

Climate and medical topography in their relation to the disease-distribution of the Himalayan and sub-Himalayan districts of British India : with reasons for assigning a malarious origin to goitre and some other diseases / by F.N. Macnamara.

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Publication/Creation

London : Longmans, Green, and Co., 1880.

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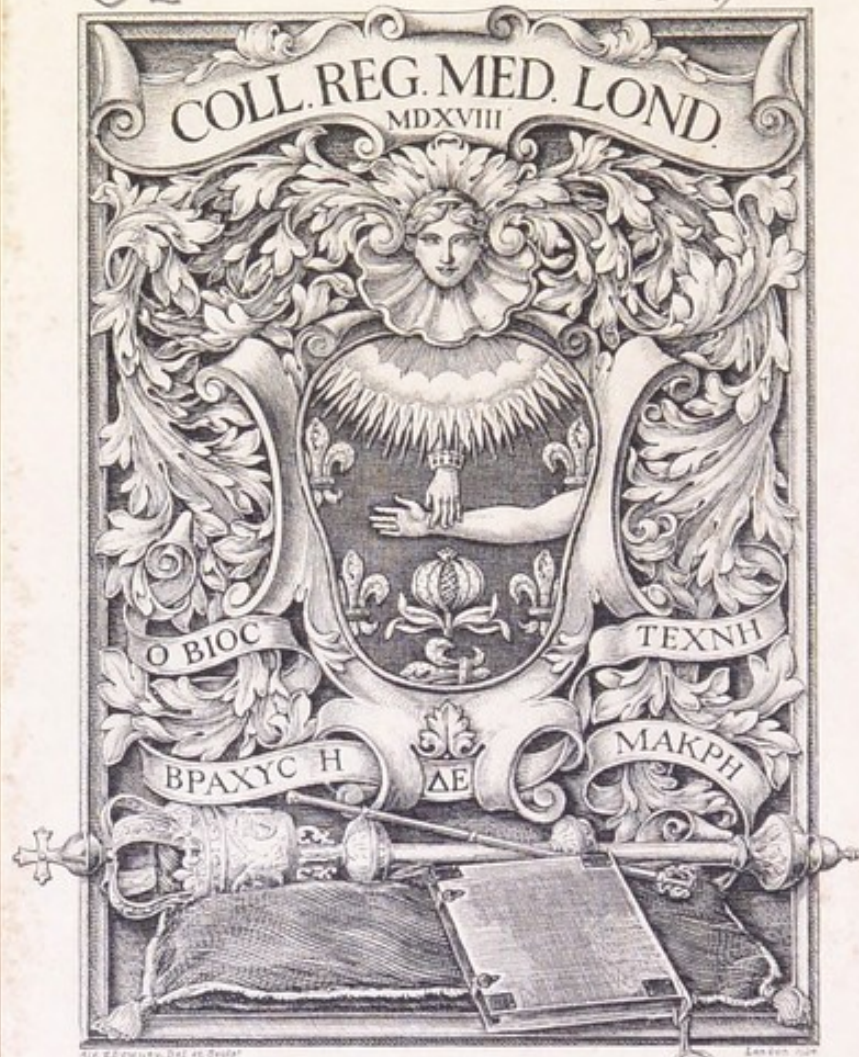
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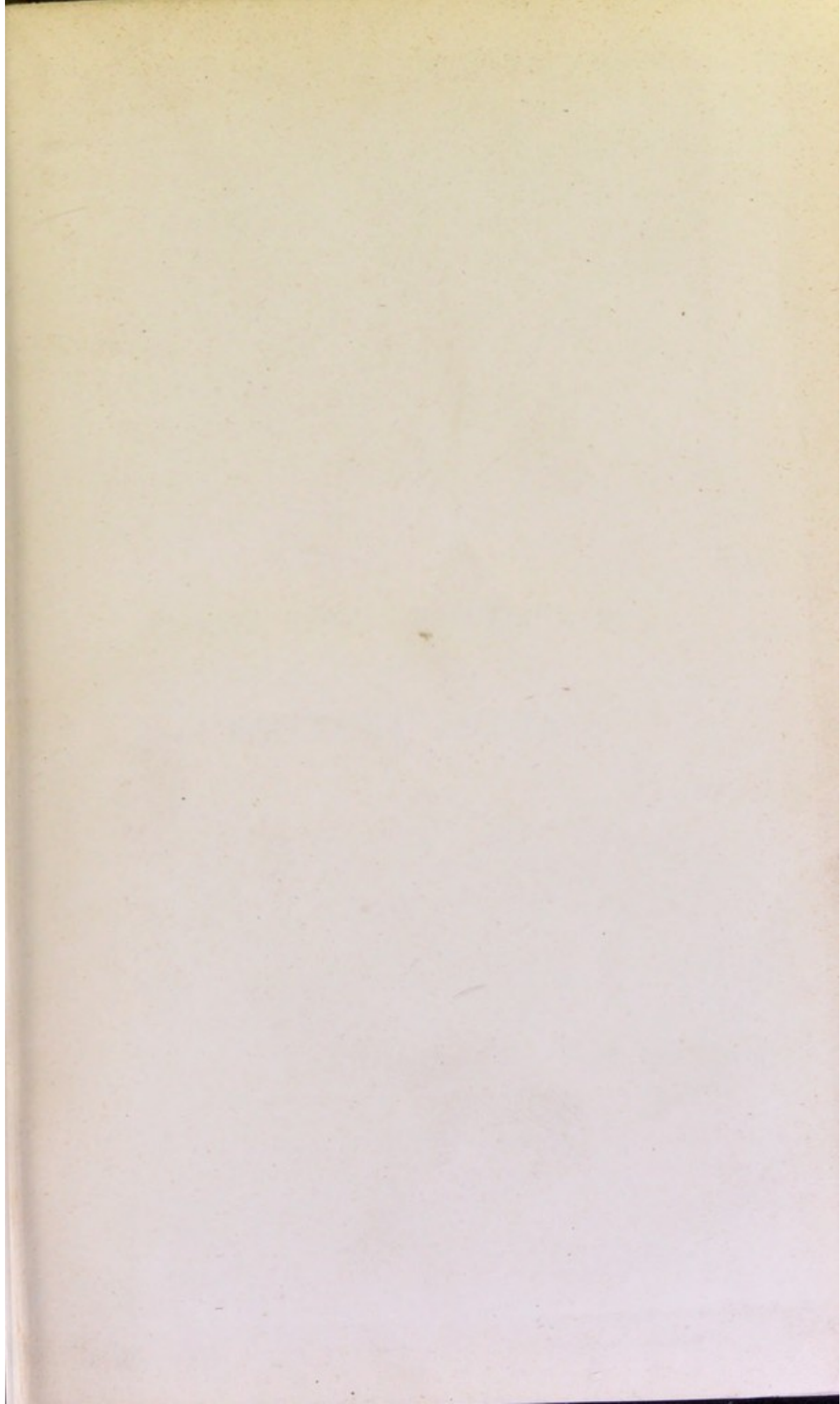
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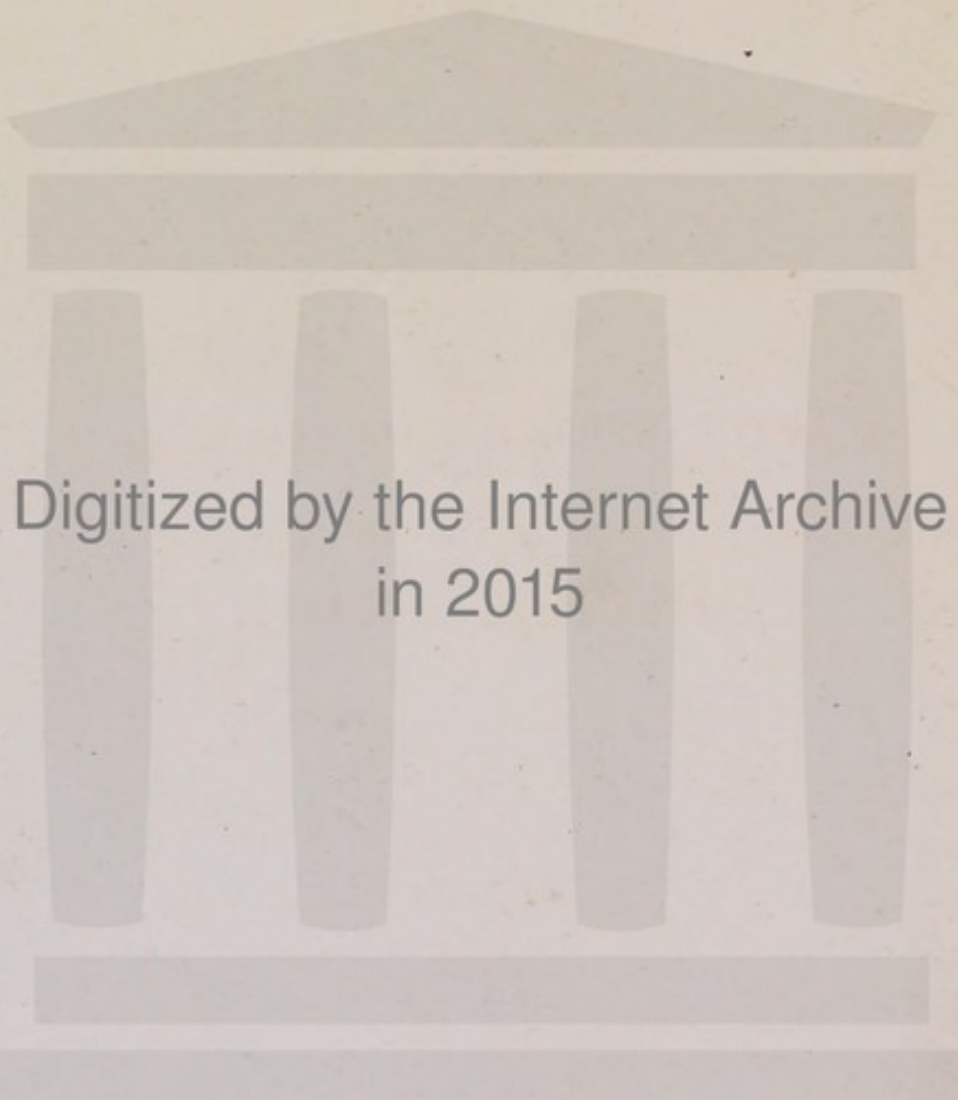


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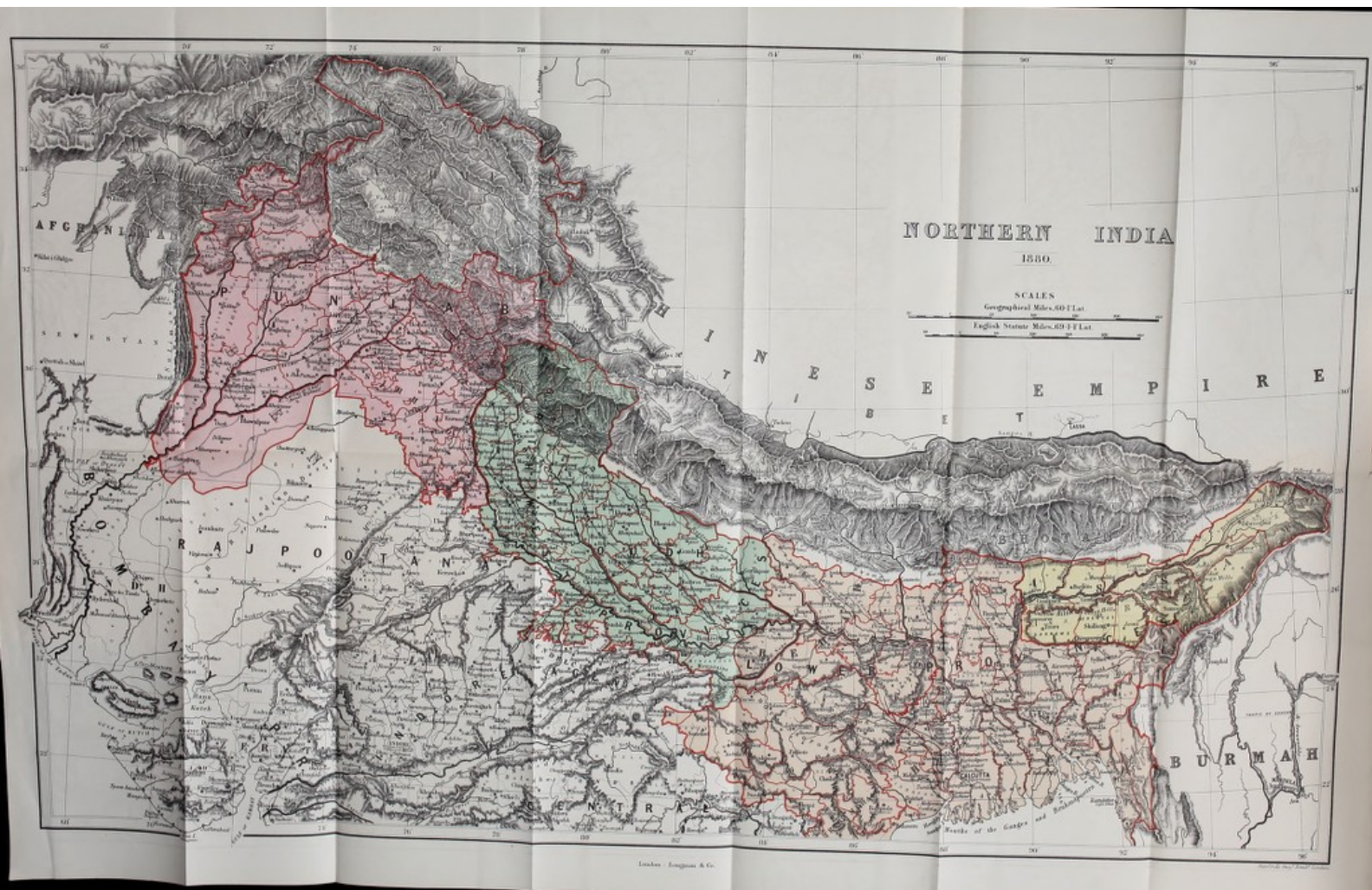
CLIMATE, MEDICAL TOPOGRAPHY, &c.

OF

BRITISH INDIA

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
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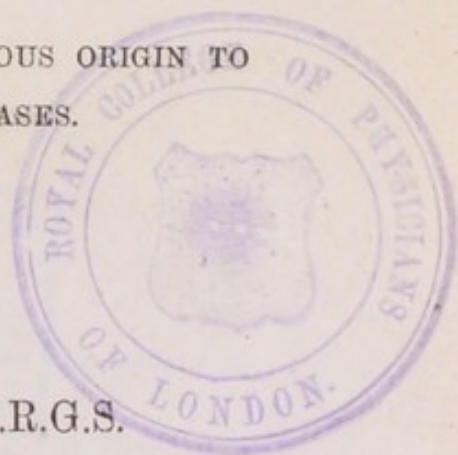
CLIMATE AND MEDICAL TOPOGRAPHY
IN THEIR RELATION TO THE
DISEASE-DISTRIBUTION
OF THE
HIMALAYAN AND SUB-HIMALAYAN DISTRICTS
OF
BRITISH INDIA :

WITH REASONS FOR ASSIGNING A MALARIOUS ORIGIN TO
GOITRE AND SOME OTHER DISEASES.

BY

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AT CALCUTTA.



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TO MY FORMER COLLEAGUES

J. M. CUNINGHAM, M.D.

SANITARY COMMISSIONER WITH THE GOVERNMENT OF INDIA

and

H. F. BLANDFORD, ESQ.

METEOROLOGICAL REPORTER TO THE GOVERNMENT OF INDIA

I Dedicate this Volume

*Under the conviction that, while overlooking any shortcomings,
they will welcome an attempt to diffuse more widely a knowledge
of some of the many truths which they have been mainly instru-
mental in collecting and establishing.*

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PREFACE.

DURING 1866 and the five following years, while engaged in superintending the examination of the water supply of cantonments in Northern India, my attention was drawn to the subject of goitre by the mention which medical officers conducting the analyses frequently made of the prevalency of the disease (the simple hypertrophic form) in districts in which they were employed. The disease was usually attributed to the presence of a large proportion of lime and magnesia in the drinking water used by the people, a view which seems to be the one most in vogue in India, probably in consequence of the support it finds in Dr. McClelland's remarks on goitre in his well-known work on the Geology of Kumaon. I then determined, leisure allowing, to make a series of analyses of the waters of the goitrous regions of Northern India with a view to testing the soundness of this view, and in 1872 Surgeon-General Sir Campbell Brown authorised a circular to Civil Medical Officers, calling upon them for replies to a set of questions drawn up with a view to eliciting information on the subject; and also directing that samples of water were to be sent to Calcutta for analysis. The following year a second set of questions was circulated to several Civil Surgeons, and in 1874 the Surgeon-General called for statistics from all dispensaries

and civil hospitals of the proportion of cases of goitre to the total number of cases treated during the five years ending with 1873.

The replies to the two sets of circulars constitute the 'special reports' which will be often quoted in the following pages. The statistics and the results of the analyses are embodied in a table which will be found in Chap. ii.

In 1874 I brought the papers with me to England, intending to prepare a report of very modest dimensions ; but as the analyses had shown that the lime and magnesia theory of the cause of the disease was not tenable, while the habitat of the disease suggested malaria as the real cause, it became necessary to investigate the medical topography and climate of the goitrous regions. The older works on the Medical Topography of Bengal, such as those of Martin and Mackinnon, though very valuable so far as they go, were not sufficiently local for the purpose in view, and the necessary information could be obtained only by piecing together fragments abstracted from a vast number of Indian reports and periodicals.

The reports which were of most use were 'the Annual Reports on the Medical and Sanitary State of the Native Army of Bengal,' which have been compiled since 1867 in the Surgeon-General's office at Fort William by Surgeon-General J. T. Ross, F.R.C.S., and by Surgeon-Major Kenneth McLeod, M.A., M.D. ; 'the Annual Reports on the Charitable dispensaries of Bengal,' also compiled in the Surgeon-General's office ; 'the Annual Reports of the Army Medical Department ;' the Annual Reports of the Sanitary Commissioner with the Government of India (Surgeon-Major J. M. Cunningham, M.D.), including the tables of the statistical officer (Surgeon-Major J. L. Bryden, M.D.) ; and the Reports

of the special Assistant Commissioners (Drs. T. R. Lewis and D. D. Cunningham); the Reports of the Sanitary Commissioners of the Provinces of Bengal, Oude, the North-West, and the Punjaub; the Report of the Commission on the Sanitary State of the Army in India (1863); the Reports of the Analysts of the waters of military cantonments; the Special Reports already mentioned; and the Reports on Sanitary Establishments for European Troops (Military Department Press; Calcutta, 1860-62). On the subject of climate I derived much information from Mr. H. Blandford's excellent little book on the Physical Geography of India; from his more recent work, the 'Indian Meteorologist's Vade-Mecum;' from his paper on the Winds of Northern India; and from his Annual Reports as Meteorological Reporter to the Government of Bengal; also from those of the Meteorological Reporters of the other provinces; and from the first volume of the Messrs. Schlagintweit's great work, 'India and High Asia,' 1866. To this long list I must add, last but not least, many valuable papers in the 'Indian Annals of Medicine,' a periodical during many years ably edited by Deputy Surgeon-General Norman Chevers, M.D., whose valuable paper on 'the Means of Preserving the Health of European Soldiers in India' has been very useful to me; and in the numbers of the 'Indian Medical Gazette.' Had I, when I began my research, enjoyed the use of Dr. Hunter's grand work, 'The Statistical Account of Bengal,' and that of the recently published 'Official Gazetteer for Oude,' my labour would have been considerably lessened. As it is, the publication of these works has enabled me to enlarge and correct my material.

After I had completed my manuscript and forwarded it for publication, I received Messrs. H. B. Medlicott's and W. J. Blandford's work on the Geology of India (Trübner

and Co.), not too late, as the following pages abundantly show, to allow of my making very free use of it, limiting myself however very much to those parts of the work which treat of the petrography of the districts with which my main inquiry is concerned.

Only when I had collected a mass of notes from the earlier mentioned sources, and from other works, did it occur to me that the information which had been pieced together at the cost of much labour and time, might be of value to others interested in the diseases of Northern India, embodying as it does an account of the medical topography, climate, and disease distribution of Himalayan and Sub-Himalayan districts. It is this which forms the main portion of the work, goitre running through the whole as a kind of connecting and limiting thread. Where I have been led away from the habitats of goitre, it has been, either because some neighbouring region exhibited points of special interest in its medical history, or because I wished to investigate some apparent anomaly in the distribution of the disease.

I need hardly say that I claim no originality for the view that goitre has a malarious origin,¹ but I believe that the information which I have been able to collect² affords convincing evidence of the truth of that view, while it quite disproves the theory which attributes the disease to the presence of an unusual proportion of lime or magnesia in the drinking water.

Advocating as I do a view which connects goitre with the malaria which is the widespread cause of so much of

¹ See review of Dr. Zillner's work 'On the Malarious Origin of the Idiocy and Goitre in the neighbourhood of Salzburg,' in *Med.-Chir. Review*, vol. i. of 1861. See also two letters on Bronchocele by Sir Joseph Fayrer, in the *Lancet* for 1874.

² See more particularly the history of goitre in several localities, as given at pp. 178, 181, 208, 247, 258, 280, 365, 411, 420, 495, 498.

the disease of Northern India, I have been drawn to consider the distribution,¹ and especially the seasonal distribution of the chief diseases of that country, while the etiology of the disease has obliged me to discuss the origin of malaria. I have however done so but briefly ; indeed it seems to me that the question is not one which is as yet ready for thorough discussion, and that the anomalies in the distribution of malaria which now perplex the enquirer cannot be solved till we possess more exact and extended knowledge regarding, *inter alia*, the meteorology and climate of individual localities ; the relation of meteorological changes and of changes in the soil to the prevalence of particular diseases ; the influence of similar changes on the growth of low organisms, and the effect of the presence of low organisms in the system upon the health of individuals.

The reports, statistics, and memoirs of the Indian Meteorological Department ; the extension of Geological work in India ; the steady improvement in registration of the vital statistics of the civil population ; the accumulation of accurate returns of disease and mortality amongst the troops ; the careful study and record of the history of epidemics ; the special work being done in India by many careful enquirers, amongst whom must be prominently noted Drs. T. R. Lewis and D. D. Cunningham,² special Assistants to the Sanitary Commissioner with the Government of India—all this is adding largely to our stock of information, of that character which is specially required for the explanation of questions which now perplex students of the diseases of India.³ One cannot but regret that it is

¹ For much help in doing so, I gratefully acknowledge the admirable Reports of Dr. Bryden, published at Calcutta in 1874 and in 1878, on the *Vital Statistics of India*.

² See their many valuable papers in Appendices to the *Annual Reports of the Sanitary Commissioner with the Government of India*.

³ While these sheets are passing through the press, much is being said and

for the most part confined between the covers of Blue Books, for Blue Books, however interesting and valuable their contents, are too often doomed to find a place only on the shelves of a few institutions and societies. I leave my work amongst the Indian Blue Books which bear on State Medicine, not only with a deep sense of how very little I have been able to extract from the rich stores they contain, but also with an earnest wish that abler expositors may be led to broach and diffuse many portions of their contents which I have dealt with imperfectly or have left untouched.

A few words regarding the meteorological tables. They have been compiled mainly from the official reports, for 1875 and 1876, of the Meteorological Reporter to the Government of India (Mr. Henry Blandford). In the year 1875 the administration of the Indian Meteorological establishments was concentrated in a single central office. Previously each Province had its own reporter, whose

written regarding what the English have done for India. To all that has been advanced on the subject not a little might be added on the beneficial influences traceable to the Medical Services. The good they have effected is perhaps less strikingly manifest than much which has been commented on, and less calculated probably to arrest the attention of the statesman, the jurist, the political economist, the merchant, or the engineer; it has however been none the less real, and I am confident is at least as gratefully recognised by the people of the country. Great hospitals and minor dispensaries established and worked through the length and breadth of British India; Medical Schools yearly sending out thoroughly trained medical men and assistants, each one in the future to aid in the relief of human sufferings; small-pox, that once terrible scourge, attacked, and through vast districts subdued; sanitation carefully but assiduously pressed upon the masses, and its good effects made manifest in many a town and cantonment, as well as in the hospitals, jails, and other public institutions; diseases investigated, vital statistics collected, interpreted, and applied—all this, and much more which it is beyond the compass of a mere *postscriptum* foot-note to detail, India mainly owes to the Medical Services. The history of the Indian Medical Service, now, alas, it is to be feared about to lose its independent existence, would form a history of beneficent British work in India, of a kind which the people of the whole land would thoroughly understand and gratefully approve.

reports were neither uniform in arrangement, nor in the matter they included, while the instruments which were used were in some instances unverified, or exposed under differing conditions, or observed at differing hours. On the whole therefore it seemed best to use the latest available observations, those of the years 1875 and 1876, in the place of averages computed from observations which might be questioned, adding as an appendix (tables xxvi., xxvii., xxviii.) averages which Mr. Blandford has published, and has therefore, at any rate provisionally, accepted.

The observations of air temperature, pressure, clouded sky, wind direction, are at the majority of the Observatories of Northern India made at 10 A.M. and 4 P.M. ; at Calcutta they are hourly. The hygrometric observations consist in most cases of readings of the hygrometer at 10 A.M. and 4 P.M., and of the minimum temperatures of air and evaporation. In some of the tables in which the record of relative humidity of 1875-1876 is incomplete, that of 1874, or where at the time available of 1877, has been added ; but it must be remembered when comparing the records, that prior to 1875 the relative humidity of most of the stations was calculated from the mean of the observations at 10 A.M. and 4 P.M., or from that of four six-hourly observations, without reference to the observation of the minimum.

I ought to add that considering the purpose in this work of the meteorological tables which it includes I have, for brevity's sake, thought myself justified in substituting freely the nearest whole numbers for the mixed numbers of the original tables.

As to the shorter meteorological tables, those which have been compiled, or taken, from Messrs. Schlagintweit's work, or from the observations made by Regimental and

Civil Surgeons, it must be remembered that most of the observations were made with unverified instruments, which were very often fixed in places not specially prepared for them, as for instance in the open verandah of a hospital, and that the care of the observations has necessarily been at times deputed to subordinates not always entirely qualified for the duty. However, these records may in most cases be checked by reference to those of not very distant Government Observatories.

For the sake of comparison with the Indian tables, tables of two British stations—one Oxford, inland, the other Osborne, marine—have been added. They are compiled from Mr. Glaisher's quarterly 'Meteorology of England,' and from the last annual report of the Radcliffe Observatory.

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CLIMATE AND DISEASES

OF

HIMALAYAN INDIA.

CHAPTER I.

MOUNTAINS AND PLAINS OF NORTHERN INDIA.

The Himalayas; their extent; direction; relation to the course of the rivers Indus, Sutlej, Sanpoo; Eastern and Western Himalayas; Snowy range; Lower (Outer) Himalayas; Sub-Himalayas (Siwaliks). Terminal ranges; Patkoi, Burail, Assam, Salt range, Khyber hills, Suleiman range; Bhábur and Terai. Indo-Gangetic plain; extent, surface, soil. Geology of Sub-Himalayas; Siwalik, Sirmoor, Subathoo rocks. Geology of Lower Himalayas; Simla area, classification of rocks, slate series, gneissic series; Sikhim area, Dalings, Damoodas; Buxa series. Geology of Snowy range and its western representatives; the gneissic axis; granitic axis; Tibetan deposits. Origin of Indo-Gangetic plain.

THE HIMALAYAS, 'the hills' as they are commonly called by the European residents of Northern India, lie between the gorge of the Dihong (Sanpoo or Brahmapootra) near the upper end of the Assam valley on the east, and that of the Indus near the extreme northern point of British territory on the west. They¹ separate the plains of India, and the lower half of its atmosphere, from the lofty table-land of Tibet, yet allow of the constant northward flow of currents in the upper regions of the atmosphere to the arid plains of Central Asia.

To the plains the Himalayas present a vast curve, some 1,500 miles or more in length, say the distance across Europe from Calais to Constantinople. The convexity of this curve in its eastern half, lying north of Assam, Bengal, and Behar, looks to the south; while that of the western half, which borders the provinces of the North-west, Oude, and the Punjaub, in consequence of the northerly trending of the Western Himalayas, looks to the south-west.

¹ Blandford's *Meteorologists' Vade-mecum*, Part ii., p. 36.

The Indus, the Sutlej, and the Sanpoo rise on the northern base of the Himalayas, at no very great distance from one another, near east long. 81° , at an elevation of about 16,000 feet. These three are the only rivers which, washing the northern base of the Himalayas in channels parallel to the range, break through its entire breadth, and water the plains at the southern base. The Indus from its source takes a north-westerly course till it makes a great bend to the south-west, and cuts through the terminal mountains of the Western Himalayas, flowing at the bottom of a tremendous gorge some 14,000 feet in depth, which has only quite recently been explored by Europeans in its entire length. Three hundred and fifty miles east of the gorge of the Indus is that of the Sutlej, a river which has a comparatively short course along the northern base of the range, while a thousand miles further east is the gorge of the Dihong. This gorge remains unexplored; yet it is almost certain that the river is the continuation of the Sanpoo, and that through it the drainage of the northern slopes of the Eastern Himalayas finds a way to the plains.

The Himalayas are commonly divided by geographers into the Western and the Eastern Himalayas; the latter division including the great ranges eastwards from the course of the Sutlej through the mountains. The Western Himalayas comprehend the great ranges of the Pir Panjál and the Zanskar or Báraláchá, between which lies the valley of Cashmere, while north of the Indus is the Ladak range, and to the north of it the Mustagh or Karakoram range; the latter range appears to curve round to the north-west to join the mountains of the Hindoo Koosh.

The Eastern Himalayas comprehend the great Snowy range, the less elevated mountains which intervene between the Snowy range and the plains of India, and, on the northern side of the range, a second great chain of peaks, separated by high valleys from the first, which forms the watershed of India, dipping along its northern base to the valleys of the Indus and the Sanpoo. Approximately the average distance from the watershed to the southern base of the hills is about 120 miles, of which about one-third may be allowed for the distance from watershed to watershed of the great northern ranges. The Snowy range may be said to commence on the west in the Dhaoladhar mountains, at the left bank of the Beas river, near the station of Dalhousie.

The outermost range of the Himalayas, by elevation, by contour, and by geological formation, differs very greatly from the much higher mountains which it skirts. This range from its position

is distinguished by the title of *Sub-Himalayan*, or from the local name of its best known portion, as the *Siwalik* range.¹ It is of tertiary formation, and is composed of the upheaved débris of the Himalayas proper; the hills composing it commonly present a steep slope to the south, with a gentle inner slope, and as a rule the range is double, including a series of valleys or 'doons' of which the most extensive and the best-known is the Dehra Doon. East of the Sutlej the Sub-Himalayan belt is comparatively narrow, and a broad zone of mountains, the *Lower Himalayas*, which will be noticed immediately, intervenes between it and the Snowy range; but to the west of that river the breadth of this tertiary formation is very much increased by a repetition of low ridges and intervening doons; moreover it now occupies the place of the Lower Himalayas, and lies against the mountains which by elevation and geological formation may be accepted as the western representatives or prolongations of the Snowy range.

Between the debouch of the Jhelum river on the west, and that of the Dihong on the east, only two gaps in the Sub-Himalayan tertiaries have been discovered, and these are both on the Sikhim-Bhootan frontier. One of them, ten miles in width, occurs just south of Daling Fort. The other, some forty miles in width, extends westwards from the neighbourhood of the Sikhim-Bhootan boundary. In both places it is probable that the absence of the tertiary rocks is due to their partial removal by denudation, and the concealment of what remains of them under the great deposits of gravel which are here accumulated at the foot of the hills. On either side of the gaps the tertiary rocks of the normal character are in full force, showing no signs of thinning off.

Westwards beyond the Jhelum, the tertiary deposits form the Potwar or plateau of Rawul Pindi, which lies to the north of the Salt range. They are well developed in the Salt range as well as in the Murree and Hazara hills which bound the Potwar on the north. They occur again in the hills which form the southern boundary of the Peshawur valley; in the Kohat hills; and finally are found extending throughout the Suleiman range to the extensive tertiary deposits of Sind. No less extensive is the development of these tertiary deposits in the east of India, for here, beyond the Dihong, they constitute the mountain range which forms the eastern boundary of India, and enter largely into the constitution of the Assam range of hills which separates the Brahmapootra and Soorma valleys.

¹ Blandford's *Vade-mecum*, p. 521.

As has been already mentioned, the Eastern Himalayas include a broad zone of wholly mountainous country, which intervenes between the Snowy range and the Sub-Himalayas, and is known as the Lower or Outer Himalayas. With the exception of its western end, this tract is almost unexplored; indeed, some 500 miles of it belong to the kingdom of Nepaul, which, excepting the Katmandoo valley, is forbidden ground to Europeans. East of Nepaul comes a little bit of the Sikhim Himalaya, in which Darjeeling is situated, which has been partially explored; but east of this again the region of the Lower Himalayas may be said to be quite unknown. Its average breadth may be taken as from fifty to sixty miles, and the elevation of the mountains which compose it at from five to eight thousand feet—some ranging up to 12,000 feet.¹

Beyond the gorge of the Dihong, the Eastern Himalayas come into relation with the great mass of mountains which stands between British territory, and China, Tibet, and Burmah. From this tangled and almost unknown region, separates out the long meridional chain of tertiary mountains, which under the name of the Patkoi range forms the eastern boundary of India, and under the name of the Yomadong or Blue Mountains, stretches away as far south as Cape Negrais. Under the name of the Burail hills, a spur from the Patkoi range of the same geological formation extends in a south-westerly direction between the upper part of the Assam valley and Cachar, while other spurs of the same range, the Looshai and Tipperah hills, form the southern boundary of Cachar and Sylhet. The Burail hills at their western termination touch the Naga hills, and the same range, under the local names of the Jynteah, Cossyah, and Garrow hills, bounds on the south the western portion of the Assam (Brahmapootra) valley. But the Naga and other hills of the range west of the Dhunseeree river differ altogether in their geological structure from the Burail hills; of gneissic formation, they were not improbably at a very ancient (geological) period, outliers from the mass of what is now central India, while the tertiary rocks, geologically a continuation of the Burail hills, skirt their southern front in the same way as do hills of the same geological period the corresponding aspect of the Himalayas. To the western portion of this range Messrs. Medlicott and Blandford have proposed to give the name of 'the Assam range.'

¹ See a very lucid *Memoir* on the Mountains and River Basins of India, by Trelawney Saunders, Esq., Geographer to the India Office. W. H. Allen & Co., London, 1870.

On the west, beyond the Indus, the Himalayas become united with the mountains of the Hindoo Koosh, and here they send off low ranges which form the northern boundary of the valley of Peshawur, and circling its north western-extremity, reach the left bank of the Cabul river. Across the Cabul river are the Khyber hills, which belong to the great longitudinal range of the Safed-Koh. This range of mountains rises out of the table-land of Afghanistan, and running east forms two divisions, one of which takes a north-easterly direction to the Cabul river, and forms the western boundary of the Peshawur valley, while the other separates the Peshawur valley from Kohat, and reaches the Indus in the neighbourhood of Attock. South of the Safed-Koh, the Suleiman range runs north and south, bounding the valley of the Indus, and forming the eastern edge of the plateau of Afghanistan—an arid mountain mass, presenting¹ a bare surface of tertiary rocks, in which the geologist can trace the outcrops of the several formations as in a diagram section.

Crossing the doab between the Jhelum and the Indus is the low Salt range which forms the raised southern edge of the small plateau of Rawul Pindi, and exhibits a marvellous series of rocks, extending upwards from early palæozoic to late tertiary times.

Plains of Northern India. Along the foot of the Sub-Himalayan hills stretches a forest-clothed belt, the Bhábur, or as it is called opposite the Nepaul Himalayas, 'the Saul Forest,' from the trees which there predominate. The Bhábur is on an average some ten or twelve miles in breadth, and constitutes a slope, nowhere exceeding 1,000 feet in height, formed of the gravel, shingle, and boulders brought down and deposited by the mountain torrents. These torrents course through the Bhábur during the rains, but at other seasons the channels are dry, the water sinking into the porous soil and ultimately reaching a bed of impermeable clay which carries it to the verge of the Bhábur, there to reappear in the form of numerous springs. These springs give rise to the belt of swamp and marsh covered with reedy jungle which fringes the Bhábur and is known as the Terai. The Terai varies considerably in breadth, extending in places far into the plains along the banks of the numerous streams which cross it. Westwards from the Kosi it is less developed than to the east of that river, and between the Ganges and the Jumna is only partially represented by some marshy lands which skirt the foot of the Siwaliks. Beyond the Jumna it altogether ceases.

¹ Blandford's *Vade-mecum*, Part ii., p. 38.

