sierra Leone in 1827 was followed by the severe outbreak of 1828 at Gibraltar, and that of 1829 at Sierra Leone arose with the advent of the succeeding wave as in 1847; the epidemic of yellow fever in 1837 in Sierra Leone was followed by a death rate of 4·7 at Gibraltar in 1838, while the rate for the previous year was 0·9 only, about three-fourths of the mortality in 1838 was attributed to typhus.

The occasional occurrence of yellow fever at Sierra Leone, with intervals of a considerable number of years during which there was no trace of it, leads to the inference that the immediate exciting cause of the disease is generated by a special factor, acting on a suitable locality in a place where the disease appears, and which is either absent or in abeyance during the intervening periods. The slight outbreak in Bermuda commencing late in 1818, and followed by the severe one in 1819 (noticed above) for instance, may be referred to a single communication and continuance of the factor in question; the occurrences at Sierra Leone of sporadic cases in 1835 and 1845, followed by the epidemics of 1837 and 1847 respectively, without any indication of its presence in the inter-

[1] "Medical Topography of the Mediterranean," p. 119.

mediate year may have depended on the absence of the necessary local conditions in those years; but on this point evidence is wanting, and it is still more doubtful that the factor could have been present during the long intervals when no yellow fever was met with. That the exciting cause of yellow fever is sufficiently active to develop the disease, in susceptible subjects, at a time there is no indication of it among the resident population, is frequently rendered obvious by the occurrence of sporadic cases when such persons are exposed among them. The following are instances in which it occurred on a more extended scale:—In 1822, the 33rd and 91st Regiments from this country arrived in Jamaica in detachments from February onwards, their united strength in March was 884, increasing to 1,116 in May, notwithstanding their losses in the meantime. The 50th and 92nd Regiments, then nearly three years on the station, had a strength of 1,158 in March, increasing to 1,208 in May. The deaths in these two bodies in the four months, March to June, were—

| | March. | April. | May. | June. | Sums. |
|---|---|---|---|---|---|
| 33rd and 91st Regiments ... | 25 | 56 | 55 | 35 | 171 |
| 50th and 92nd Regiments ... | 6 | 7 | 3 | 16 | 32 |

The four months here given are the healthiest in Jamaica. The number includes the deaths from all causes, but nine-tenths of them in 1822 were from fever, by deducting one-tenth there still remain 154 deaths from fever among the recently arrived corps, as against 29 among those longer resident. In 1819, the 58th Regiment from England arrived in Jamaica in March, and the 92nd also from England arrived in June; great mortality from fever commenced in these corps in July, the same time as it began to increase among the men of the other regiments which had been some years in the island. In 1827 again, the 84th Regiment from England arrived in Jamaica in February and March, the first death in the corps was in July, but in August fever appeared and they lost 112 in that month alone, and 61 more by the end of the year. The years 1819 and 1827 were the first years of the wave, the influence of which would become sensible there about July, and the unacclimatised troops were the earliest and greatest sufferers. In 1822, the second year of the wave, the troops from this country arrived when its influence was in abeyance among those sometime resident in the island, but the enormous mortality that took place among them showed it was not extinct.

It thus appears that, from time to time, there is an increased

activity of those factors which lead to yellow fever over a varying extent of the earth's surface, under the influence of which that disease becomes developed when local circumstances are suitable. The latter embrace the state of the weather, the condition of particular spots, often of very limited extent, the emanation from which engenders the disease in individuals exposed to it, while there are many points in their immediate vicinity where they may remain without risk, if only they avoid the emanation in question. The determining condition seems to be a certain amount of moisture in the soil at these points, whether supplied by rain or from subsoil sources seems immaterial. Too much water obviates the result, whether by checking the formation of the emanation, or preventing its diffusion has not been determined, while too little seems practically to prevent its formation altogether. Thus while at Sierra Leone yellow fever epidemics have fallen on years when the rainfall has been low for that place, and even then the disease has been met with before the heavy rains set in, or during a break in them which occurs pretty regularly in the end of July and early in August, or after the wet season has nearly terminated; in all the epidemics heavy and continued rain has put a stop to the yellow form of fever, and the ordinary remittent has taken its place. On the other hand, their vicinity to the desert ensures Goree and Senegal a much drier climate in ordinary years, and it has been remarked their epidemics have all fallen on years more than usually wet.[1] The same combination is observed in the West Indies, a certain amount of moisture is always present when the disease springs up, and heavy rain for the time being seems to suspend the influence of the emanation.

What applies to localities on shore applies to ships also. Unless a vessel have her bilge in a foul condition from an accumulation of fetid mud, or have as part of her cargo or ballast damp material which serves as a soil for the growth of the matter of the emanation, she will not become the source of an epidemic; numbers of her crew may be exposed to the cause of the disease on shore, or in another vessel, and return to their own while it is in the incubative stage, or even fully developed, but it is found to cease with them within the recognised period of incubation, and none become affected who had not been exposed in the sickly locality; but if, as in the "Eclair," the bilge be foul, it may afford the requisite conditions or the generation of the miasm, under the influence of the pandemic and special factors, and a most serious outbreak may

[1] "De la Fievre Jaune au Senegal," par L. J. B. Berenger Féraud, p. 298.

arise, while neighbouring ships, and even the shore itself, may remain free from the disease. Other cases illustrating these points will be given in a subsequent lecture.

The re-appearance of plague at various points where it had formerly been epidemic from time to time, affords some very valuable and interesting illustrations of the different stages it passed through from its first indication to its full development. These merit a close examination to elicit what evidence they afford of the factors concerned in the production of the disease. Plague, which had been very general in Europe in the first half of the seventeenth century, during the last third of it nearly disappeared from the western half; in the eighteenth century, with one or two limited invasions, Western Europe remained free from the disease; and during the present century, with the exception of the epidemic at Malta in 1813, and those in the Balearic Islands in 1818 and 1820, and a few other limited outbreaks, the disease has been met with in the country to the east of the Adriatic, in Turkey, including its Danubian and Asiatic provinces, Syria, Egypt, and the Barbary States, along the southern shore of the Mediterranean. The disease withdrew from these countries gradually, the last experienced in Morocco having been in 1819, in Algiers and Tunis in 1837, in Tripoli in 1843, and Egypt in 1844. The last epidemic in Constantinople was in 1841, but the disease was met with in Armenia up till 1844. Nothing was heard of plague in any of these countries again until 1858, when it broke out among a tribe of Arabs living in the vicinity of Bengazy in April, and after extending over most of the province, terminated in June, 1859. There was a second outbreak in the same locality in April, 1874, which terminated in July that year. The outbreak on the latter occasion was much less diffused than on the previous one, though the character of the disease was equally well marked. Since 1858 plague has occurred on several occasions in Mesopotamia, in Kurdistan, north of Persia, and even near Astrakan, and as localities subject to it have been recognised in India and China, it will afford a clearer view of their interrelation if the epidemics at these different points about the same date be brought together as far as the general description of them permits.

In May, 1815, plague commenced in the Island of Cutch (north of Bombay), and continued there and in the neighbouring districts with various recrudescences until 1821. In 1815 also plague became epidemic in the south-west of Arabia, from Konfodeh to Yembo, and embraced the interior as far as Mecca and Assyr. In

1816 there was a very serious outbreak of remittent fever from Patna to Saharanpur, a distance of 600 miles, and that year the plague extended to the Gujerat Peninsula, and as far as Hyderabad in Sind. Plague was epidemic in Egypt also in 1815, and in Algiers in 1816; in the latter the disease continued with recrudescences up to 1821. The epidemic was severe in Gujerat and the neighbouring districts in 1818 and 1819, and in the former year there was a severe epidemic in Egypt, and while it continued in Algiers, Morocco became affected in 1818, the outbreak there continuing into 1819. Plague appeared in Majorca, one of the Balearic Islands, in 1820.

The two mountain districts of Kumaon and Gurhwal, on the southern slope of the Himalayas, have frequently suffered from a severe epidemic called by the natives mahamurree, or great death. This came to the knowledge of the Government first in 1836, when it appeared there had been a very serious outbreak in 1823 in Gurhwal, and subsequent investigation has shown the disease was bubonic plague. There was no indication of plague in the western part of India this year or the following one, but in Egypt in 1824 there was a violent epidemic, causing, it is said, 30,000 deaths in Cairo alone, and the disease continued in Lower Egypt in 1825. Plague was frequent in Armenia also in 1824 and 1825.

From 1828 and 1829 plague was in Egypt, Syria, Greece, Turkey, and as far as Odessa. In 1830 it was about Lake Urumiah and northern part of Mesopotamia, and in 1831 it was very general over the north and west of Persia, and recrudescences occurred on Persian frontier in Mesopotamia and Syria to 1834–35. In 1832 another epidemic occurred in South-West Arabia, embracing the coast line from Yembo to Jeddah and the interior as far as Mecca; Egypt was also affected.

In 1834 mahamurree was again prevalent in Gurhwal, 633 having died from it in villages widely separated. Plague was also severe in Egypt, 8,496 having died from it in Alexandria alone from November, 1834, to June, 1835. It was also frequent along the west frontier of Persia and in Turkey.

The next manifestation of plague in India occurred at a small town named Pali, in Marwar, about 150 miles north-east of Cutch and Gujerat; hence its name—Pali plague. This commenced in July, and in October reached Jhodpore, the capital of the State of Marwar. In the beginning of 1837 it extended eastward into the neighbouring State of Mewar, but did not spread very far.

Towards the end of 1837 there was another manifestation at Pali, where it died out in the spring of 1838. In 1836 the mahamurree was epidemic again in Gurhwal, and as already mentioned the country between Pali and Gurhwal suffered severely from intermittent, remittent, and the yellow relapsing fever which has proved so fatal in India of late years. Plague continued in Egypt in 1836–37, but as the deaths from it at Alexandria in these years were 176 and 153 respectively, it does not seem to have been very severe, but in Algiers in the same year there appears to have been considerable mortality from it. Turkey was likewise affected in 1836–37, and in the latter year there was a slight outbreak at Odessa. In 1838 and 1839 there seems to have been little of the disease in Egypt, the deaths from it in Alexandria having been 226 and 43 only; in 1840, however, these then rose to 1,195, and in 1841 to 1,488, and after 1844 it ceased altogether for the time: the next appearances recognised in this part of the world having been in 1853 in the Assyr country, and at Bengazy in 1858.

During this interval the mahamurree had fluctuated in the Himalayan districts. In 1846 it was frequent; in 1849–50, still more so; and in 1851–52 it caused 567 deaths in 77 villages. In 1853 plague was epidemic in Assyr, and in the end of 1852 and early part of 1853 a very severe fever prevailed in the Yusufzai Valley, north of Peshawur, which Hirsch considers to have been plague,[1] but which, from the descriptions of Drs. Lyell and Farquhar, seems to have been the yellow relapsing fever previously mentioned, and which became so common in the North-west Provinces and Punjab a few years after. It is worthy of notice here that pernicious intermittents were frequent in Mesopotamia in 1849 and 1852, corresponding in time with the increase of mahamurree, and in a district where a few years after plague broke out.

In August, 1856, Dr. Duthicul saw at Bagdad a severe fever resembling adynamic typhoid, with glandular swellings in the neck, axillæ, and inguinal region; this lasted from eight to ten days. In 1858 the same observer met with more than fifty cases of a similar description at the same place. Tholozan regards these as manifestations of benign plague, endemic, and occuring sporadically.[2] The importance of these occurrences will be noticed here-

[1] "Handbook of Geographical and Historical Pathology," vol. i, p. 510. The date of this outbreak is here given is 1832, on the authority of Dr. Murray; the proper date, however, is 1852-53, as in Dr. Murray's paper in "Epidemiological Transactions," vol. iv, p. 132.

[2] "Une Epidemic de Peste en Mesopotamie en 1867," p. 18.

after. In 1858 plague appeared in the vicinity of Bengazy, on the coast of Tripoli, early in April, in a small encampment of Arabs. It soon embraced the town of Bengazy, and extended eastward to Derna, the only other town in the province, and affected the scattered population in the high plateau between these places. In autumn the force of the epidemic was much reduced, but later a recurdescence occurred, and ultimately it died out in June, 1859. Dr. Barozzi, who was sent from Constantinople on 20th March, 1859, to assume the direction of the Sanitary Commission previously despatched to Bengazy, and who made a full and careful examination into the circumstances preceding the outbreak of 1858, states that in the spring of 1855 typhus appeared with petechiæ and engorgement of the parotids; this in 1856 became a severe epidemic causing 5,000 deaths, and as there were in a good number of cases buboes in the groins and axillæ, and a fatal termination often on the fourth and even on the third day, he concluded that even were typhus prevailing, there were many cases of plague mixed up with it,[1] an inference fairly supported by the facts. In connection with the outbreak at Bengazy in 1858, the English Consular Agent at Mourzouk, the chief town in Fezzan, twenty days' journey (485 geographical miles) south-west of Bengazy, in a letter to the Chief of the Sanitary Commission, dated 27th December, 1858, states that a fever with buboes commenced there at the beginning of April, and ceased in October, 139 cases having occurred in a population of about 5,000. The mortality seems to have been small. There was a slight recrudescence towards the end of December, as at Bengazy. It is also mentioned that in 1856, while cholera was present, typhus was prevailing, and buboes were observed in some individuals. The Agent mentioned likewise that certain of the natives, whom he considered worthy of belief, affirmed that about 1828 a similar affection appeared at Mourzouk,[2] a period when plague was active in Egypt, as mentioned above.

In the end of 1859 and in 1860 there was again an epidemic of mahamurree in Kumaon and Gurhwal, during which about 1,000 are said to have died from it. Fevers with buboes and glandular engorgements continued to appear at Bagdad and in its vicinity from 1859 to 1861,[3] and about September, 1859, there were nine cases of

[1] Tholozan "La Peste en Turquie dans les Temps Modernes," pp. 40, 41.

[2] "Recueil des Travaux du Comité Consultatif D'Hygiene Public de France," vol. iv, p. 192.

[3] "Peste Bubonique en Mesopotamie," Tholozan, p. 76.

fever with buboes at Beyrout and its vicinity, two of them severe, one of which died; these were scattered, all solitary, and there was no transmission of the disease.[1] In September, 1863, there was an outbreak among the tribe of Jellali, near Maku, in the extreme north-west of Persian Kurdistan, and which ultimately involved the town itself, but its range was very limited.[2]

The next prevalence of the mahamurree was in 1865, of which I have no details. In December, 1864, fever was met with over almost the whole of Mesopotamia, and with glandular engorgements at Bagdad, and in April, 1865, the same conditions existed, and a similar combination was met at Chanecan, on the Persian frontier. In June the glandular affection disappeared. There is no notice of the prevalent disease in Mesopotamia in 1866, but Dr. Dickson in his paper in the "Epidemiological Transactions" stated in reference to the early part of 1867, "that buboes, or swellings of the glands in the groin, armpits, and neck, have been prevalent throughout the province of Bagdad during the past spring season; and that according to native tradition this prevalence of buboes has, on former occasions, invariably preceded the appearance of plague in the succeeding year" (p. 145). In May, 1867, remittent fevers became more and more frequent, often accompanied by numerous abscesses and other symptoms of severity. While these things were going on plague broke out on 6th February of the last mentioned year, in a violent form, among a tribe of Arabs called Beni-Juroof, who lived in the very marshy district of Hindie, west of the Euphrates, near Kerbela. The inhabitants of five villages only were attacked. They amounted to about 1,000, and the deaths among them were believed to be not less than 300. The outbreak terminated in June.[3]

The next increase of mahamurree was in 1870, but beyond the fact of its prevalence, I have no details regarding it. In the district of Yunan, in south-western China, bubonic plague was very prevalent and fatal in 1871–72–73.[4] A severe outbreak of plague commenced in the end of 1870, among the villages on a high plateau about 5,000 feet above the sea, south-east of Lake Urumiah in Persian Kurdistan; during the winter days snow

[1] "Recueil du Travaux du Comité," vol. iv, p. 207.

