Remarked in a note

Epidemic Cholera in the Bengal Presidency.

NOTE

ON THE

EPIDEMIC CONNECTION OF THE CHOLERA OF MADRAS & BOMBAY

WITH THE

CHOLERA EPIDEMICS OF THE BENGAL PRESIDENCY.

BY

JAMES L. BRYDEN, M.D., Surgeon, Bengal Army,
STATISTICAL OFFICER ATTACHED TO THE SANITARY COMMISSIONER WITH THE GOVERNMENT OF INDIA.

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Letter from the Secretary to the Government of India, in the Department of Agriculture, Revenue and Commerce, to the Sanitary Commissioner with the Government of India, No. 70, dated 7th August 1871, transmits for remark copy of Report by the Sanitary Commissioner for Madras on Cholera in Southern India.*

Aspect from which the cholera of the Madras Presidency is studied in this report.

2. Mr. Cornish has professedly based his study of cholera in Southern India on the principles laid down in my reports on the cholera of the Bengal Presidency, of 1868 and 1869.

Conclusions arrived at and summarised in the report.

3. His general conclusions substantially coincide with those which I have offered, as far as relates to the origin of the cholera which appears in the Madras Presidency, the life-period normal for each epidemic and the successive reproductions occurring during the life-period of the epidemic, the control of these successive manifestations by conditions of locality, the early appearance or retardation of these manifestations in obedience to the prevailing meteorological phenomena, and even the general phenomena observed during epidemic advance.

These conclusions are expressed in the following terms :—

"When we come to examine into the life-history of cholera, we shall find that no conditions of soil or climate in this part of India are capable of perpetually renewing the contagion of the disease, and that, except in very rare instances, an invading cholera never survives beyond four years, and in most instances is extinct in a much briefer period.

"It is affected more or less by seasonal changes during the natural course of its life; active and deadly in its destructive powers at one period of the year under peculiar meteorological or climatic conditions, and dormant or inoperative at other periods, when a different order of meteorological phenomena prevails.

"Some localities harbour and reproduce the contagion for a longer period than others. There are certain districts in which a reproduction of an invading cholera will go on for three or even four years after the primary invasion; and there are other places in which the reproduction either does not occur at all or lasts for one season only, leaving a long interval of two or three years of complete rest between one invasion and the next following it.

"The history of epidemic advance in 1818 is the history for all time of the mode in which the Peninsula and Southern India are invaded. In every new invasion there are sure to be some minor differences as to the rapidity of movement of, and the extent of country covered by cholera, but the main facts are unalterable.

"In the movement of cholera from its endemic home, there are other agents than human intercourse at work.

"The broad truth in regard to invasion to be borne in view is, that the great body of cholera which invades Southern India leaves its natural territory in Lower Bengal by what Dr. Bryden terms 'the southern epidemic highway' across the Central Provinces, and southward through the Deccan and Bombay Presidencies towards the Madras territory, which in a longer or shorter space of time is occupied.

"Cholera does move in accordance with its own laws.

"Cholera is often manifested in extreme virulence, along the bases of natural barriers to its advance, and in the river basins and ravines that lie in between great mountains."

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* Cholera in Southern India: A record of the progress of cholera in 1870, and resumé of the records of former epidemic invasions of the Madras Presidency. By Surgeon W. R. Cornish, F. R. C. S., Sanitary Commissioner for Madras.

4. But at this point Mr. Cornish takes up new ground. He continues:—

Conclusions which are adverse to those arrived at from the study of epidemic cholera in the Bengal Presidency.

"There is a movement of cholera independent of strength or direction of winds. * * * There has been no relation shown as yet between the velocity of movement of cholera and of monsoon winds. It is abundantly clear that the development of cholera in a province (? invasion of a province), has no sort of relation to the rapidity of movement of the air.

"The theory, that the cholera miasm is in its nature wholly independent of man, is without any trustworthy evidence in its favor.

"I am not prepared to explain why cholera should periodically move out of the land of its birth, radiating in every direction in which physical obstacles to its progress do not exist. But it is by the fact of radiation of cholera, as from a centre, that we must explain its appearance and progress in opposite directions at the same moment of time."

5. Divergence of opinion, then, proceeds from two bases:—First, the existence of the cholera miasm as an object, having a natural history of its own and a life and movement other than that which it derives from its relations to the human race, is denied; and, secondly, the facts of epidemic movement in the Madras Presidency are held to be consistently opposed to the assertion that cholera occupies an area by aerial movement, and that its direction and limitation in space are determined by the meteorological phenomena present during epidemic advance.

Summary of the points on which there is a difference of opinion.

The whole differences virtually resolve themselves into the one, that the cholera of Madras moves habitually against the prevailing winds, and is therefore dependent for its propagation solely on human agency.

6. Mr. Cornish observes—"The other theory of Dr. Bryden's, that the cholera miasm is in its nature wholly independent of man, is, I need hardly observe, without any trustworthy evidence in its favor."

This assumption is necessitated by the denial of the primary proposition that the epidemic advance of cholera occurs *per saltum*, and that a natural area is covered simultaneously by an air-borne cholera which has no relation to the routes traversed by man.

The two questions are so mixed up that I need not discuss them separately. I shall here simply meet Mr. Cornish's statement by the counter-statement, that the events of every year and every epidemic, in proportion as our means of investigation are perfected and the area of observation widened, tend to demonstrate the grand truth that man plays no part in the vast leaps characteristic of all epidemic movements of cholera in India.

Leading proposition of this paper.

The question at issue is narrowed virtually to this—Is Mr. Cornish's statement, that the epidemic invading cholera of Madras and Bombay advances habitually against the prevailing winds, correct or incorrect?

Nowhere in this report, as far as I can ascertain, are the facts of the occupation of a provincial area by cholera studied in relation to the aerial influence prevalent at the time. It is taken for granted throughout that there is no such phenomenon as the occupation of a province *per saltum*. Thus, to take a single example, we read, p. 143—"I am not aware of a single fact which shows that cholera can advance epidemically at the same rate as the monsoon winds, which, at certain seasons of the year, travel at the rate of from 200 to 300 miles in twenty-four hours." Mr. Cornish, indeed, deems it sufficient to fall back upon the narrative of 1818; for the references which he makes to the facts of 1859 and 1864 supply no meteorological data, nor, as the narrative is written, are the successive epidemic extensions defined. With the narrative of 1818 he couples the alleged facts connected with epidemic extension to Ceylon in 1870, but to these no further allusion need be made, since the enquiry merely introduces matter indefinitely recorded and derived from a provincial area which lies beyond the limits of the Madras Presidency, within which alone Mr. Cornish has immediate sources of information.

7. The point in dispute I shall first discuss on the data of 1818 and 1868, years in which we have a distinct and connected narrative of epidemic movements. Records of the epidemics intervening are made up of fragmentary data which were never placed in order to form a consistent history, probably because it was deemed impossible that a connected history of cholera could be written for any year or any epidemic, although the simple narratives of Scott and Jameson now show us that all through these fifty years an accurate and connected record might have been kept up.

The invasion of the Madras Presidency will be here studied on the phenomena observed in 1818 and 1868.

8. But I am unwilling to pass over the histories of the epidemics of 1859 and 1863 without noticing the observations which Mr. Cornish has introduced into his notices of the cholera of these years.

Preliminary points for consideration. The relation of the Bengal cholera of 1859 to the cholera of the same year in Madras and Bombay.

Speaking of the geography of cholera in 1859, Mr. Cornish seems to imply that my theory gained something by the fact of an imperfect cholera chart of the year having been attached to my report. My theory gained nothing, and Mr. Cornish supplies only the data which I asked for and was unable to obtain, in order to render my map a correct representation of what actually did occur.

I showed how, as in many other epidemics, the epidemic leap of May 1859, derived from the great endemic cholera of 1858, occupied all the districts south of the Jumna, entering the Banda district on 7th May and the town on the 16th. Mr. Cornish takes up the narrative and tells us how in May 1859 the same cholera reached Bombay, and how in May 1859 a fresh invading cholera struck Hyderabad in the Deccan with exceeding force, the mortality being so appalling that to this day the cholera is remembered by the inhabitants as one of the severest visitations that ever afflicted them. All of this means that the one emanation of cholera from the endemic area had touched the eastern and western extremities of the great natural limit formed by influences from the north-west of India moving down to oppose those coming from the east at this date, which I have described (p. 96 of report) as Jameson's curved line of the spring cholera of 1818. As in May 1818 (see Scott's map), this May cholera of 1859 was universal to the south, the curved line forming the northern boundary of a natural area stretching far to the south and reaching from sea to sea.

Mr. Cornish says—"It is somewhat strange that a cholera map should have been drawn for 1859 so as to show a complete exemption of the western and southern tracts, the more especially as it is evident from the report that Dr. Bryden was acquainted with the fact of the invasion of Bombay in that year. The map in question is wholly misleading." I am quite ready to admit that the map in question shows only half the truth; and Mr. Cornish satisfactorily explains the deficiency. "It would seem probable," he says, "that Dr. Bryden's data being too limited for the purpose, failed to inform him of the south-western progress of cholera in 1859." The sketch was designed for the Bengal Presidency only, and I could find no data on which to colour in the Central Provinces along with the valley of the Ganges. I wrote thus—"As far as our records inform us, cholera did not invade Nagpore or any station of the Central Provinces in 1859, certainly as an epidemic cholera did not visibly cover these provinces before March 1860 in succession to the invasion of March 1856." This sentence was written in the first pages of my report (page 23). But while the work was passing through the press, I set myself to investigate further the facts which seemed to be deficient; and finally I had the satisfaction of recording the parallel which I wished to draw between 1859 and 1868. I appended to the map which Mr. Cornish has copied, the supplementary information required for its correction; and in copying the map Mr. Cornish ought to have alluded to the explanation attached to it. The following is my note (page lxxiv of Appendix, facing the cholera map of 1859), which shows that I anticipated the very facts which Mr. Cornish has produced—

"The cases at Ajmere were indicative of the movement of the invading cholera of the year on the northern epidemic highway. The cases returned from the jails of Central India evidently mark the progress of the same invading cholera on the southern epidemic highway; and although our indices are so trifling, it is certain that this was the same cholera which reached Bombay in May (see Table, page 115), as in 1818,* and which was widely spread throughout the Bombay Presidency towards the end of 1859, as in 1868. The movement of May was universal from the east as far as to Humeerpore and Jaloun, and I find that premonitory cases were thrown out beyond this western limit into the Gwalior District, for two admissions and a death occurred at Gwalior on May 6th among the men of the Bombay Artillery. *This was the northern margin of the tract occupied in the movement of May, and we may infer that the cholera moving from the east in this month covered as an aura or in substance the entire epidemic tract between Chota Nagpore and Bombay;* the very early appearance of cholera as far west as Nimar in the first days of March 1860 causes me to conclude that this cholera was revitalised from the cholera of December 1859, and was not a cholera primarily invading from the east in that month."

I repeat that to a true theory every imperfection of record is a loss, not a gain; for not one iota of fact will be out of place in the general harmony provided we know where to place it.†

The significance of the date at which Bombay is invaded, a portion of the general inquiry, and of no consequence when viewed standing alone.

9. One other observation calls for remark. In the description of the cholera of 1863 the following occurs (page 22)—"Dr. Bryden holds that the invading cholera of the Central Provinces did not reach Bombay until December; but it must be remembered that this gentleman supports a theory that invading cholera cannot move against a monsoon wind, and this may explain, perhaps, why the month of December has been pitched upon as the month of a new invasion. The ascertained mortality in the town of Bombay certainly does not warrant the idea of a new invasion of Bombay in December 1863, but points rather to the certainty that the cholera influence was in power there much earlier in the year, at the period in fact when cholera appeared in the Central Provinces. If it be a fact that cholera can cross the peninsula of India

* Meaning the May cholera of Mhow, Western Malwa, and Gnzerat.

† We find this argument applied even to the beautifully perfect details which I have brought together regarding the epidemic of 1869. It is alleged that these details may not be true, because the record for the general population is imperfect. Scientifically viewed, the data for the general population of the invaded area of 1869 were complete; so complete, that no one with a knowledge of India and Indian cholera could doubt the fact of their being perfect so far as to admit of accurate and scientific conclusions being drawn from them. Absolute completeness would have tended only to consolidate the truths plainly marked in the data as they stand. The task of the scientific inquirer becomes easy, not difficult, in proportion to the completeness of the data for elaboration afforded to him.

in June and July, in the teeth of the south-west monsoon, all theories founded on the dogma that a cholera invasion cannot progress against prevailing winds must necessarily fall to the ground."

The passage alluded to I suppose to be this (page 119)—"It was in September, October, and November that the Nagpore Jail suffered, and this cholera marched onwards to the west after waiting for the conclusion of the monsoon. This I regard as the cholera which reached the city of Bombay in December 1863, and which cut off upwards of 3,000 persons between this month and the May following." Invading cholera reached Bombay in August in 1818 and 1849; in October in 1853 and 1868; and in December in 1861 and perhaps in 1863. It is not a matter of the slightest moment to my theory whether the cholera of 1863 reached Bombay in July or December, since invasion is to be accounted for in May, August, October, and December as well as in July. It is probable that in 1863 invasion occurred in both months—that one wave of the same epidemic reached Bombay, while the valley of the Ganges and the Central Provinces were covered in July, and that another reached Bombay in December, coincidently with its renewed existence in the Central Provinces. It was the entirely exceptional fact of the occurrence of epidemic cholera in the Central Provinces in October and November 1863—a fact without parallel, as far as I know, before or since—that led me to infer that a fresh wave had struck Bombay at this date; and the facies of the table which follows is very far from suggesting anything to the contrary. For three months before the sudden rise of December, cholera had made no progress, and the increase of December initiated the great cholera which culminated in May.

Deaths in Bombay, 1863-64.

September.	October.	November.	December.	January.	February.	March.	April.	May.
178	181	176	319	622	401	302	680	837

Summary of objections to the aerial theory. Objections invalid, because the phenomena observed occur strictly as they should occur in accordance with the theoretical proposition as stated by Mr. Cornish.

10. It is needless to pursue these objections further. Let me, then, examine whether, as alleged by Mr. Cornish, Scott's data and the illustrative map warrant him in concluding that the cholera of the Madras Presidency has no relation in its movements to aerial agencies, and that, so far from its advance being promoted by these agencies, cholera prefers to march directly in opposition to them.