To the Terai succeeds the wide extent of the Ganges and Indus plains, which spread away to the foot of the highlands of Central India. Stretching completely across Northern India, with a breadth which varies from 90 to 300 miles, these plains comprise an area of about 300,000 square miles, or about one-fourth that of the whole surface of British India, and include the valleys of the Indus, the Ganges, the Brahmapootra, the Soorma, and their tributaries. Within them are included the greater portion of the richest and most populous provinces of India, those of Bengal, Oude, the North-west, and the Punjaub.

The water-parting of the plains lies very near the station of Umballa, and has an elevation of about 900 feet above sea-level, but no ridge marks the separation between the Ganges and Indus plains, so that a very trifling change in the level of the surface might at any time turn the affluents of one river into those of the other. On the western side of the water-parting the Indus plain slopes from north to south in the direction of that river, with a subordinate slope from the Aravelli hills of Central India towards the foot of the Suleiman range. The Ganges plain has its great slope from west to east with a subordinate slope from the foot of the Himalayas. As Mr. Blandford¹ has pointed out, the result of these subordinate slopes is that the Indus flows near the foot of the Suleiman range, while the Ganges is far removed from the base of the Himalayas. Probably too the tendency to the west which belongs to rivers having a meridional direction influences the position of the Indus, and in a less degree that of the Ganges, while what is wanting in this respect in the case of the Ganges is compensated by the effect of the copious drainage of the Himalayas bringing down deposits which push the river away from their base, an influence altogether absent in the case of the Indus.²

In the Indus plain the low land or 'Khadir' is mainly confined to narrow belts which stretch along the banks of the great rivers; and to these, and to the sub-mountain tract, cultivation is very much confined, scrubby desert and rolling prairie predominating elsewhere. Very different is the Ganges plain; here the low land—a recent alluvium, rarely broken by banks or ridges of 'Bhanghur' land, the old alluvium—predominates and is pretty generally inundated during the rains. The greater

¹ *Physical Geography of India*, p. 127.

² *Manual of Geology of India*, p. 391 et seq.

portion of the land is under cultivation, and where cultivation is limited it is so more often because of an excess of water in the form of lakes and marshes, than, as in the Indus plains, from a deficiency of that element.

As regards the soil-constituents of the Indo-Gangetic plain,¹ they are well illustrated by the deposits passed through in boreholes which have been made at Calcutta and at Umballa. The former, 480 feet in depth, reached to 460 feet or thereabouts below sea-level, while the latter, though carried to a depth of 700 feet, did not reach to within 200 feet of sea-level. In the latter no organic remains were discovered. In the former, at a depth of 350 feet a fossiliferous stratum, sandstone slightly aggregated, was reached, at a depth of 430 feet another of coarse conglomerate—the remains were those of terrestrial mammals and fluviatile reptiles, and fragments of shells, said to have been of fresh-water species. At a depth of 30 feet below the surface, and again at a depth of 380 feet, beds of peat with wood were found. At a depth of from 175 to 185 feet, at from 300 to 325 feet, and again during the last 80 feet of the boring, were found pebbles, which in the latter situation were of considerable size. The upper peat-bed has been discovered in many places around Calcutta, and below it stumps of trees with the roots still attached in the position in which they grew, though now buried twenty or thirty feet below the surface. The roots are readily recognised as those of the ‘Sundri,’ a tree abundant in the Soonderbunds to the south-east and south of Calcutta, the habit of which is to grow a little above high-water mark. In these strata of peat and wood and pebbles, we have sufficient evidence that this portion of the delta has undergone very considerable depression during recent geological times.

In both borings the other strata passed through were of sand, clay, and kunkur,² such as are ordinarily met with in digging wells in the greater portion of the plains.³

The oldest part of the surface is that of the Upper Gangetic plain. The alluvium of the Indus plain and that of the Assam valley of the delta of the Ganges and Brahmapootra is a more recent formation.⁴ The whole consists mainly of beds of clay and sand, but the newer formation is characterised by a larger proportion of sand, and the deposits of the Brahmapootra and of the Indus are more sandy than those of the Ganges.⁵ Beds of

¹ *Manual of Geology*, p. 399.

² See Chap. x.

³ Blandford's *Physical Geography*, p. 44.

⁴ *Manual of Geology*, p. 396.

⁵ See also Dr. Oldham's remarks, quoted in Chap. ix.

kunkur are pretty universally found throughout the plains at varying distances from the surface, and in some places, especially in Behar and in Northern and Western Bengal, the kunkur is intermixed with pisolitic concretions of hydrated peroxide of iron.

Geologically the Himalayas divide into three main regions. On the south there is the fringing belt of tertiary rocks which extends with but an insignificant gap from end to end of the range. Within this zone or belt, but confined to the region of the Eastern Himalayas, is a second zone, that of the Lower Himalayas, constituted mainly of crystalline metamorphic rocks. The third region includes the Snowy range, the mountainous country beyond it as far as the Tibetan plateau, and the whole of the Western Himalayas which lies inside the Sub-Himalayan zone.

The Sub-Himalayan deposits, of tertiary age, have an average thickness of about 12,000 or 15,000 feet, and include eocene, miocene, and pliocene formations. Messrs. Medlicott and Blandford² classify them as follows:

Sub-Himalayan System.	{	Siwalik series	{ Upper Middle. Lower (Nahun).
		Sirmoor series	{ Upper (Kussowlie). Middle (Dugshai). Lower (Subathoo, nummulitic).

‘Sandstone immensely preponderates in the deposits, and is of a very persistent type from end to end of the region and from top to bottom of the series. Its commonest form is undistinguishable from the rock of corresponding age, known as Molasse in the Alps, of a clear pepper-and-salt grey, sharp and fine in grain, generally soft and in very massive beds. The whole middle and lower Siwaliks are formed of this rock with occasional beds of red clay, and very rare thin discontinuous bands and nodules of earthy limestone, the sandstone itself being sometimes calcareous, and thus cemented into hard nodular masses.’ The upper Siwaliks are composed of conglomerates, which in places have a thickness of 5,000 feet. The Nahun series is so called from the little town of that name in Sirmoor, about 40 miles south of Simla, near which the sandstones forming an inner range of the Sub-Himalayas are in great force. In this locality as in many others the sandstone exhibits nests of fossil wood, from the presence of which it is often spoken of as the lignite sandstone.

¹ *Manual*, p. 524.

‘In the Sirmoor group generally, and locally in the Lower Siwaliks, the sandstone is thoroughly indurated, and often of a purple tint while retaining the distinctive aspect. In the upper Siwaliks conglomerates prevail largely; they are often made up of the coarsest shingle, precisely like that in the beds of the great Himalayan torrents. Brown clays occur often with the conglomerate, and sometimes almost entirely replace it.’ The clay too precisely resembles that of the most recent deposits, and in hand specimens cannot be distinguished from the clay of the plains.

The bottom member of the series differs widely from the rest in its origin, for while they are distinctly of fresh-water origin, the Subathoo group is nummulitic and marine. Moreover the Subathoo group, though this may be said of the other members of the Sirmoor series, has a very circumscribed and comparatively small area.

The whole Sirmoor series has its name from its development in a very typical manner in an area the eastern termination of which is in the Sirmoor State, at a point about 40 miles south-east of Simla. Thence the formation extends to the north-west for a distance of about 70 miles, with a breadth of about 10 miles, and terminates on the left bank of the Sutlej about 25 miles north-west of Simla. In this area are situated the three cantonments for European troops, of Subathoo, Dugshai, and Kussowlie, from which the groups of the series take their names. A remarkable point in the history of the Sirmoor series is that it is found not in the region proper of the Sub-Himalayas, but resting on palæozoic rocks of the Lower Himalayas.

The prevailing rock of the Subathoo group is a fine, pale yellowish-brown, crumbling clay, with occasional calcareous bands, or locally some thin beds of purer limestone; dark-greenish shales and, sometimes, harder sandy beds occur.¹ At the top of the group, which here varies in thickness from 200 to 1,000 feet, red clays and shales increase, and the hard purplish sandstone of the Dugshai group becomes introduced, a gradual transition taking place into deposits of a wholly different aspect. The Dugshai ridge is entirely made up of these red clays and hard purplish sandstones. The red clays gradually disappear, and on the Kussowlie ridge are from 600 to 800 feet of sandstone with only occasional partings of grey sandy shale.

On the east of the Sirmoor area only one small outlier of the Subathoo group has been discovered in the form of a small patch of nummulitic clay in a depression of the slates at the east end of

¹ *Manual*, p. 532.

the Dehra Doon. It may be said that eastwards of the Sirmoor area the Sub-Himalayas are formed of the upper tertiary series of rocks, yet in Eastern Bengal we find another and very extensive development of the nummulites along the south face of the western portion of the Assam range.

To the west of the Sirmoor area the rocks of the Subathoo group occur, and pretty extensively, in the neighbourhood of Jumoo. The nummulites are found again in great force among the rocks of the Salt range, in the Hazara hills, and across the Indus, in the hills which bound the Peshawur valley on the south, in the Kohat hills, in the Suleiman range, and very extensively in Sind. Moreover these nummulitic deposits are found in the Upper Indus valley in the neighbourhood of Leh.

The Lower Himalayas. These, as we have seen, occupy the region some 50 or 60 miles in breadth which extends between the Snowy range and the Sub-Himalayas, having its western limit a little to the west of Simla and its eastern in the unexplored country to the north of Assam. Geologically the northern boundary is the great gneissic axis with constant granitic intrusion which forms the Snowy range.¹

Regarding the distribution and structure of the rocks in the Lower Himalayas our information is very scanty. The north-western portion, that is the region bordering on Simla, Kumaon, and Gurhwal, is the one which has been most studied. Eastwards from Kumaon, throughout the length of Nepaul, the region is sealed to examination, excepting in a very small section on the route to the Katmandoo valley, and in the valley itself. On the east of Nepaul a narrow area in the Sikhim Himalayas, bordering on Darjeeling, has been observed, but further to the east nothing has been done excepting a touch as it were, here and there, upon the outer edge of the region. Messrs Medlicott and Blandford classify the rocks of the Simla (Lower) Himalayas as follows:—

A. Outer, newer, or Slate series.

	FEET
Krol: limestones (compact or crypto-crystalline), sandstones (coarsish quartz), and shales	800-1,200
Infra-Krol: shales (often carbonaceous) and flags	8,000-3,000
Blaini: limestone (compact or micro-crystalline, magnesian), sandstone (quartzite), and conglomerate	100
Infra-Blaini (Simla slates) slates (shaly) and flags	over 5,000

B. Inner, older, or Gneissic series.

Gneissose schists	6,000
Massive gneiss	100-600
Schistose gneiss	(?)

¹ *Manual of Geology*, p. 593.

The whole of the rocks are unfossiliferous, and it is therefore very difficult to affiliate them; the latest conjecture, that of Mr. Lydekker, is that both the Krol and Infra-Krol rocks belong to the carboniferous series, and that the Blaini and Infra-Blaini rocks are Silurian; and it seems probable that these palæozoic strata were deposited upon the surface of the old gneiss, part of 'a primitive gneissic mass forming a fundamental nucleus for the whole series of Himalayan formations.'¹

Far the larger portion of the Simla region is occupied by the lower (metamorphic) series of rocks, and to the eastward the area of this series gradually extends, so that at Nynsee Tal (Kumaon) the belt of unaltered limestones and shaly slates has become very narrow, and in Sikhim the gneissic series comes very close to the outer boundary of the Lower Himalayan region.²

Trap is very rare amongst the slates of the Simla region, but intrudes profusely in the neighbouring area of the Sutlej valley, and again in the basin of the Beas. There it is 'evidently connected with the extreme crushing and disturbance the slates and limestones have undergone in those positions, and the same intrusion occurs freely again to the south-east under like conditions.'³

In the Sikhim area (90 miles in length) there are three series of rocks: Darjeeling gneiss (true gneiss often passing into gneissose schist and mica schist) which forms the whole of the mountain masses above 2,000 to 3,000 feet in elevation; and a great thickness of schist and slate called the Daling series, which extends along the outer border of the mountains, and also into the valleys of the rivers behind Darjeeling; and lastly, rocks (sandstones and shales) of the Damuda series which are found only at the outer edge of the mountains.

Pale-green smooth slates or clay slates are the prevailing rocks of the Daling series in its lower outcrops, next the Damudas; but in this position they are sometimes quite schistose. The schist is sometimes calcareous or dolomitic, but the almost complete absence of lime is a character of the series. Beds of carbonaceous or graphitic schist are occasionally found. On approaching the gneiss there is always a marked increase of metamorphism.⁴

The Damudas belong to the great system, to which the name 'Gondwana' is now given, which has its main development in Central India. Mainly of fresh-water origin, it is the great plant-

¹ *Manual*, p. 621.

² *Ibid.* p. 594.

³ *Ibid.* p. 606.

⁴ *Ibid.* p. 614.

bearing series of rocks of Indian geology, and economically is of vast importance, as nearly all the coalfields of the Indian peninsula belong to the Damuda beds. Chiefly composed of sandstones and shales, these beds represent in India the marine older and middle mesozoic, and probably the upper palæozoic formations of other countries. In the Sikhim area, as elsewhere, the sandstones of the series are occasionally calcareous. Like the contiguous Dalings, the Damudas frequently exhibit much alteration, the sandstones being converted into hard quartzites, and the shales into dark slates and graphitic schists.¹

A little to the east of the Sikhim area, on the Bhootan border, a circumscribed series which, from the fort of Buxa being built upon it, is known as the Buxa series, takes the place (apparently) of the Damudas of the Sikhim area. The ground was first examined (in 1865-66) by Colonel Godwin Austen, who pointed out its peculiar features, namely, the absence or concealment of the tertiary rocks and the presence, with various slates, of a great thickness (some 2,300 feet or more) of dolomite. The dolomite is not, however, continuous through the area; thus, for a space of fifteen miles, which includes the site of the fort of Buxa, it is either absent or concealed.²

Two hundred and fifty miles to the west of Buxa, in the Dikrang valley, the edge of the Lower Himalayas was again observed by Colonel Godwin Austen, and here he found no trace of the Buxa series, but in its place, and immediately inside the tertiary zone, a belt of dark hard sandstones with carbonaceous shales, and seams of crushed flaky coal which probably represents the Damuda formation.³

The third great division of the Himalayas includes the *Snowy range* of the Eastern Himalayas, and its representatives in the Western Himalayas. Messrs. Medlicott and Blandford include the Snowy range in the central or Tibetan division of the mountains, a division which is characterised on the large scale by several parallel axes of gneissic rocks, and intervening synclinal basins of little altered fossiliferous formations.⁴

In the north-western region of the Himalayas, where alone this division has been geologically worked, two great gneissic axes are recognised, the divisions of the main gneissic axis of the Snowy range, and the Ladak axis. As divisions of the main gneissic axis Messrs. Medlicott and Blandford recognise the Dhaoladhar chain, the Pir Panjál, and the Zanskar or Báraláchá.

¹ *Manual*, v.

² *Ibid.* p. 615.

³ *Ibid.* p. 620.

⁴ *Ibid.* p. 519.

But though these great ranges are all classed as gneissic, there is clear evidence of the existence of gneiss of two ages, an older on which unaltered palæozoic strata are found in abrupt contact, and a newer which is formed of converted palæozoic rocks. The former, 'the central gneiss,' forms the great mass of the Snowy range of the Eastern Himalayas, and upon it in palæozoic times the slates and limestones of the Lower Himalayas were deposited. The gneiss of the Dhaoladhar appears to be, to some extent if not altogether, of the same age as that of the Snowy range; much uncertainty still exists as to the age of the gneiss of the Pir Panjál and Zanskar chains; observation thus far points to the probability of the presence there of both the older and the newer gneiss. In the Ladak gneissic axis the whole of the rock appears to be constituted of converted palæozoic strata. As regards the mineral character of the gneiss,¹ the central gneiss is normally composed of white quartz with white felspar (orthoclase or albite), which often forms large crystals in the more massive varieties of the rock; and the basic mineral is mica (biotite or muscovite) often abundant in the more schistose varieties. The rock of the Ladak gneissic axis is on the contrary chiefly syenite, but elsewhere the Silurian slates are found converted into ordinary gneiss.

The granitic axis extends in a band, which seldom exceeds 25 miles in breadth, along the line of peaks of the main range. It occurs in veins and dykes of every size, forming the massive core, up to the summit of the highest mountains. On the west the rock dies out completely, and has not been observed in any of the ranges at a point further west than the Báraláchá pass.²

We have seen that the slates and limestone of the Lower Himalayas are unfossiliferous, and the same character applies to the same formation along the southern face of the Dhaoladhar and Pir Panjál chains. But in crossing the Pir Panjál into Cashmere fossils are found in the carboniferous limestone, sandstone, and shales; still here the underlying Silurian slates have yielded no fossils. 'It is only on crossing the higher range into Tibet³ that a series of marine fossiliferous deposits can be fully recognised. Through this ground the geology of India can be brought into relation with the rest of the world: and the principal formations of the established stratigraphical scale, except the cambrian, devonian, permian, and neocomanian, have been identified.

As has been already noticed, eocene deposits are found in the

¹ *Manual*, p. 627.

² *Ibid.* p. 629.

³ *Ibid.* p. 624.

upper valley of the Indus in the neighbourhood of Leh. They lie in a long trough, examined by Dr. Stoliczka through 200 miles, in the Silurian gneiss of the Ladak axis, showing that here there must have been immense pre-tertiary denudation of the mesozoic and palæozoic formations of the valley.

Considerably to the south-east of this point, in the Hundes valley, the upper valley of the Sutlej beyond the Niti pass, later tertiary deposits exist which have yielded fossil remains of the hipparion, the rhinoceros, and the elephant, and therefore probably belong to the age of the great Siwalik series.¹

Origin of the Indo-Gangetic Plain. It is probable that in eocene times a great sea covered the whole of the Indus plain, and the western portion of the Gangetic plain as far east as Kumaon. The same sea covered the whole or greater part of Persia and Beloochistan, and sent an arm along what is now the Upper Indus valley in Ladak. The Himalayas, and perhaps Tibet, were wholly or in part raised above the sea, but formed in all probability a land of no very high elevation. On the then submerged portion of the uncontorted palæozoic strata of the range, the Sub-Himalayan eocene rocks were at this moment depositing. Probably this land to the east of Kumaon was united to the land of peninsular India. On the east the coast line ran across the Bay of Bengal, and a great sea covered Pegu, the greater portion of what is now the Assam range, and the country which lies to the north-east of it.

‘During the interval that has elapsed since eocene times, the whole of the gigantic forces to which the contortion and folding of the Himalayas and other extra-peninsular mountains are due, must have been exercised,’² and these forces continued in operation during tertiary and post-tertiary times, and in all probability, looking to the common occurrence of earthquakes in extra-peninsular India, these elevating forces are still exerting themselves. In miocene times Western Sind was still beneath the sea, but the existence of an immense thickness of upper tertiary beds of fresh-water origin, which now extends from the Indus along the base of the Himalayas, gives evidence that in the miocene period the greater portion of the Punjaub had risen above its waters. The occurrence of extensive marine miocene deposits in Pegu, and, as appears probable, of such deposits in the Garrow hills, indicates that the contraction of the lower and middle tertiary seas was not so marked in the eastern as in the western area. In pliocene times

¹ *Manual of Geology*, p. 651. General Strachey in the *Q.J. G.S.*, 1851, vol. vii.

² *Manual of Geology*, p. lvi.

the land of Northern India must have assumed very much its present area.

We have seen reason to assume that in eocene times the western sea reached as far east as Kumaon, and that a great eastern sea washed a coast line which was in part formed by the western portion of the Assam range. But there is no evidence that the plains between Kumaon and the Garrow hills were in eocene or even in cretaceous times subject to marine conditions—no marine deposits have been found over that area—while the evidence of the fluvial or terrestrial fossils, and of the peat beds and gravel of the Calcutta bore-hole is, that we have here ‘gradual depression of an area composed of fluvial formations throughout all the later tertiary periods.’¹

When in connection with the geology of the area, we observe ‘the coincidence in general outline, the parallelism in fact between the great area of depression, and the ranges north-east and west of it,’ we have very good reason to believe that ‘the crust movements to which the elevation of the Himalayas, and of the Punjaub, Sind, and Burmese ranges, are due, have also produced the depression of the Indo-Gangetic plain, and that the two movements have gone on *pari passu*.’²

¹ *Manual of Geology*, p. lxi.

² *Ibid.*

CHAPTER II.

GOITRE AND HARD WATER.

Statistics of the distribution of goitre, and table of results of water analysis, in the individual districts of Northern India. Bearing of these upon the 'lime and magnesia theory' of the cause of the disease.

THE table which follows exhibits the proportion of goitre cases to the total number of cases treated in the hospitals and dispensaries of the majority of the districts of Northern India during the five years ending with 1873. Further, the table, columns G and H, shows the results of the analyses which were specially made with a view to determining the amount of lime and magnesia in the waters of goitrous districts, and the amount of lime, and of inorganic matters, which, as learnt from other analyses, is present in the drinking waters of military cantonments situated in these or neighbouring localities. In the case of the latter series of results, the largest and smallest amount of lime found in the wells of each station have, as a rule, been quoted. And as these cantonment wells are generally better constructed and better kept than the wells of the surrounding villages, there can be no doubt that their water is in every respect the purer, and that where much mineral matter is discovered in the waters of the cantonment wells, there will be, soil and other circumstances remaining the same, certainly as much in the village wells.

The notes in the last column are epitomised from those which were sent by the Medical Officers when forwarding the samples of water for analysis.

Now an examination of this table is quite sufficient to disprove the view that an excessive quantity of lime and magnesia in drinking-water is the efficient cause of the disease. Thus, although we find the water almost universally hard in districts such as Purneah, Tirhoot, Chumparun, and Sarun, where goitre more or less generally prevails, yet the water is equally hard across the Ganges in the Patna and Shahabad districts, in which goitre is not an indigenous

disease. And while we find no goitre in the Peshawur valley, in Rajpootana and in Central India, where for the most part the water contains even more lime and magnesia than in the goitrous districts just mentioned, on the other hand the disease abounds in places in the Mymensingh district, and almost throughout the valley of Assam, where the people drink the soft water of tanks and rivers, and in others, as at Buxa, the neighbourhood of Kussowlie, and of Dhurmsala, where spring water very free from inorganic matters is used.

Again, in the case of the Jullundur district of the Punjaub, the water, as the analyses show, is very hard, but goitre is almost unknown there, and such is the case in that part of the adjacent district of Hoshiarpore which is in the plain, but in the valley to the north of the low Hoshiarpore hills goitre is in some places, as at Umb and Anandpore, very prevalent. In like manner the water of the goitrous trans-Gogra districts of Oude is not harder than that of the districts of Lucknow and Roy Bareilly on the south of the river, where goitre is not prevalent.

Very strong evidence of a similar kind was afforded by the analysis of waters of the Bustee and Purneah districts; for in the goitrous villages of Purneah the water varied much; in some villages it was, comparatively speaking, soft, in others hard; while in Bustee the waters of the unaffected villages on the whole presented more lime and magnesia than those of the villages in which the disease is common. In Chumparun the water of an excellent well, that of the Soogong Factory, a water which is popularly supposed to cure the disease, contains more of the earthy bases than that of any of the wells the waters of which are usually drunk by the sufferers and are believed to cause it. Another such case is afforded by the Goruckpore district, where waters were taken for analysis from two villages which were selected as representatives of goitrous and non-goitrous villages; the water of both contained a large proportion of lime and magnesia, but that of the latter the most.

In the Dehra Doon, in parts of which the disease is very prevalent, the drinking waters are very hard, but in the neighbouring districts of Kumaon and Gurhwal, where the disease is even more common, the water, wherever it has been analysed, has been found to be fairly soft. And in Dehra itself prisoners confined in the jail get rid of their goitre without treatment, though they must drink a water which even after being subjected to far more thorough

boiling in the laboratory than practically it can undergo in the jail cook room, remains, owing to its peculiar constitution, very hard.

Then again, as along the Brahmapootra and Chenaub valleys, we find that in certain spots on a river bank goitre is prevalent, while in neighbouring villages similarly situated, where the same water, that of the river, is used, there is none. And here we may notice that in almost all the goitrous localities it is during and shortly after the rains, when the waters, so far as their mineral ingredients are concerned, must be in the state of greatest dilution, that the disease most commonly commences and most rapidly develops.

But not to press at present the arguments against the lime and magnesia theory, we shall find, when we consider the circumstances of the individual districts, that facts in the history of the disease constantly present themselves which are quite unexplainable on that theory, but which tend to show that the disease depends on some influence which can develop itself very locally, independently of any local differences which we can at present recognise in soil, or water, or climate; and may prevail on any soil, coincidently with the use of any water, and in any climate, excepting that the conditions of soil, water, air, and climate must be such as generate malarious disease.

As a rule, in the plains the disease finds its habitat in low marshy tracts of country and along the banks of rivers; in the mountains it prevails in the valleys, or when it is found high up upon the mountain side, it is so amongst people whose calling obliges them to work in the valleys daily, or at least during some part of the year.

As regards the season of the year when the tumour most commonly appears or enlarges, the testimony is almost universal, that it is during or shortly after the rains—the time in fact when fever and spleen are most common. As to soil, the disease is very prevalent on the non-calcareous sand and mud banks of Eastern Bengal and Assam; on the laterite soil of the Dacca and Mymensingh districts; on the clay soil of those and many other localities; on the calcareous soil of Goruckpore and the neighbouring trans-Gogra country of the North-west Provinces; and from one end to the other of the Himalayas, without reference to the geological character of the locality.

Women undoubtedly suffer more frequently than men; but reliable statistics on this point are not forthcoming, because of the

difficulty in India of getting trustworthy information regarding the diseases prevalent amongst the female portion of the population.

Cretinism is associated with goitre in comparatively few places; over large tracts of country the latter disease is almost universally prevalent, yet there are no cretins amongst the people. Where cretinism is present, it will be found that the people suffer severely from malarious disease, and have been reduced by that influence and by inter-breeding to a wretched physical condition; and to the defective and perverted nutrition thus induced the cretinism may most reasonably be referred.

The figures included in columns A, B, C, D, E of the table are taken from the more extended tables of the eight official reports on the results of the analyses of the potable waters of the cantonments of Northern India which were published in Calcutta in 1867, and the four following years.

The potable waters of Northern India have almost without exception an alkaline reaction, dependent generally upon the presence of sodic carbonate, and the lime and magnesia of the water are therefore obtained in the solid residue in the form of carbonates. By the method of analysis which was employed in examining such waters, the total solids after ignition, and recarbonation by means of solution of ammoniac carbonate, were washed by decantation with warm (previously boiled) distilled water, and so yielded the soluble salts included in column D. The lime present in the insoluble residue was subsequently estimated, and, calculated as carbonate, is shown in column C.

The results included in columns G and H¹ of the table were obtained from analyses made, in 1873, in the laboratory of the Calcutta Medical College.² One litre of each water, acidulated with nitric acid, was evaporated down to 200 c.c., ammonia and chloride of ammonium were then added, the fluid filtered, and the lime and magnesia of the filtrate determined.

¹ A dash in either of these two columns means that the lime or magnesia has not been computed. A dash in the last column of the table, opposite the number of cases treated, means no cases of goitre recorded.

² For great help rendered on this, as on many other occasions, I have to thank my most worthy and able assistant, Assistant-Surgeon Taraprasanna Roy, M.B.

Locality	Source of the water analysed	A Total solids of filtered water after ignition and recarbona- tion, grains per gallon	B Earthy carbonates, silica, of A	C Carbonate of lime of B	D Salts dissolved by warm distilled water from A
Calcutta and neighbour- hood	River water as supplied by the Cal- cutta Water Works, August 1873	7.7	—	3.	—
Native Hospital	Tank on glacis of Fort William, April 1867	5.5	3.1	1.5	2.4
Municipal Hospital	Treasury Gate well, Fort William, April 1868	36.5	14.5	10.	—
Medical College Hos- pital	Havildars' tank, Barrackpore, April 1868	5.1	3.2	1.5	—
Alipore Dispensary	Hospital tank, N.I. Lines, Alipore, April 1868	5.5	3.5	—	—
Serampore Dispen- sary	Hospital well, Dum Dum, May 1868	19.7	9.1	4.8	—
Hooghly Dispensary	Tank which formerly supplied the Depôt at Chinsurah (Hooghly), May 1868	9.3	7.2	3.9	—
Moorshedabad.	River Bhagiruttee	11.8	8.9	3.7	2.8
	Tank in N.I. Lines, Berhampore (Moorshedabad)	6.2	4.4	3.1	1.8
	Well of N.I. Hospital	35.	17.5	12.4	17.5
	„ in compound of European Hos- pital, Berhampore	45.2	27.3	19.8	17.8
Nuddea District	—	—	—	—	—
Jessore District	—	—	—	—	—
Backergunge District	—	—	—	—	—
Furreedpore District	—	—	—	—	—
Dacca Hospital	—	—	—	—	—
Chittagong District	—	—	—	—	—
Noacolly District	—	—	—	—	—
Burmah and Arracan	—	—	—	—	—
Mymensingh District	—	—	—	—	—
„ Station Hospital	Tank in village of Shankrail	—	—	—	—
„ Tangrail Dispensary	„ „ Kistopore	—	—	—	—
„ Rungopalpore	„ „ Moocharchure	—	—	—	—
„ Hooshenpore	—	—	—	—	—
„ Sherepore	Tank in the village	—	—	—	—
Cachar, Station Hospital	—	—	—	—	—
Gowalparah District	Brahmapootra, March 1873	—	—	—	—
„ Station Hospital	—	—	—	—	—
„ Gouripore Dispensary	—	—	—	—	—
„ Luckipore	—	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goit. e treated	Remarks
·58	Alk,	—	—	—	—	The total solids of the river (Hooghly) water rise, when the river is at its lowest in March, to 16-17 grains per gallon
1·5	"	—	—	286,802	·004	These analyses fairly represent the weight of mineral matter in the better class of wells and tanks of Lower Bengal. Tanks (artificial ponds) are perhaps the most generally used source of supply to the people. They derive their water from direct rainfall, from the drainage of the surrounding soil, and from the surface drainage of the neighbourhood. The water always contains a large amount of organic matter in solution. Thus in April 1871, when the albuminoid ammonia of the Calcutta water supply from the river Hooghly averaged ·07 parts per million, that of the best preserved tanks on the Calcutta maidan varied from ·4 to ·9 parts per million. The tank water is usually very soft; thus at the period just mentioned the total hardness of the same tanks was about 3°, while that of the Calcutta water supply was about 7°
12·5	"	—	—	22,555	—	
·84	"	—	—	202,998	·009	
·6	"	—	—	58,000	·005	
5·6	"	—	—	24,888	—	
1·05	"	—	—	56,780	·004	
·63	"	—	—	80,841	·015	
·8	"	—	—	—	—	Analysed by Dr. Thomson in November 1867
14·7	"	—	—	—	—	" " "
13·1	"	—	—	—	—	" " "
—	—	—	—	35,460	·009	A goitrous district
—	—	—	—	68,595	·013	
—	—	—	—	24,165	·012	
—	—	—	—	13,170	—	
—	—	—	—	66,802	·43	
—	—	—	—	33,589	—	
—	—	—	—	13,472	·025	
—	—	—	—	—	·004	
—	—	—	—	—	—	
—	—	1·75	—	12,180	·55	
—	—	3·75	—	8,426	7·	
—	—	3·5	—	10,604	·21	
—	—	—	—	8,021	·55	
—	—	1·75	—	3,652	12·6	
—	—	—	—	5,140	·15	
—	—	—	—	—	—	
—	—	—	—	5,241	·21	Total solids (per 1,000) ·104, chlorine ·003. Total hardness 3°·8. Permanent hardness 1°·8
—	—	—	—	1,528	·9	
—	—	—	—	1,082	—	

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Gowhatty (Assam), Station Hospital	Tank in Sepoys' Lines	—	—	—	—
Nowgong „ „ .	Moree (dead) Kullung river . .	—	—	—	—
	Existing stream „ „ . .	—	—	—	—
Seebsaugor (Assam) .	Dikhoo river	—	—	—	—
Luckimpore „ . . .	Dikrang river	—	—	—	—
Luckimpore, North . .	— — — — —	—	—	—	—
Pubna, Station Dispensary	— — — — —	—	—	—	—
„ Serajgunge . . .	— — — — —	—	—	—	—
„ Doolaie	— — — — —	—	—	—	—
Rungpore, District Dispensaries	Teesta river	—	—	—	—
„ „	Well water, village of Kammeah .	—	—	—	—
Julpigoree, District Dispensaries	— — — — —	—	—	—	—
„ Buxa Fort	Spring 'known to produce goitre' .	3.9	—	—	—
	Spring 'supposed to produce goitre' .	5.9	—	—	—
	Another spring	2.8	—	—	—
	Water of a stream	—	—	—	—
Kooch Behar	— — — — —	—	—	—	—
Purneah, Station Hospital	— — — — —	—	—	—	—
Village Pranpore . .	A well	—	—	—	—
„ Kobur	A tank	—	—	—	—
„ Purroora	A well	—	—	—	—
„ Chuck	„	—	—	—	—
„ Gunnespore	„	—	—	—	—
„ Jouneah	„	—	—	—	—
„ Goobrata	„	—	—	—	—
„ Bulwole	„	—	—	—	—
„ Majdeeah	„	—	—	—	—
Bhagulpore, Station Hospital	— — — — —	—	—	—	—
„ Colgong	— — — — —	—	—	—	—
„ Mudheepore	— — — — —	—	—	—	—
Monghyr, District Dispensaries	— — — — —	—	—	—	—
Tirhoot, Station Hospital	— — — — —	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
—	—	2.75	.58	4,360	.8	
—	—	3.5	.43	2,612	31.4	Goitre very prevalent along the banks
—	—	5.0	3.21	—	—	During the rains the Brahmapootra sends a stream through this channel. At Nowgong station, where this water is drunk, it is not supposed to cause goitre, but the people in the district who live along the banks ascribe the disease to the use of the water
—	—	2.9	.58	10,152	9.	Goitre very prevalent in some villages on the bank of the river, and is attributed by the people to the use of the river water
—	—	1.87	.58	3,406	8.5	Total solids .072, chlorine .004 per 1,000. Goitre ascribed to use of this water
—	—	—	—	1,607	20.	
—	—	—	—	10,663	.1	
—	—	—	—	8,339	6.7	Brahmapootra water (see Gawalparah for analysis) largely used here
—	—	—	—	14,495	.08	
—	—	2.37	.43	94,172	15.2	At Kammeah people use well water, 2 per cent. goitred. At village on opposite bank of river, where Teesta water is used, 4.8 per cent. are affected
—	—	3.12	1.16	—	—	
—	—	—	—	30,652	1.9	Number of cases in the district very great, quite out of proportion to the number treated at the dispensary. Teesta water largely used.
—	—	2.0	.87	—	—	Natives of the neighbourhood, and troops stationed at the Fort suffer in large numbers from goitre
—	—	2.75	1.46	—	—	
—	—	1.37	.58	—	—	
—	—	2.12	—	—	—	
—	—	—	—	19,375	2.	
—	—	—	—	10,966	41.3	
—	—	5.0	2.48	—	—	No goitre in this village
—	—	4.9	2.6	—	—	
—	—	7.	2.5	—	—	Goitre prevalent in this village
—	—	6.3	3.7	—	—	" "
—	—	5.6	6.	—	—	" "
—	—	6.3	1.3	—	—	" "
—	—	4.25	—	—	—	" "
—	—	5.9	3.4	—	—	" "
—	—	19.	2.8	—	—	" "
—	—	—	—	23,980	.05	
—	—	—	—	10,308	—	
—	—	—	—	7,410	2.6	
—	—	—	—	41,677	.01	
—	—	—	—	64,791	50.	