[2] "Papers relating to the Modern History and recent Progress of Levantine Plague" (Blue Book), 1879, p. 7.

[3] "Parliamentary Papers relating to Plague," p. 10. Dickson, "Epidemiological Transactions," vol. iii, p. 143.

[4] Gordon, "Epitome of Medical Reports, Chinese Customs," 1871-82, p. 123.

fell, and the villages being shut in, intercourse with each other and with the surrounding districts, became impossible; at this time plague became active among the infected communities, and almost swept away several. As spring advanced, and communication was resumed, the disease spread over a limited area. The epidemic seems to have died out before the end of 1871.[1]

Since the termination of the outbreak at Hindie, in 1867, Tholozan states that benign plague had showed itself from time to time among the Arab tribes in the vicinity of Suk el Sheyuk, Divanieh, Hillah, up to the end of December, 1873, when another epidemic commenced at Dagarra, a locality near Divanieh, but on the opposite (eastern) bank of the Euphrates. This was the starting point for a series of outbreaks which recurred until 1876–77. The areas under the epidemic increased each year; the epidemic of 1867 was confined to a small circle of about fifteen English miles in diameter on the west bank of the Euphrates, opposite Hillah; the area of the outbreak in 1873–74, was an irregular ellipse, its greatest length being 77 miles, extending from Kerbela to the south-east, and its breadth 38 miles; the seat of the epidemic of 1867 was embraced in this. The epidemic of 1874–75, occupied new ground for the most part, its position may be indicated generally by a line from Suk el Sheyuk to where the River Tigris crosses the meridian of 40° east longitude on the east, by another from the latter point to the western limit of the marshy ground on the west of the Euphrates, in lat. 31° 45′ on the north, and from the last named point to Suk el Sheyuk on the south-west; it thus formed a large triangle, and on the northern side included about a fourth of the ground under the disease in 1874. In 1875–76, the area under the epidemic extended still farther, and embraced a space from north-west to south-east of 200 miles, with a breadth of 102 at the widest part, it may be indicated by a line from Suk el Sheyuk passing due north until it reaches the Tigris, then passing from that point until it reaches the Tigris again a little north of Bagdad, and from thence west to the Euphrates, here turning southwards it includes Kerbela, the sea of Nedjef, and marshes to the south of it, and along the west bank of the Euphrates to Suk el Sheyuk as in 1874–5. In 1876, there was a considerable outbreak of plague at Shuster and Disful, distant from the Mesopotamian plague district a hundred miles, in which space none of the disease was met with.[2]

[1] Parliamentary Papers, pp. 11, 12.

[2] Parliamentary papers, maps and numerous notices.

While these epidemics were in progress in Mesopotamia, there was an outbreak in the Assyr country in the spring of 1874, and another in the vicinity of Bengazy at the same time. Arnaud, who reported to the Turkish Sanitary Administration on the latter, stated that as early as October, 1873, isolated sporadic cases of fever with swellings in the groins, axillæ, and neck, arose among the tribe of Orphas, which terminated fatally.[1] In November, 1876, mahamurree became prevalent in Kumaon, and extended into the early part of 1877, and the plague seems to have been epidemic in Yunan at the same time,[2] as well as at Pakhoi, one of the treaty ports in China, situated at the north-east corner of the Gulf of Tonquin, where it has been met with frequently of late years.[3]

The epidemics of plague dealt with above though generally commencing about November or December seldom caused much mortality until late in March, and far the greater portion of it occurred in April and May, after which it declined rapidly and seldom extended into July. The individual epidemics, too, showed a high death rate the first year, and generally there was a recrudescence the following one with a much smaller loss; when a series of outbreaks continued for three or four years, it seems reasonable to infer that there have been at least two distinct epidemics, one following the other as has been explained above in reference to fever. This view is borne out by the facts that the first outbreak in Mesopotamia in 1873–74 was continuous with those at Assyr and Bengazy, while the extension of the disease to the northward and to Shuster in 1875–76, was soon followed by the epidemics in Kumaon and Yunan, and at Bagdad, which first experienced the force of the epidemic in 1876, the deaths from the commencement to 17th June were 2,611, while in 1877 for the same period they were only 1,672.

While the epidemics were in progress in Mesopotamia, an outbreak occurred in two villages four leagues south of Sharoud, which is south-east of Astrabad, and on the road from Teheran to Meshed. This commenced in December 1876, and terminated the following January. In March, 1877, plague appeared at Resht at the south-west angle of the Caspian, in no great force, but in May it became epidemic, and extended to several villages in the neighbourhood. Up to 12th September, it was calculated that 4,000

[1] Tholozan, "La Peste en Turquie," p. 54.

[2] "Supplement to Ninth Annual Report of the Local Government Board," p. 46.

[3] Gordon, "Chinese Custom Reports," p. 303.

deaths from it had occurred in the town and its vicinity. Cases were recorded in Baku, north of Resht, in the Russian territory, as early as January, 1877.[1]

In May, 1877, fever with enlarged glands in the neck, groins, and axillæ, showed itself in Astrakan and at various points in the vicinity; this seldom disabled the patients, who were commonly able to get about as usual. The cases lasted from ten to twenty days and all of them recovered. This complaint was most frequent in June and July; to the middle of September 200 such cases were recorded in the city of Astrakan alone, besides many others there and in the villages in the Delta which were never reported. This glandular affection appears to have been observed both in the city and Delta in 1878 and 1879, but there is no definite information as to its prevalence in these years.[2]

According to the lines on the map a fresh wave would reach Resht about 8th October of the odd year, and there were the following indications of its presence about or subsequent to that date. Cases of plague occurred in Resht in January, 1878; they had also been met with in the Khalkal district of Azerbijan, about seventy miles north-west of Resht, early in September, 1877, and in the Souk-Bulak district in January, 1878.[3] This wave would reach Astrakan on April 7th, and Vetlianka on May 1st of the same year, when the following occurrences took place. In October, 1878, some cases with moderate remittent or intermittent fever, with enlargement of the axillary or inguinal glands, occurred at a station called Vetlianka on the right bank of the Volga, one hundred and thirty English miles above Astrakan;[4] most of these seem to have recovered, but in the middle of November, they were supplanted by others of a much more aggravated description, of which the great majority died.[5] The disease appeared in six other stations along the course of the river of these Staritskoye on the right bank and Selitrenoye on the left, the highest and lowest, are one hundred English miles apart, Nikolskoye, Prichibnoye, and Vetlianka, on the right bank, and Udachnaya and Michailovka on the left, are so situated that a circle of twelve miles radius would embrace them all, and this circle is midway between Staritskoye and Selitrenoye. The mortality in Vetlianka from plague was 211 per 1,000, in the other four stations included with it 3·3 per 1,000 only, at Staritskoye 3·2 per 1,000, and Selitrenoye 11·25.[6]

[1] "Parliamentary Papers," pp. 37–38.
[2] "Supplement to Ninth Annual Report, &c.," pp. 49 to 51.
[3] "Parliamentary Papers," p. 38.
[4] *Ibid.*, p. 3. [5] *Ibid*, p. 52. [6] *Ibid.*, p. 11.

Since the termination of these occurrences in Southern Russia plague reappeared in 1879 in the Assyr country, and in 1882 there was an epidemic at Pakhoi. From 1883 to 1885 also there were limited outbreaks of it at various points in Mesopotamia, and on the Persian frontier, but detailed information as to most of them is wanting. This is of little consequence as the facts as to previous epidemics, given above, are sufficiently numerous and varied to sanction some very interesting and important generalizations which may now be entered on.

It will be observed that the localities mentioned in the details already given are either between the isoclinals 30° north and 53° north, or in their immediate vicinity; Assyr, Cutch, and Gujerat, and Pakhoi, being to the south of the former, and Astrakan and the places in its vicinity to the north of the latter. Under the assumption that the advancing edge of the wave passes over the space between these isoclinals in a year with an odd number, an outbreak may be looked for at any given point provided the wave has reached that point previous to or about the usual season for the disease becoming active there; if the wave do not reach the point until the ordinary season for the manifestation of the disease has passed, the resulting epidemic will be postponed to the following or even year. This applied equally to places south of the isoclinal 30° or north of 53° north, only substituting even for odd and *vice versâ*. Thus the wave would reach Assyr about the first week of August in a year with an even number, and as on ordinary occasions the disease commences there in the early months of the year and disappears in June or July, the epidemics are likely to occur in the following or odd year, and this was the case in 1815, 1853, and in 1879. In 1874 there was an apparent exception to this rule, in that year sporadic cases of plague commenced about the end of March and continued until the middle of July, it then became epidemic and continued so during the latter part of that month and August, and declined in September, so that the force of the outbreak must really be attributed to the operation of the new wave. In Cutch the advancing edge of the wave would be experienced about the first week in November of the even year, and as the season for the appearance of the disease was in the early part of the year it commenced in May of the odd year, 1815. There were recrudescences in 1817 and 1819, with minor extensions in the intermediate years. At Pakhoi the advancing edge of the wave would be felt in the first week of December of the even year, and here there was an epidemic early the following one, 1877, as well as in

the western part of Yunan which was then under the same wave. The epidemics in Yunan in 1871 and 1873 were obviously under similar conditions.

In the zone north of the isoclinal 30° north Kumaon and Gurhwal are so situated that the wave would reach them about the end of April of the odd year. Here there was a severe epidemic in 1823, about the time of the pilgrimage to Kedarnath, there were also epidemics of varying force in 1849–50, 1851–52, 1859–60; during the last 1,000 deaths were registered; these dates include the latter months of the first-named year and the early months of the last, and of course came under the first year of the wave: the outbreak of 1834–35, which caused 633 deaths, and of 1876–77, during which 287 only died of mahamurree seems to have occurred under the second year of the wave. The outbreak at Pali, which appeared in July, 1836, was under the second year of the wave, but it sprang up again in March, 1837, which corresponds with the access of a fresh one in the other parts of the zone, and died out early in 1838, the second year of it. In Egypt the wave reaches Cairo about 20th May in the odd year, and Alexandria a month later, and as the epidemics of plague terminate in that country in June, they for the most part fall on the early part of the even year, and when an odd and even year are given the chief mortality has occurred in the latter; there were epidemics in Egypt in 1818, 1824, when 30,000 are said to have died of plague in Cairo alone; in 1834, which was followed by a severe outbreak at Alexandria in 1835, that caused 8,496 deaths from November, 1834, to June, 1835, and again in 1836. An epidemic was experienced in 1815 (the second year of the wave), according to Hirsch (vol. i, p. 505), from whom these dates are taken. In Algiers the wave would arrive about the middle of February of the even year, and the season when the plague prevails is spring and autumn,[1] consequently the epidemics under the first year of the wave fall on the even year, this disease was in that country from 1816 to 1821, and Morocco under corresponding conditions suffered from it in 1818 and 1819. The last epidemic of plague in Algiers and Tunis was in 1836 and 1837.

Bengazy is in the province of Tripoli, which lies between Egypt and Tunis. The town would be reached by the advancing wave about 16th August of the odd year. Here plague was reported to be epidemic in April, 1858, and it declined in the autumn, it was

[1] "Hirsch," vol. i, p. 516.

found on investigation by Dr. Barozzi that sporadic cases had been occurring for months previous to the outbreak, and that in 1856 a corresponding outbreak had occurred in which, with an extensive prevalence of typhus, there were many undoubted cases of plague. While the epidemic was prevailing at Bengazy, there was a considerable number of cases of benign plague at Mourzouk, nearly 500 miles in the interior. In 1874 there was another epidemic of plague at Bengazy, this commenced early in April, having been preceded by isolated sporadic cases, many of which terminated fatally.

Coming now to Mesopotamia and Kurdistan the wave would overspread all these districts in a year with an odd number, and it will be convenient and save frequent repetitions to indicate the position of its advancing edge for three principal points, which will include all the others it may be necessary to refer to: these are :—

| | | | | |
|---|---|---|---|---|
| Shuster, which it would reach on June 6th of the odd year. | | | | |
| Bagdad, | ,, | ,, | July 12th | ,, |
| Resht, | ,, | ,, | October 8th | ,, |

In September, 1859, there were nine cases of fever with buboes in the vicinity of Beyrout, one of which proved fatal; these were scattered, all solitary, and there was no transmission of the disease. The wave would reach Beyrout about the same time as Bagdad, and six weeks at least before these cases appeared.

In November, 1863, the Ottoman Quarantine Physician at Bayazid, reported the existence of plague in the Maku district, Persian Kurdistan; this first appeared among the tribe Jellali, in the vicinity of Maku, in September, and subsequently reached Maku itself; though distinctly marked it does not seem to have been very severe. The wave in the regular course would reach Maku about 20th November, so that the outbreak seems to have anticipated this by a short period. In 1867, plague commenced on February 6th among the Beni Juroof tribe of Arabs at Hindie, on the west bank of the Euphrates opposite Hillah, it was confined to five villages estimated to contain 1,000 persons, of whom 300 died; the outbreak terminated in June. Buboes were frequent throughout the province of Bagdad the whole spring season. The wave would reach Hindie shortly before Bagdad on 12th July, and as this outbreak was at an end a month earlier, it must be attributed to the second year of the preceding one acting in a region where the benign form was extensively diffused. Another outbreak of

plague took place in Persian Kurdistan in the end of autumn 1870, or beginning of winter, in the vicinity of Bana, south of Lake Urumiah, on a plateau about 5,000 feet above the Black Sea; the disease seems to have terminated in the course of 1871. Bana is south of Resht, and as the wave would reach that place on 8th October, the commencement of this epidemic must have coincided very nearly with its arrival. The next outbreak occurred among the Affij tribe of Arabs near Dagarra, on the eastern bank of the Euphrates in the latitude of Shuster, this commenced in the end of December, 1873, and in June, 1874, was rapidly declining. As the wave reaches Shuster on 6th June of the odd year, this epidemic was distinctly under it in its first year; in 1875, its second year, plague appeared again, and extended to the south asf ar as Suk el Sheyuk, but in a considerably less violent form than the previous year. In the middle of November, 1875, plague again became active at a point on the Tigris some distance below Kut il Amara, and in two villages on the Euphrates in the vicinity of Hillah; from the beginning of 1876 it made its appearance at many other points, and by the end of February became epidemic and occupied the country from Suk el Sheyuk to Bagdad, causing a great mortality estimated at 20,000. An outlier of this epidemic was met with in December, 1876, in two villages 4 leagues south of Sharoud, a town south-east of Astrabad, and on the road from Teheran to Meshed; this terminated the following January. This epidemic of 1876 like that of 1874 occurred under the first year of the wave and terminated in June, and like it was followed by another of much less force in 1877 over nearly the same space. In March, 1877, cases of plague appeared at Resht at the south-east angle of the Caspian, but in no great force; in May, however, though under the second year of the wave it became epidemic and extended to several villages in the neighbourhood, and up to 12th September it was estimated that 4,000 deaths had occurred from it. The epidemic seems then to have declined, but it increased to a slight extent in the early part of 1878. In May, 1877, a considerable number of cases of fever with buboes occurred at Astrakan, and at various points in the delta of the Volga, though with little mortality; as the advancing edge of the wave would reach Astrakan about the commencement of May in a year with an even number these cases would be under the second year of the wave as at Resht. There was a succession of similar cases at Astrakan and in its vicinity in 1878, but there is no detailed information as to their frequency.

In the regular course of the wave a new one would reach Resht on 8th October of the odd year and this would arrive at Astrakan in the beginning of the following April or in the even year, under the wave there was a slight reappearance of plague at Resht at the end of 1877, and in January 1878. Cases of plague were likewise reported in the Khalkal district of Azerbijan about 70 miles north-west of Resht early in September, and there was an outbreak in the Souk-Bulak district in January, 1878. In October, some cases with moderate remittent or intermittent fever with enlargement of the axillary or inguinal glands occurred at Vetlianka, a Cossack station on the right bank of the Volga, 130 English miles above Astrakan, most of which seem to have recovered, but in the middle of November, these were succeeded by others of a much more aggravated nature, most of which proved fatal with the characteristic features of true plague. Thus, the extension of plague from the country south of the Caspian to the banks of the Volga took place under conditions corresponding exactly with those under which it sprang up at so many other places as already detailed.