Mr. Cornish summarises his objections in the following terms:—

"The theory of cholera distribution by monsoon winds does not in any way account for the circumstance that simultaneously with the movement of a new epidemic out of Bengal in a north-west or south-west direction a corresponding movement is going on to the south and south-east. If the monsoon winds of India blew in circles continually widening, or form a central point in radiating lines, it would be easy to understand how they might propagate cholera; but, as a matter of fact, we know that the two great winds from the south-west and north-east prevail with great regularity, and that during the seasons of prevalence atmospheric movements are mainly in one direction, while cholera may be moving in various directions."

As a matter of fact, we do not know the truth of what is thus broadly stated. My original cholera report is from first to last a treatise designed to show the natural laws under which monsoon influences fall upon areas; and all that I have demonstrated and mapped out goes to prove that no such generalisation as is here made is in the least applicable to the monsoons as they affect the Bengal Presidency.

The south-west monsoon bursts from the south-west upon the western coast of India, and again where there are no land influences to oppose it, it bursts from the south-west upon the eastern shores of the Bay of Bengal. The enormous rainfalls of Mahabuleshwar on the Western Ghâts and of Cherrapoonjee on the mountains of Eastern Bengal, come from the same direction and are derived from one and the same source. But he who has lived on the Nerbudda and on the Ganges knows that at the very moment when the west winds of the monsoon season are rushing towards the east up the Nerbudda Valley, the winds of the same monsoon are driving the fleets up the Ganges from east to west.

The general facts I may recapitulate in a single sentence:—

First, every observer in the districts of the epidemic area of the Bengal Presidency knows the direction from which the cholera comes, and he knows the seasons at which he may expect it; and all observation in the Bengal Presidency goes distinctly to prove, that be the explanation what it may, cholera does not move contrary to aerial agencies, but that cholera movements are coincident with aerial movements, and the cholera limits the limits of aerial movements. *Second*, the movements of spring cholera are coincident with the direction of agencies prevailing in the spring, and those of monsoon cholera with the direction of the agencies prevailing during the prevalence of the monsoon. *Third*, the monsoon called south-west monsoon is, as regards the Bengal Presidency, a south-east monsoon, all its influences being directed from the Bay of Bengal as a basis towards the north-western desert and the Himalayas, except in as far as concerns the district living east of the Bay of Bengal, which receive and transmit the south-

west monsoon as a south-west monsoon towards Assam and the frontiers of China. *Fourth*, the extreme south-west of our Presidency is also reached from the Bombay coast, but to a very limited extent. The desert reaches far south towards the Bombay coast, because of the inability of the monsoon to reach this tract; and Neemuch, which does not lie in our Presidency, is the last station which feels the effect of the monsoon from Bombay.

Two facts it is necessary always to keep in view—that Nagpore is the meteorological *umbilicus* of the continent of Hindostan, towards which as a centre the meteorological systems of India converge; and that from the northern shores of the Bay of Bengal there is a true radiation of monsoon influences to the east, to the north, and to the west, affected by causes which are natural and easily appreciated.

The dictum of the Constantinople conference, reproduced in this report,* is contradicted by every fact in epidemiology recorded in India since 1818; and from Jameson's facts we can also recognise that there was in his day no antagonism between the phenomena of movement and the theory that the prevailing agencies might have influenced, directed, and limited the movements.

It remains to be shown that the phenomena observed in Madras obey the same laws, and are in harmony, not in antagonism.

11. This being the case, and knowing well that natural laws admit of no arbitrary variations, we are forced to enquire, what is it that has driven Mr. Cornish to the conclusion that in the Madras Presidency cholera moves from north to south, and from east to west, against the prevailing monsoon influences? Mr. Cornish asks that we shall discuss this question on the data of 1818, and I am prepared to do so, and to admit that the data afforded are correct.

Scott's map and narrative were not compiled to suit a theory.

12. Mr. Cornish tells us (p. 14), that Scott's narrative and map are all the more valuable at the present time, having been compiled to illustrate no theory of invasion, but simply to record in a connected form the testimony of the medical officers who personally witnessed the outbreak; and he states, that he has had it re-drawn specially in refutation of the theory that cholera cannot advance "except when forced forward by monsoon winds."†

13. Again, there is another passage which I shall notice preliminary to the consideration of Scott's map and narrative—

Mr. Cornish has not followed out the study of the cholera of Madras on the basis proposed.

(p. 31.) "Dr. Bryden has shown how the cholera epidemics of recent years have occupied certain areas in the North-West and Central Provinces of India. It has been reserved for me to illustrate in what manner and at what distance of time these explosive waves of cholera from the Bengal endemic field make themselves felt in the southern districts of the Indian Peninsula." Mr. Cornish has not followed out this study as I proposed that it should be followed out. On the contrary, he has adopted a theory of movement which is not consistent with my primary proposition that epidemic advance occurs *per saltum*, and that a provincial area is covered in each leap. This is the statement of my deduction from the phenomena of epidemic advance in our Presidency. Mr. Cornish states the view which he presumes will form a sound basis of inquiry in terms diametrically opposite.—"It is abundantly clear, "he writes," that the development of cholera in a province has no sort of relation to the rapidity of the movement of the air. * * * The phenomena of epidemic movement, as I understand them, may in some respects be likened to the circular waves which follow the displacement of water in a pool when a stone is flung into the middle of it. * * * It is by the fact of radiation, as from a centre, that we must explain the appearance and progress of cholera in opposite directions."

It remains for me, therefore, taking Scott's map, as proposed, to show that the Madras Presidency is occupied in a series of epidemic leaps, each leap determining a natural area, and that the phenomena accompanying each of these leaps are not inconsistent with the theory that they take place in subordination to the direction of aerial agencies.

Consideration of the special subject in hand. Scott's narrative and map, and the lessons in epidemic history derived from them.

14. It is necessary that I should reproduce Scott's map, and I am very glad to have the opportunity of doing so. In my original report I might have entered more fully into the phenomena occurring in Southern India, although it was no part of the scheme which I laid down. But the copy of Scott's work which I had the opportunity of consulting was mutilated in the first pages and the map torn away, otherwise I should, beyond doubt, have called attention to the phenomena which it seems to me most strikingly to illustrate.

The May cholera of 1818 in Madras and its relation to the Bengal cholera of the same month.

15. In the map, I have inserted in the north, stations which Jameson's record tells us were first invaded in May 1818, namely, Hoshungabad, Saugor, Mhow, Ougein, and Mehidpore, thus extending to the west the indication of the area covered by cholera in the spring of 1818. Mehidpore in Western Malwa was struck on 12th May,

* "Cholera has never in its progress preferentially taken, as believed by some, a direction from east to west, but on the contrary, it has radiated and radiates in India in every direction, to the south as to the north, to the east as to the west, spreading itself everywhere in consequence of the facility and multiplicity of the communications. Those who think otherwise have not studied the facts, and reason as the Chinese would do, who pretend that cholera invariably proceeds from west to east."

† This, it will be observed, is Mr. Cornish's expression, not mine.

Vizagapatam on the Bay of Bengal on 15th May, and Nagpore, mid-way between, also on the 15th May. This cholera of May 1818, universal on the southern epidemic highway from the Bay of Bengal to the confines of the Bombay Presidency, and probably far beyond the western limit indicated, had a definite boundary line in the south, which I have dotted in on Scott's map. North of this line influences from the east and north, derived from the Bay of Bengal and the regions to the north of it, move in to occupy the space left vacant by the heating up of the continent. Jameson's curved line, with its convexity looking towards the north-west, beginning in Western Malwa and ending where the line of 80° strikes the Himalayas in the north, indicates the limit of eastern and south-eastern influences on the southern epidemic route, and the repression of advance by the more powerful hot winds blowing from the north-west of India.

Talking of the northern portion of the Madras Presidency and of the aerial phenomena following the cessation of the north-east monsoon, Scott writes—"From this period till towards the end of May the winds are irregular and the heat intense all over. In the Bay of Bengal and on either of its shores the winds at this time are chiefly from the south, and are remarkable for their humidity, heat, and relaxing effects."*

These winds become easterly in the Gangetic valley, and an epidemic year is characterised by the prevalence of moist easterly winds in the early months and in May. As we get nearer the centre of the continent these winds become drier, and finally fail to be characteristic, as they are in the east. They would seem to die away normally a little to the south of Nagpore, although the area brought under their influence may in certain years, as in May 1859, be extended very much to the south and west. There is probably under ordinary circumstances, a great distinction even in the 150 miles of country which separates Jubbulpore from Nagpore. Jubbulpore is as regards the meteorology of the spring months, a station under almost absolutely the same conditions as the districts of the Gangetic valley 200 miles to the north; and during the invasion of an epidemic the meteorology prevailing at Jubbulpore, Seonee or Mundla may be very different from that prevailing simultaneously at Nagpore.†

This, then, is the manner in which I account for the demarcation shown between the cholera of May and July 1818. Up to this line, after the 20th May, the south-west monsoon blowing from the Bombay Coast advances; and while it continues to blow we do not expect to find any of the phenomena of epidemic movement in a southerly direction. Movement is at an end for the time being.

16. Before proceeding to consider the occupation of the Monsoon Province (marked B. in the map), let me place here the sketch which Scott gives of the meteorological phenomena normally present in the tract in question.

Scott's description of monsoon influence as affecting the north and north-east of the Madras Presidency.

He writes—"The north-east monsoon commences generally in October, and is attended with dry weather over all the Peninsula, excepting on that narrow stripe of coast forming its eastern side, which is washed by the Bay of Bengal and commonly known as the Coromandel Coast. On this stripe, the north-east monsoon brings the periodical rains, which commence sooner or later in October, terminating sooner or later in December. From this last period till towards the end of February, the north-east wind, or monsoon, now a dry wind, continues to prevail, and the weather remains cool and in many places cold. The north-east wind then ceases, and from this period till towards the end of May the winds are irregular, and the heats are intense all over. In the Bay of Bengal and on either of its shores the winds at this time are chiefly from the south, and are remarkable for their *humidity*, heat, and relaxing effects. About the middle or end of May the south-west monsoon commences, and is attended with the periodical rains in all parts of the Peninsula, excepting the Coromandel Coast, which then suffers great heat and drought; these rains cease in August or September, when the climate becomes generally sultry and variable until the north-east monsoon sets in again.

"Thus there are two great and most important distinctions of climate. The Coromandel Coast has its rain along with its cool season,‡ and its hot season may be said to be always dry. All the rest of India has the rainy season along with the heats of June, July, August, and September, when the sun is to the northward of the Equator. These rains, indeed, in some degree, temper the excessive heat, *but their intervals are often distinguished by an intense force of the solar rays and by dead calms*, and that whole period is subject to all the effects of heat and moisture combined, acting on the soil and vegetation. The Nagpore and Hyderabad States and all others to the west and south are subjected to the rains from the south-west monsoon. The Northern Division experiences the rains of the north-east monsoon, but this tract feels also the occasional influence of the south-west rains.

"The north-east monsoon not unfrequently carries its rains far to the westward of the limits assigned, and, in like manner, the south-west monsoon refreshes the eastern parts with occasional

* Speaking of the occupation of the eastern extremity of the May province and the invasion of the Coromandel Coast in the spring of 1818, Scott writes—"Cholera appeared about the 15th May. The weather is said to have been then oppressively hot, and the air loaded with humidity."

† I believe that the cholera of 20th April 1868 reached the districts around Jubbulpore, then occupied, with eastern influences. At this date no cholera reached Nagpore. Yet even so far south as Nagpore, sixty observations on the direction of the winds taken in this month gave the following results:—North and north-east and east 23, west and north-west 25, and south and south-west 12.

‡ See the natural cholera province of the north-east Monsoon, dotted off on Scott's Map.

heavy showers. In some of the more elevated tracts, though the sun be vertical, the air is cold during the rains, especially where the wind blows fresh; but in lower situations, and where the soil is inundated, the air is often extremely hot and oppressive, and is surcharged with moisture."

17. From this description we have no difficulty in recognising, that in the north and east of the tract described we have the history of a dying monsoon influence. I have shown how towards the north-western desert, mile by mile, the rainfall coming from the Bay of Bengal diminishes, until it finally and totally disappears, and, as a consequence, the tract is a barren waste. The tract along the Eastern Coast holds the same relation to the monsoon blowing from the Malabar Coast across the continent towards the north-east. It may be reached, or it may not. As Scott expresses it above: "the northern division feels the *occasional* influence of the south-west rains." When it is not reached, eastern influences step in to take the place of those due from the south-west. The year 1868 was such a year, the monsoon from the south-west having from weakness failed to come up so far. Thus, the Civil Surgeon of Raipore writes—"The early cessation of the monsoon seems to have had a considerable influence for good on the health of the people. The wind blowing principally from the north-east, we have had none of the watery vapours generally brought up from the western coast during the autumn months. The atmosphere was therefore much drier than is usual at this time, and we had much less malarious influence at work than usual."

The distance to which monsoon influences having the south-western coast as their base reach in the north and north-east.

18. I shall do nothing more than call attention to the fact, that the invasion of the tract marked B1 occurred in 1818 in the very weeks, and in the very days, in which so many of our great epidemics, such as those of 1856 or 1861, occupied Central and Northern India in the track of the monsoon blowing from the south-east, and I need not repeat here how these were limited in their distribution to a mile by the limitation of these monsoon influences, and by no other cause.

The movement of July 1818 in Madras coincident with movement in the same weeks in the Bengal Presidency.

19. Or again, if I take the area marked B 2, our map of 1868 will furnish us with a most perfect and wonderful parallel. On the west, it was on the 14th August that Bombay was reached; on the east, it was on the 14th August that Ungool on the opposite coast was reached; in the centre, Darwar and Badamy were struck on the 13th.

This happened in 1818. Fifty years afterwards, and without the knowledge of these facts, I find that I have recorded a precise parallel, and all the more precise because the age of the epidemic was the same to a day, dated from the time of leaving its endemic home. In 1868, Malligaum, within a short distance of the Bombay Coast, was struck on 14th August;* and on the opposite margin of the field under my observation, Chanda first showed its cholera on the 15th. Akola and Ellichpore, in the middle, were suffering from the invasion on the 18th.

Movement of 14th August in Madras general from sea to sea, and absolutely homologous with the cholera of the same days of 1868.

Here, then, are two sets of parallel phenomena, which are fitted to suggest to us how and why these two divisions of Province B. were covered.

One glance at the map shows the fact that here there was no marginal extension of this cholera. One and all of the provincial definitions with the dates assigned, call for the recognition of the truth, that the occupation was by a succession of sudden and decided epidemic leaps.