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Tirhoot, Durbhungah Dispensary	—	—	—	—	—
„ Madhoobanee „	—	—	—	—	—
„ Hajepore „	—	—	—	—	—
„ Tajpore „	—	—	—	—	—
„ Seetamadhee „	—	—	—	—	—
Chumparun, Station Hospital	Well on outskirts of Betteeah .	—	—	—	—
„ Betteeah .	Well in the town of Betteeah .	—	—	—	—
„ Village Buswariah,	Well used by the village .	—	—	—	—
„ 15 miles east of					
„ Betteeah .					
„ „ Ownra, 3 miles	„ „ . . .	—	—	—	—
„ from the above					
„ „ Sunbursa, 15 miles	„ „ . . .	—	—	—	—
„ east of Buswaria					
„ „ Panapur, nr. above	„ „ . . .	—	—	—	—
Soogong Factory well, about 3 miles from Panapur	—	—	—	—	—
Sarun, Station Hospital (Chupra)	—	—	—	—	—
„ Sewan Dispensary .	—	—	—	—	—
„ Hutwa „	—	—	—	—	—
Nepaul, Katmandoo Dispensary	—	—	—	—	—
Patna, Station Hospital .	—	—	—	—	—
„ Bankipore Dispensary	—	—	—	—	—
„ Barh „	—	—	—	—	—
Dinapore „	—	—	—	—	—
„ „	Hospital well, British troops	29.5	21.2	14.9	8.3
„ „	Artillery well	56.3	29.1	21.5	27.2
„ „	No. 1 well, N.I. Lines	63.2	29.9	17.	33.3
„ „	River Soane	7.2	5.3	3.8	1.9
Shahabad, District Dispensaries	Well near Buxar . . .	—	—	—	—
	„ „ „ . . .	—	—	—	—
	Well of the Buxar Dispensary .	—	—	—	—
Gya Dispensary . . .	—	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
—	—	—	—	35,625	12·	
—	—	—	—	11,228	18·	
—	—	—	—	11,222	21·5	
—	—	—	—	6,873	11·5	
—	—	—	—	15,398	57·	
—	—	14·	5·8	19,239	30·	Not much goitre in the town of Bettedah, but a good deal in the neighbouring villages. The water of the well on the outskirts is believed to cure goitre, that of the one in the town to cause it
—	—	9·6	1·4	23,522	3·	
—	—	13·3	8·2	—	—	Much goitre in these villages. Villages very poor and dirty—only one well in each
—	—	13·2	7·3	—	—	” ”
—	—	18·3	4·4	—	—	The whole village suffers from goitre. Well in centre of village in very bad condition. Much marshy land in neighbourhood
—	—	10·5	4·1	—	—	Much goitre. Well in bad condition. Village on margin of a large marsh
—	—	18·5	13·	—	—	This water is supposed to cure goitre. Well about same depth as those of neighbouring villages, 22 feet, and about 6 feet of water in it. The well is of masonry, well constructed, and the surroundings very clean
—	—	—	—	22,604	1·	
—	—	—	—	6,121	·38	
—	—	—	—	6,499	18·	50 miles NW. of Chupra, near Gorruckpore frontier
—	—	—	—	74,008	43·	
—	—	—	—	55,224	·6	Goitre not endemic in district, but very common in Tirhoot on opposite side of river
—	—	—	—	32,884	2·6	Patients from Tirhoot on opposite bank of river
—	—	—	—	11,387	·23	Ganges at Patna in March, per 1,000 of filtered water:—Total solids ·26, lime ·0·49, magnesia ·024, chlorine ·015. Total hardness 10°, permanent hardness 2°·8
—	—	—	—	24,150	·44	
2·2	Alk.	—	—	—	—	Sodic sulphate is largely present in the water of the Dinapore wells
110·7	”	—	—	—	—	
110·3	”	—	—	—	—	
·4	”	—	—	—	—	
—	—	15·0	7·9	102,945	·037	No goitre in the district
—	—	10·5	4·1	—	—	
—	—	13·3	6·4	—	—	
—	—	—	—	23,929	·02	

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Hazaribagh Dispensary .	Artillery well, Hazaribagh . . .	15.3	7.7	5.4	7.6
Singhboom Dispensary .	Hospital, outer well . . .	6.9	4.2	1.8	2.7
Chota Nagpore . . .	— . . .	—	—	—	—
Beerbhoom and Manbhoom . . .	— . . .	—	—	—	—
Bancoorah . . .	— . . .	—	—	—	—
Burdwan . . .	— . . .	—	—	—	—
Cuttack . . .	— . . .	—	—	—	—
Sumbulpore . . .	— . . .	—	—	—	—
Sonthall Pergunnahs .	— . . .	—	—	—	—
N.W. Provinces, Ghazee-pore District Dispensaries .	— . . .	—	—	—	—
Azimgurh „ „ .	— . . .	—	—	—	—
Jounpore „ „ .	— . . .	—	—	—	—
Benares „ „ .	European Inf. Hospital well, Benares	23.9	12.6	11.5	11.3
	„ Cavalry, „	17.5	13.	11.6	4.5
Goruckpore „ „ .	— . . .	—	—	—	—
„ Village Pudrowna .	Well	—	—	—	—
„ Beeloochia, $\frac{1}{2}$ a mile from Pudrowna .	Well	—	—	—	—
Bustee, District Dispensaries .	— . . .	—	—	—	—
„ Village Kulwaree .	Well	—	—	—	—
„ Gaighat . . .	Well	—	—	—	—
„ Gahnah . . .	Well	—	—	—	—
„ Pawree . . .	Well	—	—	—	—
„ Koosowrah . . .	Well	—	—	—	—
„ Dhobahut . . .	Well	—	—	—	—
„ Shujawulpore . . .	Well	—	—	—	—
„ Bhunjareejote . . .	Well	—	—	—	—
„ Bhuggulpore . . .	Well	—	—	—	—
„ Gowra . . .	Well	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
44.2	Alk.	—	—	22,897	—	Analysed by Dr. Thomson in June 1867
41.5	"	—	—	—	—	
—	—	—	—	11,631	.02	
—	—	—	—	—	.03	
—	—	—	—	?	—	
—	—	—	—	11,003	—	
—	—	—	—	112,298	.005	
—	—	—	—	315,122	—	
—	—	—	—	22,878	—	
—	—	—	—	22,260	.017	
—	—	—	—	138,843	.037	
—	—	—	—	45,598	.03	Dr. May, December 1868
—	—	—	—	75,095	.01	
22.8	Alk.	—	—	245,389	.008	
11.7	"	—	—	—	—	
—	—	—	—	162,786	26.	
—	—	15.0	7.6	—	—	
—	—	20.	7.6	—	—	
—	—	—	—	60,453	13.	
—	—	15.8	6.6	—	—	
—	—	11.3	3.2	—	—	
—	—	22.5	7.9	—	—	5.3 per cent. of inhabitants goitred. Sanitary state fairly good. People fairly healthy 2.2 per cent. goitred. Sanitation and health of people fairly good 6.7 per cent. goitred. Village fairly healthy 7.9 per cent. goitred. Village filthy, people fairly healthy 5.2 per cent. goitred No goitre. In the Bustee district goitre is most prevalent in the police circles " Gaighat and Chupraghat along the north bank of the Gogra. Percentage of goitre in the other police circles is comparatively small. Soil in the affected districts a mixture of clay and sand; subsoil more sandy. No evidence of either being generally calcareous, though kunkhur found in places
—	—	15.	5.4	—	—	
—	—	20.6	7.6	—	—	
—	—	17.5	7.2	—	—	
—	—	12.4	7.2	—	—	
—	—	11.2	3.9	—	—	
—	—	18.7	7.3	—	—	
—	—	16.2	6.	—	—	

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Oude; Gonda, District Dispensaries	—	—	—	—	—
Village Belwa, 10 miles south of the Sudder Station	Well	—	—	—	—
Town Ultrowla, 30 miles north of the Sudder Station	Well 40 feet deep, dug in sand .	—	—	—	—
Another well in the town	Well 17 feet deep, dries up in hot season	—	—	—	—
Bharaitch, District, Dispensaries	—	—	—	—	—
Village Bunwapore .	—	—	—	—	—
„ Jarbut .	—	—	—	—	—
Another village .	—	—	—	—	—
„ „ .	—	—	—	—	—
„ „ .	—	—	—	—	—
Kheree, District Dispensaries	—	—	—	—	—
Fyzabad District Dispensaries	—	—	—	—	—
Village Bubu Serai, 1½ miles from the Gogra	Well	—	—	—	—
„ Beekapore, 3 miles from the Gogra	Well	—	—	—	—
Seetapore, District Dispensaries	R.A. Hospital well, Seetapore . .	15.4	13.	—	—
Oraie, District Dispensaries	European Hospital „ . .	14.7	12.6	—	—
	Jail well	—	—	—	—
	Station garden well	—	—	—	—
	Well of neighbouring village . .	—	—	—	—
Hurdui, District Dispensaries	—	—	—	—	—
Bara Banki „ „ .	—	—	—	—	—
Oonao „ „ .	—	—	—	—	—
Roy Bareilly „ „ .	Wells in the Station	—	—	—	—
Lucknow „ „ .	Right Infantry Lines, Hospital well	18.4	14.	8.1	4.4
	Left Infantry Lines, „ „	17.2	12.2	7.	5.
	No. 29, Right Infantry Lines . .	12.8	7.2	7.	5.6
	No. 35 „ „	23.6	15.4	9.7	8.2
	R.A. Hospital well	19.1	12.9	8.	6.2
Sultanpore „ „ .	—	—	—	—	—
Pertabgurh „ „ .	—	—	—	—	—
Rohilcund, Bareilly District Dispensaries	—	—	—	—	—
„	European troops, Hospital well, Bareilly	19.1	14.4	9.8	4.7

	F	G	H			
	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
	—	—	—	66,879	38·	
	—	16·3	6·8	—	—	20 per cent. goitred, no cretins. Village in neighbourhood of a large marsh
	—	9·6	2·8	—	—	Not many people in the town goitred. Water of this well thought very wholesome
	—	17·5	4·4	—	—	Well supposed to be fed by a stagnant pool near it. The well water is much dreaded as a cause of goitre
	—	—	—	32,875	38·	
	—	6·3	5·4	—	—	No goitre
	—	10·5	8·3	—	—	Goitrous village
	—	9·0	5·	—	—	" "
	—	8·7	3·6	—	—	" "
	—	11·3	4·4	—	—	" "
	—	—	—	53,234	·3	See account of the district. Goitre far more common than the number of cases treated indicates
	—	—	—	60,058	12·	
	—	14·	7·2	—	—	No goitre. Soil clay, then kunkhur, then sand in which water found
	—	14·6	8·0	—	—	About 15 per cent. goitred. Soil as above. Village on raised ground, but low ground around it
·74	Alk.	—	—	19,203	·04	
·84	"	—	—	—	—	Analysed by Dr. Orton in Jan. 1869
	—	4·8	10·4	—	—	No goitre in the district
	—	4·25	10·4	—	—	" "
	—	11·1	6·4	—	—	" "
	—	—	—	67,716	·005	
	—	—	—	39,630	·043	
	—	16·2	—	25,838	—	
	—	7·5	—	39,824	—	
·36	Alk.	—	—	105,969	·04	Dr. Bonavia, cold season, 1866-7
·36	"	—	—	—	—	" The soluble matters, D, in the case
·36	"	—	—	—	—	" of the Lucknow waters include
·5	"	—	—	—	—	" a large proportion of sodic carbonate
	—	—	—	22,392	—	
	—	—	—	267,589	2·6	
2·6	Alk.	—	—	—	—	Examined by Dr. Whitwell in July 1869

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Rohilkund, Bareilly District Dispensaries	Well No. 12, in the Jail	14.4	11.7	6.5	2.7
Shahjehanpore „ „ .	Well No. 9 in N.I. Lines	16.5	14.5	9.6	2.0
	European Troops Hospital well . .	21.4	17.15	10.6	4.3
	Mess House well	19.7	16.8	9.9	2.9
	Well in N.I. Lines	28.9	23.3	12.3	5.6
Budaon „ „ .	— — — — —	—	—	—	—
Bijnore „ „ .	— — — — —	—	—	—	—
Moradabad „ „ .	— — — — —	—	—	—	—
	Well in plain near the N.I. Butts .	16.7	11.7	6.7	5.0
	Well No. 3, in the Jail	15.8	12.0	6.2	3.8
Rampore State „ „ .	— — — — —	—	—	—	—
N.W. Provinces, Allahabad District Dispensaries	No. 1 well, new N.I. Lines, Allahabad	27.7	15.4	9.5	12.3
	Well. European Infantry, Mansfield Lines	28.9	16.8	11.0	12.1
„ „ .	Artillery well, Wellington Lines .	21.4	17.1	16.0	4.3
„ „ .	No. 1 well in the Fort	34.1	20.7	15.4	13.4
„ „ .	Ganges river	7.7	5.3	3.2	2.4
„ „ .	Jumna „	10.9	7.9	6.5	3.0
Futtehpore District Dispensaries	— — — — —	—	—	—	—
Cawnpore „ „ .	Hospital well, British Troops . . .	22.4	15.4	6.3	7.0
	Well in R.A. Lines	26.8	18.5	8.3	1.6
	River Ganges at Cawnpore	8.5	5.3	2.5	3.2
	Ganges Canal at Cawnpore	7.4	5.7	3.7	1.7
Furruckabad „ „ .	— — — — —	—	—	—	—
Jaloun „ „ .	— — — — —	—	—	—	—
Etawah „ „ .	— — — — —	—	—	—	—
Mynpoorie „ „ .	— — — — —	—	—	—	—
Mirzapore „ „ .	— — — — —	—	—	—	—
Allyghur „ „ .	Well No. 1, N.I. Lines	41.5	29.0	10.5	12.5
	Well in the Jail garden	19.8	12.8	6.3	7.0
	Well on the Railway platform . . .	64.0	25.8	14.4	38.3
Agra „ „ .	Moti Kooah (well)	17.2	10.4	9.7	6.8
	Scindiah's Well	22.7	16.5	12.9	6.2
	Well No. 8, British Lines	41.3	18.3	11.2	23.0
	Well No. 69, N.I. Lines	90.7	26.4	14.4	64.3
Muttra „ „ .	Well in the Church compound . . .	26.2	10.8	10.2	15.4
	Well in the Hospital compound . .	46.8	15.0	12.3	31.8
	Jumna river, 1½ miles below Muttra	12.5	7.6	4.2	4.9
Meerut „ „ .	Well No. 11½, R.A. Lines	19.2	15.0	—	4.2
	Artillery Hospital well	20.4	16.1	10.6	4.3
	Hospital well, B.I. Lines	11.2	8.0	7.2	3.2
Boolundshuhur „ „ .	— — — — —	—	—	—	—
Mozuffernuggur „ „ .	— — — — —	—	—	—	—
Saharunpore „ „ .	— — — — —	—	—	—	—
Roorkee „ „ .	Well near the Engineers' Mess House	11.6	9.1	6.0	2.5
	Well used by students of the Thomason College	10.8	6.2	5.2	4.6
Dehra Doon „ „ .	— — — — —	—	—	—	—

E	F	G	H	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon			
1.3	Alk.	—	—	—	—	Examined by Dr. Whitwell in July 1869
1.1	"	—	—	—	—	
1.4	"	—	—	94,615	0.6	
.3	"	—	—	—	—	
3.4	"	—	—	—	—	
—	—	—	—	253,222	.22	" "
—	—	—	—	43,705	.13	
—	—	—	—	—	—	
1.6	Alk.	—	—	—	—	
2.4	"	—	—	—	—	
—	—	—	—	23,725	.5	Dr. May, cold season of 1869
4.	Alk.	—	—	95,454	.004	
2.	"	—	—	—	—	
2.6	"	—	—	—	—	
3.2	"	—	—	—	—	
1.05	"	—	—	—	—	October, 1867
1.6	"	—	—	—	—	"
—	—	—	—	23,051	.013	Analysed by Dr. Compigné in October 1867
1.3	Alk.	—	—	13,190	.007	
.9	"	—	—	—	—	
.8	"	—	—	—	—	Dr. Milne, April 1867
1.2	"	—	—	—	—	" "
—	—	—	—	90,382	—	Analysed by Dr. Whitwell in August 1869
—	—	—	—	70,472	.008	
—	—	—	—	36,754	—	
—	—	—	—	20,162	.005	
—	—	—	—	132,519	.02	
3.	Alk.	—	—	65,169	—	Analysed by Dr. May in January 1869. Carbonates and sulphates of the alkalies freely present in most of the Agra well waters, with, in not a few of them, nitrates also
1.9	"	—	—	—	—	
20.5	"	—	—	—	—	
2.9	"	—	—	213,468	.005	
3.6	"	—	—	—	—	
9.8	"	—	—	—	—	By Dr. May in June 1868
32.4	"	—	—	—	—	
9.5	"	—	—	110,077	.006	
16.7	"	—	—	—	—	
1.4	"	—	—	—	—	
2.5	"	—	—	109,613	.1	Analysed by Dr. Sheppard in December 1866
2.2	—	—	—	—	—	
.5	Alk.	—	—	—	—	
—	—	—	—	68,926	.04	
—	—	—	—	41,307	.02	
—	—	—	—	11,234	.02	Dr. Murray Thomson, May 1868
1.2	Alk.	—	—	—	—	
.9	"	—	—	—	—	
—	—	—	—	—	—	
—	—	—	—	76,966	12.2	

For analysis of waters, see the text

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Mussoorie Dispensary	—	—	—	—	—
	Spring on the Castle estate . . .	15.2	11.7	7.9	4.2
	Vincent's Hill spring . . .	10.3	7.8	4.5	2.5
	Mackinnon's Brewery spring, Mussoorie . . .	27.5	14.8	10.7	12.7
	Landour Tank . . .	12.4	9.6	7.6	2.8
Gurhwal Dispensaries	—	—	—	—	—
Village Bhamote . . .	Rivulet . . .	—	—	—	—
	A spring . . .	—	—	—	—
Almorah . . .	Spring in the Goorkha Lines . . .	11.6	—	6.6	—
	Spring 1,000 feet down the hillside .	4.1	—	1.9	—
	Spring at Raneedar, 2 miles from Almorah	4.2	—	1.5	—
Nynee Tal . . .	—	—	—	—	—
Ranee Khet . . .	—	—	—	—	—
Kumaon, Ramnugger Dispensary	—	—	—	—	—
Kaladoongha „ . .	—	—	—	—	—
Huldwanee „ . .	—	—	—	—	—
Chuckrata . . .	—	—	—	—	—
Rajpootana, Bundelcund, Central India	—	—	—	—	—
Punjaub, Rohtuk District Dispensaries	—	—	—	—	—
Kurnaul „ „ . .	—	—	—	—	—
Jullundur District Dispensaries	Artillery Hospital well, Jullundur .	12.7	7.4	4.5	4.6
	European Hospital well . . .	16.1	9.9	7.7	6.2
	Well SW. of Native Cavalry Lines .	8.6	4.1	1.9	4.5
Umritsur „ „ . .	N.I. Hospital well . . .	18.1	12.2	7.7	5.9
	Hospital well, British troops in the Fort	16.2	6.1	3.3	10.1
	Well near officers' quarters, in the Fort	20.2	10.4	6.7	9.8
Lahore City . . .	Hospital well, British Infantry Lines, Meean Meer (Lahore)	56.3	8.2	4.4	48.7
	The Bath well, B.I. Lines . . .	42.8	9.9	6.3	32.9
	Hospital well, Lahore Fort	36.6	12.5	10.4	24.1
	River Ravee . . .	10.1	8.8	4.7	2.3
Jhelum District Dispensaries	—	—	—	—	—
Pind Dadun Khan .	—	—	—	—	—
	The Jhelum, 1½ miles below Jhelum	7.7	—	—	—
	Well No. 2, in N.I. Lines, Jhelum .	15.3	7.7	—	7.6
	„ No. 8, Cavalry Hospital well .	12.6	10.5	—	2.1
	„ No. 5, N.I. Hospital well . .	15.4	9.3	—	6.1

E	F	G	H			Remarks
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	
—	—	—	—	15,110	5.3	
1.2	Alk.	—	—	—	—	Analysed by Dr. May in August 1869. Dr. May says, 'The sulphuric acid present in the water shows a considerable proportion to the total amount of solids, and I believe exists nearly altogether in union with lime.'
.56	"	—	—	—	—	
.75	"	—	—	—	—	
.28	"	—	—	—	—	
—	—	—	—	37,610	7.5	
—	—	7.3	.6	—	—	Much goitre in this village. Water sources the rivulet and spring
—	—	4.7	1.1	—	—	
3.6	Alk.	—	—	26,636	16.	Analysed by Dr. May in June 1871
.6	"	—	—	—	—	
1.2	"	—	—	—	—	
—	—	—	—	24,713	2.	For analysis of the water, see the text
—	—	—	—	11,488	2.	For analysis of Rancee Khet waters, see the text
—	—	—	—	19,401	3.5	
—	—	—	—	20,043	5.	
—	—	—	—	19,729	1.3	
—	—	—	—	—	—	For analysis of the Chuckrata waters, see the text
—	—	—	—	—	—	Details not given, as goitre may be said to be absent in these Provinces
—	—	—	—	31,374	—	
—	—	—	—	148,489	—	
3.4	Alk.	—	—	126,139	.02	Analysed by Dr. R. B. Thomson in November 1868
1.5	"	—	—	—	—	" "
2.5	"	—	—	—	—	" "
.9	"	—	—	231,616	.04	Analysed by Dr. R. B. Thomson in December 1868
2.	"	—	—	—	—	" "
1.9	"	—	—	—	—	" "
2.8	"	—	—	125,264	.6	Analysed by Dr. Sheppard in January 1869. Many of the well waters contain a large quantity of alkaline sulphates and carbonates and a small quantity of nitrates
1.8	"	—	—	—	—	
5.5	"	—	—	—	—	
.32	"	—	—	—	—	
—	—	—	—	77,794	.003	
—	—	—	—	2,849	.18	
1.3	Alk.	—	—	—	—	Total hardness 2.2. Permanent hardness 1.3. Analysed by Dr. Harvey in May 1869
1.5	"	—	—	—	—	" "
1.9	"	—	—	—	—	" "

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Rawul Pindi District	—	—	—	—	—
„ Attock	—	—	—	—	—
	Indus, at Attock, when low, December 1868	9.7	5.4	—	4.3
	Indus, at Attock, when in flood, June 1868	4.8	3.7	3.	1.1
	Well No. 6, west of the Fort, December 1868	27.	—	11.6	1.1
	Well No. 1, in the upper Fort, December 1868	239.	—	—	—
„ Huzroo	—	—	—	—	—
„ Hussan Abdul	‘The springs’ (Center, Nov. 1868)	24.5	—	16.3	—
„ Futteh Jhung	—	—	—	—	—
„ Goojur Khan	—	—	—	—	—
„ Pindi Gheb	—	—	—	—	—
	R. Pindi, well No. 4, Right Infantry Lines	30.9	—	14.6	—
	R. Pindi, Artillery Hospital well	29.	—	—	—
	Well behind Right N.I. Lines	29.1	15.9	11.8	13.2
	Elahie Bux's well in the Sudder Bazaar	26.5	—	11.8	—
„ Murree	Reservoir supplying Married Men's Barracks	21.7	17.1	11.9	4.6
	Reservoir east of Clifden Barracks	13.2	11.4	9.7	1.8
	Reservoir below the Bazaar	25.3	18.9	9.6	6.4
Hazara District, Abbottabad	Hospital well, N.I. Lines	26.5	17.8	11.9	8.7
	The Kotwalie well	22.1	18.7	14.4	3.4
„ Hurreepore	Well in the Dispensary compound	18.	14.4	12.	3.6
	Well in the City	20.8	17.5	13.9	3.5
Kangra District	Spring used by E. Troops at Bagshoo, (Dhurmsala)	7.9	5.6	4.	2.3
„ Dhurmsala Dispensary	Spring 200 yards below Ghoorkha Hospital	6.7	4.9	1.	1.8
	Spring above the Native Bazaar	5.6	3.5	2.1	2.1
	General Prior's Spring	7.2	4.4	1.9	2.8
„ Palumpore	—	—	—	—	—
„ Kangra Town	Well on north glacis of Fort Kangra	29.8	21.7	16.5	8.1
	Spring on the ridge used by Troops	27.	18.6	11	8.4
	River Baingunga	4.9	2.8	1.6	2.1
„ Nurpore	—	—	—	—	—
Goordaspore District	—	—	—	—	—
„ Station Hospital	—	—	—	—	—
„ Madhopore	River Ravee	—	—	—	—
„ Pathankote	Well	—	—	—	—
„ Butala	River Chukhee	—	—	—	—
„ Dehrewala	Well	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
—	—	—	—	—	—	No goitre in the immediate neighbourhood of the Station of R. Pindi
—	—	—	—	20,608	·5	
·42	—	—	—	—	—	
·21	—	—	—	—	—	
—	—	—	—	—	—	
66·	—	—	—	—	—	
—	—	—	—	24,262	·77	Northern part of the R. Pindi district, near the Hazara
·35	—	—	—	10,166	·6	
—	—	—	—	23,629	—	In the central and southern plain portion of the district
—	—	—	—	28,153	·04	
—	—	—	—	3,003	·16	
1·12	Alk.	—	—	—	—	Analysed by " Dr. Center in October " 1868
1·3	"	—	—	—	—	" "
·74	"	—	—	—	—	" "
1·4	"	—	—	—	—	" "
1·9	"	—	—	—	—	Analysed by Dr. Center in August 1868
·7	"	—	—	—	—	" "
3·2	"	—	—	—	—	" "
1·7	"	—	—	48,331	3·8	Analysed by " Dr. Center " in September 1868.
·84	"	—	—	—	—	Goitre very common in the district
·7	"	—	—	39,590	3·2	Analysed by Dr. Harvey in August 1869
1·7	"	—	—	—	—	
·63	"	—	—	—	—	Analysed by Dr. Whitwell in May 1870
·63	"	—	—	19,928	13·1	
·18	"	—	—	—	—	
·63	"	—	—	—	—	
—	—	—	—	20,530	13·8	
2·3	Alk.	—	—	16,385	8·5	Analysed by Dr. Whitwell in April 1870
2·5	"	—	—	—	—	" " "
1·05	"	—	—	—	—	" " "
—	—	—	—	20,863	8·4	
—	—	—	—	—	—	
—	—	—	—	58,772	·52	
—	—	4·8	2·9	23,708	7·	Water of the Ravee and Chukhee largely used by the goitred people in the neighbourhood
—	—	28·7	17·7	17,698	5·5	Little goitre in the village itself
—	—	5·6	7·3	42,080	—	
—	—	8·0	1·5	—	—	57·5 per cent. goitred ; water supply partly from wells, partly from the Chukhee

Locality	Source of the water analysed	A Total solids of filtered water after ignition and recarbona- tion, grains per gallon	B Earthy carbonates, silica, of A	C Carbonate of lime of B	D Salts dissolved by warm distilled water from A
Goordaspore District					
Narot	Well	—	—	—	—
Bheempore	Well	—	—	—	—
Dalhousie	Spring at Dyune Khoon which affords the main supply to the Station	4.6	3.2	1.12	1.4
	Spring at Balloon used by the Troops	6.	4.2	1.8	1.8
	„ on the Chumba road	3.9	2.8	.8	1.1
Bukloh	Principal spring	10.8	9.1	4.2	1.7
„	Hospital spring	10.2	7.	6.	3.2
„	Spring below the barracks used by the families of the Sepoys	8.4	6.3	4.9	2.1
Sealkote Station		—	—	—	—
„ District Dispensaries		—	—	—	—
	European Infantry Hospital well, Sealkote	23.4	15.4	9.8	8.
	School-house well	20.6	11.9	6.8	8.7
	Well near Artillery stables	11.2	7.9	6.4	3.3
	Bath house well	16.4	10.2	5.	6.2
Gujrat Dist. Dispensaries		—	—	—	—
Ferozepore „ „	European Troops, Hospital well	18.5	10.6	5.5	7.9
	Artillery Hospital well	52.5	24.4	8.9	28.1
	Well No. 14, outside the Fort	30.	14.6	9.7	15.4
	Well No. 19, in N.I. Lines	28.1	15.9	8.3	12.2
Goojranwala „	—	—	—	—	—
Shahpore „ „	—	—	—	—	—
Midh village	Well	—	—	—	—
Neighbouring village	„	—	—	—	—
Chenab River at Midh	—	—	—	—	—
Delhi District Dispen- saries	—	—	—	—	—
	Jumna River at Delhi	9.7	7.2	4.9	3.5
	Putthar Ghatti well at Delhi	21.6	11.7	7.4	9.9
	Delhi Gate well „	156.2	59.4	33.4	96.8
	Khyrattee Gate well „	105.6	39.8	28.6	65.8
Umballa District. Ex- cepting Muni Majra, and Jugadri subdivisions.	—	—	—	—	—
Jugadri	—	—	—	—	—
	Tangra well, supplying troops, Um- balla	34.4	14.4	8.5	20.
	Tangri well „ „	20.3	13.4	9.7	7.6
	N.I. Hospital well „ „	75.2	30.	21.7	45.2
	Guggur River, 8 miles from Umballa	14.8	9.7	6.3	5.1
	Auxiliary Jail well, near the Guggur	38.2	16.1	10.2	22.
	Lake in Mount Morni, Sewaliks north of Umballa	9.	5.3	3.5	3.7
Hissar District Dispen- saries	—	—	—	—	—

E	F	G	H			Remarks
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	
—	—	11.1	5.0	—	—	Little or no goitre in these villages
—	—	9.8	4.3	—	—	—
.42	Alk.	—	—	7,689	2.8	Analysed by Dr. Whitwell in July 1870
.84	"	—	—	—	—	" " "
.21	"	—	—	—	—	" " "
.21	"	—	—	—	—	" " "
1.1	"	—	—	—	—	" " "
.63	"	—	—	—	—	" " "
—	—	—	—	66,633	.33	—
—	—	—	—	80,413	.003	—
.6	"	—	—	—	—	Analysed by Dr. R. B. Thomson in December 1868
2.4	"	—	—	—	—	" " "
.5	"	—	—	—	—	" " "
1.12	"	—	—	—	—	" " "
—	—	—	—	42,187	.0	—
1.9	"	—	—	49,389	.02	—
3.7	"	—	—	—	—	Analysed by Dr. R. B. Thomson in October 1868
2.1	"	—	—	—	—	" Many of the Ferozepore well waters
.8	"	—	—	—	—	contain a large amount of sulphate of
—	—	—	—	80,987	.05	" soda and a small quantity of nitrates
—	—	—	—	133,507	.05	—
—	—	11.1	3.7	—	—	Goitre very prevalent at Midh; see the text
—	—	8.9	3.9	—	—	—
—	—	5.6	.7	—	—	—
—	—	—	—	101,027	.006	—
.72	Alk.	—	—	—	—	—
3.5	"	—	—	—	—	Analysed by Dr. Sheppard in April 1867.
57.	"	—	—	—	—	The Delhi well waters, as a rule, contain an
41	"	—	—	—	—	enormous quantity of nitrates and chlorides,
—	—	—	—	154,670	—	derived from the accumulated products of
—	—	—	—	—	—	the decomposed sewage of centuries
—	—	—	—	43,596	3.9	—
1.8	Alk.	—	—	—	—	Carbonate of soda 13.2 grs. Analysed by Dr.
.75	Alk.	—	—	—	—	Sheppard, cold season 1867-68
15.3	"	—	—	—	—	—
.75	"	—	—	—	—	—
3.4	"	—	—	—	—	—
.42	"	—	—	—	—	—
—	—	—	—	68,536	—	—

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Sirsah District Dispensaries	—	—	—	—	—
Loodiana „ „	—	—	—	—	—
Simla Dispensary . . .	—	—	—	—	—
Dugshaie	Spring which supplies cantonments	12·	4·9	3·9	7·3
	{ Tank supplied by the main spring .	17·6	10·3	7·1	7·3
Subathoo	{ Canteen well	28·1	13·9	9·4	14·2
	{ Bakery well	21·2	15·2	8·8	6·
Kussowlie Dispensary .	Well at Baija, 4 miles from Kussowlie	—	—	—	—
	Main spring, Kussowlie	11·2	3·6	2·5	7·6
Nalaghur State	Sappers and Miners' spring, Kussowlie	8·8	4·3	4·3	4·5
	Deep well at the entrance of the town of Nalaghur	—	—	—	—
	Surface spring near town	—	—	—	—
	Spring at Lond	—	—	—	—
Mundi State	Sirkari Baoli	—	—	—	—
	Deh ki Baoli	—	—	—	—
	Beeas River	—	—	—	—
Hoshiarpore District Dis-	—	—	—	—	—
„ „	Well in Town of Umb	—	—	—	—
	Stream near the Town	—	—	—	—
	Well in Town of Anandpore	—	—	—	—
	—	—	—	—	—
Peshawur, City Dispensary	{ Well inside Fort Shubkudur	22·3	18·	12·5	4·3
Shubkudur	{ Well in the encamping ground outside the Fort	32·	28·8	21·8	3·2
	{ Well No. 1, in the Fort	10·5	7·5	4·4	3·
Murdan	{ Well No. 4, large well in the Fort .	11·7	9·	5·3	2·7
	{ Well No. 8, the Jail well	14·6	11·9	6·6	2·7
	Mackeson's Well, Peshawur	26·6	14·7	6·	11·9
	Artillery well	27·2	19·4	8·	7·8
	Cowasjee's Well in the Sudder Bazaar	27·	19·	12·8	8·
	Canal supplying the cantonments . .	11·4	9·2	4·3	2·2
	Well in Fort Abazaie	14·3	11·6	8·1	2·4
	Water of Swat River at Fort Abazaie	9·1	7·3	4·5	1·8
	Well in Fort Michnee	20·9	12·8	7·7	8·1
	Water of the Cabul River at Nowshera	9·3	5·1	3·5	4·2
	Hospital well, Nowshera	16·8	12·	8·2	4·8
	The Bath-house well „	17·4	11·9	8·	5·5

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
—	—	—	—	23,863	—	
—	—	—	—	77,286	·026	
—	—	—	—	4,434	5·	For analysis of the waters, see the text
5·2	Alk.	—	—	—	—	Analysed by Dr. May, December 1870
3·4	"	—	—	—	—	" " "
7·1	"	—	—	—	—	" " "
2·7	"	—	—	—	—	" " "
—	—	5·	1·1	21,971	4·5	This water is the only source to the village through the greater part of the year. Village is in and around a deep valley. 8 per cent. of people goitred
3·4	Alk.	—	—	—	—	Analysed by Dr. May, December 1870
·82	—	—	—	—	—	
—	—	35·	21·9	—	—	Considered a wholesome water!
—	—	20·1	7·9	—	—	Considered dangerous. The people believe, and the Civil Surgeon is disposed to agree with them, that the water from the surface springs is dangerous, while that from deep wells is wholesome
—	—	3·1	1·2	—	—	Supposed to cure goitre
—	—	8·7	2·5	—	—	This is considered a safe water
—	—	12·5	5·0	—	—	This source considered dangerous
—	—	3·5	1·3	—	—	" " "
—	—	—	—	95,833	·66	
—	—	9·6	11·	—	—	20 per cent. of the people in the town goitred. The people consider the water of the well the most wholesome, but because of the difficulty in raising it, use that of the stream in preference
—	—	7·5	2·3	—	—	
—	—	14·	10·2	—	—	2 or 3 per cent. of the people in the town goitred
—	—	—	—	126,128	·01	
1·5	Alk.	—	—	10,250	·09	Analysed by Dr. Harvey in December 1869
1·05	"	—	—	—	—	" " "
·83	"	—	—	22,274	·04	Analysed by Dr. Harvey in August 1869
·83	"	—	—	—	—	" " "
1·4	"	—	—	—	—	" " "
·94	"	—	—	—	—	Analysed by Dr. Center in December 1868
1·8	"	—	—	—	—	" " "
1·4	"	—	—	—	—	" " "
·52	"	—	—	—	—	" " "
·45	"	—	—	—	—	" " "
·45	"	—	—	—	—	Analysed by Dr. Harvey in January 1870
1·5	"	—	—	—	—	" " "
·6	"	—	—	—	—	" " "
·8	"	—	—	—	—	Analysed by Dr. Center in May 1868
·94	"	—	—	—	—	" " "

Locality	Source of the water analysed	A	B	C	D
		Total solids of filtered water after ignition and recarbonation, grains per gallon	Earthy carbonates, silica, of A	Carbonate of lime of B	Salts dissolved by warm distilled water from A
Kohat District . . .	Water of the springs which supply the aqueduct, Kohat	22·	12·	9·9	10·
	Well No. 4, in the Jail	28·3	14·7	11·5	13·6
	Well No. 5, the Fort well	29·4	14·	9·1	15·4
	River Tovy, 2 miles above the town (Kohat)	28·2	14·2	9·8	14·
Bunnoo District . . .	Well in the Fort, Bunnoo	39·2	19·6	12·6	19·6
	River Koorum, 5 miles above the town	15·4	7·	5·5	8·4
	Water from the canal which supplies Koorum water to cantonments	21·	10·5	6·8	10·5
Dera Ghazee Khan District	Well of Native Cavalry Hospital, D. G. Khan	39·4	10·5	7·8	28·9
	Well in N.I. Lines	59·	15·2	9·8	43·8
	Dispensary well	46·5	17·8	14·3	28·7
	Jail well	70·7	23·	14·4	47·5
Dera Ismael Khan District		—	—	—	—
„ Tank	Spring at foot of the hills, Tank . .	—	—	—	—
„ „	Rivulet near Tank	—	—	—	—
	Indus River opposite D. I. Khan . .	9·9	4·6	3·0	5·3
	N.I. Hospital well (D. I. Khan) . .	31·8	10·8	7·1	21·
	Well south of Fort, used by British Troops	43·9	17·8	12·3	26·1
	Well in Mess-house compound . . .	38·6	14·	10·	24·6
Muzuffarghur District .	—	—	—	—	—
Mooltan, District, Station Dispensary	—	—	—	—	—
„ Shujabad „	—	—	—	—	—
„ Kuhrore „	—	—	—	—	—
	Artillery Hospital well, Mooltan . .	13·8	6·4	4·4	7·4
	Well No. 3, European Infantry Lines	9·3	5·3	3·9	4·
	N.I. Hospital well	12·1	7·1	5·5	5·
	Well No. 1, immediately outside the Fort	32·8	17·4	14·	15·4
Jhung District . . .	—	—	—	—	—
Bhawulpore State . . .	Hospital well, Sepoy Lines, Bhawulpore	43	22·4	13·	20·6
	Well in front of Political Agent's house	28·7	17·5	11·2	11·2
	River Sutlej	11·5	6·2	4·4	5·3
Bhurtpore State . . .	A village well	—	—	—	—
	Another „	—	—	—	—

E	F	G	H			
Chloride of sodium of D	Reaction	Carbonate of lime, in grains per gallon	Carbonate of magnesia, grains per gallon	Number of cases treated during the 5 years ending 1873	Percentage of cases of goitre treated	Remarks
1.5	Alk.	—	—	66,327	.04	Analysed by Dr. Whitwell in October 1870
3.8	"	—	—	—	—	" " "
3.8	"	—	—	—	—	" " "
2.5	"	—	—	—	—	" " "
7.6	"	—	—	101,031	.06	Analysed by Dr. Whitwell in November 1870
1.7	"	—	—	—	—	
1.7	"	—	—	—	—	
110.6	"	—	—	76,610	.24	Analysed by Dr. R. B. Thomson in March 1869. The well waters contain a large amount of sulphate of soda
115.	"	—	—	—	—	" "
111.8	"	—	—	—	—	" "
110.8	"	—	—	—	—	" "
—	—	—	—	215,919	.07	
—	—	9.7	5.4	—	—	Goitre not uncommon in the irrigated parts of Tank.
—	—	8.6	—	—	—	
1.3	Alk.	—	—	—	—	Analysed by Dr. R. B. Thomson in April 1869 The well waters contain a large amount of sulphate of soda
5.8	"	—	—	—	—	" "
5.	"	—	—	—	—	" "
9.7	"	—	—	—	—	" "
—	—	—	—	8,940	.16	
—	—	—	—	35,741	.43	
—	—	—	—	25,161	.02	
—	—	—	—	17,259	—	
3.7	Alk.	—	—	—	—	Analysed by Dr. R. B. Thomson in February 1869
1.7	"	—	—	—	—	" " "
3.3	"	—	—	—	—	" " "
4.7	"	—	—	—	—	By Dr. Hutcheson in April 1870
—	—	—	—	60,511	.16	Goitre prevalent in certain localities in this district along the Chenab river
2.9	Alk.	—	—	—	—	No goitre amongst the people. Water analysed by Dr. Hutcheson in March 1870
2.4	"	—	—	—	—	" "
1.2	"	—	—	—	—	" "
—	—	20.2	15.6	—	—	No goitre in the district
—	—	30.	40.	—	—	"

CHAPTER III.