Though the Arabs had learned by experience that the occurrence of fever with buboes presaged the appearance of plague in a more intense form, the Council of Health at Constantinople, under the belief that plague was a contagious disease, that must be introduced from a locality where it was already prevailing, did not admit their connection; and it was not until M. Tholozan, who had recognized its real character, had pressed it on their attention, that the appearance of these cases began to attract the notice they deserved. They form a most important addition to our previous knowledge of the natural history of plague, and assist in elucidating several other obscure points in epidemiology.

The appearance of cases of benign plague indicate the operation of a separate factor, concurring with the pandemic wave in those localities where that form of disease presents itself. As has been shown above, though these may be very distant from each other yet the disease in the benign form occurs at each much about the same season as the fully developed plague—in Mesopotamia and North Africa about November or December, and, increasing in March and April, usually disappears towards the end of June or in July, showing that in these countries both are controlled by the same seasonal influences. Observations have not yet been made in a sufficient number of localities, or for a sufficient period, to admit of its being established whether this factor is to be considered

as always an invasive one, or whether it may not at times become localized and endemic. Its appearance at Mourzouk in 1858, and near Beyrout in 1859, and again, its extension to Astrakan and its vicinity in 1877, and its recognition in 1879 at Tsaritizin, Odessa, Warsaw, Vitebsk, and St. Petersburg,[1] all show invasiveness, while its more constant presence in Mesopotamia of late years is not incompatible with endemicity in suitable localities. The facts given above indicate that fully developed plague is frequently preceded by the benign form for a variable period, but it will require farther observation to show whether this anticipation of the more serious disease by the milder be the usual course.

Fully developed plague in Mesopotamia, in 1867, was confined to a very limited area in the middle of a much more extensive one in which benign plague had been pretty frequent for several years previously, and up to 1876 the successive outbreaks of the intense form of the disease in the central area were accompanied by the milder one around their margin. There must be something in addition then to the factor necessary for the production of the benign disease, and this new factor while developing the most virulent forms of disease over a large town for instance has the apparently anomalous character of doing so within the narrowest limits in individual instances. All the evidence from Mesopotamia agrees in showing the old idea that plague was communicated from a person labouring under it by contact, even though prolonged, is erroneous, and that the danger really arises from remaining in the apartment in which he resides, that the developed plague, in short, is not attributable to an emanation proceeding from the sick person's body, but to a miasm produced in the apartment altogether independent of him. Several authors who have had personal experience of plague have described it as "a poor man's disease that never went upstairs," and the sufferers, in addition to deficient food, have inhabited apartments badly ventilated, and often in the most insanitary condition; but persons in better circumstances, and not subject to these unfavourable conditions, have rarely been attacked. The late Dr. Burrell, when in charge of the medical department of the troops at Malta, examined into this question; for this purpose he had access to the police records of the epidemic of 1813 in Valetta and the neighbouring towns, which had been preserved, and in which the name of every person attacked was recorded, together with date, street, and the house or apart-

[1] "Lancet," April 8th, 1879, pp. 489–91.

ment in which he lived; and he assured me that while the disease was frequent in certain places where the poor were aggregated in considerable numbers, and in the Mezzoninos, in the better parts of the towns, in no instance was the family occupying the upper, drier, and more airy part of the houses affected. The way in which rats suffer on the approach of plague in Yunan, and mahamurree in Kumaon and Gurhwal, indicates that there is a morbific agent connected with the ground and places in which these animals burrow, which destroys them before it has become sufficiently developed to affect man, and so affords him timely notice of what is about to happen, a warning which both Chinese and Indians have not omitted to take advantage.

It is obvious from what has been stated above that the cause of benign plague may be extensively diffused without the fully developed disease showing itself; more frequently perhaps there is a variable area under the severe form, while the slighter accompanies it, surrounding the epidemic focus more or less completely. Whether the intense form may spring up independently, without being preceded or accompanied by the benign, remains for the present undetermined, as until M. Tholozan had directed attention to the subject in 1867, observers and authors had seldom recorded the facts. Whether there be a specific factor required to excite the fully developed disease, or whether that causing the benign form merely becomes intensified in certain localities from circumstances existing temporarily, are points which must also be left for future investigation, which the progress of bacteriology may hereafter facilitate.

# LECTURE III.

(Delivered 28th February, 1888).

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## EPIDEMIOLOGICAL ASPECTS OF YELLOW FEVER.

*Description of Yellow Fever.—Man or Animals subject to Yellow Fever the only Reagents for the presence and activity of its exciting cause.—The appearance of cases in a defined locality evidence only of the cause being in operation there, but not of its nature.—Cases of Yellow Fever imported into a healthy locality do not communicate the Disease.—When the Disease does spread after importation, the influence of a local cause requires to be excluded before it can be shown that the Disease was communicated by the Sick introduced.—Instances of "Isis" and "Bristol" at Sierra Leone, of "Brilliant" at Grenada, and of "Anne Marie" at St. Nazaire, examined.—Importations of Yellow Fever cases, alternating with outbreaks from local causes, at Military Hospital, Barbadoes.—Result of excluding the night air there.—Ships, and localities on land, acquire the power of exciting Yellow Fever without having received any one sick of that Disease, and even where it is not known to be present.—Instances of the "Susquehanna," and "Orion," and Bermuda in its various Epidemics.—Also Lisbon in* 1856–57.—*The potential factor seems to be diffused in a form which does not cause Yellow Fever in persons exposed to it, and it is only after it undergoes further development in a foul bilge, or in a damp spot on shore, that it becomes capable of exciting that Disease.*

Though the literature of yellow fever be very extensive, and highly controversial, the questions discussed in it are but few, the chief being whether it be a highly contagious disease, propagated from man to man, and always imported from some locality where it was already in existence to that in which it newly appears, or, whether it be dependent on causes existing at the place where it springs up, and altogether devoid of contagion. The doubts which stood in the way of settling these questions are partly due to there

having, for long, been no means of drawing a clear line of de marcation between yellow fever and the ordinary fevers of the country, where the yellow fever showed itself, and, to a much greater extent, from a complete misapprehension of the bearing of the evidence connected with its appearance. To deal successfully with this subject it is necessary to show clearly where the error lies on these points before proceeding farther.

There is no symptom seen in yellow fever that is not met with in other forms of disease, and it is only by grouping them in connection with certain periods in the disease, that its identity can be fairly established. In 1847, at Demerara, Dr. Blair found albumen and tube casts in the urine in yellow fever cases, while in the ordinary remittent and intermittent fevers, occurring at the same time, there was no trace of either in that fluid. Subsequently it was observed in the north of Italy, that in congestive forms of intermittent the urine contained albumen during the cold fit, but that disappeared during the period of reaction, which is not what is observed in yellow fever. When in Jamaica, from 1856 to 1860, I employed the opportunities which presented themselves there to follow up Blair's investigation, and to acquire what other information I could regarding yellow fever; and after my return to this country the results were arranged, and published in the April and October numbers of the "British and Foreign Medico-Chirurgical Review" for 1862 (vols. xxix and xxx). From these the following are the distinctive characters of this disease :—

1. Yellow fever usually terminates in death, or convalesence, from the fourth to the seventh day; but either may occur as early as the second, or not before the tenth or twelfth, or even later.

2. There is generally yellowness of the eyes and surface, commencing at various periods in different individuals and epidemics.

3. On the evening of the third day, or morning of the fourth, the urine usually presents traces of albumen ; on the latter a considerable sediment appears in it, consisting almost wholly of epithelium from the bladder; this is succeeded by an equally copious one on the morning of the fifth day, which consists almost exclusively of granular tube casts from the kidneys, with scarce a trace of the epithelium from the bladder. By this time the albumen has usually become considerable, the chlorides and urea have been greatly reduced, and the urine as a whole, is usually scanty, and may even go on to complete suppression ; if there be much yellowness it may contain a variable quantity of the colouring matter of the bile.

4. The alvine discharges are devoid of the natural feculent appearance from the third day onwards, becoming greyish or yellowish white, with quantities of black matter diffused through it, when they are formed; when fluid consisting of mucus tinged with the preceding, or with bile, or blood in variable quantities. On the approach of convalescence the evacuations assume the natural colour.

5. As the urinary and alvine evacuations assume these characters there is a great tendency to black vomit, or discharges of similar matter from the bowels, or to the so-called hæmorrhages from the various mucous surfaces, or even in some cases from the skin, and, after death such may be found in the stomach and intestines when they had not been discharged during life.

Such are the distinctive features of a normal case of yellow fever; but in some the urinary symptoms may occur earlier than here mentioned, and in others they seem delayed for a day or two, but whenever watched from day to day, and properly examined, it is found that the changes in the urine not only embrace the presence of albumen, but indicate desquamation of the bladder and kidneys as regular features of the disease, and when these are fully developed the urea is much diminished, and the chlorides almost if not completely absent.

There has long been a contention between the two parties as to the form of yellow fever, the contagionists affirming that it is always continued with a paroxysm of about seventy-two hours, followed by the characteristic symptoms of the disease; while their opponents maintain that the latter are often found as fully developed in cases in which the fever had been distinctly remittent, or even intermittent, as in those which present the single paroxysm. Previous to our becoming acquainted with the urinary symptoms, when the line of demarcation between the ordinary forms of fever and yellow fever could not be drawn with precision, there might have been sufficient doubt on this point to afford ground for ardent controversialists to differ upon, but the trustworthy diagnosis made possible by the present knowledge of them has enabled numerous observers, in different countries, to verify the fact that yellow fever is met with not only in the continued form, but frequently as a remittent, and from time to time even as an intermittent. Whether the continued form be that proper to the disease, and the others hybrid forms impressed on it when the ordinary malaria which gives rise to periodic fever is rife, need not be enquired into at this time, it is sufficient for the present purpose

that it be clearly understood that a fever, presenting the characters set forth above as those of yellow fever, occurs both sporadically and in epidemics in a periodic as well as a continued form.

Having thus described yellow fever, the next point for consideration is what conclusion, as to its cause, does the occurrence of such a case sanction our drawing? At present there is no means of ascertaining whether the cause of yellow fever or those of other fevers are in activity in any locality, unless by finding man or animals subject to them, contract the disease when there exposed. Men or animals may be said to be the only reagents by which the presence and activity of the cause of yellow fever can be detected, and, when one or more cases appear in any locality that fact merely proves they have been subjected to the operation of the cause, but affords no indication of its nature; this must be arrived at from other considerations altogether. The practical question for settlement in such cases is, whether the attacks of yellow fever which occur in a locality, more or less circumscribed, arise from exposure to causes in operation in the locality at the time, as one party of the controversialists maintain, or whether the disease must have been introduced by some one or more who had come recently from another locality where it was already prevailing, and from whom it was communicated to others around them, and so on, as is believed by the opposite party. Now in such an instance to establish the position that the disease was introduced, and subsequently spread by communication from the sick, it is clearly necessary to exclude the possibility of the outbreak having arisen from local causes, and it is obvious from what has been explained above that can be inferred, with certainty, only when there are no more cases in the locality at all. In the great majority of examples adduced in support of the contagiousness of yellow fever no attempt has been made to exclude a local cause, and, when legitimately interpreted, the evidence that they afford is quite insufficient to established the conclusion based on it.

There are numerous well authenticated facts showing that, when yellow fever has sprung up in a locality, persons going to that locality may contract the disease, and should they leave before it became developed and go into a healthy one, they pass through the fever without affecting any one about them, and this even when their numbers are considerable. The following is a very striking and instructive instance. There was a severe epidemic of yellow fever at Sierra Leone in 1865, and the "Isis," receiving ship, which had been lying at the anchorage there for some years had

several deaths from it on board towards its close. The "Bristol" frigate, with a crew of 500, arrived from England late in December, and anchored four or five miles to seaward of the usual place, where the "Isis" lay. It being considered advisable to alter the berth of the latter to a healthier place, a party of 116 men and officers were sent from the "Bristol" to her, on the 28th, and 29th December, for this purpose; these men left the "Bristol" in the morning, and returned to her each night, without going on shore. Two of them were attacked with yellow fever on December 31st, twenty on January 1st, six on 2nd, three on 3rd, three on 4th, two on 5th, one on 6th, and one on 12th, thirty-eight in all, of whom twenty-one died on board, and two on shore at Ascension. Though the crew of the "Bristol" included many young men fresh from England, and consequently quite unacclimatised, not a single case of the disease occurred in any one who had not been exposed in the "Isis." Here the "Bristol" was a healthy locality, for none of her crew had been attacked with yellow fever before this outbreak, nor were there any subsequently, though a large number were necessarily employed in immediate attendance on the sick while it lasted.[1] This instance may be regarded as a complete experiment, and the results are clear and well defined. The disease was well marked yellow fever, and had it been communicated on board the "Isis" by contagion it should have afforded some indication of possessing this character in the "Bristol," but there was none. Had the men remained on board the "Isis" exposed to the active cause of the disease in her, the majority of them would have been struck down by the fever within a month; and the probability is that at least half them would have died. Under these circumstances the evidence would not have permitted of the local cause being excluded, and the conclusion would have been that the outbreak was due to contagion, which has just been shown was entirely wrong. The great bulk of the evidence which is thought to establish the contagiousness of yellow fever is of the same character, it does not admit of the local cause being eliminated, and the inferences it seems to sanction are altogether erroneous.