Extension of 1818 *per saltum* and not marginal, as suggested by Mr. Cornish.

20. All the coast line south of Darwar and reaching a little to the south of Mangalore was invaded, probably when the monsoon died away, in the first week of September.

The latest dates of invasion within this tract given in the map are Hurryhur, 12th September, and Chittledroog, 15th September; this is a very beautiful parallel with the fact that with us in Northern India within the limits of the monsoon area epidemic progress ceases in the same week.

21. But in Southern and Western India new influences, parallel to those which in Eastern Bengal determine the epidemic presence of a great cholera lasting from October until the beginning of the year following, develop a cholera province which has limits and characteristics of its own, an area in which cholera is developed and flourishes throughout the prevalence of the *north-east* monsoon. This province, as defined by the invading cholera of 1818, is marked C. on the map.

Phenomena in the province of the north-east monsoon in the south of the Peninsula, corresponding to those of the natural cholera area in Eastern Bengal.

22. These are, as I read them in the history of cholera in 1818 and 1868, the natural areas upon which the cholera of these years fell. Lines of retrogression will probably be found less constant to a fixed geography than lines of epidemic advance; while in 1818 we find three zones indicative of successive recessions, we find in 1868 but one, representing the two first leaps of the monsoon cholera of 1818.

The areas mapped out in 1818 and 1868 are natural areas; and the parallel phenomena observed in both years are strictly homologous.

The area invaded in the last three months of 1818 is a distinct cholera province. But the parallel of 1868 teaches that it is not a tract rigidly defined. It may be of any extent;

* On the map the 18th is given as the date. On the 18th the Bengal Cavalry stationed at Malligaum were attacked, and cholera had appeared in the neighbourhood four days before—(Note to p. 154, Cholera Report).

it may reach, as in 1868, from Hyderabad to Bombay; and it may include the whole tract left unoccupied during the persistence of the monsoon from the south-west. The province is not the less a natural province, for it is invaded under one and the same agency, the north-east monsoon. Hence, when we turn to Scott's map and to the map of 1868,* and observe that Calicut was struck on the 15th October, 1818, and Bombay on the 15th October 1868, we recognise that the two phenomena are of identical significance, although separated by an interval of 50 years. To continue the parallel, the cholera striking Hyderabad on 15th November 1868 was strictly homologous with the cholera of the same week in 1818, depicted on Scott's map, extending from the line of 12° south to Madura, a tract which appears to have been universally covered by a primarily invading cholera in the two last weeks of November 1818. Or, to extend the parallel beyond India, although still within the limits of the north-east monsoon, the cholera announced from Zanzibar on 20th November 1870 was strictly homologous with the cholera reported from Mauritius on 20th November 1819.

23. The movement of July 1818 was coincident with the revitalisation of cholera in our Presidency. Scott writes: "In Sir John Malcolm's camp at Mhow, cholera is noticed as having attacked part of the force on 16th July." * * * "In Lieutenant Colonel MacDonell's camp near Malligaum, it appeared among the camp-followers on the 13th of July." On the coast of the Bay of Bengal lying within the area of the same invasion, cholera first appeared between the 5th and 10th July.

Details regarding the movement of July and August in Bengal and Madras. The coincidence of the movements leads to the conclusion that the agencies directing both were the same.

Jameson tells us that in July some corps of the Nerbudda force suffered considerably. Simultaneously, cholera reappeared at Allahabad, and covered the Shahjehanpore district. "On the 11th July," writes Jameson, "cholera entered the town of Coel (Allyghur). We next find the disease on the 20th at Delhi. Meerut and the cantonments attached to it suffered under it from the 28th." I quote this to show that invasion on the southern and northern highways was absolutely coincident. And since this was the case, we are entitled to conclude that the epidemic manifestation occurred under one and the same agency, and that the moving cholera was spread out, as I have described it, like an open fan, having for its centre the northern extremity of the Bay of Bengal, and for its radii the extensions to the south-east and south-west, to the north, to the north-east, and to the north-west.

In short, I take the area invaded in July to be an area in which the south-western influences were at the date of invasion repressed, and which, therefore, became a natural extension of the cholera area of the Gangetic and Central Provinces covered in the same weeks.

I believe that in these weeks the south-west monsoon did not reach this tract, and that the north-eastern limit of these influences in July was the dotted line by which I have marked out the southern boundary of this natural area. And, curiously enough, we can show even at this distance of time, that it was a new burst from the south-west which determined the beautifully marked interval between the epidemic leap of July and that of 14th August; that is to say, we can show that the meteorology after the 20th July 1818 was such that cholera moving aerially could not have progressed against it. On the 18th July, a detachment, misled by false information, moved out from Mooltye, and was cut to pieces on the 20th.† Troops were instantly sent in pursuit, and Prinsep tells us that the rains had set in with peculiar violence, and that therefore the operations of these days were the most distressing the men had yet been engaged in.‡

24. The epidemic leap of 14th August finds, as I have said, a perfect parallel in 1868, and we know what were the conditions prevailing in August 1868. The area covered in these days in 1868 was an area in which south-western influences were driven backwards, and were in abeyance. The theoretical objection that the cholera of the 14th August 1868 "crossed in the teeth of the monsoon" is merely a popular fallacy. There was in these days no opposing influence from the south-west; and the leap of the 14th August, so beautifully marked on the map for 1868, reaching nearly to the western coast, and coincident with the passing of an aura over the northern highway—the precursor of the great cholera of 1869—shows truly the passing from north-east to south-west of influences stepping in to occupy an unoccupied tract.

Meteorology of August 1868 shows absolute repression of influences from the south-west at the date when epidemic advance occurred.

In August 1868 when the monsoon should have been at its height, scarcely a drop of rain fell for weeks throughout the whole of the Central Provinces. The report for the week ending 22nd August is the same from all districts:—"The cessation of rain within the last fortnight is

* The map referred to is that affixed to my original cholera report. A parallel so remarkable cannot be too attentively studied. The maps of 1818 and 1868 should be placed together, and the area of the parallel movements of May (dotted in on the map of 1868), August, and October and November in both years, compared.

† Priusep. Administration of the Marquis of Hastings, II, 312.

‡ This does not mean that the monsoon first burst upon the Western Coast at this date; the monsoon was due more than a month before. It is not, however, out of place that I should here note the fact, that a powerful burst of the mousoon by no means implies that a normal or excessive rainfall shall follow. In 1857, which was not a year of excessive rainfall, I saw in the district occupied by Sir John Malcolm's Troops in 1818, the Nerbudda rise forty feet in one night, with a width of half a mile, following the burst of the monsoon; and in the current year, while the districts of the Berars lying below the Satpoora mountains have had a monsoon rainfall of 10 inches, the burst of the same monsoon on the Satpooras was so great as to necessitate the removal to the plains of half the garrison of Puchmurree.

causing great injury to the crops." "The want of rain is beginning to be severely felt." "Rain is anxiously looked for." "No rain at all in the interior of the district." "The prospects of agriculture generally gloomy in the extreme." "Much anxiety is felt at the continued drought." "No prospect of rain."

All of this means, that the monsoon from the south-west, which brings the rains to this tract, had no existence for the time being. At the same time, the heat is, of course, combined with moisture (see Scott's remarks, para. 16), just as in Lower Bengal at the season so favorable for the epidemic increase of cholera.

I do not consider that any monthly or weekly local data are ever likely to give with absolute accuracy the specific information which we seek as to the control of the movements of cholera. The inference which I wish to draw from the statement which follows is simply this, that south-westerly winds were not prevailing over the greater portion of the Central Provinces when the epidemic advance of August 1868 occurred; and that it may be doubted whether steady westerly winds prevailed in any single district of these provinces at the time.

District reports from the Central Provinces during the monsoon break of August 1868.

Nagpore ..
Chanda ...
Mundla ...
Chindwarra ...
Hoshungabad ...
Sumbulpore ...
} No report.

Bhundara.
"Winds variable."
Balaghat
"Wind variable."
Raepore.
"Direction of wind north and south-west."*
Belaspore.
"Wind variable."
Jubbulpore.
"Wind north-west and variable."
Dumoh.
"Prevailing wind east and north-east."
Baitool.
"Wind variable in three sub-divisions, westerly in a fourth, easterly in a fifth."
Nursingpore.
"Wind easterly in one sub-division, westerly in two."

Wurdah.
"Wind south-westerly."
Saugor.
"Westerly wind (in one sub-division easterly)."
Seonee.
"Wind south-westerly."
Nimar.
"Wind west and south-west."
Sironcha.
"Wind mostly from south-west".

25. My conclusions I summarised in the following terms in the report of last year:—

Summary of conclusions published in the report for 1869 and previous to acquaintance with the facts of 1818.

"Judging from the history of the meteorology attending this and other occasions on which epidemic cholera has crossed the continent, I have drawn the inference that the capability of epidemic advance in the monsoon season from north-east to south-west, that is from Seonee, Mundla, and Jubbulpore towards Ahmednuggur, is exactly proportionate to the extent to which meteorological influences, having as their base the north-east, take the place of those having the Bombay Coast for their base. That in short, repression of the south-west monsoon will cause a cholera which we can recognise as epidemic in the north-east, to descend towards the south and west to fill the vacancy left owing to the absence of the influences from the south-west normal for the season. The line from north-east to south-west followed in 1868 was an aerial line, as the geography indicated clearly shows. The influences from the Bay of Bengal pressing steadily on the eastern flank of the cholera kept it entirely out of the Chutteesghur Division; the monsoon blowing up the valleys of the Nerbudda and Taptee pressed on it from the west; and hence resulted precisely the shape which we see on the map, or even in looking at the figures in the table below and knowing nothing of the geographical relations involved:—

Table illustrating how cholera moves from north-east to south-west upon the Southern Epidemic Highway.

Deaths of the General Population, 1868.

Movement repressed by eastern influences from the Bay of Bengal.		Districts in the line of epidemic movement from north-east to south-west.		Movement repressed by western influences from the Bombay Coast.	
Raepore	3	Jubbulpore ...	2952	Bhopal ...	1
Belaspore ...	5	Mundla ...	1074	Nimar ...	13
Sumbulpore ...	None	Seonee ...	1638	Hoshungabad ...	2
		Saugor and Dumoh	290	Baitool ...	19
		Nursingpore ...	573		
		Nagpore Division	963		
		Ahmednuggur ...	1802		
		Poonah ...	686		

* See para. 17.

The cholera invading in the spring and making the further advances above described, lay, as shown in the map, in the invaded tract at the close of the monsoon of 1868. The devitalisation or dormancy of this cholera was then due, and it took place over the whole area of the Central Provinces invaded in the first nine months. But even in October the head of the cholera invading the Bombay Presidency retained vitality, owing probably to its meeting the moisture derived from the Indian Ocean; and when the north-east monsoon set in, this cholera reached Poona and Bombay and showed itself also in the Nizam's territories at Hyderabad."*

In studying the cholera of Madras and Bombay, it is essential that due weight should be given to the primary as well as to the secondary causes of propagation.

26. Into the question of the behaviour of cholera in the Madras Presidency, subsequent to invasion, it is not my province to enter. I ask only that due weight shall be given to the primary as well as to the secondary manifestations of the epidemic; meaning by the primary those manifestations which cholera shows in its relations to natural agencies, and by the secondary those which the epidemic manifests in its special relations to man.†

Phenomena of the south-west monsoon proper, and the rainfall of the tracts within its influence.

27. I wish here to say a few words regarding the south-west monsoon, as it affects Madras, Bombay and the Central Provinces, because I am of opinion that views very far from the truth, pass current as true, which tend to retard the study of the movements of cholera in relation to natural agencies.

In my report of last year, I have shown how, taking 1869 as a typical year, as it really was, the rainfall of Western India was insignificant as compared with that of the Central Provinces; Poona and Nassick, for example, gave respectively 19 and 22 inches, against a rainfall of from 50 to 60 inches universal over the districts of the Central Provinces.

It is an extraordinary fact that the districts lying immediately above the Western Ghâts, and receiving direct their rains from the south-west, are areas of minimum rainfall. They receive, in fact, the same amount of rain as the districts of the Bengal Presidency bordering on the desert, namely, from 17 to 19 inches. This is clearly shown in the following table, giving the monsoon rainfall for five years, which I have extracted from the *Bombay Government Gazette* for 1868 :—

Statement of Monsoon Rainfall in inches (June, July, August, and September) from 1862 *to* 1866. ‡

Bombay Presidency.	1862.	1863.	1864.	1865.	1866.	Average of the five years.
Mahabuleshwar ...	225·78	271·70	255·10	251·76	271·44	255·15
Sawuntwarree ..	165·25	163·45	94·75	122·50	136·70	136·53
Vingorla	140·42	141·32	95·92	100·40	110·20	117·65
Dapoolee	114·71	113·69	90·95	108·44	116·94	108·95
Rutnagherry ...	101·79	94·32	100·68	104·09	102 91	100·76
Bombay	76·56	80·11	56·00	73·46	92·39	75·70
Surat	38·26	33·93	20·34	47·87	39·87	36·05
Broach	32·58	50·77	21·00	31·25	33·02	33·72
Baroda	29·01	34·24	20·61	27·48	27·83	27 83
Ahmedabad ..	28·18	28·04	19·43	26·92	27·14	25·94
Kaira	33·12	28·03	15·69	24·36	27·32	25·70
Dhoolia	14·55	10·73	9·37	13·13	12·55	12·07
Ahmednuggur ...	16·95	14·70	17·18	14·81	18·44	16·42
Nassick	22·30	21·74	14 63	21·40	19·06	19·83
Poona	17·50	14·89	13 59	16·43	13·46	15 17
Sholapore	18·15	21·28	20·77	13·72	20·02	18·79
Kolapore	33·66	29·14	29·12	21·77	24·69	27·68
Dharwar	23·57	19·79	28·93	17·94	§	22·56

Here is shown the burst on the Western Ghâts, and the gradual decrease of the rainfall, even on the coast, as we go north—a decrease from 75 inches at Bombay, to 35 at Surat and

* Sequel, page 8.