GOITRE AND MALARIA.

General distribution of goitre in Northern India ; its testimony to the malarious origin of the disease. Evidence to the same effect from comparison of functions and pathology of the thyroid and spleen. Theories of the nature of malaria :—the 'chill theory,' the 'specific miasm theory ;' arguments in favour of the latter. Water and atmosphere media for the distribution of the miasm. Paroxysmal fever and malarial cachexia effects of the same poison. Reasons for not accepting the 'chill theory' of malaria.

IN the vast stretch of country described in the first Chapter, we find goitre prevailing, throughout the Himalayan ranges, in the Burail hills, and in the Salt range. Amongst the Himalayas it is less prevalent on the slopes of the hills than in the valleys which carry an almost tropical climate far into the interior of the mountain ranges, up to the very base of the Snowy range ; and the disease is more prevalent over the Eastern Himalayas, where vegetation is luxuriant, than amongst the hills of the western division where vegetation is comparatively sparse. But the most extensive, connected, and marked habitat of the disease is a tract of country, roughly triangular in shape, which skirts the base of the Himalayas from the debouch of the Gogra on the west to that of the Brahmapootra on the east, and has its apex pretty centrally as regards these points, but far away from the base of the hills near the meeting of the Ganges and Brahmapootra. On the western side of Northern India is another plainward development of the disease, in this case also along the course of a river, namely that of the Chenaub as far south as Mooltan.

As regards the climate of these regions it would be impossible to give a common account, stretching as they do through many climatic provinces. The subject must be taken up in connection with the individual provinces and districts as they come under consideration. There are, however, two circumstances which mainly determine the character of the climate of the principal habitat of the disease in the plains, and these are, the heavy rainfall upon the southern slopes of the Eastern Himalayas, and the northerly trending of the Western Himalayas. In consequence of the former the country

intervening between the base of the hills and the Gogra-Ganges on the one hand, and the Brahmapootra on the other, is intersected by numerous streams and dotted over with lakes and marshes; while as a result of the latter, the hot west winds of Northern India are guided southwards of the Gogra and its continuation the Ganges, so that the country to the north of these rivers is little affected by them. The combined result is an exceedingly moist climate for Assam, Eastern Bengal, and the tract lying between the Gogra-Ganges and the base of the Himalayas, a great expanse of country which is very nearly coterminous with that of the habitat of goitre in the plains of Eastern India.

The account which has now been given of the distribution of goitre in Northern India bears unequivocal evidence to the malarious nature of the disease, for the goitrous localities are precisely those which beyond all others are notoriously malarious. Evidence of a similar order will accumulate and amplify when the medical topography of the individual localities in which goitre is most prevalent is considered in detail.

Evidence of a different kind, yet tending to support the same view, may be found in a consideration of the acknowledged relationship, physiological and pathological, between the spleen and thyroid gland, a relationship so close that a cause of blood-disease such as malaria which constantly involves the one may be reasonably expected to affect the kindred gland.

That the functions which these glands perform in the body are analogous is a view generally received by physiologists, and the importance of the functions is testified by the large supply of blood which both organs receive, a supply greater in proportion to their size than is granted to any other organs of the body. As to the nature of these functions there can be little doubt that in common they aid in sanguification, by modifying the blood, abstracting some of its constituents and adding others on a plan which advances the elaboration of the plasma, and by supplying the cells from which the fully formed blood-corpuscles are to be developed.

A point of likeness in the pathological history of the glands which has been asserted,¹ and it is one which has especial interest in the present enquiry, is, that disease of either one or the other is associated with that peculiar condition of the blood to which the name 'Leucocythæmia' is given. And another resemblance between the glands which has been noticed, is that neither gland

¹ Mosler on 'Diseases of the Spleen,' in vol. viii. of *Ziemssen's Cyclopædia*.

is essential to life, for they have alike been extirpated without obvious ill consequences to the system; and moreover great enlargement of either, or both, is compatible with an apparent perfect state of health. It is not at all uncommon in India to meet with a strong lusty native, with plenty of red blood, enjoying vigorous health, yet with a spleen reaching two or three inches or more below his ribs, hard, but quite free from tenderness. As to the thyroid it is a matter of everyday experience with medical officers employed in goitrous districts that in a large proportion of cases of enlargement of that gland the disease of itself has no effect upon the state of health of the individual. There is, however, a difference, for enlargement of the spleen, wherever it is found, is as a rule associated with clearly defective health, while in the case of the thyroid the rule, at any rate in many districts, is the other way. And the difference is one which corresponds with the greater size, the position and connections of the spleen, and one which necessarily results if, as is no doubt the case, the spleen performs peculiar functions, other than those which it discharges in common with the thyroid; serving, as is very generally assumed, as a diverticulum to the circulation in the abdominal viscera, performing a special duty in preparing material for the use of the stomach glands and pancreas, and acting perhaps as a filter towards small corpuscular admixtures in the blood.¹

Therefore, though the functions are so far similar that the glands may be expected to suffer alike from the effects of malaria on the blood, they so far differ that a variation in the character of the malarial poison impressed upon it by season, soil, or climate, may lead to now one or now the other gland being preferentially affected, while that the spleen suffers most frequently results from the greater activity and wider range of its functions, and from its free contact with the miasm-poisoned blood.

Malarious enlargement of the spleen is frequently a direct effect of repeated congestions which the organ suffers during paroxysms of ague; the tissue thereby loses its elasticity and becomes permanently increased in bulk, and after a time, if the attacks continue, may suffer hypertrophy both of its trabecular and pulp tissue. Now in such a sequence as this we recognise a cause of disease and enlargement which cannot affect alike the spleen and the thyroid, the latter being a gland less prone to dilatation than the spleen, and from its exposed position on the front of the neck not liable

¹ Mosler, in the same article.

to the congestions which affect the spleen during the retirement of the blood from the surface which accompanies ague.

But perhaps even more frequently malarious enlargement of the spleen is a direct consequence of the diseased state of the blood which the presence of the malarial poison generates, and here is a condition which can affect both spleen and thyroid. Indeed both glands may become enlarged in an individual who has never suffered from paroxysmal fever, who can even assert that his general health is, and always has been, to the best of his knowledge satisfactory. Such histories are met with in malarious districts, but exceptionally in the case of the spleen, while they are the rule in that of the thyroid. On the other hand in the goitrous districts of India¹ we occasionally meet with cases in which rapid enlargement of the thyroid is associated with fever in a way which resembles the more constant association of fever with enlargement of the spleen.

The fact that many animals, as goats, cows, dogs, suffer from goitre affords another consideration in favour of the opinion that the disease has a malarious origin, for the same animals suffer very much from diseases of an unquestionably malarious nature, and especially do they so suffer in those regions of India in which goitre is prevalent. The late Dr. Hugh Falconer, in his evidence before the Army Sanitary Commission of 1863, says, speaking of malarious districts, 'the unhealthy conditions are not limited to the human species, who are fearfully liable to bad remittent fevers and their sequelæ, but it also affects domestic cattle. One winter I passed through the Rohilcund Terai, and at the village of Roodehpore, where I examined great herds of cattle, I found that a large proportion of them, young and old, had been fired with a hot iron in the flanks, this being the remedy practised by the Hindoos for spleen. They had also, in addition to enlarged spleen, the flabby look and pallid colour of the mucous membrane which is characteristic of splenic disease as a sequela of fever. I remember also an instance in the valley of Dehra Doon where the settlers were carried off by a violent outbreak of fever which also attacked their cattle.' Dr. Falconer's experience would be corroborated by that of almost everyone who has kept horses or cattle in India, and Dr. Hertz writes,² 'Domestic animals are affected by malaria, especially by intermittent fever of the tertian type, and

¹ See such a history of fever and goitre in the neighbourhood of Salzburgh, in the *Med. Chir. Review*, vol. i. of 1861, p. 62.

² *iemssen's Cyclopædia of Practical Medicine*, vol. ii.

also by more pernicious forms, as well as by malarial cachexia and tumours of the spleen.'

But if the goitre of Northern India is caused by malaria, the question arises, what is meant by that term? Does malaria simply express the result of certain climatic influences, or does it imply the existence of something material, a poison as specific as that of small-pox or typhus, which can be disseminated through the medium of air and water, one, however, which is not reproduced in the bodies of those affected by it?

The former view has, it must be acknowledged, the support of some observers who have enjoyed ample opportunities for watching malaria in its various manifestations; and, that climatic influences may suffice to explain the development of many of the mild attacks of fever which the physician in India hourly treats, or that they may operate as the immediate cause of a paroxysm of a more severe type, would no doubt be generally admitted. But if, as the circumstances of the case almost oblige, we look upon the autumnal fevers of India, whether mild or severe, sporadic or epidemic, as having one prime cause, we find in the hypothesis which attributes malarious diseases to a specific miasm, the one which best accounts for and connects all the phenomena, and one which explains, as the other cannot, the development of other more insidious malarious diseases which are usually but not always associated with paroxysmal fever—those cases, for instance, in which malarious cachexia or spleen happens in individuals previously in the enjoyment of good health, and remaining under the same conditions of climate to which from their birth and by their breeding their constitutions have become adapted.

The poison may be a mere chemical compound developed from organic matter in the air or soil under the conjoint influence of warmth and moisture, or, as seems even more in accordance with observed facts, it may consist of innumerable living organisms which have their breeding place in a warm damp soil.¹

Dr. Mosler,² who in a valuable article on diseases of the spleen, has adopted this view of the nature of malaria, explains the febrile attacks by the supposition that the spleen filters off these organisms from the blood, and that when their accumulation or development has exceeded the capacity of the spleen, their escape into the blood produces the paroxysm.

¹ While the above is passing through the press, the discovery by Professors Tommasi and Klebs of the *Bacillus Malariae* in the air and soil of the Agro Romans is announced.

² *Ziemssen's Cyclopædia*, vol. viii.

If we adopt this view, we may suppose that changes in the soil or in the other physical conditions under which the supposed organisms are developed may, by enduing them with more or less vigorous life, or by developing specific variations amongst them, give the poison the power of variously affecting the systems into which it finds entrance. However, it must be here remarked that as yet we know nothing of the nicer circumstances which are needful to the generation of the poison, nor do we know what is the minimum of organic matter which may suffice for its development; and we cannot therefore accept as valid arguments against the theory, the non-existence of malaria in many places which seem to present all the needful physical conditions, or the prevalence of malarial diseases in localities the soil of which contains very little organic matter. Moreover, in considering such objections we must bear in mind that in some places which are not themselves malarious the inhabitants are obliged to labour during some part of the year in malarious places; that in others the drinking water may become affected by miasm developed in it, or in the moist soil surrounding the source; and that in other cases individual attacks, or outbreaks affecting a body of men, may be referred to climatic causes acting upon systems elsewhere poisoned by malaria.

There is good reason for assuming that the malarial poison is usually taken into the system through the lungs; but evidence accumulates that water also may be the medium. Some such evidence will be adduced in the following pages; and, indeed, if goitre is a malarious disorder, the often repeated and apparently well-founded assertion that certain waters cause the disease, gives strong support to that view. For other evidence to the same effect reference might be made to many passages¹ in the annual reports of the Sanitary Commissioners of the four provinces of Northern India.

In certain localities, as for instance, in parts of the Terai, and in some of the deep Himalayan valleys, the atmosphere is charged with the miasm in a form so virulent or so concentrated that exposure for a few hours suffices to induce an attack, often of a deadly character, in a previously strong and healthy individual. But, as is more commonly the case, the atmosphere containing the

¹ See Appendix to Report for 1868 of S. C. for the Punjaub; Dr. Moore on Malaria in the *Indian Annals of Medicine*, No. 20, 1866; Mr. Bettington, on 'Water of Jungly Districts,' in the *Indian Annals*, No. 3, 1856; Parkes, *Hygiene*, edit. 1878, p. 44; Report of Sanitary Commissioner (Dr. Townsend) of Central Provinces for 1870, paragraph 136 *et seq.*

poison in a less concentrated form, the patient breathes it for some time before the system has filtered off a sufficiency to cause an attack of fever, or before such a change has been produced in the blood that an explosion of fever occurs, and for a time clears the system. Again, no paroxysmal attack may ensue, yet the blood in consequence of the presence of the poison becomes diseased, and a state of malarial cachexia results, or the blood, thus brought into a diseased state, is unable to maintain the healthy nutrition of the tissues or organs, and various pathological changes result, the seat of which may be determined by accidental circumstances, by previous local disease, or by some peculiarity in the poison itself.

In reading the annual reports made by medical officers of regiments in India, one is struck by the very frequent and often matter-of-course way in which 'chill' is spoken of as the cause of fever. That chill may—as indeed may a surgical injury or over-fatigue—determine a paroxysm of fever, and that it may do so by interfering with the elimination of the poison, or by causing a derangement of the functions which serves as a last straw in breaking down a system already strained almost beyond healthy working by the effects of malaria, there can be no doubt, but it must be remembered that such cases produce a paroxysm of fever only very rarely, excepting in localities which are undoubtedly malarious. But observers¹ have gone beyond this, and have concluded that it is needless to assume the existence of a specific malarial poison, that let an individual be predisposed by fatigue, or by the results of long-continued residence in a hot climate, especially if the climate be a damp as well as a hot one, and then a chill may suffice to produce an attack of fever. Doubtless life in a hot, damp, stagnant atmosphere, such as that of Peshawur or Assam, most powerfully predisposes the system to fever, as indeed it does to almost every other disease, and a chill is incontestably in a vast number of cases the immediate cause of a paroxysm. But if chill were the cause of malarious fever, we should have to look for the disease in many European localities where indeed the medical man often witnesses internal congestions as a result of exposure to chill, but rarely an attack of paroxysmal fever. Moreover, in malarious countries we have often to treat fever in people who have not been exposed to chill, nor indeed to any other condition which, apart from malarial poisoning, can explain the attack; nor in cases where a history of chill can be

¹ See especially Surgeon-Major Oldham's work, *What is Malaria?* London, 1871.

traced does the violence of the attack bear any proportion to its degree.

Further, if malaria is a mere expression of the effect of climatic causes on the system, we ought to find paroxysmal fever prevalent in all localities where there is marsh, a sufficiently hot and extreme climate, and occasional chilling winds. But it is not so, and indeed one of the most prominent features in the history of malaria is, that we by no means find malarious diseases in all places where every condition seems favourable to their development; nor prevailing with anything like equal violence in the same locality during successive years, under apparently unchanged conditions of soil and climate. These anomalies are, however, quite such as we might look for if malaria depends upon a more or less plentiful crop of organisms, the growth of which may be checked or promoted by physical changes which are beyond our recognition. Moreover, we find malarious fever prevalent in very equable climates, and not unfrequently most prevalent during the most equable season of the year. Thus Dr. Townsend¹ points out, that in the Central Provinces in June and July, when the rains set in, and the temperature falls 12° or 15° , fever is less prevalent than at any other time of the year. While in August and September, when fever is most prevalent, the daily range of temperature is at its minimum; and in October and November, when again marked change in the condition of the atmosphere occurs, the people suffer much from catarrh and other affections of the respiratory organs, but the prevalence of fever declines.

Finally, in support of the theory which assumes a special miasm as the cause of malaria, we have the history of epidemics of fever of a distinctly malarious character, which from time to time invade parts of India, which cannot be accounted for by changes meteorological or telluric, by contagion or infection, and can only be attributed to the widespread development of some specific poison. The history of such an epidemic will form the subject of a subsequent chapter.

¹ His report for 1870 as Sanitary Commissioner of the Central Provinces.

CHAPTER IV.

MALARIA AND THE SEASONS.

Seasonal prevalence of 'fevers,' and intensity of malaria in Northern India.

Influence of climate. Means we possess for measuring the prevalence of malaria. Dempster's spleen test; statistics of fever sickness and mortality amongst troops, jail population, and people generally. Relative prevalence of fever in the divisions of the native army of Northern India. Comparison with statistics of fever mortality amongst the general population. Influence of climate and seasons on the prevalence of fever and the development of malaria. Influence of wet and dry autumns on fever prevalence.

THE following table, A, shows the seasonal prevalence of intermittent fevers in the provinces of Northern India, amongst the native troops, prisoners in jail, and the civil population. Table B places side by side with the monthly admission rate from intermittents amongst the native troops, the average rainfall and temperature of a representative station in each province. Charts C and D display the seasonal prevalence of fever in a graphic form.

These statistics, and those of individual stations which will be found in succeeding chapters, constitute the best, in fact the only, test which is available to indicate the degree in which malaria is seasonally developed over any large area of country.

For special localities Dempster's spleen test¹ affords an excellent means for measuring the relative intensity of a particular kind of malarious poisoning; but apart from the impossibility of applying that test to the population of a whole province or district, the test does not discover all forms of malaria; particularly it does not indicate that form, the mildest though the most generally prevalent of all, which expresses itself in one or more paroxysms of fever. Paroxysmal fever is indeed an almost universal symptom of malarious poisoning; the cases are exceptional in which we find malarious spleen or liver developed without a history of antecedent attacks, mild or severe, of fever. Could all the cases of malarious fever amongst a population be correctly diagnosed and recorded, the number per 1,000 of population occurring through a series of years would form a very fair test of the more or less malarious character of the country.

¹ Chapter xxiii.

Unfortunately, the prevalence of fever as a test for malaria does not give us reliable information when we endeavour to apply it to gauge the seasonal development of the poison; for, in the first place, the period of the incubation of the fever is of uncertain length, and may be a very prolonged one; then one attack by no means clears away the dose of the poison, leaving the individual a *tabula rasa* for a fresh experiment; moreover the accession of the paroxysm is in a large proportion of cases determined by external circumstances, 'the extrinsic causes of fever,' such as chill, fatigue, indigestion, checked elimination, or a surgical injury. The influence of these extrinsic causes constitutes the main source of failure in the test; and it is no doubt because of their prevalence towards the end of autumn, that in some localities—those especially in which the change from autumn to winter is abrupt—malarious poisoning appears more frequent at the end than at the beginning of the moist warm season of the year.

The least valuable of the statistics as an index to the seasonal intensity of malaria are those of the registration of deaths from fevers amongst the civil population, for the registration is confessedly imperfect, and the diagnosis of the cause of death in individual cases is still more so. Moreover, ample reason for putting aside the recorded civil death rate from fevers as an index to the seasonal intensity of malaria, may be found in the well-known fact that a large proportion of the victims of fever do not die during the primary attack, nor do they die when, as shown by the prevalence of fever amongst the troops, malaria is most abundant. The history of their mortality is somewhat as follows. During the summer and autumn rains great numbers of people suffer from fever, which weakens them partly by the direct effects of the disease upon the blood-producing functions, partly by destroying appetite for food, and it may be added, by destroying the ability to earn food. As the season proceeds, attacks multiply; the spleen, the liver, and other organs become disordered, and so the sufferers drag on till the fever puts on a worse type and proves fatal, or till cold nights superadd bronchitis, diarrhoea, dysentery, or some other too often fatal sequela.

The records of the admissions to hospital for fever amongst the troops, especially the native troops, give us a far more reliable index to the seasonal activity of malaria. The men as a body are healthy and are fairly well fed; they are well clothed and lodged, with very much the same kind of work and degree of exposure throughout the year. They are carefully watched, put under

treatment when ill, and their diseases are correctly diagnosed and recorded.

The statistics of the jail population do not afford quite so satisfactory an index, because the population is constantly changing, and a large proportion of its members are in an abnormally depressed state of mind and body. Nevertheless the records on the whole support those of the military as to the seasonal intensity or abundance of malaria, and will be made further use of in this and succeeding chapters.

An inspection of Table A shows that fever is more prevalent amongst the frontier force serving trans-Indus than in any other division of the native army of Bengal. It is a division which includes stations of which the climate may be said to be more extreme than that of the rest of the plains of Northern India.

But that the prevalency of fever does not depend merely upon the extreme character of a climate, is evidenced by the fact that the average annual number of admissions for fever is greater amongst the troops serving in Bengal than amongst those of the Dinapore and Meerut divisions.

Indeed it is probable that in Bengal, with its hot, moist, equable climate, abundant vegetation, and heavy soil, malaria is generated more abundantly than in the North-West Provinces, far more universally than in the Punjaub; but then the extrinsic causes of malarious diseases are less active there—those causes which working in conjunction with the intrinsic cause, namely malaria and the changes it produces in the blood, so often bring about active manifestation of the presence of the poison.

On the other hand, a remarkable coincidence between the monthly range of fever admissions, and the temperature range of the provinces, shows the influence of climate upon the seasonal prevalence of fever (see Table B). Thus while in Bengal the admissions range per 1,000 of strength from 30, in the month in which the admissions are least numerous, up to 78·7 in the month in which they are most numerous, in the trans-Indus division the range is from 31·4 to 213, and the other divisions take their place in the order of the more or less extreme character of their climate, thus:—

	Range of number of monthly admissions per 1,000 of strength.	
Bengal and Assam	30	78·7
Dinapore, &c., &c.	20	79·4
Meerut and Rohilcund	14	92·6
Punjaub	23·7	203
Trans-Indus division	31·4	213

In charts C and D, the lines showing the prevalence of fever amongst the different sections of the natives in the respective provinces agree closely. Thus examining those for the Punjaub, we notice in the case of troops, prisoners, and civil population, the same rapid ascent of the fever line at the beginning of the autumn, and the rapid fall from October onwards to the end of the year. The weight of the autumn outbreak falls earlier amongst the prisoners than amongst the troops, probably because many of the former are depressed in mind and body, and therefore speedily succumb. Very probably the beginning of the outbreak amongst the civil population corresponds more closely with that of the prisoners than of the troops; and if this be so, we see why the curve which shows the mortality from fever amongst the people agrees with that of admissions amongst the troops, for this form of fever does not as a rule kill rapidly, and the rise in the mortality must therefore follow after an interval the rise in the numbers attacked.

Both in the Dinapore and Meerut divisions the lines mark an earlier date for the fever outbreak than in the Punjaub; but the contrast in this respect comes out still more strongly if we compare the statistics of individual stations,¹ as for instance, those of Dinapore and Cawnpore in the North-West Provinces with those of the Punjaub stations, Umballa and Sealkote. In the Meerut division the maximum of fever admissions is reached earlier than in the Dinapore division, or in the Punjaub, a circumstance which is probably connected with the dampness of the Meerut soil which is artificially engendered by canal irrigation.

The area of the Dinapore and Meerut military divisions geographically differs very widely from that of the North-West Provinces and Oude which they in part occupy, and therefore no comparison is attempted between the seasonal prevalence of fever amongst the troops of those divisions and of the jail and free populations of those provinces.

As regards Bengal the chart lines which mark the seasonal prevalence of fevers amongst the troops and prisoners agree very remarkably. Both bodies of men suffer in the same proportion at the several seasons of the year, and the explanation of the circumstance may be found in the consideration that the men of the upper Gangetic plain and of the Punjaub, who constitute the bulk of the native army, are, when stationed east of Bhagulpore, in a foreign country, and one the climate of which has a most depressing effect,

¹ See next chapter.

physical and mental, upon them, placing them in fact somewhat in the same condition as the prisoners in jail.

In Bengal, a region in which damp heat characterises the climate through a large part of the year, the season for malarious fevers is an early and a protracted one, while the monthly range in the number of admissions for fever amongst the troops is comparatively slight. In the Punjaub, on the contrary—a country in which though the summer heat is great and long continued, the damp season is brief, and the soil during many months of the year, except in a few exceptional localities, is very dry—the outbreak of malarious fever is deferred till the end of August, or till September. In the Dinapore circle, in Oude, Meerut, and Rohilcund—with climate intermediate in its character between that of Bengal and that of the Punjaub—the fever season, in respect to the period of its commencement and its duration, is intermediate also, as also is the range in the monthly number of admissions for fever amongst the troops stationed there.

At several stations, in the upper Gangetic plains and in the Punjaub, as well as in Bengal, the rise in the number of admissions for fever is very marked during July and August, the most equable months in respect to temperature of the year, and the admissions attain their maximum frequency in September.

The foregoing considerations, and the statistics placed side by side in Table B, point to moisture and warmth as the climatic conditions which are most influential in promoting the growth of malaria. Other conditions, such as extreme heat, great range of temperature, chilling winds, play an important part in developing various malarious diseases, but only indirectly influence the production of the poison which is the prime cause of them all.

In Table E, 46 stations are arranged, first in the inverse order in which they stand according to the prevalency of malarious fever amongst the native troops, and secondly inversely to the prevalency of other diseases.

The first list is headed by Bareilly, in every respect a healthy station, while three trans-Indus stations, and two notoriously unhealthy stations, Meean Meer and Morar, take the lowest places. The table shows that other conditions than the extreme nature of the climate, or those which render it more or less generally unhealthy, influence the fever rate of a station, for in the first list we find stations having an extreme climate, such as Rawul Pindi, Sealkote, Bareilly, taking a better place than the Bengal stations, while on the other hand, in the second list, many Punjaub stations,

such as Mooltan, Ferozepore, Delhi, Jhelum, Umritsur, which have a heavy fever rate, take a high place for general healthiness. It may be said generally, that comparing the first and second lists the Punjaub stations in the latter move up, while the Bengal stations move down, a change readily understood if we remember that while in Lower Bengal the Sepoy is living in a foreign climate, one which has a very depressing effect upon his system, and subjects him not only to diseases which are indirectly if not directly malarious, such as dysentery and diarrhoea, but also to many diseases of debility. In the Punjaub proper, on the other hand, he is in a climate most congenial to his constitution, one in which he might be expected to escape climatic disease, and even fever, were it not for the presence of a specific miasm.

A question which is frequently referred to in the reports of both civil and military medical officers, and more especially by those who are stationed in the Punjaub, is as to the effect of variations in the amount of rainfall upon the annual fever rates, and there appears to be a pretty general consensus of opinion amongst them in favour of the view that a wet autumn will be accompanied by heavy fever rates, while a dry season will be a healthy one. Thus in the official reports for 1877 we find both the Sanitary Commissioner and the Inspector-General of Prisons for the North-West Provinces stating that the comparative healthiness of that year was due in great part to the extreme dryness of the season.¹ The tables which follow, F, G, and H, have been compiled with a view to the examination of this question. Table F compares the fever rates and rainfall of thirteen stations during each of seven years. Tables G and H compare the autumnal rainfall and fever rates during the years 1874-77 of four military stations and of ten civil districts.

The tables cannot be said to give uniform support to the view in question, unless so far as they show that a dry autumn is as a rule a healthy one, a position which has been confirmed by an examination carried back over the statistics of many years. Thus taking the case of the native troops stationed in the Punjaub—the Punjaub is chosen as an example because whether we look to soil or atmosphere, the wet and dry seasons contrast more decidedly and more uniformly than in Bengal or the north-west—the average admissions for intermittent fever per annum of the period 1867-77 were 752 per 1,000 of strength. Three years during that period the admissions fell below the average; in 1868 they averaged 577;

¹ See also on this subject, Chap. xix.

TABLE E.—*Native Troops. Average of ten year period, 1867-76.*¹

Stations arranged inversely to prevalence of intermittent fevers	Admissions for intermittent fevers per 1,000 of strength	Admissions for all causes per 1,000 of strength	Admissions for all causes, intermittent fevers excepted, per 1,000 of strength	Stations arranged inversely to number of admissions, excepting intermittent fever, per 1,000 of strength	Admissions for diarrhoea and dysentery per 1,000 of strength
Bareilly	194	651	457	Bareilly	38
Bhagulpore	241	832	591	Ferozepore	61
Dehra Dun	268	880	612	Jhelum	82
Dinapore	285	777	492	Dinapore	77
Fyzabad	291	806	515	Rawul Pindi	89
Almora	326	914	588	Cawnpore	65
Benares	333	1041	708	Fyzabad	89
Roorkee	342	1014	672	Delhi	90
Bukloh	355	1009	654	Umritsur	115
Rawul Pindi	370	884	514	Mooltan	62
Sealkote	384	980	596	Meerut	78
Buxa (Bhootan)	410	1293	883	Umballa	63
Lucknow	417	1078	661	Nowshera	110
Allahabad	431	1098	667	Dhurmsala	59
Shillong and outposts	442	1230	788	Talagaon	59
Talagaon	448	1018	578	Almora	57
Cawnpore	481	995	514	Bhagulpore	80
Dacca	535	1577	1022	Sealkote	59
Fort William	545	1497	952	Dehra Dun	55
Agra	549	1374	825	Abbotabad	87
Murdan	589	1424	835	Jhansi	60
Dhurmsala	589	1158	569	Goruckpore	79
Jhelum	603	1089	486	Bukloh	41
Goruckpore	645	1288	643	Meean Meer	100
Umballa	669	1211	542	Lucknow	85
Barrackpore	685	1452	767	Morar	182
Meerut	711	1248	537	Allahabad	115
Jhansi	732	1367	635	D. Ismael Khan	99
Alipore	748	1838	1090	Roorkee	62
Abbotabad	762	1379	617	Peshawur	164
D. Ismael Khan	784	1452	668	D. Ghazee Khan	84
Debrooghur	802	1640	838	Benares	71
Gowhatty	883	1612	739	Jullundur	78
Jullundur	887	1619	732	Kohat	166
Cachar and outposts	908	1700	792	Gowhatty	159
Mooltan	940	1470	530	Barrackpore	182
Ferozepore	950	1416	466	Shillong	161
Nowshera	956	1517	561	Cachar	185
D. Ghazee Khan	1009	1707	698	Bunnoo	155
Delhi	1042	1557	515	Agra	105
Umritsur	1110	1641	531	Murdan ²	81
Kohat	1133	1867	734	Debrooghur	187
Meean Meer (Lahore)	1139	1793	654	Buxa	210
Morar (Gwalior)	1140	1805	665	Fort William	245
Bunnoo	1176	1970	794	Dacca	294
Peshawur	1338	2010	672	Alipore	396

¹ This table is compiled from the last published volume of Dr. Bryden's *Vital Statistics*.² The proportion of the number of admissions for wounds, accidents, abscesses, and ulcers, very large, 326.

in 1871, 462; and in 1877, 674, and these were the three years, and the only years of the period in which the autumnal rainfall fell markedly short of the average; 1868 and 1877 were very dry years.

As regards the influence of wet autumns in augmenting fever sickness, the statistics by no means afford equally positive evidence, and most certainly, so far as can be learnt from them, the amount of fever sickness is not directly proportioned to the amplitude of the autumnal rains. Still it is difficult to conceive that professional opinions often and strongly expressed in favour of such a connection are without any foundation; and indeed it seems quite reasonable to assume that a heavy rainfall may so chill the soil and atmosphere of a locality as to dispose the people to internal congestions and diseases of checked elimination, and thus indirectly to attacks of fever. But whether or no heavy rainfall causes the development of a large crop of malaria must depend upon the conjoint existence of various other conditions. Probably, throughout Bengal, much of the North-West Provinces, and parts of the Punjab, the average rainfall quite suffices to foster as abundant a production of miasm as other conditions are able to play their part in supplying. If this be so, more than the average rainfall will not add to the production of malaria, but may on the contrary, by swamping the soil, check it. Where, however, as in parts of the Punjab, the average rainfall is slight, it may be ordinarily insufficient in quantity to develop the full amount of malaria which might otherwise be produced. The seed, the soil, and the warmth, though ready to play their part, fail for want of moisture. Now in such circumstances a more than usually heavy rainfall would develop a heavy crop of the poison, yet not necessarily always, unless we also assume that the seed is uniformly abundant, and the soil always in the best possible condition to foster it.