The following is a well marked instance of a ship's company contracting yellow fever on shore, while the ship herself was quite healthy, and, though a very severe outbreak had occurred the attacks ceased within the period of incubation after she went to sea. H.M.S. "Brilliant," a sailing vessel of 20 guns, with a crew of about 230,

[1] "Report on the Health of the Navy for 1866," p. 226.

was at Grenada in the beginning of August, 1857, and as the island was reported healthy the crew were permitted to land, and to remain on shore three days at a time. They drank pretty freely, and conducted themselves as seamen usually do when on shore on liberty. As the disease spread rapidly, and the attacks were daily becoming more numerous, a temporary hospital was established in a commodious building on shore, and a sufficient number of healthy men told off to act as nurses and attendants; but this segregation of the sick from the rest of the ship's company did not arrest the progress of the fever, or change its fatal character. It was therefore resolved to try what a change of locality would effect; a number of the worst cases were left in charge of a civil practitioner in the island, and the "Brilliant" sailed for Bermuda on 13th September, and arrived there on there on 22nd; the following day she sailed for Halifax, which she reached on the 29th. With the exception of one case that occurred on the 24th, the disease ceased entirely four days after she left Grenada. There were in all 86 cases of fever, of which 34 terminated fatally.[1]

A ship may be considered as a locality, like a circumscribed space on shore, and she may have an active source of yellow fever produced in her, but she differs from the place on shore in this respect, that she is moveable, and can, and when in this state frequently does, convey her febrific powers unimpaired to great distances. Her crew and passengers, or such as them as may be exposed to the emanation from her hold in a moderately concentrated state, may present a succession of cases of fever during her passage from one point to another, while others who are less exposed may continue in good health, though they communicate freely with the sick; and at the end of the voyage, when the cargo is being removed by persons who have not been in contact with the crew, many of them may contract yellow fever in its most pronounced form, as well as others who, from curiosity or otherwise, may have exposed themselves to the emanations from her hold; but there is no well authenticated instance, so far as I am aware, of yellow fever having been communicated by any of the latter to other persons on shore, who have not come within the range of the emanations from the vessel. An instance of this description occurred in 1861, which was carefully examined into at the time, and which was held by many to have clearly established the communicability of yellow fever from the sick to the healthy. This was the case of the "Anne Marie," with a crew of

[1] "Statistical Report on the Health of the Navy for 1857," p. 38.

sixteen persons, which, after a month's stay at Havanna, left that port on 13th June, 1861, with a cargo of sugar, for St. Nazaire in France; none of her crew had been sick while at Havanna. On 1st July, two men were attacked with fever, who both died; from that day to the 12th, there were seven other attacks, all ending in recovery, and she arrived at St. Nazaire on 25th July, when the master and crew, with the exception of the first officer, left her. On the 27th, she commenced to discharge in the dock at St. Nazaire, seventeen labourers being employed for the purpose under the superintendence of the first officer. During the voyage all the men who were attacked were berthed in a cabin under the deck, on a level with the hold, and separated from it by a badly jointed partition, those occupying deck-houses altogether escaped,[1] though they must have been much in communication with the sick. The discharge of the cargo was completed on 3rd August, and while this was taking place several of the men engaged, as well as numbers of the crews of other vessels near the "Anne Marie" in the dock, and others who came within the range of the emanations from her hold, were attacked by yellow fever of the most marked description in the course of a few days. These cases, though many of them had left St. Nazaire before the fever declared itself, were all carefully investigated and followed up to their termination, but in only two instances was there a suspicion that individuals who came in contact with them, but who had had no immediate communication with the "Anne Marie," suffered in consequence. The attacks of the crew and labourers, and others at St. Nazaire, only confirm what has been observed in numerous other instances, that susceptible persons exposed to the emanations from a vessel having a source of yellow fever in her bilge, are very liable to be struck down by the disease, but the communication of the disease from the sick to the healthy rests altogether on the two exceptional cases alluded to, which, therefore, it becomes necessary to make sure of having been really that disease. For this purpose, I examined carefully the statement of M. Melier, in the "Memoires de l'Academie de Médecine," vol. xxvi, with the letters from the medical attendants of the various cases attached to it. The first of these cases was that of Dr. Chaillon, who lived at Montoir, 4½ miles from St. Nazaire, which he had not visited since the arrival of the "Anne Marie." This gentleman, aged 42, though robust and active, was described as of a

[1] Proust, "Essai sur l'Hygiene Internationale," p. 219.

highly nervous temperament, very impressionable, and as having had a terrible dread of the risk he incurred by visiting yellow fever cases; he had visited four of those above-mentioned, the first on 5th, and the last on 11th August, when, finding the patient suffering from cramps, he remained with him, and rubbed his limbs for nearly an hour. On 13th, a bright, hot day, while 10 miles from Montoir, he was attacked with intense headache, and felt so unable to proceed that he left his conveyance and lay down by the wayside, until some people at work in the neighbouring fields came to his assistance. He then made one or more visits and returned home, the headache continuing very severe, with pains in loins, weariness in limbs, and he passed a very disturbed night, with delirium and frequent and abundant bilious vomiting. On 14th, he was somewhat better, though still suffering much from headache; he took a purgative of citrate of magnesia which caused profuse evacuations until the afternoon of next day; in the evening of the 14th, he had himself bled to between 24 and 35 ounces, and took $1\frac{1}{2}$ grammes of quinine in six doses. On 15th, there was little fever, but during the night (the regular tertian period) there was much restlessness, and the eyes were slightly yellow. On the 16th, the yellowness became more distinct; during the night he had a little red wine and water, which was vomited soon after, and then had a blackish violet colour, and an abominable taste (*goût exécrable*). On 17th, there was stupor, convulsive movements of mouth and hands, more yellowness, petechiæ on forehead, arms, and legs. No urine was passed since previous night. Death took place at 11.30 A.M. Throughout the illness, the overwhelming presentiment that his communication with the yellow fever cases would cause his death was ever present, and undoubtedly had the most injurious influence on its course.

M. Melier himself seems to have been somewhat doubtful as to the nature of this case, for after having stated that the lesson to be learned from the occurrence of yellow fever subsequent to the arrival of the "Anne Marie," was "*importation as origin, extension, and propagation* to which the sick contribute, *necessity for sanitary measures*," and, after alluding to the labours of Chervin to counteract those views, he remarks, importation cannot be denied, and adds, "I go further, I do not believe that a single well established example of an epidemic of yellow fever in Europe can be cited which was not imported," and with reference to Dr. Chaillon's illness he says, "If it be not permissible to be altogether so explicit as to the propagation by sick, it must be admitted that

the fact, it may almost be called the experiment of Chaillon gives to this second proposition a high degree of probability not to say of certainty."[1] Now, before M. Melier's conclusion as to the bearings of Dr. Chaillon's case can be received the following considerations have to be met. Pernicious intermittents are frequent in the country about St. Nazaire, and, in August, 1861, when the heat of the weather was almost tropical, intermittents were generally attended with bilious symptoms, and displayed a greater obstinacy than during the previous years,[2] and before Dr. Chaillon's attack can be accepted as one of yellow fever the possibility of its having been merely an instance of the prevalent bilious intermittent must be excluded. The condition of the urine, which might have cleared up the difficulty was not observed; the vomit, which has been taken as black vomit, mixed with the wine he had previously drank, was described as having an abominable taste, which leads to the inference that the dark colour it presented was due not to the black vomit of yellow fever, which if not acid, has no prominent taste, but to bile, and the course of the disease otherwise was not incompatible with its having been a bilious intermittent, aggravated by the mental condition of the patient. It cannot be accepted, therefore, as a case of yellow fever, and does not establish M. Melier's position that those who contracted the disease from exposure to the emanations from the "Anne Marie," had contributed to its propagation to others subsequently, a position, too, directly opposed to the results in all the other instances of persons whose attacks were due directly to this unfortunate vessel.

The other instance in which yellow fever was supposed to have been communicated to a person who had not been in the immediate vicinity of the "Anne Marie," was in a woman named Boquien, who kept a cooking place, where sailors came to cook their food, and from whom she purchased old clothes and the *débris* of canvas and cordage. Dr. Durand, who attended and described the case, states this woman was aged 50, of sanguine temperament, and had acquired habits altogether those of sailors, that she drank brandy, absinthe, and other strong drinks, better even than an old salt (*qu'un vieux loup de mer*). Dr. Durand also mentions a fact, which he says he was able to elicit only after much trouble and delay, that Boquien had bought several articles brought from the

[1] "Memoires de l'Academie de Médecine," vol. xxvi, p. 96.

[2] *Ibid.*, "Statement of Dr. Juillonzo," pp. 129-146.

"Anne Marie," such as men's clothing, pieces of sail and rope, and the anxiety shown to conceal the fact renders it evident that if it became known it was feared the police might have interfered. Under these circumstances this woman complained on the night of 6th August, and was seen by Dr. Durand the following morning in high fever, excessively restless and tossing about, with severe headache, nausea, and cramps in the stomach. The bowels, which had not been moved since the morning of the 6th, were freely opened by calomel and jalap, and the evacuations were dark and extremely fetid. Cold was applied to the head, a blister to the epigastrium to produce a surface for absorption, to which an anodyne was subsequently applied; at 7 P.M. 15 leeches were applied round the anus. A calming potion, of which a table spoonful was to be given every two hours, was prescribed for the night. There were three copious stools during the night, and there had been some retching without vomiting. At 6 A.M. on the 8th there was less fever, the headache was also less, and the pain in the abdomen seemed to have yielded to the blister and anodyne. Pulse 84. The eyes, forehead, and temples had a sensible yellow tint. A gramme and a-half of quinine was given in divided doses, extending over four hours, and in the evening there was so general an improvement that Dr. Durand considered the patient "*comme presque tirée d'affaire.*" About 2 A.M. on the 9th (the regular tertian period), however, Dr. Durand was called to see her, she had been delirious, and called on her husband to remove the coffin which they had placed beside her, saying they had been in too great a hurry to order it as she felt she was well. Dr. Durand found that the patient had vomited abundantly thrice since his visit the previous evening, the matter the last two times being greenish, there was excessive agitation, but not much fever, and the patient complained of acute pain in the loins, legs, and hypogastrium, no urine had been passed for six hours. An ointment of 6 grammes of "Ext. Belladonnæ," 30 grammes axunge, was applied over the blistered surface on the epigastrium, sinapisms to the legs, and citric acid ærated lemonade for drink. These measures produced relief, and on visiting her at 7 A.M. Dr. Durand found that she had slept since 4 A.M., and then had only severe headache and uneasiness in the bones and limbs, the surface and particularly the eyes had become of a decided lemon character, fading, however, towards the lower extremities; up to this time neither the eyes nor the pulse had shown the action of the belladonna and a fresh application was made to the blister, in an hour the pupils were

highly dilated and the pulse full, when strong coffee was administered, the ointment removed from the raw surface, and they gradually went off. In the afternoon 1·5 grammes of quinine were given between 3 and 7 P.M., the patient had a better night, without either vomiting or stools, and no urine was passed. From the 10th to the 13th there was nothing extraordinary, and she was convalescent from the 14th.[1]

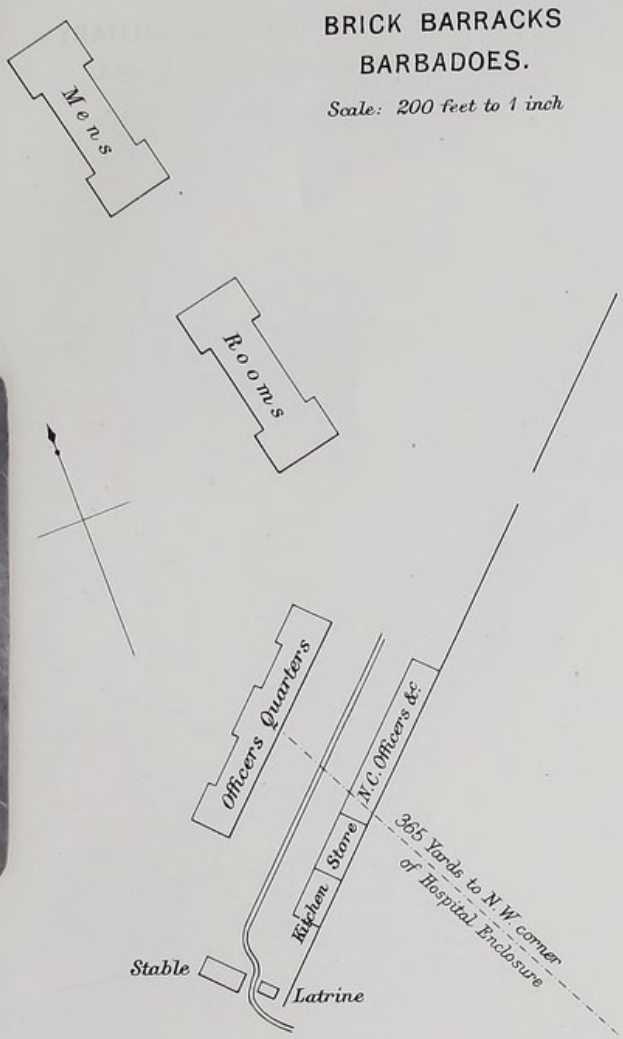
The details just given in nowise sanction the conclusion that this was a case of yellow fever. As has been mentioned above, intermittents with yellowness were common at St. Nazaire and in its vicinity in August, 1861, and this woman, who was a free liver, and whose intestinal functions were evidently disordered, was a very likely subject to be attacked. She had received various articles from the "Anne Marie," and had, no doubt, heard of the sickness connected with that vessel, and was under the impression that she incurred considerable risk from the articles in her possession, while, on the other hand, she was very anxious to conceal the fact of having them from the authorities. The mental anxiety arising from this combination of circumstances was extremely likely to lead to the attack of fever, which commenced with her on the afternoon or evening of the 6th. The symptoms described by Dr. Durand indicate a much greater degree of intestinal irritation than is common in yellow fever, and the manner they yielded to the remedies he used on the 7th, was such as to lead him to suppose that, on the afternoon of the 8th, the case had almost recovered. A little later, however, the regular tertian period, there was a return of excitement in a form that frightens people unaccustomed to it, but which those who have practised in the tropics are not unacquainted with; in which, in free livers, without much fever or annoyance from other symptoms, there are extraordinary delusions, like those of delirium tremens, which disappear again as the paroxysm abates. The rapid subsidence of these that night left the patient virtually free from fever, and there was nothing in the case subsequently to identify it with yellow fever.

The behaviour of yellow fever at another point, where, with occasional outbreaks due to an obvious local cause, there were frequent importations from men-of-war on the station, may now be noticed. The Military Hospital at Barbadoes, which is close to the sea shore at the south-west part of the island, has some low

[1] "Memoires de l'Academie de Médecine," vol. xxvi, pp. 141–4.

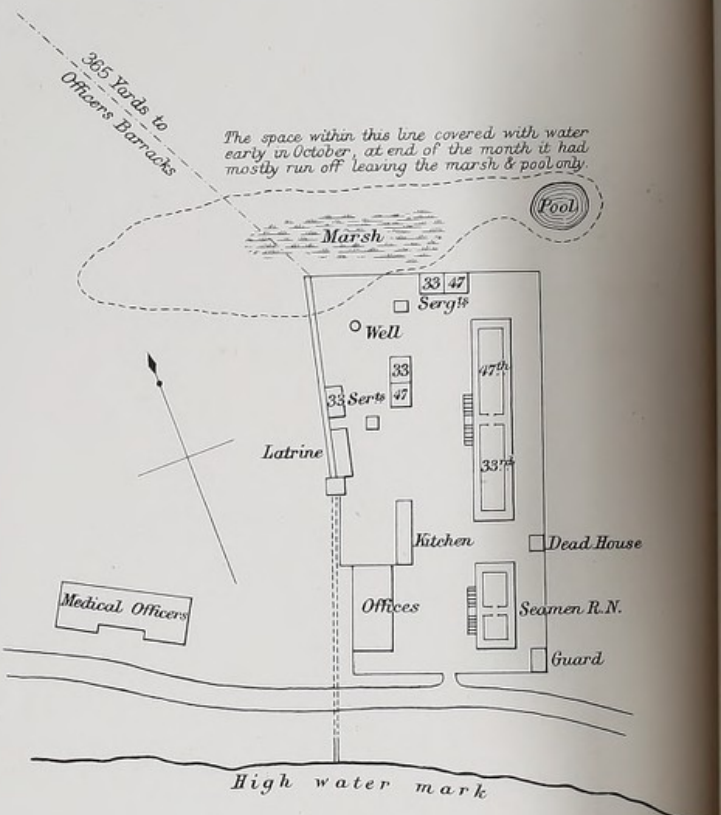
## BRICK BARRACKS
## BARBADOES.

*Scale: 200 feet to 1 inch*




## PLAN OF HOSPITAL (MILITARY) AT BARBADOES IN 1841

*Scale: 200 feet to 1 inch*




Stanford's Geog.l Est.

ground just outside the enclosure on the land side, where water collects after heavy rain, and, as the drainage in 1841, when I was there, did not carry this off, a large pool remained, which gradually evaporated under the action of the sun, leaving at last a circular pool with rather abrupt banks, and a small piece of marsh. The size and position of these, and their relation to the buildings of the hospital, will be seen on the accompanying plan. The buildings occupied by the sick were the two large ones on the east side of the enclosure; these were built of stone, with two floors, and with verandahs 10 feet wide all round; the upper floors were reached by an outside stair. There was a ten-foot passage in the centre of each floor of the larger building, dividing it into two wards, to which, at the same time, it afforded the means of entrance. The walls of the passage were open jalousie work, so there was really free air communication on each floor from end to end. The window spaces on either side, and at the ends of this building, had merely jalousies, and inside them wooden shutters which could be closed as desired. The larger building, in 1841, was told off for the hospitals of the two infantry regiments in the garrison, each having one of the wards on the ground floor and the corresponding one on the upper. The upper floor of the smaller building was usually employed for the accommodation of the sick of detachments of other corps temporarily in the garrison, or for those of the navy, who were its most frequent occupants. The lower floor was usually occupied by the sick of the coloured regiments. There are two rooms at the north wall of the enclosure; these were for the hospital sergeants; these were raised a few feet from the ground, and each had a window with jalousies and shutters in the back and front walls, the former looking over the marsh, the latter into the enclosure, with a door at the end. The northmost building on the west wall was for the hospital orderlies (sick attendants) of one of the regiments. This was on the ground, with a door and a jalousied window, both towards the centre of the enclosure. Lastly, the small building at the south-east angle of the enclosure was the guard room. The other buildings shown on the plan were offices, surgeries, stores, kitchens, &c. The building outside marked for medical offices was of stone, with two floors, and surrounded by a 10-foot verandah, and contained mess room and quarters usually occupied by Staff on the upper floor, and for regimental offices and occasionally sick officers on the lower.