† In the *Madras Monthly Journal* for October 1871, we are told that the invading cholera of 1868-69, now in its fourth year, is in every quarter showing a disposition to die off. With this is coupled the remark, that some of the movements of 1871 have occurred, in opposition to Dr. Bryden's views, against the prevailing aerial agencies. In the Bengal Presidency we watch the phenomena of revitalisation within an invaded area, and secondary movements which transgress the boundary lines of the tract already covered; but movements *within* an area covered for two years we do not profess to trace with accuracy, knowing that every fact observed in such a case is difficult of interpretation and is apt to be misinterpreted. When we add to this, that in accordance with Mr. Cornish's present views, human intercourse is essentially connected with movement, it follows that even supposing the interpretation of the phenomena observed in Madras in 1871 to be correct, they fall into the category of secondary manifestations, with which I do not wish to deal in this paper.

‡ *Bombay Gazette* 18th June 1868. § No return.

Broach, and to 25 at Ahmedabad and Kaira, which ends with a minimum of rainfall in the districts skirting the desert, and with a total absence of rain when the desert is reached.

28. When we look to the districts immediately east of the Ghâts, we find the wonderful phenomenon that we are in a region nearly beyond the influence of the monsoon. As far as the rainfall is concerned, Dhoolia in the north, which lies close to Malligaum and within a short distance of the sea, gives consistently a rainfall of 12 inches only. Do not let us lose sight of such a fact in connection with the fact of Malligaum having been struck on 14th August in 1868, a year of minimum rainfall and a repressed monsoon, or the fact of Bombay having been reached on 14th August in 1818. Ahmednuggur, Nassick, Poona, and Sholapore give a rainfall of from 16 to 20 inches, the minimum recorded in the five years being 13 and the maximum 22 inches.

The monsoon rainfall of the tract along the Western Coast of India, immediately east of the Western Ghâts, corresponds in quantity with the rainfall of Delhi and the districts bordering on the desert in Northern India.

It is obvious that little repression is required to bring down cholera from the north-east on these districts, if it be a truth that cholera moves aerially to fill up a vacant area. And it is most interesting to observe, that it was into Ahmednuggur and Poona that our cholera of the Central Provinces of 14th August 1868 fell, at the very date when Malligaum and Dhoolia were reached.

29. What then is the significance of all this? It seems to me to mean, that as regards the Madras and Bombay Presidencies, the south-west monsoon is an agency very frequently of no great power. It is an agency which dies normally long before the Eastern Coast is reached, and it is continually liable to be overcome or to fall back, from a *vis a tergo* being wanting, and to map out as it recedes zones of retrogression which are filled up step by step as the western monsoon influence dies off towards the ocean. Bombay is not necessarily struck after the setting in of the north-east monsoon. It may be included in any of the zones of retrogression during an epidemic prevailing in the monsoon months in the Central Provinces; and it may be reached even by a May cholera, when Malwa, the Nerbudda Valley and the Nagpore territories are being covered by the spring cholera of an invading epidemic. It was this explanation which I had in my mind, in saying that it was a matter of indifference, in a theoretical point of view, whether in 1863 Bombay was first affected in August or November.

Zones of retrogression, indicative of the failure and recession of the monsoon influences.

30. While I write, the facts of 1868 and previous years, as regards the meteorology of these western districts, are being repeated. Northern India and the Gangetic Provinces have been deluged for months from the south-east by the rains of the south-west monsoon, while the districts lying close to the west coast, which, in theory, are supposed to receive the full force of the monsoon, are threatened with famine from the absolute cessation of the rainfall.

The facts of the monsoon period of 1871 are now repeating the meteorological history of 1818 and 1868.

In the latest Gazettes,* we read:—*Dharwar*—"Crops throughout most of the districts withering, and sowing operations retarded for want of rain." *Khandeish*.—"Prospects bad."† *Poona*—"Rain very scanty. Sowing at a stand-still, the few growing crops not promising." *Sholapore*—"About 1 inch and 73 cents have fallen within the last three days (date of report, 1st September), and more is threatening. The prospects, hitherto appalling, are now brightening."

31. Thus far I wrote, assuming in my mind that 1818 was a year parallel, as regards the phenomena of the monsoon season, with 1868. I had no knowledge that such was actually the fact, until, thinking it possible that in the records of our famines in Bengal some allusion might casually be made to this year, I consulted the Reports of Baird Smith and Girdlestone.

The year 1818 was a year in which south-west monsoon influences failed, the result being that 1819 was a famine year in Upper India.

The years were, as far as I can gather, precisely parallel. As the monsoon repression of 1868 was followed by the great famine of Central India and Rajpootana of 1869, so was the drought of 1818 followed by famine in the North-West in 1819.

Both Baird Smith and Girdlestone note 1818-19 as a period of great scarcity. Baird Smith brings up this period in succession to the drought of 1803; Girdlestone interposes a minor famine in 1812-13. Baird Smith writes—"Regarding the drought of 1818-19, I have been able to learn even less than that of 1803. I can only judge of its severity from the references made to it by intelligent and apparently reliable native informants who invariably placed it among the very bad years.‡

Girdlestone extracts from the records of the Revenue Board the detailed history, as far as it can be gathered, of the measures adopted to meet the effects of the famine of 1819.§

* *Gazette of India*, August 19th and 26th, September 2nd, 1871.

† "In consequence of the scarcity of rain at Dhoolia, the price of grain has been raised, and the result is that many of the poor natives have been actually starving."—*Bombay Gazette*. Again, in the beginning of October the report is the same:—"The accounts of the sufferings of the poor in Khandeish ought at once to attract the attention of Government. Already we are told that the Bhils are living on tamarind seeds and wild roots, and the annual crops have not been sown owing to the drought." From Ahmedabad and the Berars, at the same date, we have the same history of a deficient rainfall and its consequences.

‡ Report on the famine of 1860-61. Section II, p. 47.

§ Report on past Famines in the North-West Provinces. Paras. 51 to 57.

We know from experience that a single year of drought does not bring about a famine; consequently, when we read, that in August 1819, in Saugor multitudes were dying daily from famine, and that emigration was taking place from Marwar and Gwalior, we know that the events were parallel with those of all other visitations affecting the regions in which monsoon influences die off. We know that as the great famine of 1869 followed the drought of 1868, so the famine of 1819 must have followed an abnormal meteorology in 1818.

As the famine of 1861 was the result of three exceptional seasons, 1858, 1859, and 1860, so the famine of 1819 appears to have culminated after three bad years, 1816, 1817, and 1818. As predisposing the army of the Marquis of Hastings to the cholera of November 1817, Prinsep mentions the scarcity and badness of the food supplies. He writes: "That part of Bundelcund where the division was encamped was low and notoriously unhealthy; besides which, except when obtained from running streams, the water was generally indifferent. The year was one of great scarcity, and grain had been collected for the troops and camp-followers with extreme difficulty, and was of course of very inferior quality."

The description which Jameson gives of the meteorology of 1816, preceding the deadly epidemic of yellow malarious remittent fever which ravaged Upper India in the last four months of the year, is well known. Jameson writes:—"In the Upper Provinces, the extraordinary scantiness of the rains was yet more remarkable, and was attended by more deplorable results. A few showers fell in the month of July, but they were partial and of short continuance; more generally from Benares upwards, Oudh, the districts within the Doab, and those west of the Jumna were dried up by the long continued and unceasing heat. The parching westerly wind kept blowing throughout August and the first fortnight of September. * * * This long period of drought was succeeded by heavy and incessant rains for many days, and the whole country was laid under water". * * * "A similar mortality," he adds, "preceded by great scarcity of grain, prevailed about the same time in Cutch, Sinde, and the other states bordering on the western side of India."

GENERALISATION IN CONTRADICTION OF THE STATEMENT THAT THE INVADING CHOLERA OF MADRAS HAS BEEN IN THE HABIT OF ADVANCING IN OPPOSITION TO THE SOUTH-WEST MONSOON WINDS.

32. Starting from the facts of 1818 and 1868, I wish here to make a broader generalisation, which I shall support by facts drawn from the history of many different epidemics. It is this, that the irruption of cholera into the Madras Presidency is, *as the rule*, followed by drought, scarcity, and famine in Bengal or Northern India, and frequently also in Southern India, as a consequence of the failure of the rains of the south-west monsoon; or in other words, to use the expression so repeatedly quoted in contradiction of what I allege to be the truth, it is, *as the rule*, when the teeth of the south-west monsoon have been drawn, that cholera has made its epidemic advance from north-east to south-west into the Madras Presidency.

I do not profess to trace the phenomenon in the case of every epidemic, because the data are not at my disposal, and because it is more than probable that the invasion of Madras from Bengal is not caused by one series of phenomena which does not alter; but what I shall record is, I conceive, sufficient to indicate, that in the coincidence we have conclusive evidence of the operation of a great and natural agency, working in harmony with the same laws which in the Bengal Presidency so beautifully determine the limits of epidemic influences. The coincidence of cholera in Madras with famine in the Bengal Presidency does not, to my mind, stand as a curious but inexplicable fact, or as a phenomenon indicating a natural association of the two scourges of communities; and I regard the phenomena observed in conjunction as associated in obedience to natural and appreciable laws.

The epidemics of the past forty years, in which it can be shown that cholera in Madras was associated with drought, scarcity, or famine in Bengal or Southern India, were, dating backwards, those of 1868-69, 1864-65, 1859-60, 1850-52, 1841, 1837-38, and 1832-33. In the period intervening between 1818 and 1830, the same association can be traced; and from the records of past centuries, it is possible to bring together the isolated facts in such a shape as to show in the clearest manner that then, as now, the southern highway was occupied in seasons when south-western influences were in abeyance.

A. Going backwards from 1868, let me recall how the cholera of 1863—the cholera of 1864-65 in the southern epidemic tract, one of the greatest epidemics of recent times, and the origin of the European cholera of 1865—was driven from Northern India by the meteorology of 1864, a year which was in Upper India, as a consequence of this meteorology, one of the most favorable years of our period as regards the health of the troops. And we cannot forget that with this meteorology is associated the famine of the Behar provinces of 1865*, which occupied precisely the tract from the Ganges to the Bay of Bengal which I have assigned as a natural province to the invading cholera of July 1866 and July 1870, and which we find, under apparently precisely similar conditions, to have limited the invading cholera of July 1817.

It was this meteorology of 1864-65 which brought about the scarcity ending in the terrible calamities of the spring of 1866 in Orissa. Orissa, depending for its rains on the influences of

* Report on the Famine in the Behar Districts and Southal Pergunnahs, by F. R. Cockerell, Esq., C.S., Calcutta, 1866.

the south-west monsoon which set in from the south and south-east, lost its normal rains of the monsoon season, and became in fact for the time a portion and continuation of the natural province which Scott describes, which normally receives no moisture from the south-west monsoon rains.

On the east of the Bay of Bengal, rain fell sufficient to ensure abundant crops; and it was only in the Western Districts of Bengal Proper and in Orissa that the failure of the rains reduced the famine area for the time being to a desert.*

B. I have already in various places, and for different purposes, detailed the phenomena of the years from 1858 to 1860 which ended in the great northern famine of 1861; it is sufficient here to indicate the fact that in association with the meteorology of the same years, the southern epidemic highway and the Madras Presidency were swept by invading cholera.

I have no details regarding the invading cholera of 1856 which would authorise me to give any opinion as to the circumstances under which Madras was occupied in the course of this great epidemic.

C. In the invading epidemic immediately preceding that of 1856, the coincidence of the cholera with the famine in the districts immediately to the east of the Western Ghâts, which I have shown to be so wonderfully exempted from monsoon influences bursting on the Western Coast of India, is recognised.

The Orissa Commissioners, quoting Mr. Maltby's Report, write as follows :—

"In 1852-53 there was a great failure of rain in the country above the (Western) Ghâts, the Bellary district being chiefly affected. That is a dry country, where, in a hotter climate, the rainfall hardly equals that of the driest districts of the North-Western Provinces, and in the famine year, only about one-third of the usual quantity seems to have fallen." * * * * * "The result of the measures adopted (by Mr. Maltby) in saving the people is stated in his report to have been successful; since he says that, *with the exception of some severe outbreaks of cholera*, no great loss of life occurred."

D. As with us in Bengal, the years from 1841 to 1846, in which at least two separate epidemics appear to have run their course, was in Madras a period throughout which cholera was in full vigour.

I have stated in my original report, that I had great difficulty in completing the analysis of the events of this period, from the length of time that had elapsed, and the confusion of the records. But in tracing the original invasion there is no difficulty, and I have shown it sweeping up the valley of the Ganges, covering Chota Nagpore, and occupying the southern highway, as the recognised successor of the epidemic of 1837-38.

And I have called attention to the fact that the phenomenon of repression of the monsoon was seen in 1841, quoting the Report of the Superintending Surgeon of Saugor, who writes :—

"The season of hot weather was much protracted, the clouds collected but slowly, and the greater part of the month of June was cloudy, threatening, and very close; but the fall of rain, which is usually rather abundant from the 12th June to the end of July, did not, up to the 21st July, give more than 8¾ inches, and up to the close of July less than one-third of the amount of rain due in an ordinary season fell."

E. The year 1837, which I have shown to have been also a year of invasion in Madras (Report, p. 106), had, on the southern epidemic tract, a meteorology precisely parallel with that of 1818 and 1868. As in these years, there was a great cholera distributed over the eastern districts of the Central Provinces, the epidemic commencing in Jubbulpore on 20th May; and the epidemic leap of the monsoon season towards the south-west took place on 9th July, as in 1818. The history given by the Superintending Surgeon of the Saugor Division, in his report for the year 1837, as I extracted it from the records of the Medical Board, will be found at page 104 of my original Cholera Report.

The meteorology of the year 1837, also a year of invasion in Madras and Bombay, parallel with that of 1818 and 1868.

My remarks on the meteorological phenomena of the year in the Saugor district were as follows :—

"Here, too, the monsoon rains were very deficient, and the weather is described as cloudy and threatening only, while rain should have been falling. The first fall was but small, and was followed at irregular periods of from seven to ten days by partial showers, so slight in their effects that after a month the soil was not found to be penetrated for more than five or six inches. The total rainfall of the year was twenty-five inches in place of forty-six."