TABLE A.—*Monthly Prevalence of Fever.*

NATIVE TROOPS 1867-1876, ADMISSIONS FOR INTERMITTENT FEVER, PER 1,000 OF STRENGTH													
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year
Bengal proper and Assam	35.7	30.	33.3	44.7	45.8	47.7	65.	77.	72.	78.7	75.7	52.7	659
Dinapore, Benares, Oude, and Cawnpore	21.4	20.	26.	24.2	25.2	23.6	33.4	42.	52.4	79.4	57.4	30.7	436
Meerut and Rohilcund	17.	14.	16.4	21.2	29.4	25.5	27.8	62.	92.6	72.5	43.6	22.8	446
Punjaub	35.4	25.2	23.7	24.7	31.4	36.5	38.7	78.4	159.	203.	142.	63.3	863
Punjaub Frontier Force	49.	33.7	31.4	29.4	39.4	40.7	39.4	79.3	148.	213.	168.	83.4	956
JAIL POPULATION 1867-1876, INTERMITTENT FEVER, PER 1,000 OF STRENGTH (ADMISSIONS)													
Bengal and Assam	28.5	25.	30.	32.	30.	31.	42.	48.6	46.	52.	51.	38.	455
Oude	11.2	11.4	13.5	13.4	15.6	14.	12.5	17.2	20.2	22.8	27.3	19.8	199
North-West Provinces	12.7	11.	14.	18.2	19.4	16.6	22.6	37.8	45.4	46.2	26.9	17.	288
Punjaub	25.3	19.	22.	28.5	35.	34.	35.	85.	119.	119.	74.	40.	636
CIVIL POPULATION, DEATHS PER 1,000 FROM FEVERS													
Bengal selected circles, 1875.	1.09	.95	.94	1.02	1.02	.97	1.13	1.26	1.26	1.46	1.84	1.58	14.6
" 1876.	.9	.85	1.03	1.05	.9	.8	.9	1.1	1.23	1.41	1.5	1.37	13.1
Whole population, 1877.	.8	.69	.76	.89	.87	.76	.79	.88	.98	1.13	1.54	1.77	11.85
North-West Provinces, 1875.	1.34	1.08	1.2	1.7	1.83	1.84	1.6	1.91	2.6	2.52	1.96	1.8	21.82
" 1876	1.5	1.42	1.76	2.	2.07	2.21	1.78	1.98	2.52	2.4	1.95	1.66	23.39
Punjaub, 1875	1.95	1.74	1.51	1.64	1.8	1.62	1.52	1.68	2.61	4.	3.12	2.32	25.6
" 1876	1.73	1.26	1.25	1.18	1.36	1.4	1.36	1.76	4.1	6.	4.06	2.85	28.4

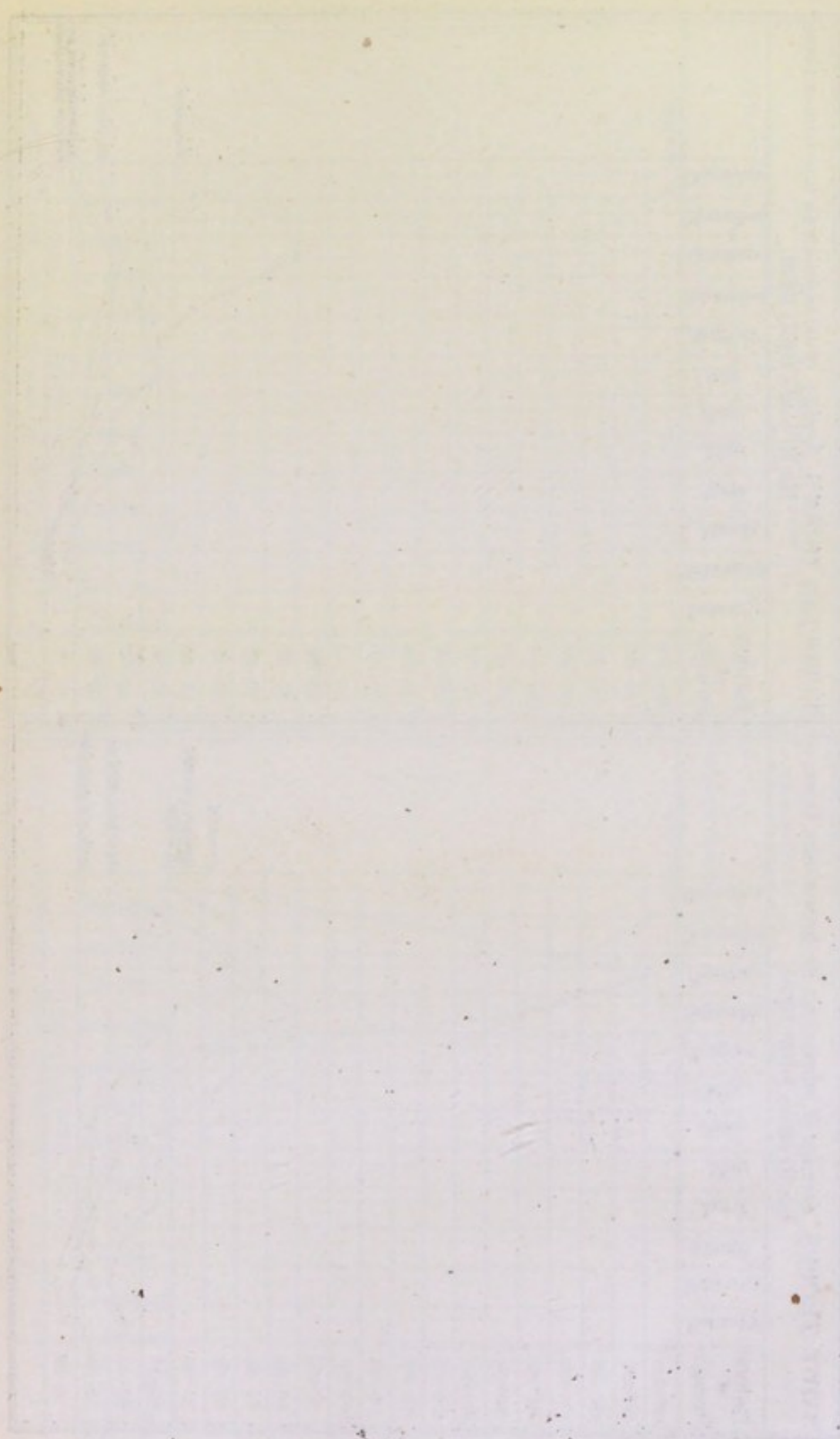


TABLE B.—Native Troops admissions for intermittent fever, per 1,000 of average strength, for the years 1867–1876 in the Bengal, Dinapore, and Meerut divisions, and in the Punjab, together with average rainfall and temperature of four representative stations.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year
BENGAL PROPER AND ASSAM													
Intermittent Fever . . .	35.7	30	33.3	44.7	45.8	47.7	65.	77.	72.	78.7	75.7	52.7	659
Rainfall, Jessore Station, 14–17 years	.6	.62	1.7	3.7	7.4	13.5	10.8	11.5	8.8	5.6	.73	.12	64.9
Temperature " " 8–9 years	65	71	79	83	85	84	83	83	83	80	74	65.5	77.9
DINAPORE, BENARES, OUDE, AND CAWNPORE													
Intermittent Fever . . .	21.4	20.	26.	24.2	25.2	23.6	33.4	42.	52.4	79.4	57.4	30.7	436
Rainfall, Benares Station, 20–21 years	.7	.47	.26	.15	.5	5.3	12.7	11.9	6.9	1.6	.05	.08	40.5
Temperature, Benares, 8–10 years	60	67	76	87	92	91	85	84	84	78	69	60	77.7
MEERUT AND ROHILCUND													
Intermittent Fever . . .	17.	14.	16.4	21.2	29.4	25.5	27.8	62.	92.6	72.5	43.6	22.8	446
Rainfall, Meerut Station, 20 years	.72	.84	.56	.4	.93	3.8	9.7	6.7	4.	.22	.02	.21	28.1
Temperature, " " 5–6 years	57	63	73	84	89	93	86	84	82	73	66	59	76
PUNJAB													
Intermittent Fever . . .	35.4	25.2	23.7	24.7	31.4	36.5	38.7	78.4	159	203	142	63.3	863
Rainfall, Lahore Station, 10 years	.5	.91	.91	.27	.92	1.2	6.3	3.9	2.54	.6	—	.5	18.5
Temperature " " 8–10 years	53	60	69	81	89	93	88	87	84	77	65	55	75

TABLE F.—*Fever admissions per 1,000 of strength amongst the Native Troops, and of the rainfall of the year.*

	1870		1871		1872		1873		1874		1875		1876	
	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall
Sealkote . . .	504	33	305	32	410	29	311	38	232	25	377	49	563	50
Umballa . . .	846	35	476	39	1329	52	639	37	662	45	299	34	1063	26.5
Jullundur . . .	1162	22	488	21	835	45	766	19	454	23	866	56	1869	27
Ferozepore . . .	426	14	167	12	303	32	1202	23	1297	12	1383	29	3124	13.5
Mooltan . . .	439	2.5	216	1.9	1339	5.5	1229	8.4	1536	9.7	752	3.7	2241	6.2
Meean Meer . . .	862	9.0	376	8.7	1581	20	1485	19	662	15	1204	33	1715	21.5
Jhelum . . .	672	20	283	13	920	18	314	13	272	20	505	29	960	22.3
R. Pindi . . .	991	30	311	29	183	31	218	30	283	42	206	49	307	34.8
Peshawur . . .	1607	7	671	11	1051	16.5	1389	12	1390	15	1430	19	1588	16
Kohat . . .	1507	15	1043	20	1277	26	1031	14	1006	27	1352	29	1099	23
Bunnoo . . .	1404	32	971	50	1328	9.3	1181	9	1155	19	1189	16	872	12.2
D. G. Khan . . .	1169	2.4	804	3.2	1271	8.3	847	8.9	1593	9.6	874	8	1048	10.6
D. I. Khan . . .	803	7.8	517	4.6	1201	9.3	803	9.8	1087	12.6	695	11.3	918	9.7

TABLE G.—*Autumnal fever amongst the Native Troops, and rainfall at Sealkote, Jullundur, Umballa, and Meean Meer (Lahore).*

Station	1874		1875		1876		1877	
	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall	Fever admissions	Rainfall
Sealkote								
May . . .	16	—	16	.4	6	1.5	31	.5
June . . .	19	2.6	17	.6	8	1.3	26	1.4
July . . .	23	8.2	18	17.8	12	32	42	2.1
August . . .	26	7.9	35	22.4	74	5.1	15	.6
September . . .	28	2.5	71	4	170	5.8	22	1.8
October . . .	23	.2	52	.7	164	.6	47	.5
Jullundur								
May . . .	3	—	14	2.4	55	.1	28	.4
June . . .	12	4.5	35	.8	25	1.5	15	1.6
July . . .	17	3.5	14	7.1	17	12.4	35	2.7
August . . .	40	2.8	22	17.8	136	3.3	15	1.5
September . . .	70	6.8	51	24.1	214	2.7	9	12.1
October . . .	36	.5	100	.8	246	.5	81	.8
Umballa								
May . . .	22	1.3	16	.2	26	2	19	.2
June . . .	45	10.5	39	.8	21	.2	16	2.9
July . . .	36	19.5	21	4.2	13	10	16	2.8
August . . .	107	2.5	25	12.5	145	4.6	17	1.1
September . . .	122	3.4	32	12.8	371	6.5	21	2
October . . .	84	—	37	—	286	1.6	31	1.3
Meean Meer (Lahore)								
May . . .	43	—	43	1	31	.3	93	.4
June . . .	24	.2	64	.9	27	2	167	.9
July . . .	26	4.6	29	3.2	35	4.4	151	3.2
August . . .	66	3.3	73	14.5	325	3.3	52	14.5
September . . .	116	1.4	271	9.7	567	1.4	41	9.7
October . . .	185	—	502	1.3	471	—	345	1.3

TABLE H.—*Autumnal fever and rainfall.*

District	Year	Deaths registered from fevers, civil population						Aggregate rainfall of 5 months, June-October	Rain-fall of the whole year	Deaths per 1000 of whole year
		June	July	August	Sept.	Oct.	Nov.			
Umballa	1874	689	581	986	1212	1423	1090	40.1	44.6	10.15
"	1875	1047	973	712	793	1296	859	30.3	33.8	11.8
"	1876	839	723	914	3208	4125	2573	22.9	26.5	17.
"	1877	1149	789	693	656	603	729	10.1	23.7	9.6
Jullundur	1874	869	811	1014	863	991	1027	18.1	23.2	12.6
"	1875	889	777	1009	1520	2968	3188	50.6	55.7	21.5
"	1876	922	801	2028	7699	12,308	6972	20.4	27.1	48.5
"	1877	1155	1119	1058	990	1394	1519	18.7	39.6	18.7
Hoshiarpore	1874	746	772	917	1126	1496	1009	29.8	37.	10.4
"	1875	943	783	1109	2828	6407	4541	40.5	44.6	25.1
"	1876	964	723	1411	8099	10,469	5636	26.2	35.5	36.2
"	1877	1304	971	1095	876	1147	1441	27.2	47.8	13.9
Umritsur	1874	826	712	870	866	1181	1088	11.8	19.4	12.8
"	1875	923	822	976	2474	4298	3231	39.2	16.2	23.1
"	1876	719	705	605	1149	3562	7603	27.8	43.	30.5
"	1877	1209	1175	1035	872	1230	1257	9.9	30.7	15.3
Sealkote	1874	875	674	697	733	941	1024	21.4	25.1	9.7
"	1875	761	673	912	2490	4265	2625	45.5	48.9	17.5
"	1876	568	522	1265	6657	11,326	6399	44.8	50.1	32.8
"	1877	1358	1214	867	724	850	918	6.4	32.4	12.
Lahore	1874	694	603	821	740	1159	1054	11.1	15.	14.5
"	1875	682	743	665	1337	2791	2501	29.6	33.2	20.2
"	1876	718	757	798	1191	2333	4239	19.7	21.5	25.
"	1877	1133	988	854	887	1114	1300	4.	16.6	16.57
R. Pindi	1874	536	420	487	586	749	761	31.2	42.1	10.8
"	1875	550	491	565	597	748	732	38.5	48.8	12.8
"	1876	580	633	695	787	1033	905	19.2	34.8	11.5
"	1877	999	889	677	646	948	1085	11.4	40.6	13.4
Jhelum	1874	293	286	263	326	677	603	15.2	19.7	10.7
"	1875	353	388	347	450	581	521	25.1	28.9	11.7
"	1876	357	297	347	581	833	678	14.8	22.3	10.4
"	1877	536	478	420	409	511	646	9.6	36.2	10.8
Mooltan	1874	367	258	308	525	1347	1184	8.5	9.7	15.9
"	1875	574	451	345	556	1190	1503	2.7	3.7	20.9
"	1876	507	419	381	645	1137	1176	5.7	6.2	21.5
"	1877	664	464	384	494	584	747	9.7	13.6	17.9
D. I. Khan	1874	277	214	238	371	821	726	7.4	12.6	14.
"	1875	324	312	224	296	412	444	6.9	11.3	13.4
"	1876	257	276	168	320	503	638	6.5	9.7	12.2
"	1877	578	358	271	363	347	419	.9	11.7	13.

CHAPTER V.

AN EPIDEMIC OF MALARIOUS FEVER.

Notes on the fever epidemic of 1869. Commencement and progress of epidemic.

The type of fever clearly malarious. Cause of epidemic not to be found in climatic conditions; more probably dependent on an unusually luxuriant crop of miasm. Evidence as to the identity of the fever of the epidemic, and of that of the ordinary autumnal outbreak, and argument therefrom for the dependence of the autumnal fever upon the existence of a specific miasm.

PERHAPS of all the fever epidemics on record, that of 1869-70, which embraced the Punjaub and Central India, was the severest and the most widespread. The year 1868 was a non-epidemic year in Northern India; 1869 on the other hand was marked by epidemics both of fever and of cholera. The epidemic of fever began in August, was at its height in October, and terminated in November; but its influence extended into 1870, as we learn from the Sanitary Commissioner of the Punjaub, who reports that the death rates of the civil population from fevers continued very high during the first quarter of the year, while amongst the troops sickness from fevers was unusually great at many stations of the province throughout the year.

The Gangetic provinces, Oude, and Rohilkund were quite untouched by the fever epidemic; it had its eastern limits at Roorkee and Delhi, and from the former place to the Peshawur frontier it was almost continuous, but few stations or districts escaped its malign influence. And so likewise from Allahabad across Central India to Kurrachee, the geographical continuity of the fever wave was, writes Dr. Bryden, unbroken.

Neither in time nor place were the epidemics of fever and cholera universally associated. 'There was no special manifestation of malaria with the great movement of cholera in the first week of June; the monsoon cholera of Oude, Cawnpore, and Allahabad was not accompanied by any outburst of malarious fever, nor did a single case of cholera accompany or follow the great fever of Meean Meer or Rawul Pindi; and the great cholera of the Central Provinces was dead when late in the

year the population was dying from fever by thousands. Rohilkund and Meerut was as regards both cholera and malaria an exempted province in 1869; the stations of the Gangetic provinces and Oude suffered universally from cholera, and were, with the exception of Allahabad, nearly free from the epidemic of malaria.¹

Turning to the fever epidemic of the Punjaub, we find that the troops at Sealkote and Umballa were unaffected by it, and those at the stations of Ferozepore, Jullundur, Umritsur, and Phillour suffered little, if at all. The Sanitary Commissioner of the province² states that the following districts either escaped altogether or suffered lightly, viz. Gurgaon, Delhi, Rohtuck, Jhung, Shahpore, and Dera Ghazee Khan.

As regards the commencement of the outbreak, there can be no doubt that it occurred in the middle of August in many districts widely separated; such was the case at Roorkee, Rawul Pindi, Kangra, Kohat. At Roorkee the commencement was quite a sudden one; Dr. Eteson says that on going to the hospital on the morning of August 12, he found that during the night an epidemic had set in. He reckons³ the epidemic at that station to have begun on August 10, and to have ended on November 10.

Dr. Bryden, guided it would appear very much by the increase in the number of admissions for fevers amongst the native troops, concludes that one common influence prevailed in the week which ended August 13, which in every station of the area caused the development of fever among the inhabitants, and that this influence gained its maximum in the month of October, and continued in force till the middle of November. He does not trace the existence in strength of the epidemic in Central India until the second week of September. In some places, he writes, the invasion did not occur in that province till October, at the date at which the monsoon rains which lasted up till October 10, began to dry up.⁴

The following table shows the recorded mortality from fevers amongst the civil population of the Punjaub, and the admissions for fevers amongst the native troops, during the distinctly epidemic months. The table also shows the rainfall registered during July, August, and September of 1869, and the average aggregate rainfall of those months.

¹ Bryden's *Cholera Report* of 1874, sequel, p. 42. ² *Report* for 1869, p. 121.

³ *Medical and Sanitary Report of the Native Army* for 1869, p. 90.

⁴ *Report*, p. 43.

1869	Deaths from fever, Civil population					Admissions to Hospital for fever, Native Troops					Rainfall in inches			Average of 10 years for the 3 months
	July	Aug.	Sept.	Oct.	Nov.	July	Aug.	Sept.	Oct.	Nov.	July	Aug.	Sept.	
Districts														
Umballa	646	914	2435	2805	1970	34	38	35	96	73	12.4	—	8.3	26.
Umritsur	650	600	941	1406	1283	2	10	26	57	21	7.6	.2	2.2	16.7
Bunnoo	189	176	216	403	520	50	213	580	926	968	3.9	1.3	.7	5.7
Delhi	534	690	1351	1523	1479	9	83	93	180	177	6.5	2.2	8.2	17.2
D. Ghazee Khan	187	178	327	636	566	—	—	—	—	—	4.1	1.9	1.1	3.9
" Ismael Khan	368	272	455	950	952	—	—	—	—	—	1.1	1.3	2.	4.1
Ferozepore	295	256	541	940	683	14	52	49	133	33	17.2	.8	7.3	15.9
Goojranwala	303	320	456	606	688	—	—	—	—	—	9.	3.1	6.	18.1
Goojrat	470	528	998	1346	816	—	—	—	—	—	10.5	.9	4.8	18.1
Goordaspore	839	1049	2640	3805	2947	—	—	—	—	—	10.4	4.4	9.7	21.8
Gurgaon	379	501	770	913	734	—	—	—	—	—	7.	1.7	11.9	21.
Hazara	333	468	871	671	532	83	353	553	709	427	8.9	4.1	6.	21.8
Hissar	314	335	572	628	601	—	—	—	—	—	2.5	1.8	5.1	10.6
Hoshiarpore	713	1028	3505	5009	2954	—	—	—	—	—	7.9	6.9	8.1	23.5
Jullundur	861	821	1819	3672	2419	28	49	105	115	113	14.4	1.7	7.1	21.5
Jhelum	509	490	1047	1158	1104	43	153	156	473	419	4.4	3.1	1.1	11.6
Jhung	165	126	140	228	309	—	—	—	—	—	6.5	.4	1.6	6.6
Kangra	604	968	1394	1170	629	42	104	137	131	59	29.6	33.7	31.2	95.8
Karnaul	453	577	1059	1303	1028	—	—	—	—	—	6.9	2.	5.7	20.4
Kohat	62	49	85	111	111	94	695	1236	1002	563	3.	3.5	6.	10.
Lahore	673	545	801	1400	1378	28	210	277	869	750	5.5	.2	4.9	12.7
Loodiana	476	489	1092	2160	1454	2	30	26	78	26	16.4	1.4	10.3	17.7
Montgomery	307	293	277	461	599	—	—	—	—	—	8.2	4.3	9.4	6.4
Muzaffargarh	233	251	400	650	857	—	—	—	—	—	3.	.5	1.	4.
Mooltan	370	274	410	867	1006	34	115	103	278	199	2.7	2.8	1.9	3.9
Peshawur	199	184	269	428	550	327	1040	1279	1611	1135	—	.9	7.	5.5
Rawul Pindi	708	940	1482	1746	1691	44	112	221	350	200	4.9	.3	4.	18.1
Rohtuck	381	537	998	1276	1227	—	—	—	—	—	7.4	1.6	7.3	14.2
Shahpore	348	246	343	423	486	—	—	—	—	—	1.6	1.6	1.	7.4
Simla	10	28	28	21	5	—	—	—	—	—	16.4	13.4	11.4	41.3
Sirsa	96	130	191	282	186	—	—	—	—	—	1.7	.8	6.3	9.1
Sealkote	1065	1332	3394	5224	4568	30	31	38	72	103	20.8	2.4	4.5	28.5
Roorkee	—	—	—	—	—	8	72	120	117	50	—	—	—	—
Total	13,734	15,595	31,307	44,221	36,332	—	—	—	—	—	—	—	—	—

The table shows a great increase in the number of admissions amongst the native troops for fevers at most of the stations in August; but I would venture to question whether this circumstance may be accepted as evidence that the commencement of the epidemic was universal in that month; for every year, epidemic or non-epidemic, August in the Punjaub is marked by the outbreak of autumnal fever. Thus taking the average admissions for fever per 1,000 of strength among the native troops of the province for the months of June, July, August, and September, they are as follows: 36·5, 38·7, 78·4, 159. And indeed we find regimental medical officers distinguishing between the commencement of the autumnal fever and that of this epidemic. Thus Surgeon Mantell, in charge of the 9th Bengal Cavalry at Meean Meer, writes,¹ that previous to the fall of rain in September, autumnal fever, such as is usual in the Punjaub, had set in, but that immediately after the fall admissions into hospital increased in number daily, and he places the commencement of the epidemic at that time.

Looking to the recorded mortality among the civil population, the districts of Goordaspore, Hoshiarpore, and Kangra suffered very early; while in others, as Jullundur, Jhelum, Loodiana, Mooltan, the rates give no evidence of being influenced by the epidemic until September.

The Sanitary Commissioner writes: ² ‘The fever first appeared in August. It did not break out simultaneously all over the province. In August, Hazara, Rawul Pindi, Kohat, Goordaspore, Kangra, Umballa, Hissar, and Mooltan, (Hoshiarpore?) were attacked. In September, Hoshiarpore, Jullundur, Kurnaul, Lahore, Loodiana, Muzuffurgurh, and Sealkote were involved. In October, Bunnoo, the cis-Indus portion of D. I. Khan, Peshawur, Goojranwala, Goojrat, Jhelum, Sirsa, and Montgomery became attacked.’ The report on the fever of the year in the Army Medical Report for 1869, places the commencement of the outbreak over the greater part of the Punjaub in the middle of August.³ ‘Cases of intermittent fever first became numerous in the month of August.’ ‘In August the hospitals began to fill everywhere in the circle except Sealkote’ (Lahore circle), writes Deputy Inspector-General Hastings. At Jhelum the fever did not assume the character of an epidemic till September. At Rawul Pindi the epidemic is said to have begun in the middle of August; in the Hazara late in

¹ *Medical and Sanitary Report of Native Army* for 1869, p. 117. See also *Reports* from Mooltan and Murdan to the same effect, at pp. 121 and 165 of the same report.

² *Punjaub Report* for 1869, p. 121.

³ *Ibid.* p. 197.

August; at Peshawur on the termination of the cholera epidemic in October; at Kohat in the middle of August. At Bunnoo and at D. I. Khan fever did not begin to prevail till September.

It is clear that in some districts the epidemic was either absent or its effects so slight that they were not distinguishable from the ordinary fever of the season; in others, sooner or later, the numbers attacked, and the severity with which numerous individuals were attacked, revealed the epidemic character of the disease; while in other districts the suddenness of the outbreak, and its severity from the very beginning, demonstrated the existence of an influence more powerful in degree than that which in non-epidemic years begets autumnal fever.

As to the nature of the fever, the reports, both of civil medical officers and regimental surgeons, concur in pronouncing it malarious. Thus, Deputy Inspector-General Hastings, reporting on the epidemic as it affected the Lahore circle, writes: ¹—‘Intermittent fever prevails annually in the Punjaub at the change of season in the autumn. The poorer classes suffer most, and a large number die. The native troops also suffer, but being better fed, better lodged, and having appropriate treatment in hospital, a few deaths only usually occur amongst them from this cause. During the last five months of 1869, this form of fever affected native troops and population alike. The whole country from Kangra to Mooltan was most severely afflicted. Among the troops the mortality was small, but among the people the death rate was high everywhere, and at some places very high. Poverty and the absence of everything needed by the sick caused the difference.’ ‘The cause of the fever was no doubt of malarious origin. Among the troops the returns show the admissions to have been chiefly caused by intermittent fever of the quotidian type. A few cases only presented the tertian form, and still fewer that of remittent fever.’ Deputy Surgeon-General Morton, reporting on the epidemic in the Peshawur circle, says: ² ‘There was but little characteristic of the prevalent fever beyond its being the usual autumnal fever in an exaggerated form, somewhat lower in type perhaps, and accompanied by a more than ordinary tendency to diarrhoea.’

Surgeon J. R. Johnson, in charge of the corps of Guides stationed at Murdan in the Peshawur valley, writes: ³ ‘Autumnal malarious fevers prevailed throughout the district to an extent seldom or never before experienced. No house or family escaped the visitation. The attacks, although prostrating, were seldom

¹ *Medical Report of Native Army of Bengal*, p. 199.

² *Ibid.* p. 201.

³ *d.* p. 164.

followed by fatal results (amongst the troops), and the disease never assumed a relapsing or typhoid form. It was in fact pure malarious fever, and probably caused, or at any rate greatly aggravated, by late and heavy rains.' 'Intermittents commenced towards the end of August, and increased so gradually and insidiously, that it would be difficult to say when they became epidemic. A most decided increase in the number and severity of the attacks was observed about September 20, and from that date to the end of October the disease was at its work.'

Turning to the reports of civil medical officers, Dr. Taylor of Umritsur says¹ that 'it was purely a malarious fever, and intermittent or remittent in its main symptoms. Its duration was extremely variable; the post-mortem examinations showed the usual negative signs of malarial poisoning, with enlargement (occasional only) of spleen and liver, and congestion; no alteration of any sort was observed in the intestines, nor was any disease of Peyer's patches, though carefully hunted for, detected.' The fever readily yielded to quinine. The disease was, in Dr. Taylor's opinion, caused by excessive malaria generated by the late and heavy rain. Dr. Warburton of Jullundur states: 'there was nothing unusual in the character of the fever which has prevailed in this district during the last two or three months.' Mr. Barnes describes the fever as it came under his observation at Hoshiarpore under three types:—1. The ordinary intermittent of the quotidian form. 2. The second form commenced as a quotidian, then became a tertian, in the latter stage of which diarrhoea set in, followed by anæmia and anasarca, and in many cases terminated in death, but chiefly among the very old. 3. The third form commenced as an ordinary intermittent, and then suddenly took on a low typhoid form, and generally terminated in death from the seventh to the eleventh day.'

The Sanitary Commissioner writes: 'The civil surgeons are almost unanimous that it was malarious fever.' One more quotation only regarding the nature of epidemic fever, and that from Dr. Cutcliffe's report on a previous epidemic, one which ravaged the Meerut division in 1867. Dr. Cutcliffe writes:² 'From all that I saw and heard of the disease, it seemed to me to be no other than the same malarious fever with which I have been familiar for ten years past in

¹ *Report of Sanitary Commissioner of the Punjab*, p. 123.

² *Report on the Sanitary Condition of certain Districts in the Meerut Division*, by H. C. Cutcliffe, Esq., F.R.C.S., p. 62.

the Meerut division, and with which during that time I have kept up a very extensive, and, I am happy to say, a very successful warfare. It is true the old enemy appeared often in different forms, and assumed very great varieties of aspect, and played his devilries sometimes in a most complicated manner, and frequently with a violence which well nigh allowed him to conquer. But his identity could not be completely masked, and quinine, aided by the support of fresh air and such food as could be assimilated, soon exposed and vanquished the fiend, who left me to complete the restoration of his victim by nursing and proper care. The evidence contained in my notes seems to me to be conclusive that the character of the fever which I have been directed to trace and study was malarious fever manifesting itself most frequently in intermittent fever, but often in severe remittent fever, and frequently attended by complications, especially visceral affections, of which, however, none are remarkable either for novelty or peculiarity.'

With reference to the cause of the epidemic of 1869, we find a very great concurrence of opinion among the District Civil Surgeons, and the Surgeons of Native Regiments stationed in the province, that it was due to malaria caused by the late and heavy autumnal rains. The records of the Meteorological observer show that the autumnal rains were very general throughout the province; and all the fever-afflicted districts, Peshawur excepted, received them plentifully, while over the northern and western districts they were unusually heavy. The Meteorological observer (Dr. Neil) notes that throughout the Punjaub the rainfall of September was heavy, and to this circumstance he ascribes the great prevalence of fever in the province.¹

As to the case of Peshawur, the district, with or without rain, is, owing to its natural physical conditions, and to superabundant irrigation, so damp that no inference can be drawn from its history as to the influence of the rainfall on the epidemic. But in the case of Umballa and Sealkote, two very healthy stations, the rains were plentiful, and the September rains, as shown by the following table, heavy, yet the native troops were quite unaffected by the prevalent fever. At Ferozepore too, the troops were little, if at all, affected.

	UMBALLA			SEALKOTE			FEROZEPORE		
	July	Aug.	Sept.	July	Aug.	Sept.	July	Aug.	Sept.
1869	12.4	—	8.3	20.8	2.4	4.5	17.2	.8	7.3
Average (ten years). .	12.8	7.9	5.3	14.2	10.	4.2	7.1	6.2	2.6

¹ Dr. Neil's *Report* for 1869.

Moreover those districts which escaped the epidemic, or suffered lightly, had all, Shahpore excepted, their full complement of autumnal rain, and more than usually heavy rain in September. Further, as the Sanitary Commissioner of the Punjaub points out, the epidemic began in some districts—notably, as shown by the following table, in Rawul Pindi—early in August, although up to that time there had been nothing unusual in the rainfall.

RAWUL PINDI					HOSHIARPORE			
	June	July	Aug.	Sept.	June	July	Aug.	Sept.
1867 . . .	·1	2·2	7·6	1·7	2·3	9·6	9·2	2·4
1868 . . .	·1	9·1	2·6	·9	1·6	9·1	6·4	·4
1869 . . .	1·5	4·9	·32	4·	·8	7·9	6·9	8·1

In Hoshiarpore too, though the district was not perhaps as a whole affected till September, the epidemic was recognised about the middle of August at Tanda, where a large number of people were making a road.

The Sanitary Commissioner with the Government of India concludes: ¹ 'If the previous years be taken, it will appear that in some of them, with a rainfall quite as high as in the past year there was no unusual prevalence of fever. At Rawul Pindi for example, in 1868, the rainfall during the five months July to November was 12·9, or one-fourth heavier than in 1869, and yet 1868 was a year strikingly non-epidemic in its character.² Nor can any relation be traced between fever and difference in temperature in the autumn months. The statistics on this point have been carefully examined, but they lead to no result. These facts are of great importance as illustrating how very ignorant we still are of the circumstances under which malarial diseases assume an epidemic character.'

We may say then that the circumstances of the epidemic of 1869, and of other epidemics of malarious fever in Northern India, while opposed to that view of fever epidemics which would refer them merely to climatic or meteorological causes, are not incompatible with the hypothesis that the epidemic depends upon the production of an unusually luxuriant crop of fever germs fostered by subtle changes in air and soil. Though ignorant of the essential nature of these changes, we yet recognise two physical conditions, warmth and moisture, and perhaps the presence of decomposing organic matter, as more especially conducing to them. On this view the Punjaub, like the rest of India, must be looked upon as

¹ *Report for 1869*, p. 89.

² The *Sanitary Commissioner* gives 7·5 as the rainfall for July.

being the habitat of the malarial germs, just as are parts of Bengal of those of cholera. But why the cholera germs should in certain years breed in unusual abundance in the one province, and the malarial germs in the other, we cannot say. Probably the germ of malaria may, as we have good reason to think is the case with germs of cholera, become wafted by the winds to a distance from the place of their production, to multiply afresh where they find adequate warmth and moisture—or other conditions favourable to their growth and development which are less understood—as for example in the damp atmosphere of a barrack room, or in the damp soil around the water sources.

Here and there in the Punjaub, as for instance in the sub-tropical valleys which penetrate the Himalayas; in the Kadir of the rivers; in places which are by nature marshy, as, for instance, in the Doaba district of the Peshawur valley; and, neighbouring upon the Punjaub, in the tract of country between the rivers Jumna and Ganges, we find malaria of most pernicious character existent throughout the greater part of the year, and often showing itself in the production of fevers which in severity resemble those of the most pronounced malarious epidemics.

The existence of such decided fever localities; the circumstance that an outbreak of malarious fever marks each autumn in the Punjaub; and the fact that anywhere throughout the province, where the soil is such that crops can be raised, a superabundance of water serves to develop a fever nest, prove clearly enough that the soil and the climate of the Punjaub present conditions very congenial to the malaria germ.

Recurring to the quoted opinions of medical officers, civil and military (and such quotations might be, were it needful, multiplied tenfold), that the epidemic fever of 1869 was in its nature essentially the same with that of the ordinary autumnal fever, or climatic fever as it is sometimes called, of Northern India, though the correctness of that view may be, and is, questioned, yet there can be no question of the fact that a body of medical officers, whose hospitals are yearly stocked with fever cases, cannot distinguish between the so-called climatic and the epidemic fevers, a circumstance which in itself is strong evidence that the distinction does not exist. And the opinion in question is fortified by the following considerations. 1. In every station during a non-epidemic, or as it is ordinarily called a healthy, autumn, though the majority of cases of fever are of a mild type, there are some cases, perhaps only a few, of a serious character, cases such as

would form the staple of a bad epidemic season, and intermediately there will be cases of every shade of severity. 2. While the well-constituted men may suffer from mild intermittents only, the weakly members of the regiment are very apt to become victims to fevers of a more severe type. Yet all are under the same external conditions. 3. While the majority of the well cared-for sepoys who suffer at all are experiencing slight attacks, the agriculturists, their countrymen, ill-lodged, ill-fed and clothed, who are living immediately around the cantonments, are many of them suffering from severe intermittents and remittents. 4. Another consideration, and it is one which depends upon a well-recognised phenomenon of fever epidemics, is that mere elevation of the dwelling place commonly alters the type, or diminishes the severity of the fever.¹ Dr. Bryden narrates a case in point. He writes: 'In the epidemic of malaria of the end of 1859, I found that the elevation of the fort of Buxar (about forty feet) sufficed, not to prevent the attack of malarious fever, but to alter its type. Every case which occurred in the Naval Brigade occupying the fort (and every man suffered) was a case of purely intermittent fever, while in the detachment of Her Majesty's 6th Regiment, occupying temporary barracks on the ground level, every case, both in officers and men, assumed the remittent type, passing in several cases into continued fever, and ending in death.' 5. Another consideration is this, that an epidemic of malarious fever may manifest itself in the mildest form of intermittent, or, according to circumstances, prove so malignant, that in a few days the patient sinks into the 'typhoid' condition of the worst description of jungle fever.²

Now in all the cases that have been mentioned, it may hardly be doubted that the cause, whatever it is, which gives rise to the severer forms of fever is in its nature identical with that which produces the milder cases; and if the former depend upon the presence of a specific miasm, the mild cases must so also, whether they occur during an epidemic or non-epidemic season. The difference between the cases is one of degree only, and depends upon the dilution of the miasm; or upon the state of the recipient; or possibly, assuming that the miasm is a living organism, upon the stage or vigour of its growth; while the development of an epidemic results from an excessive and widespread production of the poison.

¹ Bryden's *Vital Statistics*, vol. of 1874, p. 226.

² *Ibid.* vol. of 1876, p. 189.

CHAPTER VI.

DISEASE DISTRIBUTION OF NORTHERN INDIA.

Distribution of the chief diseases of Northern India exemplified by the statistics of disease and mortality amongst the British and Native troops, and the jail population. Statistics of disease and mortality amongst the men, women, and children of the British Army, and amongst the Native troops. Notes on statistics of British troops. Mortality in relation to length of service and season. Mortality amongst the women and children. Mortality in relation to cause and season amongst British and Native troops. Contrasted death rate amongst the Native troops in relation to locality. Mortality and sickness amongst jail population as influenced by season and locality. Causes of mortality amongst the prisoners :—diseases of debility, epidemic contagious diseases, cholera, dysentery, heat apoplexy, malarious fevers, enteric fever, typhus.

TABLE I.—*British Troops. Average daily sick per 1,000 of strength.*

	1871-75	Men. 1872-76						Women. 1871-75	Chil- dren. 1871-75
	Army of Bengal ¹	Bengal proper	Dina- pore, Benares, Oude, and Cawn- pore districts	Meerut and Rohil- cund districts	Agra and Central India districts	Pun- jaub	Hill stations, exclud- ing con- vales- cent depôts	Army of Bengal	Army of Bengal
January . .	51	51	57	50	38	52.4	40	29.5	24.9
February . .	50.5	49	60	48	50	48	37.4	27.8	24.3
March . .	49	45	61	44	46.4	45	42	30.8	27.3
April . .	52.6	48.4	63	48.4	46	46.4	45	40.1	39.5
May . .	57.	52	64	52	50.4	51	49	49.	48.6
June . .	60	56	66	55	50	56	49.4	54.1	50.3
July . .	62	63	69	55	51	58	52	55.7	55.7
August . .	66	68	71	62	55.4	61.4	50	62.8	63.1
September . .	67	65	73	69	66	70	45.6	66.3	60.9
October . .	65	60	74	66	64.4	74	41.4	54.	48.2
November . .	58	55	66	59	58	70.4	38	41.8	36
December . .	53	50	56	51	48.4	62	38	31	26.8
The year . .	57.5	55.4	65.	54.7	52.7	57.5	45.2	45.2	42.2

Composition of the admission rate per 1,000 of strength.