In 1816, a very wet year, when there was a great deal of fever

in Barbadoes, the 2nd Regiment arrived there from England, and suffered very much from that disease. The 2nd was quartered at St. Ann's, about two miles from Bridgetown, along with the other troops in garrison, but the records of the epidemic afford very little information as to the barracks they occupied, so that their distribution cannot be made out. In Bridgetown the prevailing disease was yellow fever of the worst type, but the men of 2nd suffered chiefly from severe remittent, with a few cases of developed yellow fever up to October at least,[1] but after that date the numbers of the yellow fever increased. The fevers were treated partly in the hospital described above, and, as the accommodation there was insufficient, partly in another called the Naval Hospital, about half a mile to the eastward, in a dry and healthy situation, and were there attended by orderlies from the ranks, as in the other establishment. The numbers employed at each were not mentioned, but of those in the Naval Hospital two only were attacked by fever during the epidemic, while at the Military there were eleven attacked.[2] At the Military Hospital the fever cases were treated on the upper floor, the others on the lower, and it was found that though constantly among the worst cases, much fewer of the orderlies attending the fevers suffered from that disease than of those employed below, who did not come near them, an immunity ascribed to the former sleeping on the upper floor, while the latter slept below, and were more within the reach of the emanations from the ground during the night.[3]

In 1838, the 52nd Regiment arrived at Barbadoes in H.M.S. "Hercules," from Gibraltar, and landed on 6th November, without a medical case. They occupied what are called the Brick Barrack, in which the 36th Regiment had been quartered, and the latter corps embarked in the "Hercules" the following day. To render the occurrences of this and the following years clear, a plan of the officers' and men's quarters of the Brick Barrack is annexed. On the evening of the 6th November, Major Cross, who was in temporary command of the 36th, had a rigor, and the following day he became feverish, but embarked with his men, the fever however increased, and he died in three days with black vomit. This seems to have been the first case among the troops here at the time. Major Cross lived in the officers' quarters. On 10th November, Lieutenant Gough, 52nd Regiment, became indisposed and died in

[1] Bancroft, "Sequel to an Essay on Yellow Fever," p. 184.
[2] *Ibid.*, p. 454. [3] *Ibid.*, p. 449.

three days of yellow fever, and between this date and 31st December, out of 36 individuals including officers, their servants, non-commissioned officers and soldiers, all of whom were occupied about or residing in the officers' quarters, and neighbouring buildings, 28 were attacked with fever, and 10 died, while of the remainder of the corps residing in the soldiers' barrack fifty yards off, only 30 were attacked and no one died. During this period none of the other troops in the garrison were in the least affected.[1] The sick soldiers on this occasion, as usual, were treated in their regimental establishment at the Military Hospital, and none of the attendants suffered, though they had arrived from Gibraltar at the same time, and were quite unacclimatised. Much rain seems to have fallen shortly before this outbreak, and the ground outside the enclosure at the hospital was a swamp, and that between the officers' quarters and the small houses behind very wet. The north-west corner of hospital enclosure is 365 yards from the centre of the officers' barrack, very nearly south-south-east true, and Dr. Spence, writing in November, 1846, thought emanations from this swamp might have been the source of the outbreak.

In 1839, during the last ten days of October, the weather was very variable, frequent heavy showers alternating with a powerful sun in the intervals, with changeable winds. The low ground close under the northern wall of the hospital, and to windward of the Brick Barrack was a complete swamp for some days. The first cases of yellow fever in the garrison, on this occasion, were those of the hospital sergeant and three orderlies of the 52nd Regiment, about the 29th October, and two of the latter died. The disease next appeared among the families of the married men, in huts outside the barrack enclosure, then among those occupying the small houses inside (opposite the officers' quarters), and lastly in the officers' quarters and the easternmost barrack room. There were in all 93 persons of the 52nd attacked on this occasion, of whom 27 died, and in the whole of the rest of the garrison there were only three fatal cases from yellow fever.[2] There were 39 cases of yellow fever sent from H.M.S. "Vestal" to the military hospital at Barbadoes, from 17th to 28th November, 1839.[3] So far as can be made out, there do not appear to have been any for some time before November,

[1] Dr. Spence, Staff Surgeon, in "Second Report of General Board of Health on Quarantine," pp. 231–2.

[2] "Quarterly Report of Assistant-Surgeon Robertson, 52nd Regiment, from 1st October to 31st December, 1839.

[3] "Report on the Health of the Navy, 1837 to 1843," p. 107.

nor late in 1838. The ground, between the officers' quarters and the small houses behind, forms a layer of a foot to a foot and a-half in thickness, lying on the coral rock, the soil is firm when dry, but on becoming wet it opens and will retain a large quantity of moisture until dissipated by evaporation. Towards the end of the outbreak of 1839, the 52nd cut a trench through the centre of this, down to the rock, and, as the surface slopes away from the barracks to the hospital, it was carried so far as to afford a free outlet to the water from the space between these buildings.

There was but little fever in 1840, among either the troops or the men-of-war on the West India station, but in 1841 fever again became very prevalent in both services, a result enhanced in the former no doubt, by the arrival of four regiments from the Mediterranean in March and April that year, to relieve an equal number that had been in the country for some time. Of the new arrivals the 33rd and 47th (to which I then belonged), were retained at Barbadoes, the 47th were quartered in the Brick Barrack, and the 33rd the Stone Barrack, which is on a somewhat lower site 650 yards south-west by west of the brick and with a meadow called the Savanna intervening. There was a good deal of diarrhœa among the men of both corps, attributable chiefly to the brackish water they had to use, and their irregularities led to slight febrile affections, but there was no serious disease to any extent among them until the end of October, where yellow fever made its appearance. Previous to this, H.M.S. "Hecla" (a steamer) arrived from Jamaica on 19th May, with yellow fever on board, and having lost some of her people from that disease on her passage; between the 20th May and 13th June, she sent 33 cases of yellow fever to the Military Hospital, of which ten terminated fatally.[1] There were a few more from other vessels in the course of the summer, but the naval report does not enable these to be traced. All the men were treated in the upper floor of the smaller building in the hospital, and the orderlies in attendance on them were supplied by the 33rd but none of these, nor any other person connected with the hospital was attacked at this time. Late in September there was heavy rain, and a large body of water collected along the north wall of the enclosure, there was a drain along the west side leading to the beach, but whether it was not deep enough originally, or had merely got partially choked, a large quantity remained; the space covered by the water in the first week of October, is indicated

[1] "Report on the Health of the Navy, 1837–43," p. 116.

by the outer line on the plan, this during the course of the month was gradually reduced by evaporation to the pool and marshy space within the former line.

While things were in this condition, a man of the 33rd, named Gallagher, who had been in hospital on the ground floor of the south division of the larger building for about a month, was discharged to duty at 5 P.M. on 30th October, he was sent back to hospital at 10.30 the same evening with fever, and placed in same ward; he died on 9th November, having been yellow and had black vomit; this was the first case of yellow fever among the troops this year, he had been in a separate building to windward of that in which the men of the navy had been treated, and had no communication with it, or them, or any one else labouring under that disease.

On the night of 1st November the second window from the partition to the entrance passage, on the east side of the ground floor of the north division of the large building, was left open, the two men whose beds were at each side of this window felt chilly and uneasy on the afternoon of 2nd, but did not complain; but next morning at the usual hour of visit (between 6 and 7 A.M.) both men were found in high fever. One of these men had been in hospital, in the same bed, since 13th September, with secondary syphilis; he became yellow, and had black vomit, and died at 7 A.M. on 6th November; the other had been under treatment in the next bed for upwards of a month for diarrhœa, and was quite convalescent, he was subjected to active treatment, and recovered without becoming yellow or having black vomit. Neither of these men had had any communication with Gallagher of the 33rd, or any other yellow fever case. There were two or three other attacks in the 33rd on the lower floor between October 30th and November 3rd which recovered, but as I have the list of the fatal cases only I cannot specify them. The next fatal case was that of Private Wright, 33rd, a patient in hospital at the time, he also was reported with fever at 7 A.M. on 3rd November; he became yellow, and died on 10th. Private Kershaw, 33rd, their hospital cook, was the next; he was reported sick at 5 A.M. of 5th November, he was yellow the same morning, had black vomit at noon the same day, and died at 3 P.M. on 8th. About the 5th November men began to come from the Stone Barrack, but for the reason already assigned I cannot follow up the dates of admission of those who recovered. In all, up to 4th December, when the regiment was removed to Gunhill some eight miles off, there had been 21 deaths in the 33rd from yellow fever: of these there were:—

| | |
|---|---|
| Patients in hospital ... ... ... ... | 4 |
| Hospital attendants ... ... ... ... | 3 |
| Men from barracks ... ... ... ... | 14 |
| | 21 |

I had been watching the marshy ground just outside the enclosure for some time with considerable misgiving, and drew the attention of the Inspector of Hospitals to it, but nothing was done to remove the water. On finding that the 47th men referred their attacks to the open window on the 1st November, I took immediate steps to have the windows on the east side and north end of the wards (the weather side with both land and sea breezes), on both floors closed every night at sunset, and that all the attendants should sleep in the wards, and the sergeant and orderlies were duly cautioned as to the risk they incurred if they neglected this precaution. The practical result was that in addition to the fatal case already mentioned, there was another which was admitted on 13th December with ordinary catarrh; on the evening of the 16th he had a rigor, and he died on 18th yellow with black vomit; this man slept on the upper floor on the east side. Another man who had been under treatment for bowel complaint from 5th to 11th December, had fever that morning, coma ensued, and he died on 13th without yellowness. On examining the body the only morbid appearances found were a good deal of ulceration in the colon with inflammation of the mucous membrane in several places, and the liver was unusually pale; whether this was an instance of cerebral complication causing death before the usual characteristic symptoms of yellow fever were developed, I will not venture to say. There were other two men who had been under treatment for bowel complaint, who were discharged well, they got chilled after reaching barracks, and were returned to hospital within 36 hours with fever; both recovered without the disease in either developing the character of yellow fever. No other patient under treatment nor any of the hospital attendants nor people in barracks were affected. At the barrack the ditch, already noticed, between the officers' quarters and the line of houses behind, kept water from lodging on either side of it, and the ground never became in the least swampy, and at the men's rooms, while particular attention was given to keep the surface to windward of them clean and dry, the window shutters on that side were closed every night at sun down, and kept so until the men rose in the morning. In the 33rd

at the hospital at least, these precautions were not observed. I am not aware whether any such measures were adopted at the Stone Barrack.

The following instance of extensive and continued introduction of yellow fever from the same source, to the hospital at Barbadoes, may be added here to complete the illustration. H.M.S. "Dauntless" arrived at Barbadoes from St. Thomas on 16th November, 1852, having lost several men on the passage from this disease; the sick were sent to the Military Hospital on 17th, part of the crew was landed, and part remained on board; the latter continued to supply fresh cases, which were sent to the hospital as they occurred, while the men on shore soon ceased to be attacked. Altogether from November 17th to January 5th, 157 officers and men were treated in the Military Hospital, where 65 died. Mr. Denny, surgeon of the 34th Regiment states:—"Although 61 men of the "Dauntless" have been treated in the wards of the 34th hospital, indiscriminately intermingled with the soldiers of that corps affected with various complaints, in no instance has any individual been attacked under such circumstances, nor has any hospital attendant suffered."[1]

These details illustrate some very important points connected with the outbreak of yellow fever. They show there was a local source of that disease at the hospital, which became active from time to time, and affected the attendants and patients under treatment there, quite independently of any importation from elsewhere; in 1839 the first cases at the hospital were attacked in the end of October while the sick from the "Vestal" were admitted on 17th November only, had the latter come to the hospital 17 days before instead of after the sergeant and orderlies of the 52nd were attacked, it would have been maintained by many that the sequence established communication of the disease from the sick to their attendants at the hospital, but the premises would not have justified the conclusion as the evidence in that form would not have admitted of the local cause being excluded. So it is in all such instances, communication of yellow fever from sick to well cannot be established if the operation of a local cause at the time, and in locality, cannot be excluded. The sick from the "Hecla" in May and June 1841, and from the "Dauntless" in November 1852, did not communicate the disease to any of the other sick or their attendants in these years, and that there was no active local cause in

[1] Milroy in "Lancet," vol. i, 1861, p. 358.

operation at these periods was obvious there having been none of the sick soldiers or the attendants attacked.

The surface drain cut by the 52nd behind the officers' quarters proved of the greatest value in 1841, while I was there; in that year water never lodged on the surface between these and the houses opposite, nor was the soil ever soaked by retained water, and while the epidemic was active at the hospital, and in the Stone Barrack, there was, in November and December, a complete absence of fever from these buildings, and only eight cases of ordinary fever (besides those already mentioned in connection with the hospital) from the men's barrack in the immediate vicinity. The closing of the windows at the hospital, during the epidemic, also proved most satisfactory, as but a single case of fever appeared among the sick of the 47th, or their attendants, after this measure was enforced, though in the 33rd, in which this precaution was not adopted, both sick and attendants continued to be attacked. The site of the Brick Barrack is higher and more open than that of the Stone Barrack, and seems likely to be the healthier of the two, but the closing of the windward windows, during the night while the epidemic lasted, most probably contributed to the immunity from fever enjoyed by the men of the 47th in barracks, as it evidently did at the hospital.

The means by which localities on shore, and ships, acquire the power of producing yellow fever, is a very important subject for inquiry, and, as the latter often present the facts in a form more suitable for analysis than the former, well recorded narratives of such outbreaks, and the circumstances preceding and accompanying them, are most valuable. The cases of the "Eclair," and the "Anne Marie," upon which so much has been supposed to hang, have been examined in detail above, in neither could the first appearance of yellow fever be traced to communication with a preceding case. The following is a well-marked instance of the same character. The United States' steamship "Susquehanna," while at Spezzia, in 1857, received orders to proceed to San Juan de Nicaragua, and left on 22nd October. After touching at Genoa, Madeira, and Key West (where there had been no yellow fever since 1854), she reached San Juan early in December, with her crew in perfect health. She seems to have anchored inside the harbour, where the shipping are within the range of the malaria from the swampy ground surrounding it, and in about ten days intermittent fever began to show itself among her crew, then remittent, and diarrhœa, cholera morbus, and scorbutic complaints

were not infrequent. This state of things continued until 20th March, 1858, when the first fatal case of fever occurred. The ship was then taken outside, and stood off and on for four days, then anchored sufficiently far off to be, it was hoped, out of the reach of the malaria; but the fever increased notwithstanding, and the sick list rose to 30. It was now determined to proceed to the northward, and the ship left on 1st April, and reached Jamaica on 5th. On 6th and 7th, 85 cases of yellow fever were landed from her at the Naval Hospital at Port Royal, of whom 23 died. The "Susquehanna" left Jamaica for New York on 8th April, and arrived there on 15th, 50 more cases of fever having been placed on the sick list during the passage. All the crew were ultimately removed from her, and she remained nearly three months with no one on board. At the end of this period, people employed to remove her stores were again attacked with yellow fever. The surgeon of the "Susquehanna" had not heard of any yellow fever at San Juan while she was there, and though the other ships in port at the time had intermittent and remittent, none of them had any yellow fever.[1] The hold of the "Susquehanna" evidently contained the soil suited for producing the emanation, and the other factor being supplied during her stay at San Juan, it began to be evolved with the result mentioned above; while both on shore, and in the rest of the shipping, for want of a suitable soil, the general factor, to all appearance, proved inoperative. The sick of the "Susquehanna" were landed at Port Royal, during the healthy season, and the disease died out with them.