I have in the same place prominently drawn attention to the fact, that the comparative deficiency of the rainfall does not in this situation prevent the advance of invading cholera along the epidemic tract; and in connection with what I am now writing regarding this special

* "Speaking in general terms of the countries on the Northern Coast of the Bay of Bengal, it may be said that the rains brought by the south-west monsoon commence earlier and fall in greater quantity and more regularly to the east, and diminish both in quantity and still more in regularity towards the west." * * * "In all this part of India (Orissa) there is but one monsoon. * * * What are called the cold weather crops, the grains and seeds of temperate climates grown after the rains (of the south-west monsoon), are extremely scanty in that climate; and a small rice crop grown at that time in places where water lies is also very scanty and depends on late (monsoon) rains."—Report of the Commissioners on the Famine in Bengal and Orissa, paras. 17-22.

aspect of invasion, it is right that I should reproduce the commentary which I then made. It was as follows:—

"A non-epidemic season has on the southern highway features very different from a non-epidemic season in our North-Western Provinces. The spread of cholera in the hot season with a limited rainfall is exactly what takes place in the endemic area; and it is the absence of the normal south-west monsoon and the substitution of eastern influences for it, that determines the phenomena of a year such as 1837. When the Superintending Surgeon of Saugor or Dinapore writes that the season is one of the hottest he has known, the statement is apt to mislead any one unacquainted with the meteorology of these districts into the belief that the long continued prevalence of the hot, dry, and westerly wind is implied, whereas the very contrary is the case. It is the continuance of moist and relaxing east winds that brings a hot, oppressive, and unhealthy season. This is in fact an extension of what is natural for the endemic area. It is precisely what we observe in regard to the cholera of Calcutta, for example; it is the hot season of Lower Bengal (April to June) which develops the maximum of cholera. But it is not heat alone, but heat with moisture, that causes the cholera to prevail."

While thus the south-west monsoon failed in the Central Provinces, Bengal, from Orissa to the north-western desert, was desolated by famine. The famine of 1837-38 was one of the greatest of modern times; it has been described by many authors, and all the details are accurately known:—"In Cuttack, insufficiency of wholesome food had made cholera prevalent, and the pangs of hunger were compelling mothers to dispose of their children; in Calcutta, the tanks were empty, and the grain merchants doubled their prices within six months; in Behar, sickness and mortality were rife, and the abnormal state of the weather was blamed as the cause. Far in the west the country was deserted, and the emigrants from Marwar or Hurrianah fled into the districts of the North-Western Provinces. But even in the Doab and Rohilcund matters went from bad to worse.* The utter hopelessness of their case was enough in the minds of the lower classes to justify recourse to violence, and neither store-houses nor grain-boats were safe from attack, whilst the public roads became dangerous owing to the number of armed men roaming about in quest of plunder."†

F. Going backwards, the next great cholera epidemic in Madras is that which terminated in 1833. This, too, was coincident with famine both in Madras and Bengal. The Orissa Commissioners class together the famines of 1832 and 1852-53 as the only two famines of modern times in Madras. Regarding the first of these they write: "It was principally this disaster which led to the great irrigation works on the Kistna and Godavery, in imitation of the ancient works on the Cauvery, which had preserved the delta of that river. * * * In 1832, the rains failed below the Eastern Ghâts, which caused great distress in the coast districts from Madras northwards in that and the following year. The suffering was indeed continued into 1834. The most severe suffering was in the Guntoor district, 200,000 of the inhabitants of which are stated to have perished from hunger and disease."

Girdlestone gives many interesting details regarding the famine of 1832-34 in Northern India. He says: "The Punjab appears again to have suffered in 1832-33, but the information concerning the events of that period is very scanty. Rohtuk and the western division of the Delhi territory were the parts principally affected, and in the case of the former, suspensions had to be made, whilst in the latter, a total remission of revenue was sanctioned. The famine extended on this occasion also to Ajmere. It is said that not a single shower fell during 1832. Many of the Mairs either resorted to plunder, or fled to Malwa in the hopes of obtaining a livelihood. So great was the loss in population and cattle, that several years were required before the country recovered its former state of prosperity." We are told that in 1833-34 drought still continued in Ajmere, and that the tract south of the Jumna suffered also very greatly from famine, which caused unparalleled distress to the people and great loss to the Government. "Famine, pestilence, and emigration deprived the district of half its population."

G. The years 1824 and 1825 appear to have been bad epidemic years in Madras, judging from the army returns. Of the facts of the epidemic I have no accurate knowledge; but it is worth while to point out that in these years "drought pervaded the whole of the territories then known as the western provinces," which comprehended all the districts above Cawnpore. In some districts on account of the drought, the Governor General granted a remission of the whole year's revenue.

H. In the last century, one season in particular is brought to our notice in which cholera was widely epidemic in the Madras Presidency, namely, 1782 and the spring of 1783.‡ This

* All famines have distinct geographical areas, which correspond with the tracts which I hold to be, as regards epidemiology and meteorology, natural areas. In my report for 1869, (Sequel, page 30,) I showed how the breaking up of the drought of that year was a provincial phenomenon, limited by the line of 80°, the line which stops the advance of cholera from the east. The parallel of 1837 is perfect:—"Rain fell in torrents for some hours at Allahabad, and instantly all anxiety concerning famine ceased; the inhabitants of Furruckabad, (Futtehghur), and Shahjehanpore had a similar piece of good fortune, and were equally sanguine about the harvest. But the people (further west) were soon deploring the partial character of the fall; for between the western boundary of Mynpoory and the eastern limits of Meerut and Delhi scarcely a single shower had been vouchsafed."

† Girdlestone, Section V, paras. 83 to 119.

‡ Balfour quotes ten different authorities, showing that this cholera of 1782 was epidemic throughout the Madras Presidency, and from sea to sea.—*Statistics of Cholera*, 1870. *Appendix A.*

cholera followed the Bengal epidemic of 1781. The duration of the epidemic in Madras coincided with that of the Bengal cholera; for the cholera of the same epidemic which in January 1783 appeared in the army of observation in the Madras Presidency, caused the great outbreak at Hurdwar in Northern India two months later.*

The Mahratta Armies engaged in the War with Tippoo, suffered both from cholera and extreme scarcity of grain and forage. "Just at this period," writes Grant Duff, "the following letter appears in the official correspondence of Hurry Punt, the Mahratta General, and in his own handwriting:—'The loss sustained by the Army, in consequence of the cholera morbus, is very great; medicines are liberally supplied; some do recover, but by far the greater part die.'" History of the Mahrattas, III, pp. 15—17.

The famine of 1783 has always been reckoned as one of the worst experienced in Upper India. Warren Hastings tells of the state of affairs in Shahabad and Benares as he saw it in passing through the country.† But it was in the region in which the monsoon normally dies that distress was chiefly felt. Girdlestone writes:—

"I believe that the chief suffering was in the country round about Jummoo, Lahore, and Agra, and in the Native States of Rajpootana, and to the south-west of the Jumna. It was from these quarters that the hordes of emigrants flocked towards Lucknow. * * * * There are many men still living who have heard the story of those days from their fathers. I have consulted several whose opportunities should make their tale trustworthy, and all agree in saying that the famine of 1783 was the most awful that the country above the Kurrumnassa ever underwent. Throughout its tract, natives date events from the "Chalisa", as we ourselves do from the mutiny. Every child in the Punjab, the Doab, and Oudh has heard of it."‡

I. In the same century, one famine only, besides that of 1783, is noted prominently by writers, namely, the terrible famine of 1770. Baird Smith says regarding this famine:—"Of the series from 1770 to 1861, it seems probable from all historical accounts that the famine of 1770 was the most intense that India ever experienced." The Orissa Commissioners write: "Like most Indian famines, that of 1770 was not exclusively the result of the failure of a single crop. The crop of 1768 was a bad one, and the early crop of 1769 is also said to have been bad. The main crop of 1769 failed in an excessive degree, owing to the premature cessation of the rains. In October not a drop of rain fell, and in November serious famine commenced. Before the end of April 1770, the famine had spread universal desolation."

The Madras records show that in the years 1769 and 1770, cholera raged both among Europeans and Natives, this being the first record of the appearance of the epidemic since 1756.§

This was probably a great cholera epidemic in the Bengal Presidency also,—the "fever and flux" of Dr. John Clark (1768-71), which frequently carried off the patient in twelve hours. Regarding the disappearance of *remittent fevers* from Calcutta, Martin writes—"Neither do such sweeping epidemics as that recorded by Clark in 1770, with its *cold stage of twelve hours*, occur, carrying off 80,000 natives and 1,500 Europeans."

J. It is perhaps more than a coincidence that the first account we have of cholera by an European observer was written by Bontius of Batavia in 1629, the same year in which an abnormal meteorology initiated the terrible famine of the reign of Shah Jehan, of 1630-31, "which afflicted not only India, but almost the whole of Asia." We are told that "disease followed famine, and death ravaged every corner of India." Balfour quotes Zacutus Lusitanus as an authority for the fact of the epidemic prevalence of cholera in India, Arabia, and Morocco, in 1632, a geographical distribution which tells us that this cholera must originally have occupied the southern epidemic highway in Hindostan. I have no doubt that such was the case, and that cholera was the pestilence of 1630 which Grant Duff notices as associated with famine in that year.‖

K. The next great invading cholera that we hear of in Europe subsequent to 1632, is Sydenham's cholera of 1669 and of 1674-76; this cholera was consequent on the cholera of the southern highway of 1666 (Dr. Thevenot), 1674 (Fryer), and 1676 (Dellon).¶ We can, I think, trace the fact of an invasion, following that of 1676, in 1684, when the Army of Sultan Mauzum, who was co-operating with Aurungzebe in Southern India, was attacked. Both 1684 and 1685 appear to have been years when the monsoon failed; the army suffered from famine as well as from pestilence, and we are told that very little rain fell and scarcity prevailed in the

* Tradition tells of a great cholera in the Banda district preceding this cholera of Hurdwar; this was the connecting link with the cholera of Lower Bengal of 1781—the occupation of the tract south of the Jumna in the epidemic advance on the northern highway.

† The despatch of 15th October 1783, as quoted by the Orissa Commissioners, is as follows: "We are here under great apprehensions of a famine. The solstitial rains have failed in all the western parts of Hindustan, from beyond Lahore to the Kurrumnassa. It has raged most violently in the countries most remote; our province of Behar has suffered greatly by the failure of the last harvest, and by the artificial want caused by the apprehensions of greater. The complaints and fears of it have already extended to Bengal (Proper), where we have great plenty."

‡ Girdlestone, Op. Cit., para. 18.

§ Balfour, Statistics of Cholera, Appendix A. Also, Corbyn, quoting Scott, page 4.

‖ "During the season 1629-30 no rain fell in the Deccan, and a famine, accompanied by pestilence, ensued." Op. cit. I, 103.

¶ John Macpherson quoted by Balfour.

Deccan.* This invasion would exactly correspond with that of Hyderabad and Bombay of October 1868.

L. I have constantly asserted the truth that the phenomena of epidemic invasion do not alter except under definite laws which are capable of demonstration. It is more than curious to be able to go back five centuries, and from the history of the period to show, that then, as now, the epidemic invasion of Madras occurred when the teeth of the south-west monsoon were drawn.

We are not told that the Madras Presidency was on one occasion to which I am about to refer, famine-stricken at the time when cholera was destroying the invading army. In Northern India and in Malwa the very same tracts were simultaneously affected by famine as in this century; and the famine of 1345 was coincident with the irruption of cholera into the districts of Madras affected in 1818 and 1868.

In the volume of Sir H. M. Elliot's History of India, lately published,† we have two notices of the famine and pestilence of the reign of Sultan Muhammad Tughlik, one by the historian Barni, the other by the traveller Ibn Batuta, a native of Tangiers, who was resident at Delhi at the time of the famine, and describes scenes which he witnessed.

Ibn Batuta writes: "The Sultan arrived in the country of Tilang. He halted at Badrakot, capital of Tilang. Pestilence then broke out in his army, and the greater part of it perished. When the Sultan saw this calamity, he returned to Daulatabad. On his journey he was taken ill, and the rumour spread that he was dead."

Next follows the account of the famine in the north:—"During the time the Sultan was absent from Delhi in his expedition a famine arose. Distress was general, and position of affairs very grave. The famine being unendurable, the Sultan ordered provisions for six months to be distributed to all the population of Delhi."

We have further details in Barni's history: "The Sultan started from Delhi in order to prepare for a campaign against Ma'bar. He had only marched three or four stages from Delhi when the price of grain rose and famine began to be felt. When he arrived at Deogir (Daulatabad), he made heavy demands upon the Musulman chiefs and collectors of the Mahratta country, and his oppressive exactions drove many persons to kill themselves. After a short time he sent a lieutenant to Delhi, and marched to Tilang. The Sultan arrived at Arangal,‡ where cholera (*waba*)§ was prevalent. Several nobles and many other persons died of it. The Sultan also was attacked. He appointed a ruler over Tilang, and himself returned homewards with all speed.

"The Sultan proceeded to Dhar, and being still indisposed, he rested a few days, and then pursued his journey through Malwa. Famine prevailed there, the posts were all gone off the road, and distress and anarchy reigned in all the country and towns along the route. When the Sultan reached Delhi, he found the country desolate, a deadly famine raging, and all cultivation abandoned. He employed himself in restoring cultivation and agriculture, but the rains fell short that year and no success followed. The Sultan advanced loans to promote cultivation, but men had been brought to a state of helplessness and weakness. Want of rain prevented cultivation, and the people perished."

This epidemic I take to have been the origin of Hecker's Great Black Plague of 1348—"the corruption of the atmosphere which came from India." Hecker describes precisely the Northern and Southern Epidemic Routes in indicating the direction followed by this plague—through Central Asia to the Caspian and the eastern shores of the Black Sea, from Bagdad through Arabia to Egypt, and through the Red Sea by maritime communication. "In all these directions," he adds, "contagion made its way; and, doubtless, Constantinople and the harbours of Asia Minor are to be regarded as the foci of infection, whence it radiated to the most distant seaports and islands." This extract is important as teaching us that five centuries ago, when intercourse with the East was restricted, cholera found it as easy to reach Europe as at the present day, when the means of communication are infinitely multiplied. The fact of the epidemic following, in Hecker's theory, all these different routes, is quite opposed to the conclusion which he draws, that human intercourse brought this plague to Europe. The idea had evidently suggested itself to his mind, that this might have been an air-borne pestilence; and he clearly recognises the effects of meteorological agencies on the epidemic. In defence of the position he takes up, he brings forward the very same argument which has been proposed as an objection to my observation in recent times, namely, that I have mistaken the laws of culmination for the laws of movement. He writes—"The disease itself came not on the wings of the wind, but was only excited and increased by the atmosphere where it had previously existed."

* "In the month of October, a pestilence broke out in his camp, which swept off many of the men and greatly diminished his force. Sultan Mauzum had successively captured Gokauk Hooblee and Dharwar; but famine, pestilence and the drafts from his force required to garrison the new acquisitions had greatly reduced the numbers and efficiency of his troops. Most of the horses being dead, nobles and troopers were reduced to the necessity of marching and fighting on foot. The wreck of this fine army returned to Ahmednuggur more effectually reduced than if they had been vanquished in many battles." Grant Duff, Op. cit. I, 334.