Cholera . .	4.8	1.	7.3	5.4	3.4	6.	3.	7.9	6.8
Intermittent fever . .	356	129	146	439	449	536	191	217	120
Remittent and continued fevers . .	175	251	154	96	103	287	57	152	102
Enteric fever . .	3.7	2.5	6.7	3.9	2.1	3.6	2.7	1.6	—

¹ Includes the whole of the British troops serving in the provinces of the Bengal Presidency.

TABLE I.—continued.

	1871-75	Men. 1872-76.						Women. 1871-75	Chil- dren. 1871-75
	Army of Bengal	Bengal proper	Dina- pore, Benares, Oude, and Cawn- pore districts	Meerut and Rohil- cund districts	Agra and Central India districts	Pun- jaub	Hill stations, exclud- ing con- vales- cent depôts	Army of Bengal	Army of Bengal
Apoplexy .	3·2	2·6	4·8	4·9	2·8	5·	3·6	1·7	—
Delirium tre- mens	3·	Not computed							
Dysentery .	30·4	52·4	37	34	21	24	18	36	21·
Diarrhoea .	61·	52	67	67	43	53	54	72	113
Hepatitis .	50·3	60	52	47	48	43	34	21·4	
Spleen disease	7·6	2·8	4·9	6·4	5·6	11·	4·5	3·5	3·3
Respiratory diseases	84	58	68	77	74	10	84	36·3	51·
Phthisis pul- monalis	9	Not computed						11·2	—
Rheumatism .	64	45	57	59	54	69	68	21·3	—
Venereal diseases .	196	Not computed							
Eye diseases .	22	12	30	21	21	20	13	75·1	168
Abscess and ulcer	83	Not computed						27·4	14·5
Injuries .	89	Not computed						10·3	14·5
General de- bility	—	—	—	—	—	—	—	225	—
Abortion	—	—	—	—	—	—	—	22·5	—
Diseases of women	—	—	—	—	—	—	—	36·3	—
Measles .	—	—	—	—	—	—	—	—	47
Whooping cough	—	—	—	—	—	—	—	—	14
Anæmia and debility	—	—	—	—	—	—	—	—	102
Tubercular diseases	—	—	—	—	—	—	—	—	8·
Meningitis and hydro- cephalus }	—	—	—	—	—	—	—	—	3·5
Convulsions .	—	—	—	—	—	—	—	—	14·8
Dentition .	—	—	—	—	—	—	—	—	40·7
All other causes	199	Not computed						125	60·5
Admission rate of the year	1444	1326	1416	1414	1302	1677	970	1103	904

TABLE I.—continued. *Army of Bengal, 1871-75.*

COMPOSITION OF DEATH RATE PER 1,000 OF STRENGTH.

	Men	Women	Children	Composition of 100 deaths of men (army of Bengal) in 1st and 2nd years of service, excluding accidental deaths, cholera, and small-pox.	The same in men whose residence has exceeded ten years
Cholera	3.23	5.38	5.2	—	—
Remittent and continued fevers	1.53	4.32	7.02	8.	4.6
Enteric fever . .	1.7	1.	—	26.7 ¹	.5
Apoplexy	1.33	.74	—	12.2	9.5
Delirium tremens .	.13	—	—	—	—
Dysentery	1.24	4.75	2.91	8.5	13.7
Diarrhoea	—		16.4	—	—
Hepatitis	2.05	1.69	—	12.3	15.7
Respiratory diseases .	1.06 ³	1.05	7.05	4.4	6.6
Pathisis pulmonalis .	1.25	3.32	—	9.1	7.8
Heart-disease . .	1.27	.95	—	4.7	17.6
Suicide . . . .	.55	—	—	1.8	6.1
Measles	—	—	3.24	—	—
Whooping cough . .	—	—	.99	—	—
Anæmia and debility .	—	1.21	8.9	—	—
Tabes mesenterica .	—	—	3.12	—	—
Meningitis and hydrocephalus	—	—	2.31	—	—
Convulsions . . .	—	—	11.08	—	—
Dentition	—	—	7.11	—	—
All other causes . .	—	—	5.34	12.3	17.9
Death rate of the year ²	18.5	29.7 ⁴	80.61	—	—

¹ Died per cent. of enteric fever during the months as follows:—

January	6.0	May	11.4	September	16.5
February	4.5	June	12.3	October	7.3
March	3.2	July	10.7	November	4.5
April	9.	August	10.3	December	4.3

² Death rate of the Hill stations average per 1,000 of strength, excluding cholera, 9.8. The ratio for cholera was in 1872, 6.22; 1875, .90; 1876, 2.23.

³ Including croup and diphtheria.

⁴ Includes child-birth 3.06, and all other causes than those mentioned, 2.27.

TABLE II.—*British Troops. Ten year period 1860-69.**a* ADMISSIONS, AND *b* MORTALITY, PER 1,000 OF AVERAGE STRENGTH.

	Cholera	Small-pox	Intermittent fever	Remittent and continued fevers	Apoplexy	Delirium tremens	Dysentery	Diarrrhoea	Hepatitis	Respiratory diseases	Phthisis pulmonalis	Rheumatism	Ophthalmia	All causes	Average aggregate strength of the ten years
proper— <i>a</i>	10.8	.5	341	227	3.3	10.7	94	168	54	71	6.5	79	38	1821	24,286
nd Cawnpore <i>b</i>	6.26	.04	.58	3.74	2.02	.95	5.23	.66	3.6	1.07	1.52	—	—	29.6	—
ore, Benares. <i>a</i>	12.3	2.3	269	198	4.0	4.6	54	104	60.4	65	7.7	79	51	1615	105,971
. <i>b</i>	8.12	.4	.48	3.24	2.24	.58	2.7	.8	3.5	.93	1.6	—	—	28.6	—
t and Rohilcund <i>a</i>	9.3	3.4	249	161	3.5	3.4	48	98	67	72	8.8	87	48	1576	57,090
„ <i>b</i>	6.6	.7	.56	2.8	1.8	.44	2.7	.82	3.8	.88	1.7	—	—	26.6	—
istrict, and Central <i>a</i>	26.6	3.1	790	206	6.6	5.1	48	132	54	78	6.4	86	47	2169	48,675
„ <i>b</i>	15.9	.4	1.2	3.3	3.	.62	3.	.9	3.6	.99	1.25	—	—	38.5	—
ub. <i>a</i>	14.4	1.4	544	197	4.3	3.7	34	96	55	80	6.5	77	43	1741	146,697
. <i>b</i>	8.9	.2	.6	2.4	1.7	.3	1.9	.53	2.6	.9	1.4	—	—	25.2	—
stations (excluding) <i>a</i>	3.3	.6	186	54	.5	1.5	32	99	42	67	8.	75	45	1070	19,956
ivalescent depôts) <i>b</i>	1.8	—	—	2.3	.15	—	2.7	1.0	1.4	.75	.9	—	—	14.8	—

TABLE II.—continued. *Admitted to Hospital each month, per 1,000 of strength.**a* CHOLERA, *b* INTERMITTENT FEVER, *c* REMITTENT AND CONTINUED FEVERS.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year
Bengal proper ¹	.2	1.4	2.1	1.8	2.2	.8	.7	.2	.2	.3	.7	.3	10.8
"	19.1	12.9	13.9	15.1	28.8	32.	46.2	42.8	39.	34.7	29.3	27.2	340.6
"	3.7	4.5	7.8	16.3	23.8	41.5	37.2	24.9	27.8	20.1	11.5	7.3	226.9
Dinapore, &c.	.1	.1	1.2	2.7	.6	.6	1.7	3.6	1.2	.2	.1	—	12.3
"	17	11.3	13.7	19.6	18.5	25.6	27.1	28.6	30.4	33.	25.8	18.3	268.7
"	5.4	4.2	11.4	25.2	19.9	25.5	23.8	19.7	22.4	22.3	11.4	5.1	198.3
Meerut and Rohilcund	—	—	.1	.2	.1	.1	3.5	2.6	2.2	.1	.1	—	9.3
"	14.2	9.3	12.6	18.8	20.4	22.7	24.8	24.6	28.6	30.5	25.3	14.5	249.2
"	3.6	3.6	6.8	17.9	18.	18.3	25.9	20.1	16.8	12.5	8.2	4.2	161.2
Agra and Central India	—	—	—	1.4	.9	.5	5.5	15.5	2.4	.3	—	—	26.6
"	33.2	22.1	23.	38.5	37.6	43.9	57.8	69.4	102.6	158.6	138.4	77.5	790.1
"	3.8	3.6	7.5	17.5	17.5	19.2	21.7	28.7	30.	36.5	15.7	4.7	205.6
Punjaub	—	—	—	.1	1.3	.9	1.2	6.6	3.6	.6	.1	—	14.4
"	25.3	15.5	17.2	25.	37.	40.	45.9	46.9	64.	90.4	84.9	52.3	544.
"	2.2	2.3	3.7	12.4	29.9	29.3	28.6	28.7	27.4	18.1	7.	2.9	197.3
Hill Stations	—	—	—	.1	.05	.4	.15	2.2	.4	—	—	—	3.3
"	3.85	1.7	6.6	18.8	27.3	30.5	28.8	25.2	18.9	14.5	6.2	3.6	186.1
"	.85	.5	.95	4.4	9.4	8.7	7.8	7.2	7.	4.2	1.9	.95	53.9

¹ Compiled from Surgeon-Major Bryden's *Vital Statistics of the Bengal Presidency*. Calcutta, 1874.

TABLE III.—*Native Troops—ten year period 1867-76.*

ADMITTED TO HOSPITAL FOR ALL CAUSES, PER 1,000 OF STRENGTH.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The period per 1,000 of strength
Bengal proper and Assam	110	93	101	117	125	121	144	150	142	153	149	123	1523
Dinapore, Benares, Oude, and Cawnpore districts	71	64.5	76	71	74	72	87	106	113	136	111	81	1062
Meerut and Rohilcund	61	54	55	66	77	70	72	113	142	121	93.5	69	987
Punjaub	84	63	62	68	80	85	94	142	223	263	191.5	112.5	1459
Punjaub Frontier Force	109	80	77	79	100	101	107.5	162	224	290	229	141.5	1680
ADMITTED TO HOSPITAL PER 1,000 OF STRENGTH FOR <i>a</i> INTERMITTENT FEVER, <i>b</i> REMITTENT AND CONTINUED FEVERS, <i>c</i> DYSENTERY.													
Bengal, &c.	35.7	30.1	33.3	44.7	45.8	47.7	64.9	76.9	71.9	78.7	75.7	52.7	659.
" . . . . .	.73	.91	1.03	1.21	2.11	2.13	2.18	1.86	2.0	1.83	1.68	.97	18.7
"	15.5	10.9	12.	13.6	11.6	11.0	10.6	9.6	9.47	11.2	10.6	12.0	139.
Dinapore, &c.	21.4	20.1	25.9	24.2	25.2	23.6	33.4	42.	52.4	79.4	57.4	30.7	436
" . . . . .	.5	.78	.84	.84	.79	.68	.6	.74	.96	1.09	.9	.39	9.2
"	3.3	3.9	4.6	4.5	3.3	2.7	3.3	6.2	5.6	5.3	6.2	5.4	54.4
"	17.	13.9	16.4	21.2	29.4	25.5	27.8	62.	92.6	72.5	43.6	22.8	446.
Meerut, &c. . . . .	.87	1.05	1.35	1.6	1.7	1.1	1.36	1.54	2.8	2.4	.83	.85	17.5
"	2.9	1.6	2.06	2.7	3.2	3.	2.5	3.7	4.0	5.6	5.7	4.6	41.5
"	35.4	25.2	23.7	24.7	31.4	36.5	38.7	78.0	159.	243.	142.	63.3	863
Punjaub . . . . .	.71	.48	.64	.89	1.4	.76	.63	.85	1.16	1.24	.9	.67	10.3
"	3.9	2.3	2.4	3.6	3.7	3.5	3.8	6.5	8.	9.8	9.7	6.6	63.9
"	49.	33.7	31.4	29.4	39.4	40.7	39.4	79.3	148.	213.	168.	83.4	956
Punjaub Frontier Force	1.7	1.47	1.08	.76	.85	.63	.54	.65	.82	1.4	1.3	1.5	12.7
"	4.9	2.6	2.5	3.5	4.4	4.4	4.4	7.9	9.1	8.9	9.3	7.0	69.1

TABLE III.—continued. *Native Troops—ten year period 1867-76.*NUMBER OF ADMISSIONS TO HOSPITAL FOR *a* CHOLERA, *b* DIARRHŒA, *c* SMALL-POX, *d*, RESPIRATORY DISEASES (EXCLUDING PHTHISIS).

	January	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	The period per 1,000 of strength
Bengal, &c.	20	14	74	88	79	40	35	13	10	20	16	28	—
"	591	419	494	540	619	586	587	505	514	471	490	471	—
"	4	9	27	33	17	12	1	—	—	—	1	2	—
"	581	475	451	374	310	267	284	304	336	362	427	499	—
Dinapore, &c.	—	9	9	21	27	17	18	42	9	11	6	2	—
"	103	130	237	214	178	197	181	278	158	140	142	147	—
"	9	15	48	29	20	7	—	—	1	—	—	6	—
"	248	247	240	144	144	90	132	135	141	192	265	262	—
Meerut, &c.	—	—	3	12	11	6	4	20	10	4	1	1	—
"	59	77	92	133	123	140	109	141	103	94	109	94	—
"	22	9	7	28	16	10	2	—	—	1	1	13	—
"	223	262	199	154	136	114	95	106	97	176	186	217	—
Punjaub.	—	2	—	8	29	51	76	35	178	93	7	1	—
"	347	232	274	378	394	443	583	592	626	645	659	524	—
"	10	22	13	10	5	15	1	1	—	1	3	3	—
"	1318	1074	865	538	397	286	297	324	304	408	771	1226	—
Pnnjaub Frontier Force.	—	—	—	30	2	3	24	87	63	220	10	—	—
"	358	238	252	332	387	400	491	619	559	496	502	503	—
"	3	7	4	4	2	1	3	2	—	2	9	14	—
"	1410	990	754	470	311	199	167	215	199	266	504	1154	—

TABLE III.—continued. ADMITTED TO HOSPITAL PER 1,000 OF STRENGTH.

	Dengue	Cholera	Small-pox	Enteric fever 1872-76	Intermittent fever	Remittent and continued fevers	Dysentery	Diarrhoea	Hepatitis	Spleen	Respiratory diseases	Phthisis pulmonalis	Rheumatism	Veneral diseases	Eye diseases	All causes	Average strength of the period
Bengal, &c.	22.4	5.9	1.4	.4	659	19.	139	84.	2.6	17.2	62.6	3.1	63.3	36	17	1523	74,585
Dinapore, &c.	23.6	2.5	2.	—	436	9.2	54.	31.	1.6	3.3	33.	2.6	53.	50	29	1062	67,678
Meerut, &c.	3.1	1.4	2.1	—	446	17.5	41.5	25.	2.6	10.3	38.	2.6	46.	40	27	987	51,281
Punjab	.1	3.2	.6	.1	863	10.3	64.	38	1.7	13.	52.	1.6	55.	26	29	1459	149,410
Punjab Frontier Force	—	4.4	.5	.1	956	12.7	69	51	2.1	13.	66.	1.8	59	22	28	1680	100,144

DIED WITH THEIR REGIMENTS PER 1,000 OF STRENGTH.																	
Bengal, &c.	—	3.1	2.7	3.38	2.1	1.7	.17	.74	1.77	1.11	—	—	—	—	—	19.1	—
Dinapore, &c.	—	1.5	.35	1.45	.8	.3	.2	.27	1.15	.7	—	—	—	—	—	8.4	—
Meerut, &c.	—	.82	.25	2.57	.7	.5	.27	.25	1.95	1.17	—	—	—	—	—	11.2	—
Punjab	—	1.73	.09	3.32	.95	.78	.08	.12	3.94	.6	—	—	—	—	—	14.2	—
Punjab Frontier Force	—	2.73	.37	3.4	.91	.27	.11	.18	4.8	.5	—	—	—	—	—	15.9	—

TABLE III.—continued. NUMBER OF DEATHS PER MONTH IN HOSPITAL FROM *a* INTERMITTENT FEVER, *b* REMITTENT AND CONTINUED FEVERS, *c* RESPIRATORY DISEASES.

	January	February	March	April	May	June	July	August	September	October	November	December
Bengal, &c.	14	6	18	8	6	8	7	13	9	10	13	10
"	"	10	9	5	8	11	11	13	11	13	7	7
"	"	15	16	9	11	9	6	7	5	4	9	16
Dinapore, &c.	"	3	5	2	2	3	—	4	1	10	8	8
"	"	3	7	3	6	4	4	3	1	1	6	5
"	"	7	10	3	6	3	3	4	2	4	8	14
Meerut, &c.	"	4	4	3	3	3	6	4	3	6	11	8
"	"	10	7	6	4	4	2	6	5	6	3	4
"	"	18	14	6	7	7	5	1	2	6	8	8
"	"	35	23	7	10	8	6	7	7	34	72	55
Punjaub	"	14	14	22	9	17	11	9	9	14	20	21
"	"	81	53	45	26	10	10	10	9	18	61	128
"	"	3	4	8	5	6	3	5	9	15	25	21
Punjaub Frontier Force	"	25	13	14	9	13	13	9	14	13	26	30
"	"	106	36	30	12	6	4	3	7	4	43	108
"	"											

Names of stations included in the above divisions.

BENGAL PROPER AND ASSAM

Fort William
Alipore
Dum Dum
Barrackpore
Berhampore
Dacca
Cachar
Shillong

Gowhatty
Tezpur
Nowgong
Debrooghur
Buxa
Julpigoree
Bhagulpore

DINAPORE, &c.

Dinapore
Segowlie
Benares
Chunar
Goruckpore
Fyzabad
Lucknow
Seetapore
Futehghur
Cawnpore
Allahabad
Nagode

MEERUT, &c.

Meerut
Delhi
Roorkee
Dehra Doon
Almora
Shahjehanpore
Bareilly
Moradabad

PUNJAB

Umballa
Simla
Phillour
Ludiana
Jullundur
Ferozepore
Mooltan
Sealkote
Dhumsala
Bukloh

Umritsur
Mecan Meer
Jhelum
Rawul Pindi
Talagaon
Attock
Murree
Nowshera
Cherat
Peshawur

PUNJAB FRONTIER
FORCE

Muridan
Abbotabad
Kohat
Bunoo
D. Ghazi Khan
D. Ismael Khan
Rajanpore

TABLE IV^a.—Compiled from Dr. Bryden's 'Vital Statistics of India,' Calcutta, 1878. The nearest whole numbers made use of in columns 'a' and 'b,' and in the composition of the admission rate.—Native Troops, selected stations. Ten year period 1867-76. Table showing admission rate 'per 1,000 of strength' for 'a' all cases, 'b' intermittent fever; and 'total number of admissions' for 'c' cholera, 'd' remittent and continued fevers, 'e' dysentery, 'f' respiratory diseases.

	Barrackpore						Deebroghur and outposts					
	a	b	c	d	e	f	a	b	c	d	e	f
January .	91	35	3	12	132	54	105	38	1	1	60	65
February .	79	24	1	5	69	53	74	22	—	5	30	34
March .	96	38	6	6	70	34	75	23	1	—	44	45
April .	147	89	6	11	75	23	91	27	9	1	83	60
May .	120	42	—	12	60	26	123	34	7	1	102	37
June .	92	33	1	10	46	21	140	54	6	6	100	32
July .	113	48	3	15	66	16	160	75	4	92	99	37
August .	136	76	1	12	73	15	192	122	2	12	74	36
September .	125	71	2	5	78	26	201	128	2	8	66	35
October .	163	88	4	9	105	32	196	131	5	4	72	22
November .	157	76	1	8	83	49	172	94	1	4	57	39
December .	143	65	1	7	92	31	115	52	2	1	63	37
Year .	1452	685	29	112	949	380	1640	802	40	52	873	479
Average strength for the 10 years	8470	—	—	—	—	—	7853	—	—	—	—	—

	Lucknow						Bareilly					
	a	b	c	d	e	f	a	b	c	d	e	f
January .	68	18	—	2	47	49	43	7	—	3	8	29
February .	65	22	1	2	55	53	49	12	—	10	11	26
March .	92	37	—	6	78	59	42	14	1	13	14	22
April .	83	29	9	13	61	33	55	16	—	3	10	20
May .	84	28	5	5	46	49	63	15	—	6	17	10
June .	78	25	4	5	46	19	54	13	—	3	14	17
July .	99	40	6	6	28	26	52	15	—	3	12	15
August .	127	52	7	6	69	25	63	18	1	7	23	19
September .	105	48	2	21	68	33	65	25	—	6	25	16
October .	108	56	7	14	67	39	76	32	1	14	38	23
November .	99	43	3	8	90	49	54	17	—	5	22	25
December .	71	20	—	4	55	36	36	79	—	3	22	14
Year .	1078	417	44	92	710	470	651	194	3	76	216	236
Average strength for the 10 years	15,614	—	—	—	—	—	9106	—	—	—	—	—

TABLE IV^a.—continued. *Native troops, selected stations.*

	Ferozepore						Meean Meer					
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
January .	97	70	—	2	8	31	111	42	—	5	49	228
February .	92	64	1	2	6	26	80	32	—	6	35	146
March .	72	50	—	2	4	23	79	34	—	22	45	108
April .	77	40	—	—	19	14	79	32	1	33	36	69
May .	86	44	—	1	16	12	86	33	—	18	55	45
June .	87	51	5	—	6	3	79	35	—	10	32	31
July .	106	57	—	1	10	7	79	32	11	5	28	17
August .	157	101	—	2	17	14	177	118	20	20	61	26
September .	197	146	—	1	33	5	272	215	6	19	100	14
October .	212	168	—	2	31	15	356	286	—	16	144	35
November .	137	88	—	3	35	23	271	191	—	12	149	74
December .	114	69	—	—	19	22	169	90	1	11	87	177
Year .	1416	950	6	15	204	195	1793	1139	39	177	821	970
Average strength for the 10 years	5944	—	—	—	—	—	12,382	—	—	—	—	—
	Jhelum						Peshawur					
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
January .	57	19	—	3	26	51	103	49	—	50	227	404
February .	43	14	—	1	16	47	74	32	—	32	133	345
March .	46	17	—	6	28	57	65	27	—	37	112	268
April .	53	17	1	11	70	37	70	29	—	26	148	152
May .	67	24	—	9	59	40	89	40	25	100	134	93
June .	62	20	2	4	45	21	103	48	33	51	202	76
July .	74	27	2	4	53	32	114	53	4	43	211	80
August .	102	54	5	5	82	21	165	97	3	34	391	87
September .	147	101	—	7	79	17	322	238	162	48	475	85
October .	209	160	—	29	86	25	452	360	91	74	495	99
November .	158	106	—	16	96	64	318	252	6	56	570	224
December .	82	43	—	3	89	62	170	108	—	48	376	413
Year .	1089	603	10	98	729	474	2010	1338	324	599	3474	2326
Average strength for the 10 years	11,836	—	—	—	—	—	36,310	—	—	—	—	—
	Kohat						D. Ghazee Khan					
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
January .	124	54	—	43	143	369	109	44	—	43	55	308
February .	80	34	—	32	69	201	80	33	—	13	32	160
March .	76	34	—	23	70	168	79	29	—	22	33	146
April .	78	33	—	23	94	105	78	30	—	14	56	65
May .	99	41	—	18	131	81	84	34	—	12	47	27
June .	104	46	—	11	135	40	85	34	—	5	41	25
July .	115	53	11	16	163	31	94	29	2	2	24	17
August .	201	115	66	15	334	48	161	83	1	9	44	26
September .	299	216	59	12	341	43	274	191	1	11	165	16
October .	333	245	189	34	244	59	340	251	—	15	195	33
November .	236	174	2	33	239	121	232	171	—	45	135	105
December .	155	89	—	37	199	349	126	77	—	22	66	121
Year .	1867	1133	327	297	2162	1615	1707	1009	4	213	893	1050
Average strength for the 10 years	23,776	—	—	—	—	—	14,461	—	—	—	—	—

TABLE IV^b.—Composition of the average annual admission rate, per 1,000 of strength.

	Barrack- pore	Deebro- gurb	Lucknow	Bareilly	Ferozepore	Meean Meer	Jhelum	Peshawur	Kohat	D. G. Khan
Cholera	3.4	5.1	2.8	.3	.1	3.1	.8	8.9	13.8	.3
Intermittent fever	685	802	417	194	950	1139	603	1338	1133	1009
Remittent and continued fevers	13.4	7	6	8.4	3.5	14.3	8.3	16.8	12.6	14.7
Apoplexy . . . . .	.2	.4	.4	.7	.2	.6	.1	.4	.6	.7
Dysentery	112	111	46	24	40	66	62	96	91	62
Diarrhoea	70	76	39	14	22	34	20	68.5	75	22
Hepatitis	1.6	1.4	1.8	.8	1.1	2.3	1.5	1.8	1.7	1
Spleen disease	32.7	12	5	2.1	7	17	3	29	12.5	13.8
Respiratory diseases	50	61	30	26	52	78	40	64	68	73
Phthisis pulmonalis	2.2	1.7	1.6	1.5	1.4	4.4	.6	1.4	1.2	1.3
Dropsy . . . . .	.4	1.4	.1	.1	—	.6	.3	.4	.2	.3
Scurvy	11.3	1.7	.6	.7	2.6	1.2	.7	1.6	2.1	3
Rheumatism	57	80	64	29	40	64	34	55	61	57
Venereal diseases	34	21	47	28	18	23	30	24	22.6	16
Eye diseases	11	20	31	29	39.6	25	29	24	20	26
Abscess and ulcer	53	132	122	85	113	133	90	91	118	159
Wounds and accidents	99	146	149	134	108	104	85	93	111	134
All other causes	222	160	115	75	80	82	81	98	122	114
Average annual admission rate	1452	1640	1078	651	1470	1793	1089	2010	1867	1707

TABLE V.—Native Troops. Certain individual stations, period 1867-1876. Composition of the average admission rate per 1,000 of strength, and admissions per 1,000 of strength for fevers, period 1870-74.

	Dacca	Cachar and outposts	Gowhaty	Dinapore	Goruckpore	Cawnpore	Debra Dun	Meerut	Umballa	Sealkote	Nowshera	Murda	Abbotabad	R. Pindi	Bannoo	D. I. Khan	Mooltan	Agra	Almora	Bukloh	Dharmasala
Cholera	14.1	4.1	13.1	7.6	3	8	3.2	1	1	1	3	8	2	6	2.4	2	3	2.1	1.5	—	9.7
Intermittent fever	535	908	883	285	645	481	268	711	669	384	956	589	762	370	1176	784	940	549	326	355	589
Remittent and continued fevers	49	14.8	10.2	7	9.5	6.1	5.9	20	5.9	7	1.1	9	6.1	6.9	22	12	3.5	12.1	12.5	3.3	25
Apoplexy	3	2	4	6	4	5	—	6	1	4	2	—	3	4	1.3	8	2	1.1	—	1	—
Dysentery	191	120	95	40	65	30	23.7	59	43	37	92	27	36.6	45	97	70	40	56.7	41	17.4	30
Diarrhoea	103	65	64	37	14	36	31.7	19	19.6	22	17.8	54	50	32	58	29	22	48	16.5	24	30
Hepatitis	3.4	2.6	2.6	1.9	1.7	2	13.7	1.9	1.3	1.5	2.5	6.2	2.9	2.1	1.8	1.5	1.1	1.5	1.5	1	2.2
Spleen disease	11.8	12.2	14.4	4	6.5	4.4	46.5	11.6	3.5	3.1	8.4	9.3	7.3	5.2	16.6	18.5	6.6	4.3	2.5	9.7	4.6
Respiratory diseases	80	64	58	25	40	38	28.6	55	31	52	42	80	69	46	71.7	49	52	39	39.6	38.7	25
Phthisis pulmonalis	2	3.7	6.1	1.5	4.5	3.1	8.7	1.5	1.3	6	6	2.4	3.3	1.3	1.9	1.9	1.4	2.4	3	1.3	4.2
Dropsy	—	6	1.3	2	1	2	6	2	7	4	2	2	1	3	3	5	—	2	2	6	7
Scurvy	7	1	8	1.7	3	7	6	1.5	7	2.9	1.1	1.7	4.1	2	2.2	2	2.6	5	1.3	4	2.9
Rheumatism	72	86	35	39	46	37	46	39	55	71	46	81	57	52	57	49	40	71	90	69	71
Veneral diseases	34	34	36	44	76	38	44	29	30	29.8	19	34	24.7	27	17.6	26	18.3	54	98	24	30
Eye diseases	12.8	25.5	24	15	34	29	71	23	56	34.6	24	63	35	23	26	23	39.6	28	28	34	40
Abscess and ulcer	64	76	100	86	95	112	56	79	92	93.7	109	114	84	84	149	169	113	138	69	50	67
Wounds and accidents	94	144	118	99	121	105	151	92	117	130	107	213	142	102	130	108	108	159	82	270	143
All other causes	311	139	151	84	129	72	80	102	85	110	88	140	98	84	139	109	80	227	101	110	84
Average annual admission rate	1577	1700	1612	777	1288	995	880	1248	1211	980	1517	1424	1379	884	1970	1453	1470	1374	914	1009	1156

Admissions per 1,000 of strength for fevers, period 1870-1874.

	January	February	March	April	May	June	July	August	September	October	November	December	Average annual admission rate
Admissions per 1,000 of strength for fevers, period 1870-1874	22	20	32	64	60	54	55	62	53	55	55	27	559
Cholera	—	—	—	—	—	—	—	—	—	—	—	—	—
Intermittent fever	57	8.8	8.8	24	19.4	14	32.4	51	25.7	44.3	33	15	291
Remittent and continued fevers	36	15.6	15.2	32	33.5	38.6	50	56.4	90.2	105	88.4	41	687
Apoplexy	—	—	—	—	—	—	—	—	—	—	—	—	—
Dysentery	—	—	—	—	—	—	—	—	—	—	—	—	—
Diarrhoea	—	—	—	—	—	—	—	—	—	—	—	—	—
Hepatitis	—	—	—	—	—	—	—	—	—	—	—	—	—
Spleen disease	—	—	—	—	—	—	—	—	—	—	—	—	—
Respiratory diseases	—	—	—	—	—	—	—	—	—	—	—	—	—
Phthisis pulmonalis	—	—	—	—	—	—	—	—	—	—	—	—	—
Dropsy	—	—	—	—	—	—	—	—	—	—	—	—	—
Scurvy	—	—	—	—	—	—	—	—	—	—	—	—	—
Rheumatism	—	—	—	—	—	—	—	—	—	—	—	—	—
Veneral diseases	—	—	—	—	—	—	—	—	—	—	—	—	—
Eye diseases	—	—	—	—	—	—	—	—	—	—	—	—	—
Abscess and ulcer	—	—	—	—	—	—	—	—	—	—	—	—	—
Wounds and accidents	—	—	—	—	—	—	—	—	—	—	—	—	—
All other causes	—	—	—	—	—	—	—	—	—	—	—	—	—
Average annual admission rate	559	559	559	559	559	559	559	559	559	559	559	559	559

Table I.¹ shows the average daily sick rate of each month, the composition of the admission rate, and of the death rate, of the men, women, and children of the British army of Bengal, during the five year period 1871-75.

Table II. shows the composition of the admission and death rates, and the numbers admitted to hospital each month for cholera, intermittent fevers, and remittent and continued fevers, during the ten year period 1860-69, also of the British Army.

Tables III., IV., and V. exhibit statistics of the native troops of the divisions of the army of Bengal for the ten year period 1867-76. Table III., admission to hospital for all causes and for the chief diseases in each month of the year, the composition of the admission and death rates, and the deaths each month from fevers and respiratory diseases. Table IV., the composition of the admission rate, and the monthly admission rate for the chief diseases, at ten representative stations. Table V., the composition of the admission rate, at certain other stations, and the monthly admissions for fever at some of them.

The following brief notes on the statistics of the British troops are compiled from Dr. Bryden's recently published volume on the 'Vital Statistics of India' (Calcutta 1878).

During the six years ending 1876, 3,554 men, the survivors, with the corps, of a body of 15,529 men, left India. Seventy-seven per cent. of the original number had disappeared. Of these 31 per cent. had been discharged as time expired, had volunteered into other regiments, had purchased their discharge, or had been removed by sentence of court-martial; of the remaining 46 per cent. of loss, 18 were made up by deaths, and 28 by invaliding.

A very large number of men break down in the early years of their Indian service; as much as 48 per cent. of the invaliding from the army of India occurs in men who have been under five years in India. In the army of Bengal, out of 100 invalided, 45·4 had served four years or less; 24·9 from five to seven years; 29·7 above seven years.

Further, the proportion of the newly arrived who die is strikingly large—the death rate of the whole army of India, after excluding cholera and violent deaths, in the 5 years period in question fluctuated between 11 and 15 per 1,000, that of the new regiments from 17 to 23 per 1,000. Table I. includes a comparison

¹ These tables are taken or compiled from the annual *Reports* of the Sanitary Commissioner with the Government of India, and from Dr. Bryden's *Vital Statistics of India*.

between the composition of the death rate of the men of short service, and of those of long service, in Bengal. It will be seen that deaths from fevers and apoplexy, but most strikingly from enteric fever, preponderate amongst the men of short service. Except in the case of heart disease the ratios of the acclimatised class appear consistently in a favourable aspect.

Of 100 deaths from all causes, excepting cholera, in the army of India, 23·8 per cent. died in November, December, and January; 20 per cent. in February, March, and April; and 56·3 per cent. in the remaining months of the year. The great mortality from fevers and bowel complaints of the last quarter of the year, which used to characterise the older statistics, has almost disappeared, and during late years, with November begins a healthy condition which is consistently maintained till the end of January. Heat apoplexy doubles in June; and fevers, dysentery, and hepatitis cause a high death rate in September.

During the five years ending with 1876 the death rate from cholera in the army of Bengal was 3·23 per 1,000 of strength; in the army of India¹ the deaths were 741, or 2·54 per 1,000. These 741 deaths were distributed through the months as follows:—March 6, April 24, May 67, June 44, July 59, August 260, September 181, October 67, November 30, December 3.

Only sixty deaths in the army of India were attributed to delirium tremens during the six years ending with 1876, and this out of a body of men the average strength of which is about 58,500.

Venereal diseases swell enormously the admission rate and daily sick rate of the armies of all the Presidencies, not less than 20 per cent. in relation to the strength.

A large proportion of the army has now the chance of comparative immunity afforded to it by removal during the hot season from the influence of the plains. In Bengal one-fourth of the strength, besides women and children, are located in the hills during the hot weather.

As regards the mortality amongst the women, Table I. shows that it is considerably greater than amongst the men. The man dies in a higher ratio from violence, accidents, heat apoplexy, heart disease, and hepatitis; but in respect to all other diseases, notably so in the case of cholera, dysentery, remittent and continued fevers, and phthisis, the ratio for women is the highest.

The following very instructive table (Table VI.) is also compiled from Dr. Bryden's report. It shows the deaths at different ages

¹ The army of India includes the armies of Bengal, Madras, and Bombay.

from the chief causes for mortality amongst the children of the British troops serving in India; it also shows the seasonal mortality, and the seasonal prevalence of cholera and of fevers amongst the children. The heightened mortality of the hot season, and the decrease in the liability to death in the advanced years, is shown very strikingly. The cholera season corresponds with that of the troops; the fever season corresponds rather with that of the native than of the British troops; it is not, as amongst the latter class, pronounced in May, June, and July.

Other tables—Tables VII. and VIII.—contrast the seasonal mortality of the Europeans and natives of the army of Bengal, and the chief causes of mortality, amongst the two sections.