Another instance of a ship acquiring the condition necessary for producing yellow fever, without communication from a previous case, occurred in H.M.S. "Orion," a screw line of battle ship of 91 guns, which was stationed at San Juan de Nicaragua early in 1857. This ship drew too much water to permit of her going inside the harbour, and she anchored outside about three miles from the landing place. While getting under weigh on 30th March, at Pearl Cays, about sixty miles from San Juan, the "Orion" unfortunately got on shore, and soon after proved to be in a leaky condition, frequently making from three to four feet water during the twenty-four hours, and requiring the continued use of the chain pumps during the passage to England. When allowed to

[1] "Report on Fever in the United States steamship, 'Susquehanna,'" by R. J. Macroom, M.D., in "American Journal of Medical Science," vol. xxxvi, pp. 321-28.

stand and the hold not regularly pumped out, the effluvia of stagnant water was at times considerable. While at San Juan, the "Orion" had 12 cases of remitting or intermitting fever with diarrhœa, similar to what was met with in the other ships there, of which three died. On 5th June, the "Orion" left to join the Admiral at Halifax. She was one day at Port Royal, and went on to Havanna, which she reached on the 14th July, and left again on the 16th for Halifax, but the dates of her arrival there and subsequent departure for England are not mentioned. She ultimately reached Plymouth on the 27th August. When the "Orion" reached Havanna, she was "exceedingly healthy having only 36 on the list." The crew of the Spanish Admiral's ship at this time had yellow fever on board to a considerable extent, and it was prevalent among the merchant shipping in the harbour, and there were frequent sporadic cases in the town. The "Orion" anchored well up the harbour about half-a-mile from the esplanade, well exposed to both sea and land breezes, and 1½ miles from the Spanish flag ship. The crew were not allowed to leave the ship but several of the boats communicated with the Spanish vessel, and with the shore, but none of the officers of the "Orion" or of the crews of these boats, with the exception to be mentioned immediately, suffered from fever subsequently. On July 18th, three men were attacked with remittent fever, and one with intermittent; of the former Gribbles was coxswain of one of the boats and most likely had been on shore, the others, Bartlett, a stoker, and Lavender, of the carpenter's crew, and Cormack, an ordinary seaman, who had intermittent, had not left the ship. On 19th, 21st, and 22nd July, three marines were attacked with remittent fever. All these cases were of a mild description and recovered, but, on 24th July, three persons, a boy and two seamen, who had not been out of the ship, were attacked with yellow fever, all these died with the characteristic appearances. On the 25th, the ship's corporal was attacked, and died on 27th, also a characteristic case. On the 27th, a ropemaker was put on the sick list, and died on 3rd August. On 30th, when the ship seems to have been at Halifax, another man was placed on the list who died on the 1st August; the symptoms in this case were more like those of cerebro-spinal fever than yellow. On August 7th, a midshipman was attacked, who died on 12th. On 15th, a man employed in the bread room was attacked and died on 20th, and on 20th, a marine was attacked who died on 23rd. Besides these, three cases occurred at Plymouth where they were sent to hospital on 27th

August. In addition to these fatal cases there were, from the 25th July to 27th August, twenty cases of a milder form classed as remittent, which all recovered. It is almost needless to add that the fever did not extend to any of the attendants or others in the hospital at Plymouth.[1]

The details given above show the outbreak on board the "Orion" to have been a very peculiar one. That the leaky condition of the ship after she was on shore in March, by washing down dust into her bilge, was connected with the subsequent development of yellow fever in her there is no reason to doubt, but where the additional factor was acquired that determined the soil so formed to give out an emanation productive of yellow fever, whether at San Juan, or Port Royal, or Havanna, or at any intermediate point, is not so clear. What is certain is that no case of the disease from another source had been on board, nor had any of those who landed from her, or communicated with the Spanish ship, contracted the disease before it appeared in the ship herself among persons who had not been out of her, and, during its progress the marines and men employed below were the principal sufferers, which indicates the disease depended on a cause within the ship herself, to which these men were more exposed than others. The sudden outbreak of the severe fever on the 24th and 25th July, followed by single cases at intervals, and at last by three fatal cases at Plymouth in the end of August, is worthy of observation; this possibly may have arisen from the temporary accumulation of water in the intervals (as alluded to by the surgeon) sufficient to cover the source of the disease more or less, and so prevent it giving off the morbific matter. It used to be a common remark among seamen formerly that a leaky ship was a healthy one, but to ensure this result the water accumulated in the bilge was always considerable and seldom pumped out completely.

Extending this enquiry to localities on shore, the succession of epidemics at Bermuda present the facts in a form that admits of the question of importation being satisfactorily disposed of. The histories of the epidemics of 1818–19, 1837, 1843, 1853, and 1856 were carefully examined by the late Sir William Smart, when he was in charge of the naval hospital at Bermuda, and had access to the records left by his predecessors in that office, and to those con-

[1] These details have been derived from the Journal of the Surgeon of the "Orion," which the Director-General of the Naval Medical Department, Sir John Watt Reed, kindly allowed me to peruse, and from the "Statistical Report on the Health of the Navy for 1857," pp. 39-40.

nected with the naval and civil establishments in the island, and he submitted a paper to the Epidemiological Society embodying the result of his enquiry in March, 1863.[1] As is the case with such epidemics, there are always some persons who are under the impression the disease has been imported, and different individuals refer to different channels through which the importation might have been effected; the arrivals in Bermuda were not very numerous, and as the population, exclusive of the military and convict establishments, was only 11,453 in 1861, of whom about 4,500 lived in the two principal towns, St. George and Hamilton, and their vicinity, it was comparatively easy to find the localities in which the first cases occurred with the dates as well as the dates of arrival of the various ships supposed to have introduced the disease. There were Government enquiries as well into the circumstances preceding and accompanying the epidemics of 1853 and 1856, of a full and searching character. There is not time to go into the facts set forth in these various documents fully on this occasion, but the conclusions arrived at by Sir William Smart and by the Commissioners, which seem fully borne out by the evidence they adduce, may be given. Sir William Smart says, "the origin of these outbreaks has always been attributed to 'importation,' but my investigations have impressed me with a conviction that in every instance that opinion is ill founded."[2]

The Commissioners in their Report on the epidemic of 1853, state with regard to importation:

"33. A very general belief is entertained in the community, and participated in by persons of much intelligence and experience of former epidemics, that this fever was imported from abroad. Without undertaking to affirm that yellow fever could not be so imported, the evidence in support of that opinion, as applied to this occasion, has not been such as to satisfy the Commissioners that is was so introduced; and this point is still left involved in much obscurity."[3]

The Commissioners who reported on the epidemic of 1856, after detailing the circumstances connected with the arrival of the three vessels inculpated, H.M.S. "Argus" and "Malacca," and the trader "Margaret Musson," state:

[1] "Transactions of Epidemiological Society, vol. ii, p. 24.

[2] "Transactions of Epidemiological Society," vol. ii, p. 27.

[3] "Report of the Commissioners on the Yellow Fever in Bermuda in 1853," p. 13, Parliamentary Paper, December, 1854.

"16. We will now briefly state the conclusions at which we have arrived on the first and most important question, 'The Origin of the Epidemic.'

"We have concluded (with some doubt on the part of one of the Commissioners as stated in a note attached to this Report), that the disease was not introduced by any of the three suspected ships that it was not introduced in any '*ab extra*,' but that it originated in this colony."[1]

The member who dissented from the other Commissioners was Mr. Duncan Stewart, the Attorney-General. This gentleman considering the introduction of the disease as a question distinct from that of its first appearance, was impressed with the belief that the fever which affected the crew of the "Malacca," who were treated at Ports Island, late in June, may have remained dormant there during July, and soon after developed itself, and became epidemic on the main island distant about a mile from the quarantine station, and goes on to say "I apprehend that the germ of the late epidemic may perhaps be considered to have been derived from the "Malacca," to have existed at Ports Island, and gradually extended its influence to the opposite shore. I submit this view of the question, however, rather to express the doubt which I entertain than as the result of positive conviction on the subject."[2]

There was another epidemic of yellow fever at Bermuda in 1864, and a Commission was appointed to investigate the circumstances connected with its origin and prevalence. Their report embraces 80 paragraphs, dealing with the origin of the disease, its incidence on the various classes of the population, and in different localities, and the hygienic condition; but while giving the evidence on the subject does not deliver a specific answer upon the question of importation or local origin; but from the details it is clear the evidence is altogether in favour of its arising on the island and not attributable to importation, as was found to be the case in previous epidemics.[3]

These facts show that the different epidemics of yellow fever in Bermuda, of which there are specific accounts, sprang up at different points in the islands without the previous introduction

[1] "Report of the Commissioners on the Yellow Fever in Bermuda, 1856," p. 6, Parliamentary Paper, March, 1858.

[2] "Report of the Commissioners on the Yellow Fever in Bermuda, 1856," pp. 9–10.

[3] "Report of the Commissioners on Yellow Fever in Bermuda, 1864," pp. 8, 9, Parliamentary Paper, August, 1866.

of persons labouring under the disease from elsewhere, as was previously shown to have been the case, not only in the "Susquehanna," and "Orion," in the West Indies, but also in the "Eclair," at Sierra Leone, and at Goree on the coast of Africa. It is clear then, that such an importation does not constitute a necessary factor in the development of the conditions required to produce yellow fever, while the immunity which follows more extensive importations of persons labouring under that disease in healthy localities, or during the healthy part of the year at those which are occasionally subject to it at the usual sickly season, go far to prove that this introduction has no influence in determining it. All that is known of the nature of the immediate exciting cause of yellow fever seems to indicate that it is particulate, and is given off from a collection of mud in a ship's hold, or from a marshy or damp spot on shore, with its pathogenic germs fully developed, but until it arrive at this condition the crews of the ships, as in the cases of the "Susquehanna," and "Orion," do not have any attacks of the disease. It would appear, therefore, that the potential factor must be diffused in a form incapable of giving rise to the disease until it met with a suitable soil for farther development, and as in these two ships must have been air borne, there having been no other source from which it could have been derived. The course of the various epidemics at Bermuda quite accords with this view, and they show that the potential factor can be diffused by the air, even over very extensive geographical areas. On most of the occasions on which Bermuda has suffered yellow fever has extended along the Atlantic Coast of the United States to as high, or even higher latitudes than that of Bermuda, and it has appeared in Europe occasionally about the same time. The epidemics at Lisbon, and Oporto, which commenced at those places to a limited extent in 1856, and were developed to a much greater one the following year, corresponded with this of 1856 in Bermuda. Both had arisen under the extension of the same pandemic wave which was experienced at Monte Video in 1853, the progress of which northwards was traced in a previous lecture. Of the outbreaks at Lisbon Dr. Lyons states:—

"After most careful enquiry among various official persons, and in all quarters in which reliable evidence could be expected in such matters, I am obliged to state that in no one instance did I obtain such a consistent assemblage of facts, or such an array of well supported allegations as would, in my mind, warrant the

conclusion that the importation theory was even moderately well founded."[1]

So that the Lisbon epidemics arose under similar circumstances to those described above in the West Indies and Bermuda.

To arrive at the conclusions stated above I have made use of illustrations that presented the evidence on each point in a clear and precise form, and I trust I have not pushed my inferences beyond what the facts bear out. Much of the evidence relied on by controversialists in this question is so involved as to defy trustworthy analysis, and deductions from theory, which themselves required to be proved, have been too often employed to supply conclusions which could not be established from the facts of the case. Such a system must be abandoned before any real progress in epidemiology can be made.

[1] Lyons, "Report on the Pathology, Therapeutics, and General Etiology of the Epidemic of Yellow Fever which prevailed at Lisbon during the latter half of this year, 1867," p. 6, Parliamentary Paper.

# LECTURE IV.

(Delivered 1st March, 1888.)

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## EPIDEMIOLOGICAL ASPECTS OF CHOLERA.

*Opinions of Epidemiologists regarding Cholera.—The forms of Cholera.—Though Cholera nostras comes every summer it varies in numbers in different years, and is frequently accompanied by sporadic cases of Malignant Cholera.—An attack of Cholera in a person who had not been away from the locality indicates merely that the cause of the Disease was in operation there.—Outbreaks at Southampton, and Theydon Bois, in* 1865, *and at New Orleans in* 1873.—*The connection of Cholera with Pandemic Waves.—Relations of Cholera nostras to Malignant Cholera.—Cholera in Bengal not a new disease.—Epidemics issue from Endemic area nearly every second year.—These pursue different courses.—Opinions as to means causing Diffusions.—Great reduction of Cholera in India in* 1873-4, *followed by severe Epidemic of* 1875.—*Frequent attacks of Coolie Ships at sea in* 1872–3–4.—*Cessation of these in* 1875.—*The track of Sea from Sumatra to Mauritius in which Coolie Ships attacked in* 1872–74, *similarly affected in* 1819, *when Mauritius suffered.—When Cholera appears in South-western part of Indian Ocean its indications cover a large area.—Cases of "Swanton," and "New York," in North Atlantic in* 1848.—*The exciting cause of Cholera conveyed by Atmospheric Currents at a great height, and when these brought to ground out-breaks occur.—As with Yellow Fever healthy ships do not retain it beyond incubative period, but with a suitable soil a Ship Epidemic may arise.—Case of "England," at Halifax, in* 1866.

Cholera, like yellow fever, has given rise to much controversy among the members of the medical profession, since it became active in India seventy years ago. It has been described by many as being highly contagious, and always transmitted from man to man; and, as it was supposed it never travelled faster than man, it was concluded he was the active agent in carrying and diffusing it, and

from this it was deduced that, as his means of locomotion increased in speed, cholera would spread over the world with corresponding rapidity, and along the lines of communication he most frequented. By others, chiefly those who had experience of it in India, the disease was held to be devoid of contagion, to depend on local causes; and Jameson, who compiled the earliest report on the epidemic of 1817–18, from the observations of the medical officers in the Bengal Presidency, attributed its extension, from Bengal to what are now called the North-west Provinces and the Punjab, to the active cause being carried by the moist easterly winds on the setting in of the monsoon. As was the case with yellow fever, much of the evidence, supposed to sanction particular conclusions, was in a form that did not permit it to be analysed, so as to eliminate various factors that might have been in operation, the influence of which it was necessary to exclude before the point under investigation could be established.

Cholera occurs in two forms; in one, commonly designated summer cholera, or cholera nostras, though there may be frequent vomiting, and diarrhœa with severe tormina and griping, and cramps of the voluntary muscles, yet there is seldom much collapse, the matter vomited is bilious, and the stools are coloured, the voice may be weakened, but is little altered otherwise, the urine is not suppressed, and the mortality is very small. In the other, usually called Asiatic or Indian cholera, but which, as involving no hypothesis, I will hereafter designate malignant cholera, is characterised by marked collapse, the matter vomited is devoid of bile when the disease is fairly developed, the stools are watery, colourless, with mucous flakes floating in them, the voice is like a hoarse whisper, the urine is suppressed, and the mortality very great. Cholera nostras appears every summer to a limited extent, though in some years in considerably greater numbers than usual. Malignant cholera, in temperate climates at least, generally occurs as an epidemic, and advances over new ground in successive years. A typical case of cholera nostras is readily distinguished from one of malignant cholera, but there is nevertheless a relation between them resembling that between benign plague and the fully developed form of that disease.