† The history of India, as told by its own historians, Vol. III, London, 1871, p. p. 243 and 618.

‡ Worungull, 90 miles north-east of Secunderabad.

§ "Waba, Arab. Hind. of Dekhan." Balfour, Statistics of Cholera, 1870, Appendix B. 15.

In concluding this paragraph, I wish it to be understood, that the coincidences spread over these years do not occur by chance. At one time the interval is long, and at another short; but whether the interval between be long or short, the fact of the renewed invasion of cholera in Madras comes up constantly in history as associated either with famine or with a meteorology which renders famine imminent.

33. Thus, then, the radii of the fan taking their origin at the head of the Bay of Bengal, and diverging towards the south-west reach the Malabar Coast. The radii proceeding towards the south-east, to reach Singapore and Java, follow, I have no doubt, the courses indicated by the aerial currents which prevail over the regions reaching from Eastern Bengal as far south as the Equator, and to some distance beyond. The aerial movements of cholera in this direction I have not the means of tracing. I wish to add the following quotation only for the purpose of showing that it is not inconsistent with the fact of the obedience of the movement of cholera to monsoon agencies that the tracts furthest to the south and east known to have been reached by the epidemic, may have been invaded even during the south-west monsoon in accordance with what is normal as regards the direction of the monsoon influences in this geographical situation.

The invasion of the remotest tract reached by cholera moving in a south-easterly direction, from Eastern Bengal towards the Equator, is not inconsistent with the theory of the movement of the epidemic in subordination to aerial currents.

The extract which follows is from a paper published many years ago by Captain Forrest, on the Indian monsoons as affecting the track of sailing ships at different seasons; and the fact which he mentions is, I presume, now recognised. He writes, speaking of the region from the northern extremity of Sumatra to the Line: "During the summer monsoon the south-west winds that blow in the Bay of Bengal, meeting here the high mountains, are checked, and blow down this coast *from the north-west*. They bring rain and bad weather as far as the Line."

34. In distinction to all that I have said in the preceding paragraph, let me here draw attention to the beautifully defined epidemic line shown in the cholera map of 1867, limiting the invading cholera in the south and extending unbroken from the Bay of Bengal to the southern margin of the north-western desert.* If we turn to the monsoon chart (page 65), drawn long before the epidemic of 1867, we see that the line of 1867 is a reproduction of the identical line, which normally limits monsoon influences coming directly from the south-west coast. The full influence of the monsoon from the south-west was felt in 1867 on the southern highway, and the passage was closed against the great body of cholera, which, consequently, moved off into Northern India. Dr. Rice writes from Jubbulpore:—"The rains (of 1867) set in with their usual regularity on the 7th of June, and from that day till the day of cessation—the 19th September—it rained on 73 out of the 104 days." The rainfall for the province was 60 inches, and it was seasonably distributed.

The geography of 1867, when invading cholera was repressed from the Central Provinces, beautifully illustrates the full occupation of the area normally covered by monsoon influences from the south-west.

35. I place no importance on the passages which Mr. Cornish has selected from Scott, as proving that in the successive advances of 1818 the cholera moved against the prevailing winds;† and, indeed, they are scarcely worth noticing, were it not that we may derive some instruction even from the consideration of cases apparently anomalous. In a closely printed narrative of nine pages, containing hundreds of detailed facts of the highest interest, as showing how intimate are the relations of cholera to the meteorology of the seasons, three passages are selected and italicised as affording direct evidence against the movement of cholera in obedience to monsoon agencies. Two of these passages relate to the cholera of July; the third to a portion of the area covered in the advance of 13th August.

The passages italicised by Mr. Cornish, in Scott's Report, of no importance as demonstrative of the alleged fact that the cholera of 1818 did move in opposition to monsoon influences.

In the first passage, Scott draws attention to the fact that cholera appeared at Jaulna ten days in advance of the cholera that appeared at Malligaum, 100 miles to the north. He remarks that this seems an exception to the general fact that cholera moved southwards in the Madras Presidency.

In reality, this was no exception to the rule. That cholera appeared at Malligaum after having appeared at Jaulna is of no significance, because the events were in no way connected. The force of Scott's observation is destroyed by simply quoting the fact, that the Mhow Force and the Nerbudda valley, two hundred miles to the north of Jaulna, and having no connection with it, suffered on the very same day on which Malligaum became affected. Malligaum was implicated in the general movement, when, in the week ending 16th July, the epidemic limit of May was over-leaped from Mhow and the Nerbudda to the Bay of Bengal.

The second passage italicised is not so readily explained, because accurate data are wanting. The Jaulna district was invaded ten days in advance of the general epidemic leap; and at the

* Cholera Report of 1866-68, p. 140, and Appendix cxlvi.

† "I have italicised a few passages relating to the southern progress of this invading cholera against the south-west monsoon. I would refer the reader to Mr. Scott's map, upon which I have indicated by arrows the course of the monsoon winds, to satisfy himself that the recently propounded theory that cholera cannot advance against a monsoon wind is quite opposed to what actually did take place in 1818." Cornish, p. 9.

time when the cholera appeared it is stated that "the atmosphere was generally cloudy, and the wind blew steadily from the south-west."

There are many points to be taken into account before we can pronounce an opinion on this cholera of Jaulna of 3rd July, which was beyond doubt a detachment of the coming epidemic thrown forward in advance of the general invading cholera of the middle of July; and we are not now in a position to estimate the actual truth. As far as Scott's narrative tells us, the cholera of Jaulna was a nine-day cholera, commencing on the 3rd and dead on the 11th July, and general during the time that it lasted, for various bodies of troops leaving Jaulna during the period suffered heavily after having been for some days on the march. I can judge of its significance only by the facts recorded, and by the parallels of modern times which seem to me to teach a similar lesson. I could offer many suggestions in explanation; I offer but one, namely, that this nine-day cholera of the 3rd July was not an invading cholera, but was a cholera which culminated at this date. We know the date at which in the area occupied in May 1818 a cholera is revitalised and adapted for epidemic invasion. It appears after the 20th June; and no doubt cholera was generally prevailing in the spring area subsequent to the invasion of the second week of July. There was, apparently, no rainfall at Jaulna from the 20th June to the 3rd July when the cholera broke out; but we read—"Since the middle of June, when several heavy showers had fallen, the weather had been cool and pleasant, the thermometer ranging from 80° to 88°, seldom varying more than 4° in twenty-four hours." If the showers of June were from the north, as is very likely to have been the case, and if with this meteorology cholera was introduced into the Jaulna district, the 3rd July is the very date on which the cholera then distributed would culminate throughout the district, and the steady heat would in every way be conducive to its growth. The parallels which teach us that this explanation may possibly be the true one are the invasions of the Peshawur Valley in 1867 and 1869.* The cholera invading on 19th May 1867 culminated in the first week of June, and the cholera of the first week of September 1869 culminated universally on the evening of the 18th.†

Regarding the third and last case to which Mr. Cornish invites attention, I have only to observe that the cholera occurred at first among camp-followers only, and that in all probability some conditions existed special to this body. The argument that the wind was blowing in Hoobly from the south-west at the date of this special attack, is of no weight as leading to the deduction that at this time the district was invaded; for we read in immediate context—"Neither Hoobly nor any of its adjacent villages had at this time become affected."

Of this we may be sure, that when Scott and Jameson say that ninety-nine out of each hundred cases were consistent with the presumption that the cholera of 1817-18 moved in subjection to aerial agencies, the failure to harmonise the facts observed in the hundredth case, is to be accounted for not by the antagonism of the facts, but by the inability of the observer correctly to determine the epidemic relations of what has occurred before him.

How the natural history of the epidemic should be studied in the Madras and Bombay Presidencies.

36. What I would recommend is, that the invasions of the Madras Presidency should be recorded, as Scott has recorded the history of the epidemic of 1818, and that the phenomena of advance should be mapped irrespective of theory. We find no difficulty in mapping out year by year in simple sketches, the area covered in our Presidency, and we know these, diagrammatic as they are, to represent the truth as regards areas occupied. If they are incorrect, those who have a theory to sustain to which the details of geographical distribution as given are opposed, are at liberty to object to their accuracy. As they stand, they bear out the definite proposition which I maintain, that cholera falls upon natural areas, and that these natural areas can for any year be definitely mapped out.

Nature does not shape her epidemic lines to a theory which is false; either the lines are falsely delineated, or else they stand as representative of grand truths—whatever be the significance to be attached to the rigid and provincial demarcation. The truths which I have mapped are either no truths at all, or else they place before our eyes epidemic facts of the broadest and most definite character. I offer no apology for my geographical delineations. I know that they stand true for all time to come, because they interpret to us the action of agencies which are natural and above human control.

I am well aware that it is difficult to put on one side, even for a time, the strongly impressed conviction that the movement of cholera cannot take place without the intervention of man.

The study of three fundamental laws will, however, tend to lessen or remove this difficulty—

First, the law of the succession of epidemics. This teaches the doctrine universally admitted in India, that in what we recognise as a new epidemic, it is a fresh material which

* Sequel, p. 50.

† I have noticed the fact that the years 1813-14 were famine years in Northern India (Girdlestone, paras. 44 to 50), and I might have brought forward this as an additional illustration of famine in Northern India, coupled with an invading cholera in Madras; for Jaulna was struck by cholera in 1814, in the epidemic preceding that of 1818. As in 1859, this tract was included in the May province. We know nothing of the monsoon extensions of the cholera of 1814, hence I have not included this invasion with those enumerated in the preceding paragraph. It is worth while to keep in view the possibility that the Jaulna District, immediately bordering on the area occupied by the invading Cholera of May, may have received, in common with the districts lying to the north, a portion of the spring Cholera of 1818; in this case, the fact of the Cholera of 3rd July being a revitalised, and not an invading Cholera, would satisfactorily account for the phenomenon of manifestation in advance of the general invasion, and with the meteorology described as prevailing at the time of the outbreak.

invades. And the special antagonistic doctrine which it opposes, is that which suggests, that it may be an old soil-sown cholera, possibly derived from man, which is drawn out from the earth by a special meteorology.

Second, the law of progress in directions which are definite, and which are not those of human currents. Whether these currents are aerial currents, as I maintain them to be from the consistent history of the past fifty years, is a matter of observation; the radical point to be grasped in connection with this law of progress is, that epidemic cholera in its great movements does not follow routes of human intercourse—a doctrine which is in accord with all Indian experience.

Third, the law of advance *per saltum*, and the immediate occupation of natural and definite areas. What in my previous reports I showed to be true for Bengal, I have now shown to be true for the Madras Presidency. I undertook to examine the statements to the contrary in the full faith that the laws of epidemic advance being natural laws, the facts would not in Madras be found in antagonism with those observed in Bengal, upon which the law of advance was based. Every observer recognises Scott's cholera of 1818 as a new invading cholera; consequently, when I demonstrate in the course of this epidemic the simultaneous occupation of areas, it cannot be objected, that in this instance I have mistaken the law of culmination for the law of advance—an assumption by which the attempt has been made to interpret according to a different theory the broad and universal phenomena which I have recorded.

In relation to these fundamental laws deduced from observation in India, the phenomena of the epidemic now prevailing in Europe should be investigated. The "slowly-creeping" theory finds little countenance in this country; and it is of extreme importance that it should be ascertained with scientific accuracy how far the phenomena observed in the East and in the West differ or are in harmony, in order that the etiological relations of cholera viewed in every aspect, may receive due consideration from the epidemiologist.

I would have attention directed also to a phenomenon which increases in interest in proportion as the study of the movements of cholera assumes a more definite shape, namely, the passing of the aura of an epidemic. Very many cases of cholera occurring in unoccupied areas, and regarded as sporadic or fortuitous, can be placed in position in regard to the epidemic, by watching and recording the movement of cholera as an aura. In homology, the shadow of a moving cholera is the same as the substance, in as far as relation to natural agencies and the areas covered is concerned. The study of the shadow of such a cholera as was projected in the last week of May of the current year as far as Ajmere, may afford in epidemic history the only record in the western division of the epidemic area of our Presidency, of an emanation from within the endemic province—a puzzle and a problem incapable of being solved by the epidemiologist in the future, unless accurately noted at the time of its occurrence, as was this aura of the last week of May 1871.*

37. And this leads me to what I neglected to remark on in an earlier paragraph, namely, the assertion that "it is abundantly clear that the development of cholera in a province has no sort of relation to the rapidity of movement of the air;" and Mr. Cornish's remark which is added—"I am not aware of a single fact that shows that cholera can advance epidemically at the same rate." In making these observations Mr. Cornish ignores the facts of movement *per saltum* over areas previously uninvaded, so beautifully illustrated on Scott's map.

It is a fact, and not a theory, that cholera moves in epidemic leaps, and covers a province as rapidly as aerial agencies permit.

When I say that cholera appeared epidemically in 1869 from the Runn of Cutch to the slopes of the snowy Himalayas bordering on Thibet in the same week; when I say that the first case marking the invasion of the Punjab occurred in the same week; when I map down definitely the fact that Central India was covered universally in the same week; when I show another great and definite tract covered on the 18th August in the same year, and a further projection in the first week of September, culminating on the same day throughout the Peshawur Valley and in Southern Scinde, I state a fact and no theory. It is no imperfection of our information which determines that I shall thus place on record as true what is substantially incorrect, however beautiful it may be in theory. The terrible epidemics of 1856 and 1861 in Northern India had each the same distribution and limit to a mile, the same day and date of invasion, and the same phenomenon of an instantaneous leap into the unoccupied area; and

* See Annual Report of the Sanitary Commissioner for 1870, p. 25, where the relations of the cholera of this movement of the end of May and first days of June 1871 are described. This movement was in homology identical with the movement of the same week in 1869, occurring in the course of the preceding epidemic, although in the one case the shadow of an epidemic passed over Upper India, and in the other a powerful body of cholera; the cases of cholera which I have described as occurring widely spread and simultaneously on the 28th, 29th and 30th May 1871, were, for example, homologically identical with the cases of 27th May 1869 which initiated the great Umritsur cholera of the year. Dr. Moore reports the appearance of the shadow at Ajmere, dating 6th June; and on the same day the aura seems to have passed over the Mhow cantonment, at a time when there was no suspicion of the presence of cholera. I find the following notes of a fatal case in the Weekly Return of Her Majesty's 59th Regiment cantoned at Mhow, for the week ending 9th June. The death was returned as due to ague. The medical officer reports:—"When admitted (on June 5th) the man was already in a state of collapse, face sunken, and pulse hardly to be felt at the wrist; in fact, he had almost the aspect of a cholera patient. After a partial rally he became still worse; and although vomiting and purging ceased by about 8 P. M., no reaction set in, and he died at 7-30 A. M. on the 6th."

it is no mere theory that such was the case. The phenomena of every year and every epidemic are calling for the recognition of the same truth—a truth which may be contradicted but cannot be controverted.