Table VIII. shows 'that bowel complaints diminish, while respiratory diseases multiply as we proceed westwards from Bengal. Climatic influences predominate with Europeans in the hot and rainy months. Sixty-two per cent. of the mortality (deaths from cholera and violence excluded) fall in the hot months and thirty-eight per cent. in the cold. In the ten year period ending with 1876 the proportion was nearly the same. Sixty per cent. of the mortality occurred from May to October, and 40 per cent. from November to April. The case is very different with the native soldier. Climatic influences, from which the European readily recovers, leave lasting effects on his weakly frame; and while the European regains health and energy in the cold months, the native under exposure develops fatal disease. Sixty-three per cent. of the mortality (cholera and accidents excluded) falls in the cold months, and 37 in the hot season. In the ten years ending 1876, excluding cholera, 64 per cent. of the total mortality of the native army took place between November and April, and 36 per cent. between May and October. It is, however, necessary while considering this contrast, to remember that the native has the advantage in the hot season over the European, in suffering comparatively very little from the ardent fevers, heat apoplexy, and enteric fever diseases of the hot months amongst the Europeans.¹

Table VII. which contrasts the causes of mortality shows that 'the death rate of the native army is chiefly influenced by cold, and by the prevalence of diseases of the anæmic type. Fever is followed by diarrhoea, spleen enlargement, dropsy, scurvy, and atrophy; and when the system is thus debilitated, exposure to cold readily determines a fatal pneumonia' (Bryden). Four-fifths

¹ See Dr. Bryden's *Vital Statistics of India*, 1878; Section ii.

TABLE VI.—*Children of British Troops, Army of India 1872-76.*

Ages	Aggregate of the annual strengths 1872-76	Total deaths	Cholera	Small-pox	Measles	Whooping cough	Scarlet fever	Enteric fever	Ague	Remittent fevers	Sunstroke	Dentition	Convulsions	Meningitis	Tubercles	Phthisis	Dysentery	Diarrhoea	Anæmia	Bronchitis	Croup	All other causes	Died per 1,000 of strength
Under 6 months . . .	3964	1011	4	7	5	6	1	1	5	44	1	29	295	17	21	1	14	170	252	69	5	64	255.05
Between 6 months and 1 year . . .	4714	944	5	1	26	9	—	—	9	44	5	204	153	49	24	1	43	211	73	56	12	19	200.25
12 to 18 months . . .	4256	726	13	2	32	2	1	—	5	23	—	143	82	21	37	1	36	181	66	43	16	22	170.58
18 months to 2 years . . .	4079	343	14	—	19	1	—	—	2	16	—	35	38	7	32	2	22	90	28	22	5	10	84.09
Between 2 & 3 " . . .	5983	372	37	—	37	4	—	—	6	29	2	10	32	7	27	2	29	69	19	22	21	19	62.18
" 3 & 4 " . . .	5506	236	38	—	15	3	1	2	1	27	3	—	22	9	10	1	21	30	15	3	17	18	42.86
" 4 & 5 " . . .	5083	122	20	—	6	—	1	3	2	11	1	—	13	6	9	1	8	6	5	5	18	7	24
" 5 & 6 " . . .	4679	79	13	1	6	1	1	2	1	9	5	—	7	3	2	—	4	4	1	3	10	6	16.88
" 6 & 7 " . . .	4082	66	14	—	2	—	2	2	4	10	—	—	6	3	2	—	1	4	2	3	4	7	16.17
Above 7 years . . .	18,080	177	55	3	6	—	—	2	1	28	7	—	4	4	3	2	9	6	3	5	13	26	9.79
Total . . .	60,426	4076	213	14	154	26	7	12	36	241	24	421	652	126	167	11	187	771	464	231	121	198	67.45

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Died per 1,000 (excluding cholera) . . .	3.54	2.73	4.87	6.71	6.68	5.98	7.11	8.78	7.17	4.93	4.53	4.78
Admitted to hospital for cholera . . .	—	2	—	4	25	7	46	98	59	24	10	—
Admitted to hospital for fevers, intermittent, remittent, and continued . . .	434	313	576	806	910	954	953	1139	1399	1723	1360	747

TABLE VII.—*Army of Bengal. Table contrasting seasonal mortality of British and Native Armies.*

	European Troops 1860-69. Died out of each 100. Deaths in each month. Deaths from cho- lera and violence excluded	Native Troops 1864-73. Died out of each 100. Deaths in each month. Deaths from vio- lence and cholera excluded	Native Troops 1864-1873. Died, per cent. of the total in each month					Number of fever deaths 1867-1876	
			Regular Army			Frontier Force			
			Fevers	Dys- entery	Respi- ratory diseases	Fevers	Respi- ratory diseases		
January .	6·	13·4	11·5	11·9	21·8	12·9	23·6	45	130
February .	4·3	8·6	7·5	7·9	12·8	8·0	18·7	48	102
March .	4·4	9·	8·6	8·3	10·8	6·9	7·3	37	101
April .	6·5	7·	7·1	4·1	7·9	6·3	7·8	83	65
May .	7·6	6·6	6·9	4·4	6·	6·9	2·6	135	62
June .	11·	5·5	6·5	5·2	2·8	6·6	2·6	129	66
July .	10·1	5·5	5·4	6·7	2·6	3·5	1·5	95	58
August .	10·7	5·7	6·3	6·7	2·7	4·9	·9	134	69
September	11·6	5·4	5·3	6·3	2·2	5·5	2·3	161	61
October .	11·4	8·7	10·1	11·	3·7	9·5	·9	108	107
November.	8·8	11·4	13·3	12·3	10·3	15·5	8·5	80	163
December.	7·6	13·2	11·5	15·2	16·4	13·5	23·3	52	136

TABLE VIII.—*Army of Bengal. Table contrasting causes of mortality in British and Native Armies.*

	European Army, 1867-76. Aggregate strength 353,450		Native army 1867-76. Aggregate strength 395,081							
	Average annual loss per 1,000	Died out of each 100 deaths, cholera excluded	Average annual loss per 1,000	Died out of each 100 deaths, excluding violent deaths and cholera						
				Whole army	Bengal	Gangetic Provinces	Meerut and Rohilkund	Punjab	Punjab Frontier	Goor-kha regiments
Cholera .	5·19	—	2·12	—	—	—	—	—	—	—
Smallpox .	·15	—	·2	—	—	—	—	—	—	—
Fevers .	3·31	21·2	2·84	25·8	22·6	22·7	26·	28·	27·1	19·
Apoplexy .	1·88	12·1	·22	2·0	—	—	—	—	—	1·1
Dysentery .	1·68	10·9	2·01	18·3	25·3	16·9	12·	14·6	9·4	11·6 ¹
Hepatitis .	2·60	—	·15	1·4	1·2	3·	2·8	·7	·9	3·6
Phthisis pulmonalis	1·38	8·9	·77	7·	7·4	10·6	11·9	5·1	4·	20·3
Respiratory diseases	·99	6·4	2·57	23·4	11·8	18	19·7	33·3	38·4	16·8
Heart disease .	1·29	—	·2	1·8	2·1	1·6	3·4	1·7	1·7	1·9
Spleen disease, dropsy, scurvy, and atrophy	·19	1·3	1·03	9·4	16·3	8·	10·2	6·1	4·7	7·5
All other causes	2·05	14·2	·99	10·9	11·5	16·4	12·	9·2	10·5	18·2
Accidental and suicidal deaths	1·61	—	·74	—	—	—	—	—	—	—
	22·32	100·	13·84	100·	100·	100·	100·	100·	100·	100·

¹ Dysentery and diarrhoea.

of the deaths from disease amongst the men of the native army may be accounted for by these diseases.

The character of the fatal fevers of the European and Native armies is very different, and the fever mortality amongst the Europeans is from remittent and continued fevers, but more especially from enteric fever occurring in the hot and rainy months. The deaths from fever amongst the natives occur mainly during the cold season, between the beginning of October and the end of February. Enteric fever, excepting amongst the Goorkhas, is of very rare occurrence in the native army. In the European army, as shown in Table I., it occurs almost entirely amongst the men during the 1st and 2nd years of their service, and from May to September. 'The disease,' writes Dr. Bryden, 'has no geography; no regiment or battery escapes enteric fever in the first year, whatever cantonment of India may be selected for it.' Twenty-nine deaths from enteric fever occurred amongst the natives during the six years ending with 1876, against 373 amongst the Europeans, and in these 29 cases it was as a rule the young Goorkhas, or a young recruit from beyond the frontier, who suffered.

The solitariness of many of the cases amongst the British troops, and their widespread occurrence in regions in which the disease is unknown amongst the natives, obliges us to look for some other cause than contagion for the disease, while, however, the occasional occurrence of outbreaks which cannot be referred to any mere general influence afford evidence that some local cause has originated, or aggravated, the disease.¹

That the enteric fever of the British soldier in India is identical with that of Europe is proved, if in no other way, by the fact that in the fatal cases the lesions found are exactly those which are found in the enteric fever of Europe.

'No doubt,' writes Dr. Cunningham,² 'the circumstances under which enteric fever appears in this country seem often to differ widely from the circumstances under which it arises in temperate countries, but must disease always arise from exactly the same causes, and no others? Setting aside the specific poison doctrine as altogether inapplicable to the history of enteric fever in India, may not the lesions, with the fever attendant on their development, which are due to certain insanitary conditions in Europe, be due to other insanitary conditions in India; or may not other disease-causes, which have little effect on the young soldier in

¹ Bryden's *Vital Statistics of India*, p. 59.

² *Sanitary Report for 1877*, p. 24.

England, exercise a very powerful influence on him when aided by the heat and other tropical influences telling on his rapid transfer to this country ? ’

The Europeans, as will be seen from the above table, suffer from cholera far more severely than the natives ; the contrast is strengthened if, following Dr. Bryden, we compare the statistics of the four epidemic years 1867, 1869, 1872, and 1875. During the years the average of deaths per 1,000 of strength was, for the Europeans 10·2, for the Natives 3·6.

‘ The mortality from dysentery and diarrhœa is greater amongst natives than Europeans ; but how seldom those diseases are attended with hepatic complication is evident from the fact that, on the average, six deaths only are attributed annually to liver disease ’ (Bryden). Heart-disease is far more common amongst Europeans than natives ; the contrast in this respect shown in Table VIII. is heightened if it be added that in the last seven years 260 British soldiers died from aortic aneurism in the army of India, while during the same time only nine deaths were caused by it in the native army of Bengal, which in strength approximates to the European army in India.

The details of the death rate of the Goorkhas approximate to those of the European in so far that many of them die from hepatitis and from cholera. But phthisis is the chief cause of mortality amongst them. Small-pox also is both more frequent and more fatal amongst the Goorkhas than amongst the other troops of the native army. In the notes on the diseases prevalent in the Punjaub, which will be found in Chapter XII., the mortality from diseases of the respiratory organs and from fever amongst native troops is further noticed.

In contrasting the ratios for the European and native army it must be considered that every year 6,000 men of the native army are sent away at the beginning of the hot season on furlough or sick leave, and while during the ten year period 5,467 men died with their regiments, 2,282 died at their homes. The men who go home are still borne on the strength of their regiments, and the true death ratio calculated for 7,749 deaths is 17·5 per 1,000. Further, writes Dr. Bryden, ‘ In the ratio for cholera and violent deaths the excess against the European is at least 4 per 1,000 ; and if this be considered, the ratios for climatic disease will be found to approximate very nearly, although differing in the details.’

Table VIII. supplements Table III. in contrasting the relative components of the death rate in the provinces of Northern

India. Beyond the Indus, and east of Dinapore, the native soldier is in a foreign country, and the death rates are very high. Thus, with Dr. Bryden, comparing the mortality per 1,000 of strength of the native troops serving trans-Indus, in Bengal proper and Assam, and in the Gangetic provinces and Oude, we find that the average for the seven years 1870-1876 was as follows: 17.5, 13.4, 8.2. Out of 1,890 cholera deaths in the native army 1,402 occurred on the north-western frontier, on the eastern frontier, and in Bengal proper, areas which are foreign to the bulk of our native soldiers. 'How a native army employed in an unhealthy climate may melt away was shown in the Bhootan campaign of 1865. The force was 7,000 strong in March 1865, and before October upwards of 2,000 men had been removed by death or sent to their homes. In the field 520 men died; and in the year following, 169 deaths were noted amongst the men sent sick to their homes. The whole force passed through the hospital nearly four times, and the number daily sick, from May to October, was never less than one-fifth of the total strength' (Bryden).

The following Tables,¹ IX., X., XI., exhibit the causes of mortality, and the seasonal prevalence of mortality and disease, amongst the jail population of Bengal, the Gangetic plains, and the Punjaub.

Taking the jail population as a whole, the statistics resemble those of the native army in showing marked increase of disease and mortality from August onwards through the year, culminating in November, and diminishing only in December because ere then the old and diseased members have been carried off by death. 'In August,' writes Dr. Bryden, 'fevers, dysentery, and diseases of anæmia begin to prevail; and towards the end of October pneumonia comes in to carry on to a fatal termination what has been in progress during the three unhealthy months preceding. Contrasting the provinces in regard to the seasonal prevalence of disease, we find, as might be expected, that diseases, markedly fevers and bowel complaints, are more equally distributed through the year in Bengal than in the upper Gangetic plains and the Punjaub; and as noted in Chapter iv. the season of the prevalence of malarious diseases is, by a month or more, earlier in Bengal than in the other provinces.

Contrasting the causes of disease and mortality, 75 per cent. of the jail mortality of Northern India is due to diseases of debility—which in the opinion of many observers is more or less

¹ For these tables and the substance of the notes which follow, I am indebted to Section iii. of Dr. Bryden's *Vital Statistics of India*. Calcutta, 1878.

directly the result of malarious poisoning—diarrhœa, spleen disease, low forms of chest affections, and pulmonary consumption. In Bengal this class of disease contributes 82 per cent. of the mortality; in the North-Western Provinces 78; in Oude 70; and in the Punjaub 58. Dr. Herbert Baillie, quoted by Dr. Bryden, gives in his report on the Alipore jail for 1868 the following vivid description of the way in which cachectic prisoners die in the jails of Lower Bengal. ‘Most of those who died laboured not under one, but a complication of diseases, arising from a cachectic state of the system. A prisoner is relieved of an attack of dyspepsia and is sent back to jail. After a while, he returns to hospital with diarrhœa or dysentery. His aspect has much altered in the interval. Anasarca of the extremities, and perhaps swelling of the face, is observed. After a few weeks, serous effusion into the peritoneum occurs; the diarrhœa or dysenteric affection is relieved, but an attack of bronchitis or pleurisy, or perhaps pneumonia, sets in. This has to be combated, the dropsical tendency all the while increasing. The kidneys then are possibly found affected, and at last the poor wretch dies completely worn out. After death, if not detected during life, tubercles or even tubercular cavities are often found, which have served to hasten the termination of the case. Such was the progress in many of the fatal cases recorded.’

In Bengal, epidemic contagious diseases have added little to the death rate. Not so in the Gangetic plains and the Punjaub, as we shall have occasion to note presently. But in Bengal, as throughout Northern India, the death rate of particular jails is affected not only by a special unhealthiness of the locality, a fact which might be illustrated by a comparison of the statistics of the healthy jails of Dacca and Rajshahye in Bengal, with the unhealthy Rungpore jail, and in Oude by comparing those of Lucknow and Goruckpore, but also by visitations of famine and epidemic malaria. Such visitations, however, affect the jail population in a secondary way only, that is by sowing the seeds of disease in the population from which the jails are recruited. As a matter of fact the prisoners in jail are as a rule very little affected by malarious epidemics sweeping a province, and frequently escape the effects of the local epidemics which ravage the free population after excessive rainfalls or floods, a result which may be in a great measure ascribed to their being shut up at sunset or shortly after, and sleeping in dry and generally well-raised wards.

The following table compares the deaths per 1,000 from

cholera¹ and fevers amongst the prisoners of the five provinces of Northern India for the periods 1859-67 and 1868-76.

	Fevers	Cholera
Bengal, 1859-67	4.8	19.4
„ 1868-76	3.5	7.85
Oude, 1859-67	22.7	7.4
„ 1868-76	2.42	.82
North-West Provinces, 1859-67 .	22.4	7.6
„ 1868-76	3.3	1.45
Central Provinces, 1859-67 . .	12.7	11.27
„ 1868-76	3.35	2.73
Punjaub, 1859-67	21.9	2.19
„ 1868-76	9.25	.82

The comparison shows very forcibly the diminution of the fever death rate in those provinces in which the fever mortality is mainly caused by fevers of the contagious class, and the diminution of the cholera mortality in all the provinces, during the later period. Doubtless in the case of both fevers and cholera the diminution must be chiefly ascribed to improved sanitation, diminished over-crowding, better conservancy, improved water-supply, and also to greater attention to the separation of the infected from the other prisoners, and to improvements in the general management of the prisoners which tend to keep up the standard of health.

Dysentery is one of the main causes of mortality amongst the prisoners, and is more fatal in Bengal than in the other provinces. Its connection with malarious disorders is shown by the season of its greatest prevalence, namely from July to November in Bengal, and from August on to the end of the year in the upper Gangetic plains and in the Punjaub; and by the association of outbreaks of the disease with malarious epidemics.

Dysentery and diarrhoea amongst the prisoners, as amongst the men of the native army, is rarely followed by hepatitis; for the ten years under review the deaths from hepatitis reached only .17 per 1,000 of strength.

Heat-apoplexy is more common amongst the jail population than in the native army, the deaths averaging annually .56 per 1,000 of strength. 'In a few days before and after June 20, 1869, 200 prisoners were seized with heat-apoplexy in the jails of Upper India from Benares northwards, of which 80 died.' 'It is,' writes Dr. Bryden, 'poisoning by stagnant and polluted air which deter-

¹ Additional statistics of cholera mortality are given in the following chapter.

mines the attack in the prisoner, just as the poison of alcohol or small-pox predisposes to it in the case of the European soldier.'

As regards the fevers of the jail population of Northern India these are, the malarious, enteric, typhus in various forms, and relapsing contagious fever.

The malarious fevers in Lower Bengal are not very unequally fatal throughout the year. November is the month of greatest, May and June the period of least, mortality. In the Behar provinces the mortality from fever rises in July, and attains its maximum in October. Probably in the Lower Provinces a larger proportion of the fever deaths result directly from fever and its concomitants than in the Pnnjaub; in the Punjaub the people, a more robust race than those of malaria-stricken Bengal, shake off attack after attack of fever, till the cold season introduces the more destructive sequelæ.

Enteric fever is little known in the jails, for during the five years ending with 1876, only 26 cases were returned from 14 different jails and from all the provinces of the Presidency.

Typhus fever¹ is unknown in the jails of Bengal. There is no record of typhus in the province excepting in the case of gangs of prisoners removed from the jails of the Upper Provinces to the Alipore jail on their way to the Andamans.

In parts of the Himalayas the contagious fevers² are but too well known, and on three occasions within the last sixty years have spread thence over India through Oude, the North-Western Provinces, and Rajpootana.³ This happened in 1816-20; 1836-38; and in 1859-65. 'In all these periods, we find,' writes Dr. Bryden, 'the association of epidemic malaria, famine, and typhus. But if I should assert that famine in each case has developed the typhus, the facts as far as I know them would not bear out the statement.' In 1852-56 contagious fevers established themselves on the Punjaub frontier, and showed themselves in Rajpootana, in Rohilcund, and in the Himalayas. With reference to this period Dr. Bryden writes:—'The districts bordering on the great north-western desert are the endemic home of Indian typhus in its various forms. Pahlunpore and Guzerat, Pali and Marwar, the districts lying west of Delhi, Ferozepore, Sirsa, and the trans-Indus tracts, have all been ravaged by typhus in an epidemic form several times within the past sixty years.'

These typhus periods have been characterised by the prevalence

¹ Bryden, p. 167 of *Report* of 1878.

² See chapter xviii., diseases of Kumaon.

³ *Bryden*, p. 184.

of differing varieties of contagious fevers, such as relapsing typhus which has prevailed in every period, and has been the mainstay of the epidemic; continued yellow typhus; buboe typhus, characterised by buboes and other glandular swellings, the 'Mahamurree' of the Himalayas;¹ and the variety in which the force of the typhus is thrown on the lungs and is marked by profuse hæmoptysis, epistaxis, and vomiting of dark grumous coffee-coloured blood. Further, Dr. Bryden shows that amongst the troops, the jail and free population, deadly outbreaks of pneumonia and dysentery have been associated with contagious diseases, erysipelas, diphtheria, and typhus fever, in such a way as to render the hypothesis an extremely probable one that such outbreaks were of a contagious nature.

But though the varieties of contagious fever are many, Indian experience corroborates that of Europe, that the one fever never begets the other; typhus propagates typhus; relapsing fever propagates relapsing fever. As has just now been said, relapsing fever is of these fevers that which is most constantly prevalent, and Dr. Bryden² asks the question, 'whence arises primarily the phenomenon of relapse so constantly found in the contagious epidemic fevers of Upper India?' and he thinks he finds the reply in the association of epidemics of malaria and relapsing typhus. He writes, 'as far as I can judge, famine fever in India does not present the relapsing type unless it be preceded, accompanied, and followed by an epidemic of malarious fever.' But he is careful to explain that such a view gives no countenance either to a not uncommon misapprehension, namely that the ordinary fevers of August and September can degenerate into typhus, or to the mistake that the deadly remittent type of a malarious epidemic can, like typhus, be propagated from man to man. Nor must it be inferred, from the frequent association of malarious and typhus epidemics, that either the individual or the district must be unhealthy in order to become the subject of typhus, whether typhus proper, or relapsing typhus.

¹ *Bryden*, p. 192.

² *Ibid.* p. 179.

TABLE IX.—*Jail Population—ten year period 1867-76.**a* ADMITTED, *b* DIED FROM ALL CAUSES PER 1,000 OF STRENGTH.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The period per 1,000 of strength
Bengal proper and Assam.	<i>a</i> 85	83	100	103	97	96	120	123	114	116	110	95	1240
"	<i>b</i> 3.95	3.13	3.51	4.17	3.95	3.43	4.49	5.	5.12	5.06	5.46	4.98	52.3
Oude.	<i>a</i> 43	39	46	49	45	44	50	55	52	55	49	42	572
"	<i>b</i> 2.45	1.68	1.5	1.28	1.37	1.39	1.38	1.89	1.5	2.17	2.55	2.88	22.1
North-West Provinces	<i>a</i> 48	42	50	56	56	55	64	85	90	86	64	52	751
"	<i>b</i> 3.39	2.02	1.58	1.75	1.8	1.71	1.79	2.88	4.01	4.85	4.87	4.53	35.4
Punjab	<i>a</i> 65	58	67	75	82	79	80	128	159	159	113	80	1151
"	<i>b</i> 3.78	2.69	2.63	1.73	1.87	1.76	1.28	1.65	2.68	3.46	4.36	4.29	32.3
ADMITTED PER 1,000 OF STRENGTH FOR <i>a</i> CHOLERA, <i>b</i> INTERMITTENT FEVER, <i>c</i> REMITTENT AND CONTINUED FEVERS, <i>d</i> DYSENTERY.													
Bengal	<i>a</i> .31	.45	2.0	2.6	2.4	1.4	3.7	2.2	1.8	.54	1.2	.7	19.5
"	<i>b</i> 28.5	25.	30.	32.	30.	31.	42.	48.6	46.	52.	51.	38.	455.
"	<i>c</i> 1.4	1.4	1.8	1.7	1.6	1.7	2.3	2.5	2.8	2.5	2.2	1.4	23.6
"	<i>d</i> 10.4	8.4	11.1	13.4	12.4	12.9	18.6	20.8	19.2	16.1	15.	13.5	172.
Oude.	<i>a</i> .	.02	.07	.1	.15	.07	.17	1.3	.06	.9	.26	.03	3.2
"	<i>b</i> 11.2	11.4	13.5	13.4	15.6	13.9	12.5	17.2	20.2	22.8	27.3	19.8	199.
"	<i>c</i> .4	.8	.83	1.3	1.2	1.2	1.4	1.6	1.5	1.7	1.5	.86	14.4
"	<i>d</i> 4.7	3.	3.3	3.7	3.	2.7	3.8	6.1	5.8	5.4	7.3	5.8	55.
North-West Provinces	<i>a</i> .005	.47	.2	.14	.06	.06	.54	.76	.48	.12	.1	.015	3.
"	<i>b</i> 12.7	11.1	13.9	18.2	19.4	16.6	22.6	37.8	45.4	46.2	26.9	16.9	288
"	<i>c</i> .7	.76	1.1	1.4	1.3	.9	.7	1.06	1.4	1.3	1.01	.73	12.4
"	<i>d</i> 4.3	2.5	3.4	3.7	3.2	2.9	5.4	11.7	12.3	10.4	8.5	6.8	75.3
Punjab	<i>a</i> .	—	—	—	.17	.17	.4	.76	.55	.1	—	—	2.2
"	<i>b</i> 25.3	19	22	28.5	35	34	35	85	119	119	74	40	636
"	<i>c</i> 1.5	1.8	2.3	1.9	2.1	1.6	1.4	2.2	4.9	5.3	2.8	1.4	29.
"	<i>d</i> 4.1	2.5	2.9	3.9	4.4	3.8	3.8	6.8	8.	8.8	8.3	6.2	63.7

TABLE IX.—continued. *Jail Population—ten year period 1867-76.*

ADMITTED TO HOSPITAL PER 1,000 OF STRENGTH

	Cholera	Small-pox	Enteric fever	Contagious fevers	Intermittent fever	Remittent and continued fevers	Dysentery	Diarrhoea	Hepatitis	Spleen disease	Atrophy and anaemia	Dropsy	Respiratory diseases	Phthisis pulmonalis	Rheumatism	All causes	Average strength of the period
Bengal proper and Assam .	19.5	1.4	.2	—	455	24	172	160	1.6	14	22.1	6.9	39	7.6	31	1240	195,386
Oude	3.2	2.9	—	6.7	199	15	55	58	.8	2.3	11.9	.8	19	5.4	11	572	75,038
North-West Provinces .	3	2.2	—	—	288	12	75	59	.7	4.4	9.8	.7	29	2.4	11	751	192,160
Punjab	2.2	.4	.1	24	636	29	64	53	.7	8	7.4	1.3	52	1.9	15	1151	129,933
DIED PER 1,000 OF STRENGTH.																	
Bengal proper and Assam .	8	.16	.09	—	3.4	22.3	.24	.67	3.02	1.62	4.2	52.3	—	—	—	—	—
Oude . . . . .	.96	.11	—	1.4	1.5	8	.16	.15	1.7	.25	2	22.1	—	—	—	—	—
North-West Provinces .	1.5	.11	.01	—	3.2	16.6	.12	.37	2.25	.35	4.8	35.4	—	—	—	—	—
Punjab	1.07	.05	.03	3.0	6.1	7.8	.12	.19	.83	.3	7.6	32.3	—	—	—	—	—

TABLE X.—*Jail Population 1867-76, per 1,000 of strength.*

a AVERAGE ADMISSION RATE, b AVERAGE DEATH RATE, PER 1,000 OF STRENGTH.

	Jails of Eastern and Northern Bengal	Jails of Assam and Cachar	Jails of Behar	Jail at Dacca	Jail at Rungpore	Jail at Rajshahai	Jail at Tirohot	Benares Central Jail	Bareilly Central Jail	Meerut Central Jail	Lucknow Central Jail	Goruckpore Central Jail	Agra Central Jail	Lahore Central Jail	Jail at R. Pindi	Working gangs at Ruper and Gungur (Um-balla)
All causes	1188	1802	896	854	1336	610	982	950	686	861	290	1197	523	1129	1381	2679
"	54.3	51.5	65.1	30	128	47.9	96	30	42.2	82.3	20.7	92.3	21.3	40.4	60	44.2
Dengue	4.6	9	—	7.7	—	—	—	—	—	—	—	—	16.3	—	—	—
Cholera	17.2	16.1	32	12.1	16.7	21.4	35	6	6	2.3	9	21	9	3.4	1.7	1.8
"	7.5	8.65	13	5.1	5.9	10.6	17.4	4.3	4.3	1.4	1.7	11	4.3	1.7	97	8
Enteric fever 1872-76	2	1	1	5	—	3	—	—	—	—	—	—	—	—	—	—
Intermittent fever	467	607	242	227	405	241	217	376	257	479	79	339	181	725	689	1489
Remittent and continued fevers	34.3	24	6.7	53	42.5	8	9.6	2.4	48	5.2	15	14.3	1.4	17.6	29.6	168
All fevers	5.04	3.97	2.26	2.2	5.92	4	2.5	3.64	10.3	7.3	8.1	3.2	7.5	9.2	6.9	13.2
Contagious fevers	—	—	—	—	—	—	—	—	—	—	—	—	—	—	266	—
"	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27.9	—
Dysentery	117.5	223	187	94	305	109	241	89	36	125	37	254	54	67	47.8	109
"	20.1	21.4	34.4	3.9	53	14	56	16.68	14.2	47	7.5	56.7	7.4	9.7	7.7	14.3
Diarrhoea	1.9	228	130	66	122	70	117	110	68	44	28	165	29	33	66	169
Spleen disease	42.8	29	3.9	14.6	38	12	4	2.8	7	7	2.1	11	2.5	15.2	7.6	7
"	1.4	24	37	1.6	3.6	1.35	1.12	21	—	—	—	2.7	27	28	54	—
Respiratory diseases	10	59.5	28.4	60	42.5	17	22	11.1	26	46	17.6	30.6	49	67	61	49
"	4.8	4.4	3.2	6.3	5.15	3.4	3.4	1.4	6.3	12.2	9.8	5	5.1	13.3	8.3	7.3
Phthisis pulmonalis	12	3.8	4.7	9	34.2	4.8	?	1.7	2.8	3.7	12.8	2.1	3.9	3.1	2	8
"	4.9	1.6	2.2	4.4	22.4	2.54	1.6	3.2	2.4	3.7	4.9	1.7	2.1	1.7	9	6
Atrophy and anemia	2.1	25.6	17.7	5.8	32.4	27	30	8.7	9.5	23	18.4	30	5.8	2.3	12.3	13.8
"	3	4.1	3.2	9	8.5	5.2	6.9	8	4.3	5.7	2.5	5.8	6	1.4	1.4	3.4

Other causes of admission, as scurvy, dropsy, rheumatism, &c. in detail omitted.

Dacca, 'a healthy jail of Eastern Bengal'; Rungpore, 'an unhealthy jail of Northern Bengal'; Rajshahai, 'a healthy jail of Northern Bengal'; Tirohot, 'an unhealthy jail of Behar'; Lucknow, 'a jail consistently healthy throughout the ten years'; Goruckpore, 'a jail consistently unhealthy throughout the ten years'; Rawul Pindi, 'a jail which in several years of the period has suffered from outbreaks of contagious fever.'

TABLE XI.—Jail Population. Total admissions of the period 1867-76 for 'A' Intermittent fevers, 'B' Dysentery, 'C' Respiratory diseases, and deaths from non-contagious fevers 'a', Dysentery and Diarrhoea 'b', Respiratory diseases 'c'.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	During the ten years	Average strength of the period	Per 1,000 of strength
Eastern and Northern Bengal	2176	1923	2259	2326	2172	2245	2907	3556	3353	4125	4116	3110	34,268	73,368	467
" " " " "	33	16	35	38	21	16	26	33	32	33	54	33	—	"	—
" " " " "	428	450	1002	1095	792	693	779	843	765	638	583	556	8624	"	117.5
" " " " "	145	93	83	98	101	95	107	120	133	137	172	192	—	"	—
" " " " "	70	49	68	68	67	67	60	46	46	60	65	66	732	"	10
" " " " "	38	36	34	28	18	24	27	20	16	36	32	41	—	"	—
Assam and Cachar	486	346	422	525	670	766	939	814	692	716	679	595	7650	12,596	607
" " " " "	3	2	1	5	—	2	5	7	9	6	6	4	—	"	—
" " " " "	175	124	195	252	248	300	256	311	307	237	202	202	2809	"	223
" " " " "	16	13	12	16	25	20	23	22	38	33	26	25	—	"	—
" " " " "	62	63	64	52	65	69	61	59	66	57	63	68	749	"	59.5
" " " " "	7	5	4	5	4	3	6	8	4	3	1	5	—	"	—
Rungpore	117	113	105	78	81	86	105	185	173	189	173	170	1575	3886	405
" " " " "	2	1	4	6	—	—	—	2	1	2	4	1	—	"	—
" " " " "	74	69	21	129	95	95	98	106	94	115	120	98	1184	"	305
" " " " "	28	11	14	20	15	12	15	14	14	20	20	23	—	"	—
" " " " "	15	19	28	18	13	7	10	11	5	15	11	13	165	"	45
" " " " "	1	2	3	2	—	2	3	—	—	2	2	3	—	"	—
Behar provinces of Bengal	394	498	669	735	623	723	989	1236	1282	1224	914	459	9746	40,279	242
" " " " "	1	2	3	11	9	10	3	9	12	15	7	9	—	"	—
" " " " "	325	219	498	547	437	420	795	1324	1041	822	607	435	7517	"	187
" " " " "	87	47	54	58	50	55	87	161	204	252	189	140	—	"	—
" " " " "	98	118	86	87	92	70	75	76	109	115	98	120	1144	"	28
" " " " "	12	10	6	5	13	6	11	9	9	13	16	20	—	"	—
Benares Central jail	318	233	268	369	396	321	452	630	711	646	552	383	5274	14,027	376
" " " " "	3	1	4	2	2	3	3	1	11	8	8	5	—	"	—

"	B	65	42	56	50	36	32	86	238	202	171	155	113	1246	"	89
"	b	20	8	7	6	5	2	5	14	37	43	39	48	—	"	—
"	C	29	19	19	13	9	9	8	8	11	8	6	17	156	"	11
"	c	2	1	4	—	—	—	2	1	2	2	2	3	—	"	—
Meerut Central	A	161	80	109	144	273	167	490	1420	1130	870	433	231	5508	11,499	479
"	a	8	3	2	2	3	2	2	12	15	14	14	7	—	"	—
"	B	66	16	14	24	31	17	41	166	350	352	204	152	1433	"	125
"	b	68	14	6	5	4	4	5	11	68	122	125	107	—	"	—
"	C	68	42	41	61	35	46	34	21	22	35	41	85	531	"	46
"	c	19	6	6	14	7	11	1	9	14	12	13	28	—	"	—
Lucknow Central	A	93	81	85	81	61	68	101	121	183	242	173	75	1364	17,300	79
"	a	—	2	1	—	—	1	3	2	1	2	1	1	—	"	—
"	B	78	26	30	34	28	20	46	63	68	69	97	77	636	"	37
"	b	25	14	3	7	5	3	5	9	13	15	9	22	—	"	—
"	C	27	23	19	8	27	23	20	18	7	26	51	55	304	"	17.6
"	c	2	1	—	1	3	—	1	3	2	—	3	1	—	"	—
Lahore Central	A	808	484	493	569	702	729	801	2405	2778	2848	2044	1081	15,742	21,713	725
"	a	14	19	11	8	9	9	5	17	26	40	28	13	—	"	—
"	B	117	66	64	69	72	81	65	82	164	235	265	184	1464	"	67
"	b	30	13	10	10	8	3	5	5	20	25	37	45	—	"	—
"	C	294	162	102	80	86	64	39	44	68	91	146	269	1445	"	66.5
"	c	66	28	22	11	14	14	4	7	11	18	29	65	—	"	—
Rawul Pindi Central	A	379	276	262	283	281	252	356	849	1171	1129	705	426	6369	9240	689
"	a	—	—	2	11	12	5	3	3	5	8	9	6	—	"	—
"	B	19	21	15	24	23	20	26	50	59	61	78	46	442	"	48
"	b	10	6	2	3	2	1	1	2	12	10	12	10	—	"	—
"	C	104	85	52	24	12	36	22	9	9	29	71	106	559	"	61
"	c	14	16	9	3	2	2	4	2	1	4	8	12	—	"	—
Working gangs at Ru- par and Ghuggur in the Umballa district	A	489	336	492	816	1082	1002	837	1965	2129	1899	1275	912	13,234	8891	1489
"	a	10	6	7	4	6	4	4	6	17	19	24	10	—	"	—
"	B	58	32	53	103	116	76	53	129	105	71	79	91	966	"	109
"	b	11	2	1	5	4	1	2	9	19	20	20	33	—	"	—
"	C	56	17	30	24	51	54	31	35	28	14	26	59	425	"	48
"	c	8	10	8	2	6	7	4	—	5	—	7	8	—	"	—

CHAPTER VII.

CHOLERA AND MALARIOUS FEVER.

Seasonal prevalence of cholera compared with that of malarious fever. Employment of statistics of cholera mortality as an index of the presence of the specific poison. The statistics not to be used as a measure of the cholera-producing conditions of the individual months. Seasonal prevalence of cholera in special areas of Northern India. Endemic and non-endemic areas. Dependence of variations in seasonal prevalence upon varying physical conditions. Influence of special atmospheric and telluric changes in cholera prevalence. Seasonal history of cholera interpreted by seasonal physical conditions in the endemic and non-endemic areas. Small number of centres of population attacked during an epidemic. Small proportion of attendants on cholera cases attacked. Dirt, especially in water, and cholera. Dr. Bryden's view of a cholera epidemic. Association of cholera and malarious fever. Probable allied character of the miasms. Wide-spread existence of malarious fever no argument against the miasm theory of cholera.