Nearly every summer, since the invasion of Europe in 1830, sporadic cases have been met with presenting the characters of the malignant disease so completely, that, had they occurred in the middle of an epidemic, they would have been accepted without hesitation as typical examples of it. These cases generally appear

singly; at other times they are followed by a few others, forming a small group; but, in both instances, those who believe cholera to be transmitted from man to man decline to admit them as malignant cholera because they cannot affiliate them to a previous case, and they are not invasive, that is, do not form centres from which the disease radiates. Yet if an individual come from a place where cholera is prevailing to another still unaffected, and have diarrhœa, either on arrival or within a few days after, and cholera subsequently appear among those he had mixed with, the same party maintain the diarrhœa was incipient cholera, and that it was through this individual cholera was introduced into the locality. These two conclusions, though opposed to each other, have been adopted as necessary requirements of the theory which ascribes the diffusion of cholera to man, to enable it to embrace the actual occurrences; but, so far as I am aware, there is no evidence from the behaviour of the disease itself, when properly analysed, which supports either of them.

The occurrence of a case of cholera in any locality (supposing the person who is attacked has not been away from it for some time), merely indicates that the cause of the disease is active in that locality at that time, as has already been explained in connection with yellow fever, and before the appearance of the disease in the locality can be attributed to communication from a previous case, which had arisen elsewhere, it is necessary to exclude the influence of local causes, a precaution that in the great majority of instances has been altogether overlooked. There are now on record a good many instances of even extensive epidemics of cholera, which broke out at points far removed from any place where the disease was already in progress, and without any trace that could be detected of importation by man or fomites. I will mention two which were investigated minutely at the time by able and experienced observers, who failed completely in eliciting any evidence of importation. These were the outbreak in this country in 1865, and that in America in 1873.

In 1865, when the epidemic of that year was in full force in the Mediterranean and south of Europe, an outbreak commenced at Southampton and its immediate vicinity, with contemporaneous manifestations at Weston Common, and Bitterne, places two miles from Southampton in different directions. A case had occurred in Southampton on 12th August, which Dr. Langstaffe, who treated it, first thought to be a severe attack of cholera nostras, but subsequently considered it to have been true Asiatic cholera. The

first case recognised at the time as malignant cholera, appeared on 22nd September in a man named Rose, who resided at Brewhouse Court, five furlongs from the railway station. Rose had been affected with diarrhœa from the 17th, and died on the 24th September. On the 23rd a lad named Hill, residing at Weston Common, was attacked, having had diarrhœa for two days previously; and on the 26th his father and sister were also attacked with cholera. On the 27th a man named Stanley and his son were attacked at Bitterne, the latter having had diarrhœa since the 17th and the former since the 24th. On the 28th there was another attack of cholera in Southampton, and the disease went on until 4th November, when, including all the localities named above, there had been sixty persons attacked. The late Dr. Parkes investigated this outbreak, at the instance of the Medical Officer of the Privy Council, with all the zeal and ability which characterised him, and in his narrative of it in the "Eighth Report of the Medical Officer of the Privy Council" (from which the above details are taken), in summing up the results he stated:—"The origin by an unknown epidemic influence, alone or coinciding with local conditions, presents formidable difficulties, even if we cannot quite reject it. The origin by importation is deficient in precision of evidence" (p. 436). In short, though firmly believing that cholera was usually introduced by importation, he utterly failed to trace it in any instance.

About this time another outbreak took place at Theydon Bois, in Essex, which, had the facts connected with it come fairly before Dr. Parkes, might have influenced his opinion regarding epidemic influence. Mr. and Mrs. Groombridge, from Theydon Bois, had been at Weymouth for their health for fifteen days, when on September 23rd, the former passed some time on the hills overlooking Portland Harbour, exposed to a strong breeze from the sea; while in this situation he became indisposed, and diarrhœa, sickness, and cramp ensued, from which he suffered on that and the following day. On the 25th, he was still ailing, but able to travel, and he and his wife returned to Theydon Bois, by railway, from Weymouth to Southampton, and on to London, and neither seems to have left the station while at Southampton. On reaching home, Mrs. Groombridge (aged fifty) complained of pain in the back, and some discomfort in the stomach and bowels, which she attributed to the shaking of the train. On 26th, diarrhœa ensued, followed by sickness and cramps on 28th, and collapse on 29th. Reaction commenced on 30th, secondary fever succeeded, and she

died on 11th October. On 30th September, a daughter, aged 8, was attacked with cholera, and died the same night; and in the next week six other persons of, or immediately connected with, the family, contracted the disease (including Mr. Groombridge himself, on 6th October), and some others followed. It was subsequently found that the soil pipe from the water-closet leaked into the well from which water for household use was drawn, and from the appearance of the spot this seemed to have been going on for a considerable period.

Now the question arises, Where did Mrs. Groombridge contract cholera? The late Mr. Radcliffe, who investigated this case, was informed by the local medical practitioners, and others, that neither epidemic cholera, nor anything resembling it, nor choleraic diarrhœa, nor autumnal cholera, had been observed at Weymouth, Portland, or Dorchester, in September, 1865.[1] At Southampton, as already mentioned, the first attack of cholera (at this time) was on the 22nd, followed by death on the 24th, at a point five furlongs from the railway station; and a second case occurred at Weston Common, two miles from Southampton; but as neither Mrs. Groombridge nor her husband left the station or railway, communication with either was out of the question; and from Southampton to Theydon Bois, no case of the disease was known, On reaching home, it is highly probable that the use of the contaminated water from the house-well aggravated, if it did not excite Mrs. Groombridge's diarrhœa; but as, up to this time, no cholera evacuation could have had access to it, the so-called *materies morbi* was wanting, and the theory which would account for the attack by means of this breaks down. It may be asserted that Mr. Groombridge's attack at Weymouth was one of cholera, and that the well was contaminated by his evacuations; but, even if this were so, it only removes the difficulty of accounting for the first case from his wife to him, and the evidence is equally conclusive against his having contracted it from a previous case as with her. The evidence, then, leaves no alternative but to fall back on epidemic influence coinciding with local conditions, a combination, Dr. Parkes admitted, he could not quite reject. That the local conditions were unusual at the time around Theydon Bois, is indicated by the fact that several cases of common sporadic cholera occurred in the neighbouring districts of Epping, Harlow, and Mitchingham, quite unconnected with the Groombridge family.

[1] "Transactions of the Epidemiological Society," vol. iii, p. 95.

The epidemic of 1873, in the United States, commenced at New Orleans in February, and, during the summer, extended northwards along the Valley of the Mississippi, and eastwards and westwards along those of the Ohio, and Missouri, respectively, but did not pass into the Valley of the St. Lawrence, and great lakes, or cross the Alleghany range, so that the whole Atlantic seaboard, and the country bordering the south of the lakes remained exempt, save at the south-west corner of Lake Michigan, where Chicago came within the epidemic field. The earliest known case occurred on 8th February, in a man who came from Pensacola two months previously, and had since resided in New Orleans; the second, on the following day was in a man who had lived in New Orleans four years; these men resided at a considerable distance from, and had had no communication with, each other. The next case occurred on 27th February, and from that date to 31st March, inclusive, eighteen attacks were recorded in detail; of these, all except four were residents in New Orleans, though at points much separated from each other; of the four non-residents, two came from the Washita River above New Orleans, the other two from the country, the place not specified, but they were not recent arrivals from Europe. The Board of Health, at New Orleans, was most anxious to obtain exact information on every point connected with the origin of the disease, and investigated "all modes of infection and importation, as by visiting ships, the washing of clothing for persons connected with shipping, visiting sailors' boarding-houses, contaminated drinking water, &c.," not only in these instances, but in every subsequent attack during the outbreak, and was led to the conclusion that it was endemic, and had not been imported.[1] Surgeon Van Buren Hubbard, United States' Army, who made an investigation in 1874, at the instance of the Central Government, admitted, "It has been found utterly impossible to establish the arrival of individuals who were personally affected with cholera,"[2] but instead of stopping there, he fell back on theory where facts failed him, and expressed his belief that the disease must have been introduced by emigrants from Europe, for which he offered no better reason than that quarantine had been imposed with laxity, and that cases of cholera might have passed without detection.[3]

These instances show conclusively that malignant cholera may

[1] "On the Cholera Epidemic of 1873 in the United States," p. 101.
[2] *Ibid.*, p. 104. [3] *Ibid.*, p. 110.

spring up in a locality far removed from the place where it is epidemic, without being introduced by persons labouring under it, or their surroundings, and as small groups of cases, as at Southampton and its neighbourhood, can so arise, it is clear single sporadic cases may do so, and there is really no ground for declining to admit such cases as the malignant form of the disease when they exhibit the symptoms of that form, even though they do not spread. On the other hand, there may have been importation to a locality of persons labouring under cholera previous to an outbreak in that locality, but this fact cannot establish the conclusion that the disease was communicated by them, unless the local cause can be excluded, which in the great majority of such instances the nature of the evidence does not permit of being done.

In Volume VIII of the Army Medical Reports for 1866, p. 383, a paper of mine was published "On the Influence of Pandemic Waves in the production of Cholera." This was written in 1865, when I was serving at the Cape of Good Hope, and embraced all the information in my possession at the time. The conclusion arrived at was "epidemics of cholera, though not unfrequently occuring in the year more common to those of fever at any given station, yet seem rather to present themselves in the following one, so that localities which usually have their epidemics of fever in an odd year, display their epidemics of cholera for the most part in an even one, and *vice versâ*" (p. 387). From this it was concluded there was a difference between the influences which determine the epidemics of fever and cholera, and in the absence of the necessary evidence, instead of endeavouring to define what this consisted of, it was thought that for the present it would facilitate investigation if these influences were attributed to two waves, each with a two-yearly period, but so placed that the first part of the cholerific wave is always a year behind the advancing edge of the febrific one. Under this assumption the advancing edge of the cholerific wave may be taken to be, on 1st January in the—

| | Odd Year. | Even Year. |
|---|---|---|
| At the isoclinal | — | 70 south. |
| ,, | 53° south. | 30° south. |
| ,, | 0° | 30° north. |
| ,, | 53° north. | 70° north. |
| ,, | 80° north. | |

The immense addition to the information regarding the manifestations and progress of cholera, since the introduction of the

registration of deaths in India in 1865, together with the fuller accounts of its appearance, and prevalence, in other parts of the world, have shown the modifications of this idea are more numerous than was expected at first, but it still represents the facts over great distances, in longitude, and for consecutive years, approximately, and affords facilities for arranging them, and in dealing with the progress of epidemics.

In dealing with the epidemiological aspects of cholera, it is necessary to consider the relations of cholera nostras to the malignant form of the disease. Cholera nostras is not a disease depending merely on the warmth of summer, or the abundance of fruit, as many seem to believe, but when examined for a sufficiently long period its frequency and fatality are found to fluctuate considerably, rising, as the place or country under observation is approached by the malignant disease in an epidemic form, and falling again as that passes on. The death rates from cholera in successive years in the Registrar-General's forty-eighth Annual Report, for 1885, for England (p. lxi), and for London (p. lxiii), when compared with the manifestations of epidemic cholera in Europe, show this relation clearly, and the same feature is found in the Scotch returns for that country. Information from other countries is to the same effect, for instance, in 1865, where cholera was epidemic in the south of France, and other parts of the Mediterranean, cholerine, accompanied by an unusual number of cases with the character of malignant cholera, was much more common in Denmark, and the south of Sweden, than for several years previously, just as occurred in England and Scotland at the same time. The records of cholera in the Military Returns for other parts of the world bring out the same feature for previous periods. These facts sanction the conclusion that there is connection between the cholera nostras and malignant cholera, resembling that between benign plague and the fully developed form of that disease: and, as with plague, that cholera nostras together with sporadic cases or small groups of cases (as at Southampton and Theydon Bois) of malignant cholera, may precede an advancing epidemic of the malignant disease by a great distance, or may spring up on either side of the epidemic field as it passes on, as took place in this country in 1859, when with a general increase in the mortality from cholera nostras, three small outbreaks of malignant cholera occurred, one at the coastguard station on Southampton Water, near Netley, in July, another at Glass Houghton, a village near Pontefract, in Yorkshire, in October, and a third near Wick, in the

north of Scotland, in the end of summer, while cholera was epidemic along the west coast of Europe, from the south of Spain to Sweden. Though a small amount of cholera nostras is met with in temperate climates nearly every year, it is obvious that an increase of that disease, especially if accompanied by sporadic cases of the malignant form, indicates greater activity of the exciting cause of the disease, and may even presage the early approach of the malignant form as an epidemic.

The appearance of cholera in Bengal in 1817, and its subsequent pandemic extensions, have led many to believe that the disease was a new one, and that its source was what the late Dr. Bryden described as "the endemic area," the country between the meridians of 86° and 91° east, from the sea north to the base of the mountains, where it was always to be met with. Subsequent investigations have shown that malignant cholera is a very old disease, and have raised a doubt whether the endemic area, though a very important source of the miasm producing cholera, may be the only one even in India itself. This is a question of some importance in connection with the epidemiological relations of cholera, which, however, the evidence available at present may not be sufficient to place on a sound basis.

Epidemics in India proceed from the endemic area about every second year; Dr. Bryden states there were five such in eleven years, viz., those of 1864–65, 1866–67, 1868–69, 1872, and 1875. Each of these presented some distinguishing feature in its course and distribution; the first, which desolated the Central Provinces and Western India, was in Northern India a mere shadow. The second, abandoning the route leading to the Central Provinces and Western India, was directed entirely into Northern India leaving the area occupied by the epidemic of 1864–65 untouched. The third, pursuing both routes occupied Central, Western, and Northern India, from the mountains to the sea. The epidemic of 1872 covered Northern India and a part of Western India and left the eastern districts of the Central Provinces untouched. From these facts he concluded, that after leaving the endemic area the line of advance of an epidemic was determined by the meteorological agencies in action at the time, the material of the epidemic, as he calls it, being air borne was distributed where the atmospheric currents carrying it came to the surface of the ground.[1] Inferences

[1] "The Cholera History of 1875 and 1876: Illustrating how the area of Hindustan when unoccupied is re-invaded by Epidemic Cholera," in vol. v of "Vital Statistics in India," p. 273.

from a large body of facts led him to the conclusion that this matter was in two forms, one with its pathogenic powers fully developed, and capable of exciting cholera wherever it met with susceptible subjects; the other resembling what in the language of the present day are designated resting spores, which was frequently deposited at points far in advance of the limit reached by the epidemic manifestation from which it proceeded, and which did not become developed generally, for some twelve or fourteen days, even when local circumstances were favourable; and if deposition had taken place towards the end of the cholera season this material might remain dormant for months, until the return of that season, when, like other forms of vegetation, it would become developed and resume its normal activity. While in this dormant state generally, local conditions have sometimes favoured a limited development, giving rise to one or more cases of cholera from November to January, which enabled Dr. Bryden to warn the authorities that a few months later an epidemic would show itself over the district, which prediction has in most instances proved correct.

Authors on cholera in India, of late years, seem to have been of opinion that the epidemics in the southern parts of that country proceeded from the endemic area in the first instance, and are spread pretty much in the manner described by Scott as having occurred in 1818, but they differ as to the means by which the cause was conveyed. Bryden was of opinion that towards the end of the south-west monsoon, when north-easterly winds began to set in, they carried the infective material in its dormant state from the valley of the Ganges to the south-west, distributing it over the greater part of Bombay Presidency south of Baroda, and more or less in the Central Provinces, and Berar, as it passed over them. The following spring, when cholera became active again in the valley of the Ganges, if north-easterly winds were common they would distribute fresh material over the districts they reached, giving rise to what Bryden called a spring cholera, and beyond the line, the latter reached, the material deposited the previous autumn remained dormant until the south-west monsoon set in, when cholera developed wherever the requisite conditions existed. The portion of the Madras Presidency south of a line from 16° north on the east coast, to 12½° on the west, Bryden describes as having its cholera season during the north-east monsoon, which sets in during October. Others hold that the progress of cholera was frequently against the wind, and therefore subversive of Dr. Bryden's views,

and were inclined to attribute the extension of the epidemics, to a considerable extent at least, to communication from man to man. Both parties were of opinion that the outbreaks in Ceylon were derived from those of the neighbouring districts of the Madras Presidency.