38. There is a further point in Mr. Cornish's report requiring notice, since he attaches importance to his remarks, and since these observations are apt to mislead readers unacquainted with the natural history of Indian disease. He writes—"I would here protest against the assumption, so frequently repeated in ignorance of the facts, that there is no analogy between the laws of progress and decline of a notoriously contagious disease like smallpox and epidemic cholera. To my mind there are some very striking points of resemblance in the behaviour of the two contagia." Mr. Cornish refers to cycles of epidemic prevalence and obedience to the meteorology of the seasons.

The analogies between the epidemic agents smallpox and cholera, are scientifically of no importance since they are analogies not homologies.

It is true that there are periods of epidemic prevalence for smallpox as there are for cholera. We know, however, that typhus, malarious fevers, and other epidemic diseases, besides cholera and smallpox, present the same phenomenon to our observation, but it does not on this account follow that all these diseases are naturally related.

Mr. Cornish mistakes what he regards as analogies for homologies. Analogies between the phenomena of cholera and smallpox there may be—I do not say that there are; * homologies there are none. In every respect and diametrically, the homologies of cholera and malaria differ from those of typhus and smallpox. Every student of the natural history of disease in India knows the broad fact, how, when cholera and malaria die, typhus and smallpox step forward to claim their place; and how when typhus and smallpox die, cholera and malaria resume their sway. The laws under which the parallels of decay and reappearance occur are the same in either case; the alliances are natural alliances, and the phenomena are homologous, not analogous. Accidental discrepancies there may be; but these are of provincial significance only, and go still further to prove the truth of the universal law. Thus we know that cholera dies out in the regions round the mouths of the Ganges and Bhurmpooter, as soon as the monsoon has burst on the Himalayas and submerged the great Sunderbun tracts and the districts adjoining; and that, in obedience to the meteorology of the season, smallpox dies out here as elsewhere at the same date. This is an analogous, not a homologous, phenomenon There is no *natural* connection between the phenomena. An accident of physical geography determines that the phenomena shall occur together, although no natural connection exists between them.

39. Mr. Cornish has prescribed to himself a limit in his investigation, and it is to be regretted that he has done so. For placing the doctrine of the aerial movement of cholera beyond the limit of ascertainable truth, the phenomenon has in his estimation no existence; and in repudiating the alleged facts upon which the theory is based, he is necessarily driven to ignore, or to put to the account of an imperfect conception of the facts observed, all that has been written on the presumption of the doctrine being true. Since I do not concede the correctness of his conclusions, nor the integrity of his facts, it follows that I hold his study to be incomplete; and I look for the further elaboration of the study of cholera in the other Presidencies, and for the results of investigation in a field upon which the Sanitary Commissioner for Madras has not entered.

The study of the epidemic movement of cholera in Madras requires further elaboration.

* No scientific investigation should proceed from analogies. A subject is obscured, not elucidated by dragging in argument derived from mere points of resemblance. Homologies are of a different scientific value, and are admirably adapted for the elucidation of difficult subjects of investigation.

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APPENDIX.

REMARKS

ON

OBSERVATIONS RELATING TO THE MOVEMENT OF CHOLERA IN THE MADRAS PRESIDENCY

APPENDED TO

THE REPORT OF THE SANITARY COMMISSIONER FOR MADRAS OF 1871.

The Proceedings of the Sanitary Commissioner with the Government of India for December 1871, contained a paper by me, entitled "Note on the Epidemic Connection of the Cholera of Madras and Bombay with the Cholera Epidemics of the Bengal Presidency." This Note was written with reference to certain observations made by the Sanitary Commissioner for Madras in his "Review of Cholera Epidemics in the Madras Presidency," which was forwarded for remark by the Secretary to the Government of India in the Department of Revenue, Agriculture and Commerce.

The Epidemic discussed in my note was the last which had invaded the Madras Presidency when this "Review" was written, namely, the epidemic of 1868, invading the Central Provinces in the spring, Western India in the middle of August, and the Madras Presidency in the two last months of the year. The facts of this invasion I held to be parallel with the facts of the invasion of 1818; and the facts of 1818 and 1868 were reviewed from one and the same point of view.

Facts on which the study of the parallel epidemics of 1818 and 1868, invading the Madras Presidency, was based.

2. The objection made by the Sanitary Commissioner to the generalisation contained in my original report was stated thus:—Dr. Bryden cannot reconcile the facts relative to invasion in 1818 on the theoretical ground which he has taken up. "Scott's most interesting narrative is all the more valuable at the present time, because it was not compiled to illustrate any 'theory' of invasion, but to record in a connected form the testimony of the officers of the Medical Department who had personally witnessed the outbreak of this, the first epidemic invasion in modern times. Mr Scott's map of the Presidency, with dates of cholera appearance at various places, I have had re-drawn, and I shall have to refer it hereafter when I come to discuss the subject of monsoon influences to cholera, and especially the theory that cholera cannot advance except when forced forward by monsoon winds."

The line of argument was this: Scott's facts are true, Scott's geography is true, and Scott's meteorology is true; therefore it follows, that if Dr. Bryden cannot reconcile his theory to these facts, to this geography, and to this meteorology, his theory falls to the ground.

I did not hesitate to meet the objection on the terms prescribed. For I did not doubt that the accurate narratives of Scott and Jameson, compiled to suit no theory, contained all the facts necessary for my purpose.

By a careful study and investigation of these data, I demonstrated the harmony of the facts recorded by Scott with the results of observation accurately recorded in the history of the epidemic invasion of 1868.

The question will not be re-argued on the assumption that the facts recorded by Scott and Jameson are untrustworthy.

When in his reply, appended to the Report for 1871, the Sanitary Commissioner re-opens the question, the basis which he assumes is the opposite to that from which he asked me to reconcile, if I could, the facts of 1818 and 1868. The thread of his argument of 1872 runs thus: Scott's facts are no facts; Scott's geography does not represent actual occurrences; Scott's knowledge of meteorology was not up to modern requirements, and therefore is not to be depended on.

I shall not again go over the ground which I traversed last year. I bestowed much care and much thought on the paper of 1871, and now, as it stands, it represents to me an accurately written chapter in the epidemiology of India; and it is my hope that in years to come the facts of this modern period may be classed with the facts of Jameson and Scott.

3. It is necessary that I should notice a remark which the Sanitary Commissioner for Madras has introduced into his paper published in 1872. It has reference to the provincial distribution of cholera in 1818 in the Madras Presidency, so perfectly and truly depicted in Scott's map. I showed that the line dividing the cholera of July, August and September from the cholera of the three last months of 1818, was a definite line, and that this line mapped out the Presidency into two distinct sections; the one I termed, with reference to the facts of 1818, the province invaded during the period of the south-west monsoon, and the other the province in Southern India invaded during the period when the north-east monsoon prevails.

Remark that the limits of the natural areas defined by the cholera of 1818 are not definite monsoon limits, inapplicable.

On the fact of my adopting this nomenclature, an argument, that this geography does not represent with accuracy the limits of the north-east monsoon in the Madras Presidency, is founded. I need scarcely point out that the argument is inapplicable; and that my statement of the simple fact of a certain area of the Madras Presidency being covered by cholera in October and November, has nothing to do with the question of the limitation of the area of the north-east monsoon.

4. On the publication of the Madras Report for 1871, the Sanitary Commissioner thought it right to send to the Government of India a remonstrance against the course pursued, in introducing into this investigation elements of discussion unbecoming to an important scientific enquiry.

Explanation called for by the Sanitary Commissioner with the Government of India, and by the Army Sanitary Commission.

I do not willingly return to the subject at the present time. But I do so at the request of the Sanitary Commissioner with the Government of India, and because the Army Sanitary Commission at home has suggested that further information on this interesting question is desirable.

5. In the paragraph which follows, the history of the invasion of the Central Provinces in April 1868 is again brought up, in contradiction of my assertion, that in this month the meteorological conditions were present under which it was possible for a cholera of Bengal to descend from the north-east into the north-eastern districts of the Central Provinces, with aerial influences. The argument of the Sanitary Commissioner for Madras is embraced in this sentence:—"Both Dr. Townsend, Sanitary Commissioner for the Central Provinces, and Mr. Blandford, Meteorological Reporter for Bengal, have shown that in the years and months of cholera invasion the Central Provinces were not exposed to any winds from the endemic area."

Meteorological phenomena attending the appearance of cholera in the Central Provinces in April 1868, not inconsistent with the theory of aerial distribution.

I am not aware that Mr. Blandford has made any enquiry into, or published any facts relating to, the meteorology prevailing in 1868; and the facts which I produced in support of my statement were not my own facts, but those published by Dr. Townsend. And the facts as regards the winds of April, even so far south as Nagpore, were these, that out of the 60 observations taken at Nagpore in April 1868, the wind was found on 23 occasions to be from the north, north-east or east, the directions from which invasion was to be looked for, and did occur.

It is perfectly true as a generalisation, that hot westerly winds may be expected to prevail in the Gangetic valley in April, May, and June, up to the setting in of the monsoon from the south-east. But such a generalisation does not represent the whole truth, unless it be coupled with the reservation, that in very many years the westerly winds cease during a great part of this period, and that easterly influences step in and take the place of the westerly influences proper to the season. And the seasons in which easterly influences prevail in spring, the dwellers on the Ganges know to regard as those in which invading epidemic influences may be expected.

The facts of the meteorology in relation to the invasion of cholera, are to be viewed as they present themselves. Generalisation does not suffice in such an investigation.

If Mr. Blanford's generalisation be true, it is liable to precisely the same modification, with reference to the facts of each season, as is the generalisation regarding the meteorology normal to the spring months in the Gangetic valley.* And in a far greater degree, for Nagpore is, as I have described it, the umbilicus of India, around which meteorological influences from all quarters circle.

On each occasion of invasion, the actual facts of meteorology, and not the theoretical, must be studied. This we know, that the same conditions do not prevail during the movement of each cholera epidemic. The facilities which human intercourse might be supposed to furnish for the invasion of the Central Provinces, are the same on every occasion when epidemic cholera coming from the east, fills the Gangetic valley. And yet we know that under these circumstances, the Central Provinces are not necessarily entered. The great Gangetic cholera of 1866-67 refused to show its presence to the south of a definite geographical line; and the great cholera of 1872 steadily maintained its progress from Jessore to beyond the north-western frontier without deviating into the area in question. And this is an area which epidemic cholera naturally selects as in every respect congenial to its requirements for development and diffusion.

Epidemics shape themselves according to natural laws. The shape of the epidemic in relation to the Central Provinces varies, and the cause of the different variations is a natural one.

The inference is, that the assertion that cholera moves into the Central Provinces by human intercourse is a theory, and not a fact; and the point for observation in future is, in what respect the constitution of a year in which cholera is epidemic at a certain season in the

* See the meteorology of the North-Western Provinces in May 1871, quoted at page 7 of my Report on the aspects of Cholera in 1872; or the meteorology attending the outbreak at Cawnpore in May 1872, at page 23 of same report.

Gangetic valley and absolutely refuses to move southwards into the Central Provinces, differs from the constitution of a year in which cholera epidemic in the same situation in the north, moves upon this area and decimates the population.*

6. It will not be forgotten, that, in his report of 1871, in the chapter on Cholera Invasions, the Sanitary Commissioner for Madras introduced the subject of the invasion of 1859 with the preamble, that "unfortunately Dr. Bryden's researches do not help us to understand anything about this particular cholera." In my paper of last year, I showed that the details asked for by the Sanitary Commissioner were most carefully weighed, in a note appended to my map, copied in the same report, and commented on as being drawn contrary to the facts of the year.

The parallel facts of 1872 give an answer to explanations required by the Sanitary Commissioner for Madras regarding the geography of the epidemic of 1859.

It is most satisfactory to be able to point to the facts of 1872, as corroborative of the position which I took up in estimating the significance of the cholera of 1859. The geography of 1859 and 1872 is precisely parallel, as regards the fact of the existence of a great invading Gangetic cholera in the north, and an invading cholera in Western India, without any visible connecting link binding the cholera of the two different provincial distributions together. Whether the cholera of the Gangetic system passed over the Central Provinces, as I have no doubt it did both in 1859 and 1872, to become a great cholera in Western India, does not fall into the argument. The point is, that I would no more have been justified in colouring in the area of the Central Provinces as covered in 1859, than I would be in saying, that, in 1872, the same area formed portion of the tract covered by the cholera of the invasion now in progress.†‡

The geography of the epidemic of 1853-54 was also identically the same in relation to the Gangetic Valley and Western India. I described this geography in my original report, p. 115 and 116. And now, for the third in 20 years, the phenomenon recurs—a phenomenon inexplicable upon the assumption that cholera is distributed by human intercourse.

The parallels of 1859 and 1872 repeat the epidemic history of 1853-54 over the same provincial area.

As in the days of Sir John Malcolm, so in 1872, Nimar brings forward the already distributed cholera at the earliest date. The same cholera which appears in Malwa in April comes forward in Nimar any time after 20th February. It is not to be wondered at that Malcolm should have concluded that cholera was endemic in Nimar. But in every case, this cholera of Nimar, a district within 200 miles of the western coast, whether it be of 1854, 1860 or 1872, is associated with a Gangetic cholera, and often, as I have described, without a visible geographical link. The recent railway surveys have shown the Nerbudda to be, in the Nimar district, only 560 feet above the sea level. The Malwa plateau is 2,000 feet. The constantly repeated phenomenon, that the population of Nimar first gets cholera, and that, a month or six weeks later, the districts above the Vindhya suffer, seems strongly to point to human intercourse as the vehicle, while it has really no such significance.

Early revitalisation of cholera in Nimar in the spring of 1854, 1860, and 1872, a parallel phenomenon. Explanation of the phenomenon.

7. I cannot conclude this paragraph without calling attention to one of those coincidences which constantly occur in succeeding epidemics, not fortuitously, but in obedience to the definite laws which control the appearance of an epidemic in any particular province.

Shadow of the epidemics of 1859 and 1872 in the uninvaded tract of the year, appearing in Central India on the same day in both years.

In the note appended to my map of 1859, above referred to, I state, regarding Central India:—"Premonitory cases were thrown out beyond the western limit (of the eastern invasion of 1859) into the Gwalior district; for two admissions and a death occurred at Gwalior, on May 6th, among the men of the Bombay Artillery."

Place beside this the parallel fact of 1872. The epidemic had passed, and the shadow shows itself, on the identical date, the 6th May, in 1872.

I quote from the weekly returns of the Madras troops occupying Central India in 1872:—

3rd Madras Cavalry, Jubbulpore, week ending 10th May.

"One case of ague proved fatal. The man was admitted in a weak state. He died rather suddenly about noon on the 5th instant, after a paroxysm of fever, and two rather copious watery evacuations, which induced great exhaustion and syncope."

15th Madras Native Infantry, Nowgong, week ending 10th May.

"A man, æt. 20, was admitted on 6th May. He complained of ague. His skin was hot, pulse quick, tongue clean, bowels regular; was ordered diaphoretic mixture.

"*7th May.*—Still feverish; did not sleep last night, bowels confined; ordered sulphate of magnesia mixture, which relieved him.

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* I observe in a recent review (*British and Foreign Medico-Chirurgical Review*, July 1872, page 70) the case of the invasion of the Chatisghur Division of the Central Provinces, on the 12th May 1869, alluded to, as if it were an ascertained fact that cholera had moved upon this tract as the result of human intercourse. The facts were, that the cholera invading on 20th April 1868, and propagated far and wide throughout Western India and Hyderabad up to the end of the year, sat down for 13 months upon the margin of this area—a tract of most evil repute for retaining and fostering an epidemic cholera. And here it remained, powerless to move one mile towards the east. From the eastern margin of the invaded tract of April and May 1868, eastward over the wide stretch of country between Nagpore and Orissa, 8 cholera deaths were registered in 1868, while cholera was epidemic to the west and south-west. And when Raipore was invaded in May 1869, the invasion was *per saltum*, and occurred almost on the same day on which our cholera of Bengal moved upon the districts south of the Jumna, and, following the parallel of 1818, upon Saugor, which was struck simultaneously. So far from this case of Raipore affording an argument in favour of the primary entrance of a district by the agency of a moving population, the whole bearings of the case tend in exactly the opposite direction.

† This was written in the autumn of 1872.

‡ In his controversy with Pettenkofer, Sander refers to my cholera charts as drawn on an erroneous principle, that is, not in accordance with Sander's theory that cholera is propagated along highways of communication by human intercourse. In making such a statement, the writer is necessarily unacquainted with the phenomena of Indian cholera.

8th May.—He complained of nausea, and vomited twice some congee fluid; pulse weak. At 2 A. M., he again vomited congee fluid; at 6-30 A. M., on 8th instant, having drank a little congee, convulsions came on, and he fell back dead on the bed."

8. In various publications of 1872, the Sanitary Commissioner for Madras has made a point of impressing on his readers, that the invading cholera of the Eastern Coast of 1872, which he recognises as a new cholera coming from within the endemic area in Bengal, has advanced from the north into Ganjam by a slow advance. In his annual report (page viii) he writes:—"This movement had already reached the Ganjam district of the Madras Presidency in the month of March of the present year; but in the detailed accounts of its history, which I daily receive, there is no evidence of a *per saltum* leap."

Evidence of the epidemic advance of cholera *per saltum* into Ganjam in March 1872, necessarily wanting. Parallel of revitalisation, not invasion, in Ganjam, the Gangetic valley, and Nimar in the spring of 1872.

It is vain to look for the epidemic phenomenon in question in these invaded districts in March 1872. When the cholera of March 1872 appeared in Oude and Jounpore, we knew well that it was revitalised, and was not an invading body of cholera; and when, on 20th April, cholera appeared west of Delhi, we concluded that this was the coming forward of a cholera distributed months before.

Now in my report of the cholera of 1872, when I traced the commencement of the epidemic within the endemic area, the point which I was called on to illustrate, affecting the Madras Presidency, was the movement from the north-east in the end of December of a body of cholera over the districts west of the Hooghly. I showed how, in common with a large tract of Bengal Proper, Midnapore and all tracts to the south, had been free from cholera throughout 1871 up to December; and how every medical officer remarked on this wonderful exemption, which extended even to pilgrims, who suffered neither at Juggernauth nor on the road. But upon this immunity followed the invasion of December, comprehending within its area the districts round Calcutta and all the region to the south-west. And this invasion was carried up to the southern limits of the Bengal Presidency. Cholera does not recognise the boundaries of the Madras Presidency as a limit during invasion. And hence, I conclude, that Ganjam, which borders on Orissa, was covered along with all the region lying to the north, in December 1871, and that the cholera of March, expected to exhibit the phenomenon of movement *per saltum*, was a cholera locally grown, revitalised from a moving cholera which had made its epidemic advance three months before.

This is beyond a doubt the same body of cholera which has, since entering Ganjam, covered India and the countries beyond, from the Sunderbunds to the sea of Aral, in the stages which I have described in my report of the cholera of 1872.

It is very beautiful to observe how in the spring of 1872 the same body of cholera came forward in epidemic strength in the same weeks, in Ganjam on the Bay of Bengal, in Nimar within 200 miles of the mouth of the Nerbudda, and in the Benares districts of the Gangetic Provinces.

SPRING REVITALISATION IN 1872, IN EASTERN, WESTERN AND NORTHERN INDIA, OF THE INVADING CHOLERA OF THE END OF 1871.

Cholera Deaths of the General Population, 1872.

	Jan.	Feb.	March	April	May	June	July.
EASTERN INDIA.							
Ganjam	5	...	44	576	1,179	931	302
WESTERN INDIA.							
Nimar	...	...	39	177	50	177	192*
NORTHERN INDIA.							
Benares	25	21	84	361	381	187	88
Mirzapore	5	4	71	372	474	273	205
Azimghur	9	19	33	618	998	472	125
Jounpore	11	14	1,147	5,788	1,113	132	21
Goruckpore	...	...	60	528	1,297	698	47
Bustee	3	...	92	2,670	3,987	2,458	153

The diversion into the north-east of the Madras Presidency seems to have been of little weight. But in November 1872, as in November 1868, Secunderabad was epidemically affected, probably by this same body of cholera. On 10th and 12th November two men, one of the 2-24th Regiment in cantonments, and the second of the 76th Regiment, in the military prison, were attacked, cholera being at the time epidemic. In the invasion of 1868 the first cases occurred in Secunderabad on 14th November.

9. The rest of the paper is taken up with the republication of the letter of an anonymous newspaper correspondent, and in comment on what is advanced by the writer.

The republication of the letter is excused on the ground, that the views of the writer entirely coincide with those held by the Sanitary Commissioner.

By reproducing this letter, an importance has been given to it which its contents do not merit. And even were all that the writer states correct, as it is not, the real argument in the case in point is left untouched and undisturbed.

In disputing the accuracy of conclusions regarding the movement of cholera, the Sanitary Commissioner for Madras mixes up two series of phenomena, and reasons as if these were identical.

In producing this letter, the Sanitary Commissioner remarks:—"The question between myself and Dr. Bryden is one of the ability of cholera to move contrary to prevailing winds, and has nothing to do with rain-fall; and he meets my objection that the winds do not

* This cholera died with the close of the monsoon of 1872. No death from cholera was registered in Nimar in October, November or December.

assist in the movement, not by showing that the winds come from a contrary direction, but by the assertion that the rain-fall is a measure of the strength of the wind."

In opposition to this statement it is only necessary to point out, that the main proposition in my "Note" was based upon the fact of the dying away of the winds of the south-west monsoon in the week of 1868 when cholera moved into Western India in the last invasion.

Two series of meteorological phenomena, which are entirely different, are mixed up, and the point in debate is reasoned on as if these were one and the same.

My conception of the full relations of the Province of the South-west Monsoon Proper are, I conclude, not different from those of others. To me the eastern coast of India south of a certain line is the eastern extremity of a great arc which terminates in the west in the western desert. The desert area in the west is a desert area, because it does not receive monsoon influences; the area in the east becomes a famine area also if the influences of the north-east monsoon fail to compensate for the normal deficiency of the south-west monsoon.*

Within the limits of this great arc, throughout a large portion of its circumference, monsoon influences, be they winds or rains, terminate.

This last statement is applicable to what occurs at the eastern and western extremities of the arc. But in the centre, which receives the full of the monsoon influence, influences from the West Coast proceeding towards the north-east normally advance so far as to meet the influences having the Bay of Bengal for their base of departure, on the edge of the arc.

The chief objection contained in the letter in question, is based upon the assumption of my want of knowledge of the monsoon phenomena occurring in Western India. But in my report on the "Aspects of Cholera in 1869," published in 1870, the same in which the phenomena attending the invasion of the Bombay and Madras Presidencies in 1868 are studied, the question and its bearings were carefully treated of—why the districts east of the Western Ghats receive 19 or 20 inches of rain only, while in a full monsoon season the districts in the centre of India supplied from the same base have a rainfall of 50 inches.

The argument of the writer proceeds on the assumption that famine in some portions of Western India in 1871 was due to the rain-clouds having been driven over the area in which drought occurred; and this was probably the case on the south. But in the tract bordering on the desert, the appearance of famine has a different meaning. We know the conditions under which famine appears in the districts of Northern India bordering on the desert area. Famine is not due to the passage of the rain-clouds over the famine tract from excess of wind influence. It is a pure manifestation resulting from deficient strength, and the districts adjoining the desert become for the year part and portion of the desert tract.

And this is how the monsoon influence, as represented by the rain-fall, dies away in different years—

Monsoon Rain-fall in inches.

	1865.	1866.	1867.	1868.
Delhi	24·3	32·3	32·6	3·8
Kurnaul	20·9	15·0	27·7	7·1
Hissar	16·8	10·2	19·5	4·8
Rohtuck	13·7	11·8	21·4	6·5
Sirsa	15·5	13·7	13·9	6·1
Jhung	6·0	4·1	11·2	6·0
Mooltan	1·9	2·1	5·0	·1
Dera Ismail Khan	·8	·7	4.5	1·1

There is no mistaking the meaning of this table. Monsoon winds and monsoon rains both die away over the north-western desert. The contrast which 1868, the year of repressed Monsoon influence, presents is evident; and I draw attention once again to this contrast, since it was upon the facts of 1868 that my reasoning regarding the epidemic phenomena in western invasion was based.

Seeing that the desert in the north shows these phenomena, I do not hesitate to apply the deduction from the facts to the southern tract of the same desert and the adjoining districts. And when I find famine in Guzerat and Khandeish in 1871, I do not argue that the excess of wind influence prolonged the desert southwards. It is normal in every year for the monsoon influences to die away gradually from Bombay northwards until they cease altogether as the desert is reached.†

The facts of 1871 which I adduced, were altogether secondary; I gave the illustration merely as corroborative. The argument which runs through my note, and my conclusions, were drawn, not from the facts of 1871, but from the data afforded in the year and month and week in which epidemic cholera moved upon the tract in question. Had the meteorological facts of August 1868, and not those of August 1871, when no cholera invaded this tract, been appealed to, the reasoning and the conclusions would have been different. And hence the facts proper to the enquiry are ignored.

I repeat, that the meteorology of the week in which the invasion of Western India occurred, was in accord with the theory of aerial advance, the phenomenon which I assumed to have taken place in this week. Not only did the rains from the south-west fail, but with the exception of the districts *which did not get cholera in this movement*, not one district of the Central Provinces reported that its winds were from the south-west in this week.

* See original report, page 72.

† Since this was written, I have had an opportunity of talking over the point with the Political Agent at Sirdarpore in Western Malwa. He tells me that from his district westward to the desert every hundred miles of country has a gradually decreasing rain-fall, until the rainless tract is reached.

With reference to the consistently small rain-fall of Khandeish (12 inches on the average of the five years 1862-66), I wrote—"Do not let us lose sight of such a fact in connection with the fact of Malligaum having been struck on 14th August in 1868, a year of minimum rain-fall and a repressed monsoon; or the fact of Bombay having been reached on 14th August in 1818. Little repression is wanted to bring down cholera from the north-east on these districts, if it be a truth that cholera moves aerially to fill up a vacant area. And it is most interesting to observe that it was into Ahmednuggur and Poona that our cholera of the Central Provinces, of 14th August, fell at the very time when Malligaum and Dhoolia were reached."

Cholera appeared at Jaulna in the second week of August 1868, a fact corroborating the universality of distribution at this date.

10. The dates which I assigned to the invading cholera of August 1868 were no more imaginary than those which Scott assigned to the cholera of August 1818. When I spoke of the general appearance of cholera over a great area during this week in 1868, in which monsoon influences were repressed, I spoke of the fact as a fact—apart from theory. In the centre of the tract then occupied lies Jaulna, separated by intervals of upwards of 100 miles from different stations which afforded information as to the date of invasion in 1868, and which told us that they got their cholera on the 14th and 15th. In answer to a circular letter from the Foreign Office addressed to medical officers serving under this Department, Dr. McVittie of Jaulna, in giving the details of what he observed in 1872, remarked, that he had been observing the cholera of Jaulna since the date of invasion in 1868. I thought it worth while to write to Dr. McVittie, to ask on what date the invasion of Jaulna in 1868 occurred; and his reply, dated August 12th 1872, was—"On 13th August 1868 the first case was reported in cantonment."

The necessity for a careful study of the facts attending the invasion of cholera in Southern and Western India.

11. It is not to be expected that observation extended over a few months will atone for half a century of neglect. I believe that the points essential to epidemic research in connection with the invasion of the Madras and Bombay Presidencies, are indicated in the general deductions which I have made from the epidemic history of the past 20 years. The primary conception of the epidemic by the local observer must be inadequate, and his education is difficult. From a daily study of the aspects of cholera in Bengal followed out for ten years, we now can recognise that the epidemic has a natural history. Each succeeding invasion brings up before us the same phenomena—phenomena which are parallel, because they happen in subjection to laws which are natural.

No argument is worth listening to which does not recognise that the same phenomena fall in obedience to the same natural laws in each epidemic. Ten years of observation in Madras may afford an adequate basis for generalisation such as we now possess in Bengal; and it will not be found by the impartial student that the beautiful harmonies of the Epidemic are confined to the area under our special observation.