In 1873 the deaths from cholera in the Madras and Bombay Presidencies, and in the Central Provinces, and Berar, were very few, and in 1874 there were only 360 registered in all these together. In 1873 there had been 64,366 deaths from cholera in Bengal, and 15,416 in the North-western Provinces and Oudh; in 1874 the deaths in Bengal fell to 56,866, and in the North-west Provinces and Oudh to 6,464; the epidemic field this year reached a line from Ganjam on the coast to Benares, and from that a little east of Fyzabad to the base of the Himalayas. In 1875 this was altogether changed, the deaths from cholera were, in

| | |
|---|---|
| North-west Provinces and Oudh ... | 64,427 |
| Bengal ... ... ... ... ... | 109,938 |
| Central Provinces ... ... ... | 14,643 |
| Berar ... ... ... ... ... | 22,465 |
| Bombay ... ... ... ... ... | 47,573 |
| Madras and Mysore ... ... ... | 97,051 |

The disease was experienced to the north-west, as far as Lahore, and the whole peninsula was covered by it from 24° north to Cape Comorin, except a portion of the Central Provinces, and the Vizagapatam, Godavery, and Kistna districts, on the east coast, and that of Kanara, on the west coast. In Ceylon there had been no death from cholera in 1874, but in 1875, 1,817 were registered; these commenced in January at Colombo, where there were 16 deaths that month, in February occurred 57 there, 9 at Negombo, a little north of Colombo, and 1 at Galle, the packet station at the south-west of the island; in March there were 194 deaths at Colombo, 48 at Galle, 25 at Negombo, and 14 at other points. During these months there were only 30 deaths from cholera in the whole of the Madras Presidency, 23 of which were in the districts of Tangore, Trichinopoly, and South Arcot, on the east coast, but to the north of, and not in communication with, Ceylon; of these 7 occurred in January, 13 in February, and 3 in March.

It would occupy too much time to detail the steps by which cholera spread over the immense area it covered in 1875, it may be stated, in general terms, to have manifested increasing intensity in

Bengal, at Sambalpur in the Central Provinces, in March; from Bombay to Kaira, and especially in the Poona and Nasik districts in April, and in the Tanjore district in Madras, also in April. From these localities the disease extended as the season advanced, and fresh influences came into play. In the fifth volume of his "Vital Statistics of India," Dr. Bryden examines these steps in detail, and applies the principles he deduced from the course of the epidemic of 1818, and subsequent outbreaks, to their explanation, but he does not appear to have ventured on accounting for the sudden aggravation of the disease, not only in Bengal, but also in the districts to the south, where, for two years previously, it may be said to have disappeared as an epidemic. Without pretending to fill in this blank I may here give some evidence Dr. Bryden was not aware of, though it be derived from facts published in the "Report of the Sanitary Commission with the Government of India," for 1881, p. 135. This is a statement of the names, &c., of vessels which have reported deaths from cholera among coolie emigrants to foreign ports from 1871 to 1880.

The statement includes thirty-two ships, which sailed from Calcutta, for Mauritius, Natal, and the West Indies, in each of which the deaths, from cholera, daily, among the coolies, are specified from the first to the twentieth day after embarkation, and above twenty days they are given in a single group. Another vessel which sailed from Pondicherry for Martinique, in which there was one death from cholera, but the day not specified, has been omitted. I have arranged this table according to the days after embarkation on which the first death occurred, and from this it appears that of these thirty-two vessels four had their first case from the first to the fourth day; in the last instance there was another death on the sixth day, and no more. The first death did not occur on the fifth or sixth day in any ship. In a second group, embracing nine ships the first deaths were from the seventh to the sixteenth days; in this group the last deaths were one on nineteenth and one on twentieth days. In a third group of eight ships the first deaths were all after the twentieth day, there having been no instance in which the earliest death occurred on the seventeenth, eighteenth, nineteenth, or twentieth days. There is a fourth group of eleven vessels, in three of which, with deaths up to the fifth day, others occurred from the seventh to the twentieth, but none after; two had deaths in all the three periods mentioned above; and six had deaths during the second and third periods only. The total number of emigrants from Calcutta in the ten

years was 129,527; of these 14,752, or 11·4 per cent., sailed in the above noticed thirty-two vessels, and of these 181 died of cholera, or 12·3 per 1,000 of those embarked in them.

Ships leaving Calcutta for places south of the Equator, or round the Cape, proceed south as near as they can to the meridian of 90° east until they reach the south-east trade wind, and from this point their track is very nearly the same, whether their destination be Mauritius, Natal, or the Cape. Taking the mean of several cases, the approximate latitude of a sailing ship, from Calcutta, on the sixth day at sea is about 15° north, on the fifteenth day about 7° north, and on the twentieth day about 1° north, with a variation, in individual instances, of about three degrees in the last. It thus appears that sailing vessels during the first of the three periods mentioned must have been between the land and 16° north, in the second from 15° north to about 2° north, and during the last from about 1° north southwards, and the factors which determined these outbreaks must have become active in these positions respectively. The deaths up to the sixth day, being all due to cases arising within the recognised incubative period, may be referred to exposure to the cause previous to embarkation. Six ships had such cases in 1872–74, and three only in the other seven years of the decade. During the second period fourteen ships were affected in 1872–74, while there were only six in the other seven years. In the third period twelve ships were affected in 1872–74, and four only in the other seven years. One of the ships in 1874, the "Blenheim," was a steamer. She embarked her emigrants on 13th June, and landed them at Natal on 8th July, the twenty-sixth day after. The vessel had five deaths in all, after the twentieth day, consequently she must have been south of Mauritius when the outbreak commenced. Another vessel, the "Enmore," was a steamer; she sailed for Demerara on 4th July, 1873. There were two deaths in this ship by the fifth day, three from the eleventh to the twentieth, and five more after the twentieth day. On the assumption that her progress southward did not differ materially from that of the "Blenheim," the "Enmore" must have been south of Mauritius also by the twentieth day.

While these manifestations were taking place at sea, there seems to have been an outbreak of cholera in the Island of Timor in 1872. In 1873 it was epidemic at Sincapore, in the Kingdom of Siam, and along the valley of the Irawaddy from Rangoon to Bhamo; and the Dutch troops at Acheen, at the north end of Sumatra, were attacked in December, and during 1874 they suffered severely.

Thus the cholerific factor was active from 1872 to 1874 over the sea from Sumatra to the south-west as far as Mauritius, while over the greater part of Hindostan it was in inoperative, and the disease had almost disappeared. This frequency of cholera over the sea ceased suddenly in 1875, there having been but one death reported that year, in the "Lady Melville," bound for Mauritius, after she was twenty days out, and, coincident with its cessation, the epidemic overspread Hindostan from Cape Comorin to Lahore, and what was unusual, Ceylon was affected before the neighbouring portion of the Madras Presidency. Such a succession cannot be regarded as fortuitous, though for the present we do not see how it is to be explained.[1]

It is a remarkable fact, worthy of being mentioned in connection with the occurrences in 1872–74 detailed above, that, during the great extension of cholera subsequent to 1817, the disease became epidemic early in 1819 at Penang, Sincapore, in Sumatra, and Java, and in November in Mauritius, passing on to Bourbon in 1820, and either in the end of that year or early in the following one it was at Zanzibar, and indications of it were experienced as far as the Cape of Good Hope, in a considerable increase in the admissions from simple cholera among the troops. The cholera on this occasion was supposed by some to have been introduced at Mauritius by H.M.S. "Topaze," which arrived on 29th October from Ceylon, having been twenty days on the passage, and having had sixteen men attacked with cholera immediately after sailing, of whom four died. On the other hand, a commission appointed by the Governor to examine into the question, reported that the first well-marked case of the disease occurred on 6th September,[2] nearly two months before the "Topaze" arrived.

I read a paper before the Epidemiological Society in 1871, which will be found in the third volume of their Transactions, at page 288, in this the details of a considerable number of outbreaks of cholera on board ships in both the Atlantic and Indian Ocean are given, with the necessary information as to time and locality, as far as they were available. These illustrate the diffusion of the epidemic factors over a very extensive area; as it would occupy too much time, however, to introduce even a moderate number of them here, it may be stated, in general terms, that when present they

[1] The facts here dealt with will be found more in detail in the "Epidemiological Transactions," vol. iv, new series, p. 90, *et seq.*

[2] "A Treatise on Asiatic Cholera," by C. Macnamara; London, 1870, p. 41.

show the cholerific influences are usually diffused very extensively in the south-western part of the Indian Ocean, though cholera may not become epidemic at many points; and what is worthy of remark, it often shows itself in the form of sporadic cases, sometimes fatal, and accompanied by an unusual prevalence of choleraic diarrhœa, in the Cape Colony, or Natal, some months before the disease becomes epidemic elsewhere nearer the equator.

An instance of ships being struck by cholera in the Atlantic, which occurred as long ago as 1848, which has not been fairly understood, may be mentioned here. The "Swanton," with German emigrants on board, left Havre on 31st October, 1848, for New Orleans; on 25th November there was a very hot south-east wind, such as the captain had never felt before, and which he described as "more like artificially heated air than anything else." On 26th November, after this wind had lasted for about twenty-four hours, the first case of cholera appeared; the ship was then in lat. 25° 47′ north, and 57° 8′ west. The "Swanton" arrived at New Orleans on 11th December, having lost thirteen passengers by cholera. Another ship, the "New York," left Havre on 9th November also with German emigrants for New York. On 24th November there was a very cold wind, and "there was a general overhauling of baggage for warm clothing." The next day the 25th became exceedingly hot, with a south-easterly wind, and the first case of cholera occurred, the ship being in lat. 42° north and long. 61° west. This ship reached New York on 1st December, having lost seven passengers, and landed eleven others with cholera. Cholera was prevalent in Germany at the time these vessels left Havre, but it had not reached the west of France. It is stated, however, that there was an emigrant on board the "New York" who had clothing that had belonged to an individual who had died in Germany of cholera. During the day of intense cold some articles of clothing were taken from the chest, and were worn by several of the passengers, and these passengers were the first taken on the ship.[1] These emigrants had been at Havre about two months before they sailed; a doubt was expressed at the time, however, whether some had not come from Germany shortly before sailing, but whether these were in one of the ships only, or were distributed between both does not appear.

The question arising out of these occurrences at the time, was, How did the passengers in these ships contract cholera, in the

[1] "Cholera Epidemic of 1873 in the United States," p. 608.

middle of the Atlantic? One body of epidemiologists said the cause of the disease had been brought from Germany in clothing, and was communicated to those who wore it, after being unpacked, on 24th November. Though the narrative is wanting in many particulars, as to localities and dates, we should look for now before coming to a conclusion on the subject, it might have been accepted then had the "New York" only been affected; but it was quite inapplicable to the "Swanton" which had not had cold weather on the 24th, nor any overhauling of chests for warm clothing. Another body of epidemiologists, seeing that a change of wind to the south-east took place with both ships before cholera appeared, were of opinion something must have been conveyed by that wind to cause the disease in both, but where it came from, they were unable to indicate. The remark of the captain of the "Swanton" that it was "more like artificially heated air than anything else," affords a clue to the mystery, that now enables it to be explained. Anyone who has experienced "a hot wind" will see at once this is what he described; but as a hot wind always originates over arid land how could such a wind have been experienced from the south-east at the place where the "Swanton" was, from which a south-easterly line would pass through the South Atlantic clear of all land? The wind was really from the desert in North Africa. In November when the north-east trade wind is being re-established over the northern Atlantic it reaches to 6° north; and about long. 30° west, and lat. 20° north at this season, winds are frequently experienced of the character described by the captain of the "Swanton," and, in addition, often bearing red dust in such quantity as to cover the sails and rigging of passing vessels, leaving no doubt as to where they originated, and illustrating their transporting powers. Such a current of air which did not come to the surface of the sea, but continued to flow at some elevation above it, would retain its peculiarities for a long time; it would pass to the inner limit of the trade wind, about 6° north at this season, and then rising in the atmosphere as the air of the trade does, will then double back to the north-west becoming a south-east wind, and would reach the "Swanton" as such, as described above. In November, 1848, when these occurrences took place, there had been cholera in Egypt and along the north coast of Africa, and with a moderate velocity of twenty miles an hour the wind might have transported emanations from that to the "Swanton" in from ten to twelve days, and, if to her, there is nothing unreasonable in the inference that it was capable of trans-

porting them to the continent of America itself, which really seems to have taken place on many occasions.

This transport of the exciting cause of cholera by a current, at some elevation in the atmosphere, and separated from the earth's surface by a thick stratum of air which may either be motionless, or forming a current flowing, it may be, in a different direction, plays a frequent part in connection with the manifestation of that disease. In reading accounts of the circumstances preceding the occurrence of isolated outbreaks in India, one is struck by the frequency with which these immediately follow a thunder storm, or a heavy fall of rain, or even a dust storm, all of which bring a portion of the higher strata to the ground, and with that of course whatever material it may contain; this sequence is quite as remarkable at the elevated mountain stations, as in the plains, and, as was the case at Peshawar in 1862, this was repeated no less than four times between the 7th July and 3rd November,[1] causing a distinct outbreak of cholera on each occasion.

The origin of epidemics of cholera in localities far removed from where the disease has been active, without the population in the intermediate space having shown any trace of the disease, as in the epidemic in Syria in 1875, must have been preceded by a similar combination of circumstances.

As regards cholera, ships behave much in the same way as with yellow fever, some have no cause of unhealthiness in them; in these though even considerable numbers of their crews or passengers may contract cholera, from exposure to its causes on shore or at sea, yet when removed from the source of the disease by change of locality, the fresh attacks usually cease within a few days, and as has been shown above, this also takes place in those some time at sea, when they have been affected there for the first time. There are other instances, however, in which the ship herself became a focus of cholera, and not only those on board suffered, but even persons outside who came within the range of the emanations from her, contracted the disease. This has taken place in crowded emigrant ships only, and has been confined in a great measure to the steerage passengers, the ship's crew suffering but occasionally, and to a limited extent, while the cabin passengers seem to have had complete immunity. The disease in

[1] Munro, "Report on the Epidemic Visitation of Cholera in the 93rd Sutherland Highlanders in 1862," "Army Medical and Statistical Report for 1862," p. 414.

most cases of this description does not seem to have been introduced from the shore just before sailing, but to have appeared some days after, and to have increased during the voyage. The following are the conditions under which the epidemic commenced, and went on in the "England," in 1866, as described by Inspector-General Carrow, then in charge of the Medical Department of the troops at Halifax:—

"The dreadful sanitary state of the emigrant's portion of the ship can be easily understood, and would fully account for their great mortality. When they first went on board, few had changed or even taken off their clothes, it is believed, for more than a week, they were in a most filthy state; then they were greatly overcrowded, and the weather was very bad; the ports had to be closed, and the hatches also, for some considerable time; nearly all were overcome by sea-sickness; clothes and bedding were more or less saturated with ejecta; they had large quantities of *saur kraut* with them, and much of this became putrid. The condition of these poor people after a few days at sea can be imagined; it must have been horrible. Then the evacuations of the cholera patients could not be got rid of as the cases became numerous. It was no wonder the disease spread with such rapidity, and was so terribly malignant."[1] The "England" had left Liverpool on 28th March with 37 cabin and 1,059 steerage passengers; of the latter it was believed from 280 to 300 died, while none of those in the cabin were even attacked; of the crew, two sailors, a steward, and three firemen died. It will not surprise anyone who has considered the subject, that when the epidemic factor was in active operation this combination should have been followed by such terrible results, and no doubt the other emigrant ships which suffered about the same time, were, to a large extent, in a similar condition. Men-of-war, and transports, and even coolie ships, in which discipline could be maintained, though, as has been shown above, subject to attacks at sea, have never shown anything like what occurred in the "England" and other ships in 1866 and subsequently.

[1] "Statistical, Sanitary, and Medical Reports for the Army," vol. vi, p. 365 (for 1864).

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