THE following table (Table I.) compares the seasonal prevalence of cholera, and of intermittent fevers, amongst the native troops distributed through Bengal proper and Assam, the Dinapore, Meerut, and Punjaub circles. Added are the statistics of cholera prevalence amongst the troops and prisoners at two stations, Calcutta and Lahore, which may be regarded as possessing climatic characteristics typical of those of the endemic and non-endemic cholera areas of Northern India.¹

We can detect the presence of the cholera poison, and can measure its strength and range, only by the sickness and mortality which it causes, making use of the statistics of mortality amongst the civil population, and of the sickness and mortality amongst the troops and the jail population. Probably the records of death from cholera amongst the former class are more accurate than those of mortality from any other disease, for the disease is one which can scarcely be mistaken, and moreover is more vigilantly watched than is any other by the authorities; further the statistics of a district

¹ See 'Cholera in Relation to Certain Physical Phenomena,' by Drs. T. R. Lewis and D. D. Cunningham, in Appendix to *Annual Report*, for 1876, of the Sanitary Commissioner with the Government of India.

TABLE I.—*Table comparing average monthly admissions for intermittent fever among the Native Troops for the ten year period 1867-76 with the total number of monthly admissions for cholera of the same period.*¹

		January	February	March	April	May	June	July	August	September	October	November	December	Per 1,000 of strength for the period
Bengal proper, and Assam	Fever	266	225	249	334	343	356	487	574	537	588	564	394	659
" "	Cholera	20	14	74	88	79	40	35	13	10	20	16	28	5.81
Dinapore, Benares, Oude and Cawnpore districts	Fever	145	137	176	164	171	160	221	284	356	539	383	208	435
" "	Cholera	—	9	8	21	28	17	18	40	9	11	6	2	2.53
Meerut and Rohilkund	Fever	87	72	86	109	152	131	144	318	475	373	224	118	446
" "	Cholera	—	—	3	12	11	6	4	20	10	4	1	1	1.45
Punjaub	Fever	530	378	355	271	469	545	578	995	2393	3036	2128	944	862
"	Cholera	—	2	—	8	29	51	76	35	178	93	7	1	3.28
Lahore and Meean Meer, troops and prisoners' deaths from cholera 25-31 years		3	—	4	17	16	26	100	1980	473	12	3	3	—
Calcutta, ditto ditto, 5-51 years		94	211	560	525	359	264	240	119	147	152	204	121	—

may generally be checked by those of some neighbouring cantonment or jail. The records of the prevalence of cholera amongst the troops serve as a very valuable index to the presence of cholera in a locality ; and they are more valuable than those of the prisons because the men lead a life more natural to them than do the prisoners, and are placed in no sort of quarantine, as practically the prisoners are. The statistics of seizures, when they can be obtained, are perhaps of greater value for our purpose than those of death, as the latter it may be hoped are influenced by treatment, and are certainly influenced by the stage of the outbreak ; for it is a well-recognised fact that deaths from cholera are proportionately more numerous during the earlier than the later stage of an outbreak. In making use of the statistics as a cholera index, we have to bear in mind that, while a whole community may be exposed to the cholera poison, only comparatively few of its members, those whom disease, or intemperance, or fatigue, or fear, or race, or some other predisposition, have rendered susceptible, will suffer an attack ; and that as these susceptible victims are carried off the number of those who are liable to seizure is diminished, even though the cholera poison remains in undiminished quantity and virulence. Therefore although we may employ the statistics as an index to the relative prevalence of cholera during each month

¹ Compiled from the *Reports* 1867-76 of the Sanitary Inspector with the Government of India.

TABLE II.—*Monthly deaths*

	Jan.	Feb.	March	April	May	June	July
Calcutta	1955	3226	4848	4658	3306	2231	1318
— — — — —	94	211	560	525	359	264	240
Atmospheric pressure	30·011	29·948	·856	·757	·665	·550	·545
Rainfall	·46	1·07	1·61	2·07	5·27	12·9	13·
Velocity of wind in miles	97	101	131	198	208	191	156
Humidity	68	68	67	73	75	83	87
Temperature, mean . .	68	73	80·5	85	86	85	83·5
Soil temperature . . .	72·6	73·1	75·4	78·8	80·9	82·3	82·3
Water level, feet . . .	13·8	14·2	14·4	14·6	14·7	14·	12·2
Relative amount of carbonic acid in soil air	5	3	1	1	2	2	2
Dacca	11	18	62	60	29	26	20
Rainfall	·64	·74	1·5	6·3	9·4	13·5	12·7
Humidity	71	68	70	77	83	88	88
Temperature	66	72	79	82	83·5	84	83
Berhampore and Moorshedabad	42	69	530	263	84	50	90
Rainfall	·45	·92	1·03	2·2	4·	9·8	9·7
Temperature	65	70·	78·5	86	88	85	84
Water level	6·9	7·7	8·5	8·3	10·6	10·4	8·3
Dinapore	46	91	346	672	702	355	403
Rainfall	·65	·5	·25	·3	1·32	6·9	9·8
Humidity	59	50	37	34	49	63	73
Temperature	61·	66	77·5	86	89	88	85
Water level	22·6	24·	25·	25·8	26·2	24·7	14·5
12 stations of Lower Bengal	431	712	2356	2836	2190	1546	1141
25 stations of Upper and Central India	124	132	720	1382	1902	2778	4778
Benares	31	26	139	245	216	188	187
Rainfall	·7	·47	·26	·15	·48	5·3	12·7
Humidity	51	41	29	26	28	53	74
Temperature	59	67	76	87	92	90	85
Water level				Highest registered level of selected			
Allahabad	8	14	105	128	310	213	192
Rainfall	·75	·57	·23	·18	·38	3·4	12·
Humidity	50	51	35	26	35	55	77
Temperature	60	66	78	87	92	90	84
Cawnpore	42	39	203	287	424	653	834
Rainfall	·7	·5	·24	·09	·56	3·4	9·2
Water level				Highest registered level of selected			

TABLE II.—continued. *Monthly deaths*

	Jan.	Feb.	March	April	May	June	July
Lucknow	1	4	44	63	43	74	329
Rainfall	1	·16	·25	·19	·56	4·7	14·1
Humidity	56	48	34	29	35	56	76
Temperature . . .	60	63	76	87	92	91	86
Water level . . .	11·9	12·2	12·8	13·2	13·9	14·6	14·4
Agra	11	13	70	117	150	832	683
Rainfall	·7	·42	·24	·13	·63	2·9	8·9
Humidity	52	46	37	27	27	46	70
Temperature . . .	78·5	65	76	86·5	92·5	93	86
Water level . . .				Highest registered level of selected			
Meerut	19	16	60	132	126	161	407
Rainfall	·72	·84	·6	·4	·93	3·8	9·7
Humidity	53	46	39	28	36	48	72
Temperature . . .	57	63	74	85·5	89	92	85·5
Water level . . .	11·4	11·5	11·6	12·1	12·6	12·7	12·6
Umballa	1	4	9	42	115	49	167
Rainfall	·54	1·3	1·1	·8	1·04	4·5	12·8
Temperature . . .	54·5	61	70	78	86·5	91	86
Lahore and Meean Meer .	3	—	4	17	16	26	100
Rainfall	·5	·9	·9	·27	·92	1·2	6·3
Humidity	57	52	46	33	24	32	49
Temperature . . .	53	59·5	69	81	89	93	88
Water level . . .				Highest registered level of selected			
Mooltan	—	1	1	1	1	1	4
Rainfall	·3	·1	·7	·5	·4	·1	2·2
Temperature . . .	54	59	70	80	89	95	92
Sealkote	—	—	—	3	5	2	2
Rainfall	1·1	1·7	2·3	1·3	1·1	2·8	12·3
Temperature . . .	51	56	64	76	85	90	86
Rawul Pindee . . .	1	—	—	2	10	13	9
Rainfall	2·05	1·8	2·8	1·6	1·2	2	8·3
—	48	52	61	72	82	90	87
Peshawur	3	—	1	5	205	164	131
Rainfall	1·3	1·3	1·6	1·3	·6	·2	1·8
Humidity	73	66	62	68	49	42	40
Temperature . . .	49·4	49	61	67	79	85	90
Bengal ¹	See statistics of Calcutta, Dacca, Berhampore, Dinapore,						
North-West Provinces ¹ .	544	1297	4954	23,983	26,110	25,056	14,406
Oude ¹	752	410	1697	18,259	19,631	17,270	7475
Punjaub ¹	71	81	59	215	1241	1691	2444

¹ From the reports of the Sanitary Inspectors of these Provinces for the years 1870-76.

Cholera.

Aug.	Sept.	Oct.	Nov.	Dec.	Total	Remarks
11	179	58	111	7	1234	As Cawnpore for 21 years
10-9	10	1-3	—	34	—	11 years
77	74	52	44	52	—	7 years
55	84	78-5	69	61	—	8 years
22-1	10-7	10-6	11-6	12-4	—	6 years
11	133	50	32	19	3501	European and Native troops and prisoners, 51 years
77-2	4-9	22	03	16	—	22-25 years
44	70	44	39	48	—	7 years
33	83	78-5	69-5	62	—	8-9 years
11 = 52 feet						
55	450	66	68	36	2596	As above, 51 years
66-7	4	22	02	21	—	20 years
22	67	47	44	52	—	6 years
44	82-5	74	66-5	58-5	—	4-5 years
11-5	10-7	10-4	10-8	11-1	—	6 years
39	303	47	24	5	1205	As above, 34 years
77-9	5-3	3	—	32	—	10 years
86	84	75	63	56	—	6 years
80	473	12	3	3	2638	As above, 25-31 years
33-9	2-5	5	—	5	—	10 years
53	53	35	39	50	—	6 years
37	83-5	77	65	55	—	8-10 years
11 (Meean Meer) = 36 feet						
77	1	5	3	—	25	Troops only, 25 years
11-1	4	—	—	3	—	9 years
39	87	76	67	57	—	6-8 years
44	23	—	—	1	80	Troops and prisoners, 24 years
10-6	4	3	—	4	—	9 years
35	83	74	61	52	—	9-10 years
21	10	5	4	1	76	Troops only, 28 years
6-2	3-7	64	33	1	—	10 years
34	80	69	57	51	—	9-10 years
25	577	343	26	—	1480	Troops only, 28 years
2-6	1-1	4	3	55	—	10 years
38	45	57	79	74	—	1877
38	82	69	60-5	51	—	1877
12 stations of Lower Bengal						
77,870	22,593	14,201	4045	1295	—	Civil population, 7 years, 1870-76
77040	6588	9418	10,456	5860	—	" " "
55849	6096	3355	569	92	—	" " "

TABLE III.—*Prevalence of Cholera according to seasons, together with seasonal Rainfall.*¹

		Number of years	October to December		January to May		June to September		Totals of cholera and of annual rainfall
			Cholera and rainfall, 3 months	Percentage of cholera and rainfall to annual totals	Cholera and rainfall, 5 months	Percentage of cholera and rainfall to annual totals	Cholera and rainfall, 4 months	Percentage of cholera and rainfall to annual totals	
Calcutta, general population		38	29,462	21.7	81,916	60.3	24,455	18	135,833
" barracks and jails		5-51	477	15.9	1749	58.4	770	25.7	2996
" " " " " Rainfall		48	6.4	9.7	10.4	15.8	49	74.5	65.8
Berhampore and Moorshedabad	Cholera	23	210	14.5	988	68.3	249	17.2	1447
" " " " " Rainfall		18-20	6.1	11.4	8.6	16.	38.7	72.6	53.34
Dacca " " " " " Cholera		23	107	30.	180	50.6	69	19.4	356
" " " " " Rainfall		15-16	5.8	8.1	18.6	26.2	46.7	65.7	71.12
Purneah " " " " " Cholera		23	4	.6	5.98	95.	26	4.2	628
" " " " " Rainfall		6-7	3.9	6.4	5.4	8.9	51.8	84.7	61.2
Midnapore " " " " " Cholera		23	20	3	310	47	327	50	657
" " " " " Rainfall		11-13	6.6	11.1	9.9	16.8	42.6	72.1	59.
Dinapore " " " " " Cholera		51	426	12.	1857	52.3	1269	35.7	3552
" " " " " Rainfall		17-19	2.9	7.6	3.	7.8	32.6	84.6	38.5
12 stations of the endemic area, excluding mortality of the general population of Calcutta	Cholera	—	2645	17.	8519	54.3	4535	28.8	15,699
" " " " " Rainfall		—	5.6	9.1	9.9	16.3	25.4	45.6	61.
25 stations of the non-endemic area (troops and prisoners)	Cholera	—	1615	6.4	4260	16.8	23.2	19,463	25,338
" " " " " Rainfall		—	1.8	5.1	3.3	9.1	14.5	30.1	35.2
Benares " " " " " Cholera		51	121	7.5	657	40.8	832	51.7	1610
" " " " " Rainfall		20-21	1.8	4.4	2.1	5.	36.7	90.6	40.5
Allahabad " " " " " Cholera		50	39	2.5	565	36.	968	61.0	1572
" " " " " Rainfall		19-20	2.7	7.2	2.1	5.6	32.8	87.	37.6
Cawnpore " " " " " Cholera		51	268	6.	995	22.4	3174	71.5	4437
" " " " " Rainfall		20	1.04	3.6	2.	7.	25.8	89.4	28.9
Lucknow " " " " " Cholera		21	176	14.3	155	12.5	903	73.	1234
" " " " " Rainfall		11	1.6	3.7	2.15	5.	39.6	91.4	43.4
Agra " " " " " Cholera		51	101	3.	361	10.3	3039	87.	3501
" " " " " Rainfall		22-25	.4	1.5	2.13	8.	23.9	90.4	26.4
Meerut " " " " " Cholera		51	170	6.5	353	13.6	2073	80	2596
" " " " " Rainfall		20	.45	1.6	3.4	12.2	24.2	86.2	28.1
Delhi " " " " " Cholera		32	35	5.2	35	5.2	601	90	671
" " " " " Rainfall		17	.68	2.8	3.5	14.3	20.3	83	24.4
Umballa " " " " " Cholera		34	76	6.3	171	14.2	958	80	1205
" " " " " Rainfall		10	.62	1.8	4.8	13.3	30.4	85	35.8
Lahore " " " " " Cholera		31	8	1.	23	.3	762	96	793
" " " " " Rainfall		10	1.1	6.	3.5	19.	13.9	75.	18.5
Meean Meer " " " " " Cholera		25	10	.6	18	1.	1817	98.4	1845
" " " " " Rainfall		10	1.1	.6	3.5	19	13.9	75.	18.5
Mooltan " " " " " Cholera		25	8	32	4	16	13	52	25
" " " " " Rainfall		9	.3	4.9	2.	32.8	3.8	62.3	6.1
Sealkote " " " " " Cholera		24	1	1.2	8	10	71	89	80
" " " " " Rainfall		9	.7	1.8	7.5	19.8	29.7	78.4	37.9
Rawul Pindi " " " " " Cholera		28	10	13.2	13	17.	53	69.7	76
" " " " " Rainfall		10	1.97	6.2	9.4	30	20.2	64	31.5
Peshawur " " " " " Cholera		28	369	25.	214	14.5	897	60.6	1480
" " " " " Rainfall		10	1.2	9.5	6.	46.7	5.7	43.8	12.9

¹ Abbreviated from table in Drs. Lewis and Cunningham's *Reports*, pp. 173 and 187.

of the year, we cannot use them as a measure of the strength of the cholera-producing conditions of the month. Thus in illustration, though the statistics show that the disease is more prevalent at Calcutta during March than April, and at Lahore during August than September, yet bearing in mind the circumstance just mentioned, and the fact that cholera is most fatal at the commencement of an outbreak, we must hesitate in assuming that the cholera-producing conditions are less active during the later than the earlier months. Not improbably, were susceptible victims forthcoming, the disease would be found more uniformly active in both.

Further, subsequent to the establishment of an outbreak, while the physical conditions of the locality may remain unaltered, the risks of the diffusion of the disease through the means of human intercourse progressively increase as cases multiply. On the whole therefore it would seem, that when investigating the influence of physical phenomena on the prevalence of cholera, our attention should be mainly directed to their character at the time of the commencement of the outbreak.

To return to the tables. Table II. exhibits the statistics of cholera mortality,¹ and with them certain meteorological and telluric data of several stations, and compares the aggregate mortality of twelve stations (*a*) situated in the endemic area with those of (*b*) twenty-five stations of the non-endemic area.

ENDEMIC	NON-ENDEMIC
<i>a</i> Calcutta Dum Dum Barrackpore Chinsurah and Hooghly Berhampore and Moorshedabad Burdwan Dacca Maldah Dinagepore Purneah Midnapore Dinapore	<i>b</i> Hazareebagh Ranchee Arrah Benares Goruckpore Fyzabad Allahabad Lucknow Cawnpore Agra Muttra Morar Jhansie Saugor Jubbulpore Raipore Delhi Meerut Umballa Lahore Meean Meer Sealkote Mooltan Rawul Pindee Peshawur

Table III. exhibits the prevalence of cholera according to seasons at several stations; showing the proportion which the number of cases of each season bears to the total number; and showing also the proportion which the rainfall of the season bears to the total rainfall. The endemic area includes the delta of the Ganges, the

¹ Lewis and Cunningham's *Report*, pp. 170-173, 183, 187.

western portion of the valleys of the Brahmapootra and Surma, and the country as far north as the base of the Himalayas. On the west the area is bounded generally by a line extending from the Himalayas southwards a little to the east of Patna and on to the coast of the Bay of Bengal near the town of Pooree. Towards the Himalayas, however, the area transgresses this line, extending westwards over the Goruckpore district, and perhaps even further in the Sub-Himalayan country.

The characteristics of the climate of the area are warmth and moisture, while the soil is clayey, retentive of moisture, one in which the decay of organic matters proceeds slowly, one moreover which a dense population has used and defiled during countless generations. Dinapore, the most western station of those of the endemic area, is on debateable ground; its climate and soil¹ are intermediate in their character to those of the Gangetic delta and those of the upper Gangetic plains.

The tables show that in the endemic area cholera becomes very prevalent in March, and that the mortality from the disease reaches its maximum in that or the following month. In most years the mortality shows a decided increase during February, and if that month happens to be a warm one cases of the disease will be numerous after the middle of the month. In May there is as a rule a marked diminution in the prevalence of the disease, a diminution which continues through June to the period of minimum prevalence in July, August, and September. In October there is usually a slight rise in the mortality, a rise which becomes decided in November, yet barely reaches the average of the year, and this rise is followed by the period of second minimum in December and January.

Passing westwards from the distinctly endemic area, we find that at Dinapore cholera prevalence reaches its maximum in April and May, and continues above the average of the year during June, July, and August. In September and October this prevalence is diminished in a very marked degree; in November there is a slight rise: and in December, January, and February occurs the period of minimum prevalence. The mortality of the seasons of maximum and minimum prevalence contrasts very much more at Dinapore than at the stations of Lower Bengal, thus the deaths are about as ten to one in the one case, and as about three to one in the other.

As we proceed still further west, through Benares, Allahabad,

¹ See Chapter viii.

Cawnpore, to the Punjaub, we find the cholera of the rainy period furnishing an increasing proportion of the whole year's cholera, so that while at Calcutta the cholera of the spring season and of the rains furnish respectively 60 and 18 per cent. of the whole, at Lahore the same seasons furnish respectively 3 and 96 per cent.¹

Comparing with the seasons of maximum prevalency of cholera those of malarious fevers, we find that in Bengal that of fever extends from August to September, demonstrating that though the causes of fever and cholera may be allied in their nature, their activity is promoted by very different conditions of air and soil. At Dinapore the great outbreak of cholera, though later than that of Bengal, does not coincide with that of fever. At Meerut the cholera season falls in July, August, and September, anticipating only by about a month that of fever; while in the Punjaub the seasons of the two diseases still more closely coincide.

Seeing that there is so marked a contrast between the seasons of cholera prevalence in the provinces of Northern India, the question arises,² how far the contrast can be connected with the existence of differences in the physical conditions of the provinces at those seasons. Clearly, looking to the characteristic physical conditions of the endemic area of Bengal, cholera most loves a damp warm atmosphere, a soil also warm and damp, and one having the properties which characterise that of the Gangetic delta.³ Warmth and, up to a certain point, humidity, are, we shall find, the physical conditions which, combined, above all others foster the development of the specific poison.

If we compare the periods of seasonal prevalence of cholera in Bengal and in the Punjaub, it is clear that a high temperature is not in itself sufficient to promote the disease, for we find that June and July, which are excessively hot months in the Punjaub, are not, over the greater part of the province, a time of cholera prevalence. On the other hand a low temperature in India, as elsewhere, is quite recognised as a condition opposed to the spread of the disease.

As regards atmospheric humidity the only striking coincidence which the table shows, so far as the endemic area is concerned, is that of maximum humidity and minimum cholera prevalence

¹ *Lewis and Cunningham*, p. 200.

² On this question see the *Report* by Drs. Lewis and Cunningham already so often quoted, and also Dr. Bryden's *Reports* published in 1874 and 1876 on the cholera epidemics of recent years in Bengal.

³ Chapter viii.

during the rains; for although minimum humidity and cholera maximum do coincide during the period of the establishment of the spring outburst, yet the humidity varies little from November to March, a period which also includes that of the November rise of cholera and the diminished prevalence of December and January. It should, however, be noted that throughout that period atmospheric humidity is very considerable. That dry hot winds are opposed to the development and spread of cholera is a fact well recognised in India, and the occurrence of those winds during April and May in Calcutta is no doubt one cause of the healthiness of those months as compared with February and March.

If we look away sufficiently far from the endemic area, to such stations as Meerut and Lucknow, and to others still further west, we find that cholera sickness does not increase until the rains, when the humidity of the atmosphere approximates to that of Calcutta in March. While Mooltan and neighbouring stations, where the feature of the atmosphere throughout the year is dryness, are, when compared with stations in damp warm Bengal, their very antipodes in respect of cholera sickness. Yet neither does damp alone foster the development of cholera; damp and warmth must conjoin.

Regarding the relation of rainfall to cholera prevalence in the endemic area, clearly heavy rainfall is opposed to it. So soon as the rains set in heavily cholera is checked, and does not burst out again till the rains have ceased and the soil is drying up. And though the period of maximum prevalence of cholera may coincide with that of slight spring rains, yet rain is not necessary to the development of cholera in Bengal; there cholera often breaks out in February though there has been no spring rain, but then it must be remembered that the moisture of the subsoil in Bengal, equally with that of the air, is, unless in very exceptional years, considerable during the whole year.

In the Upper Provinces, away from the endemic area, cholera does not become epidemic till the monsoon winds bring humidity, if not actual rainfall; there soil and subsoil, till a considerable depth is reached, say 30 feet or so, are dry through a considerable portion of the year. And though winter rains may moisten the surface during the cold season, yet the low temperature of that time forbids the development of the poison.

Daily range of air temperature has manifestly, if any, quite an indirect influence on cholera prevalence, for though the range is considerable both during the spring and autumn outbursts of

cholera in Bengal; in the Punjaub and in the North-West Provinces on the contrary, cholera, as a rule, appears at the very time, July to September, when the range of temperature is least. Yet very probably the effect of cold nights, following the warm days of the latter part of October and the early part of November, upon individuals of the lower classes in Bengal, enfeebled by the malaria of the rains, is to heighten their predisposition to disease, and in some cases may become the exciting cause of a seizure.

As regards atmospheric pressure no connection can be traced between its degree and that of cholera prevalence.

The direction, and perhaps the velocity of the winds, has a very decided influence upon the development and continuance of cholera sickness. Changes of direction may exert a twofold influence. In the endemic area when, as often happens about the middle or end of February, a northerly suddenly gives place to a southerly breeze, the change is pretty constantly followed by scattered outbursts of cholera, a phenomenon which probably depends upon a rapid development of the poison under the genial influence of the warm humid wind. The velocity of the wind at Calcutta is shown in Table II., and it will be observed that the period of most rapid atmospheric movement coincides with the period of most cholera sickness; yet it is matter of common observation in Bengal, as elsewhere, that still, close, muggy days favour cholera, and they may do so both by permitting the accumulation of the poison in and about human habitations, and by the depressing effect which such days have upon many constitutions.

In the non-endemic area also the damp southerly winds of the hot season are well recognised as bringing, and favouring, cholera; but it is a debateable point how far they exercise this influence in the way of fostering the development of the poison, and how far by serving as a medium for the transference of the poison from infected localities.

To turn from changes in the physical condition of the atmosphere to those which we are able to recognise in the soil, we find that at Calcutta¹ the soil temperature, six feet from the surface, is higher than that of the atmosphere during the cold season from November to February, lower during the remainder of the year, and no connection can be traced between these alterations and the degree of cholera prevalence. Variations in the humidity of the soil which may be brought about by a general rise in the level of the subsoil water, and by rainfall, appear to exercise a decided

¹ *Lewis and Cunningham*, p. 160.

influence on cholera prevalence, an influence which cannot, however, be traced, if changes in the water level alone be considered. The water level falls lowest, yet never very low, in the endemic area during February and the three following months, which together constitute the period of maximum cholera prevalence, and the level stands highest during August and September, a portion of the period of minimum prevalence. So far there is an association of high water level and minimum sickness, and *vice versa*; but the level stands higher during October and November, the time of the second cholera maximum of the year, than during July when cholera sickness over the greater part of the endemic area is at its lowest. If, however, we consider together the humidity of sub- and surface soil, the total of July is far greater than that of October and November, for though in July the sub-soil water has not reached its highest level, the surface soil is drenched by the heavy rainfall of that month, while after the middle of October and during November the surface is in process of drying up.

Over the greater portion of the non-endemic area the water level is throughout the year so deep that we can scarcely conceive any alterations in it affecting the miasm-producing powers of the soil, and there, therefore, the condition of the surface soil must be mainly considered, and we find that in the Punjaub during a cholera year, cholera follows the commencement of the rains, and with their development rises steadily to its maximum when the surface soil arrives at its most humid state. We may therefore conclude that a moderate degree of soil humidity favours cholera, while excessive humidity, such as that of the soil of parts of Bengal during the rains, checks its development.

With reference to soil ventilation, we may assume that so far as mere gaseous emanations are concerned they will escape from the soil most freely during the dry season, and that interchanges between the air of the soil and atmosphere will be furthered by range of temperature, by a soil temperature greater than that of the atmosphere, and by surface currents of air; while they will be checked as the soil pores become clogged during the rainy season. And this assumption is supported by such experimental data as we have of the seasonal variations in the amount of carbonic acid in the soil. The table shows that at Calcutta the amount is very small during March and April as compared with that present during the rains. Yet when we make use of the amount of carbonic acid in the soil as a measure of soil ventilation, it must

be remembered that moisture in the soil must vastly aid heat in effecting the slow decay of organic matters and the consequent development of carbonic acid, and that other conditions remaining the same we should expect the production of more carbonic acid in a damp than in a dry soil. Moreover rainfall, by carrying decaying organic matters from the surface into the depths of the soil, augments the material for its production there; while the inwash of the gas from the atmosphere by the falling showers must be accepted as another factor in the increase of the amount present in the soil during the rains. We must therefore be cautious in receiving the proportion of carbonic acid in the soil air as an index to the degree of soil ventilation.

On the whole, we cannot say that, so far as observations have as yet been carried, any connection between changes in the condition of the soil, other than those of humidity, have been traced in association with variations in cholera prevalence.

Excessive humidity of the soil may check cholera either by inducing a condition of the soil inimical to the growth of the poison, or by hindering soil ventilation. But, assuming that cholera and malarious fevers are caused by allied, earth-fostered miasms, and bearing in mind that neither the production nor diffusion of the fever miasm is lessened by the diminution of soil ventilation which doubtless results from very great humidity, we must look beyond physical changes of that kind for an explanation of the diminished cholera prevalence of the rains, and may find it in a condition of the soil engendered by excessive humidity, which incapacitates it for the development of the specific poison which constitutes the miasm.

In the light of what has been learnt regarding the effect of changes in the physical conditions of air and soil upon cholera prevalence, we may perhaps read as follows the seasonal history of the disease in the endemic area of Bengal. When, towards the end of February, the weather becomes warm—and there is at the time, though rain may not have fallen during many weeks, considerable moisture both in air and soil—cholera begins to prevail, and we must assume that at this time and in March the disease finds the conditions which are most favourable to its rapid development; this is, as it were, the springtime of the crop of cholera-poison in the endemic area. Probably the dry heat of April and May exerts some check upon the growth of the poison, but on the other hand, possibly the store already generated is becoming diffused through human intercourse, and, however this may be, the removal during

the early period of the outbreak of the most susceptible victims, diminishes the mortality later on in the season. Still the mortality continues large till, towards the end of June or in July, the rain and rivers saturate the soil, and render it unfit for the development of the poison. As the rains subside, and the soil begins to dry up, cholera again becomes active, and is so through October and November, for moisture is yet abundant, and the temperature of the air and soil has not greatly lowered. Now is the time of the second, a weakly crop of the poison, and probably its effects would be less marked than usually they are, were it not that the malaria of the rains has provided numerous fresh victims. Of these many are cleared off before the end of November, and to this, and to the check which the disease receives from the cold of December and January, must be attributed the abatement of the disease during those months.

From the recorded statistics it appears that cholera mortality amongst the civil population of one or more districts of Bengal may continue and even increase through December and January; but for this phenomenon an exceptional cause may usually be detected. Thus, during the cold season of 1876-1877, the cholera of January and February, in Backergunge, Chittagong, and Noakolly, was evidently an epidemic continuance of the cholera developed by the great cyclone of October 1876; the continuance of the disease depending upon the depressed physical condition of the people, and the insanitary conditions brought about by the cyclone. Other years, prolonged rains have accounted for deferred winter cholera.

The phenomena of cholera prevalence in Upper India quite support the view that heat and a moderate degree of humidity are, conjoined, the physical conditions which mainly foster the multiplication of the cholera poison. As we pass westwards from the damp climate and heavy rainfall of Bengal to the dry climate and sparse rains of the Punjaub, the season of maximum prevalence of the disease more and more nearly approximates to that of greatest moisture. And though the time and the degree of moisture and the season of cholera prevalence do not uniformly correspond, it must be remembered that in the non-endemic area casual circumstances, as they may be called, must play a more important part in influencing cholera prevalence than they do in the endemic area. Thus at the Ganges stations of Benares, Allahabad, and Cawnpore, cholera not unfrequently appears during the season of the hot dry winds; but then these are the very

stations which are most liable to suffer from communication with Bengal. Moreover it must be borne in mind that southerly winds are felt at those stations with tolerable frequency even during the hot dry season, and indeed so frequent is the coincidence between their occurrence and that of a cholera outburst, that medical officers commonly connect the one and the other as cause and effect.

It is a remarkable fact that far away from the endemic area in the extreme north-west corner of the Punjaub, where Peshawur lies in a highly irrigated, damp district, spring cholera is not unfrequent.¹ 'The cholera statistics indicate that the disease is not distributed over the annual period in the same proportion as in the non-endemic area generally, for 40 per cent. of the total cholera of Peshawur has occurred at other than the ordinary rainy season of the greater part of the North-West and Lower Provinces, viz. June to September.'

An interesting feature in the local distribution of cholera, and one which would be of considerable importance were we just now engaged in examining the question of the contagiousness or otherwise of the disease, is the small proportion of population centres in a district which an epidemic involves. Some statistics showing this feature will be quoted in the chapter on the diseases of Oude and the North-West Provinces; others are given in a recent report² of the Sanitary Commissioner with the Government of India. Thus in 1876 the largest number of villages attacked in any one district of Bengal was 2,308 in Jessore, where the total number of villages is 5,287. In many districts the proportion was remarkably small, as for instance 478 out of 13,957 in Midnapore. In 1877 the maximum was 1,767 out of 5,956 in Dacca. In Rawul Pindi in the Punjaub in 1876 142 villages were attacked out of 1,717. In the Central Provinces, Hoshungabad returned the greatest number of villages attacked in 1876, and they were only 291 out of 1,347. And statements of a like character from other parts of the country show that 'even where cholera is severe in a district, it is generally confined to a small proportion of the villages,'³ a statement which may be extended to the small proportion of barracks and other buildings attacked in cantonments. Moreover, writes the Sanitary Commissioner, the area of diminished epidemic intensity is distinguished not more by the small number of places attacked, than by the small number of attacks in each

¹ Lewis and Cunningham's *Report*, p. 199.

² *Report for 1877*, p. 76.

³ *Ibid.*

place, and this feature becomes still more marked in the area where there is no epidemic, and the disease is represented only by a few isolated cases.

The same report¹ furnishes valuable statistics as to the number of attendants upon the cholera sick in the military and jail hospitals of Bengal during 1876 and 1877, who suffered from cholera. Briefly, 422 cases of cholera were treated in 101 hospitals; 1,301 attendants came into immediate, and many of them into almost constant, contact with them for days, and yet out of these 1,301 persons only 18 suffered from any symptoms of cholera. In 85 out of the 101 hospitals none of the attendants suffered. Moreover, continues Dr. Cunningham, in none of the 18 instances in which attendants suffered is there evidence to show that the attack was even probably due to contact with the sick. The mere fact that an attendant is attacked is of course no proof that he was attacked because he was an attendant.

So far no allusion has been made to 'dirt' as a provocative of cholera; that such it is, whether present in the dwelling house or in soil, or air, or water, and that its removal is the best safeguard against the localisation of the disease, probably no one doubts.² And we have good reasons for believing that its prevalence in drinking water is more pernicious than elsewhere; but this point, together with many others in the history of cholera in India, is beyond the scope of these notes. Did we find outbreaks of cholera uniformly occurring at those seasons of the year when the drinking water of the community is most foul, we should with reason connect the phenomena. But it is not so. Thus in Bengal cholera is on the increase in October and November, when the drinking water is at about its best; and the spring outbreaks occur towards the end of February or in the beginning of March, at a time when the water of rivers, tanks, and wells is as yet unpolluted by the rain washings of accumulated dirt from the surrounding surface.³ The water in the tanks, which are the most common source of drinking water for the mass of the people of Lower Bengal, is in its best state (alas, in most instances, how very bad is that best) during October. Thence onwards through the dry season, the water as it concentrates by evaporation progressively degenerates,

¹ Page 77.

² On this as on other points connected with the history and etiology of cholera in India, see the works of Dr. John Macpherson and Mr. C. Macnamara.

³ See remarks by Dr. W. Palmer and myself on this point in the 5th, 6th, 7th, and 8th *Reports* on the water-supply of the cantonments of Bengal. Calcutta, 1868-71.

while on the occurrence of the first heavy fall of rain a flood of impurity, the 'dirt' accumulation of many months upon gathering grounds which are often the foul precincts of a village or the village itself, pours into the tank. As the rains subside, the water improves, and is, as has been said, at its best in October shortly after their termination. As these tanks are rarely or never cleaned out, the foul stuff which subsides coats the bottom and sides, and is in itself, independently of outside influences, a source of impurity to the water. Neither in Bengal nor elsewhere in India can we connect periodic fluctuations in the prevalence of cholera with fluctuations in the degree of impurity of the drinking water of the people. Moreover it is necessary to remember that throughout many parts of India, in Bengal especially, bad water is the rule in every village and every year; the degree of impurity varying comparatively little whether we look to place or time, while the incidence of cholera is most irregular whether we consider tracts of country or particular centres of population.

While in explanation of the spread of cholera, we allow for the diffusion of the poison by human intercourse, and through the medium of water, food, and air, there is still difficulty in explaining the circumstances of epidemics which visit the non-endemic area, manifesting their entrance by simultaneous outbursts of the disease in places far separated and scattered over a very wide extent of country. In order to explain such phenomena it has been assumed that, under certain conditions of air and soil, the cholera miasm overflows, as it were, from the endemic area, and invades, through the medium of the atmosphere, other parts of India, the seeds of the disease becoming sown through the length and breadth of one or more provinces.¹ In many parts of the now invaded area the seed, for want of congenial soil or climate, dies; in others it remains dormant until, like the seed in springtime, favourable conditions effect its vitalisation, when, if susceptible victims be at hand, an outbreak of cholera results. That these outbreaks should very frequently synchronise is what we might expect from a consideration of the uniformity of meteorological changes in India over large tracts of country. Such outbreak localities then become secondary centres from which the miasm may be distributed by winds, or by human intercourse, to multiply wherever it may find a congenial nidus.

The history of the epidemics of Northern India shows how con-

¹ See Dr. Bryden's *Report* of 1874, p. 10, and of 1876, p. 277, and many other parts of the *Reports*.

stantly those of cholera and of malarious fever are associated, an association which may be to a great extent explained if we allow that heat and moisture together are the physical conditions which are those most favourable to the vitalisation of the seeds of both miasms. Owing to this marked association of epidemics of cholera and fever in northern India, and to the frequent similarity, especially on the North-West frontier, of bad cases of malarious fever to cholera seizures, some observers have been led to ascribe the two diseases to an identical cause. And though this view is opposed by the frequent disconnection of the two diseases, yet that the miasms have an allied character may be fairly argued from the manner in which in India they affect the same localities as, Eastern Bengal, the Terai of the North-West Provinces and Oude, Peshawur, and other places which might be mentioned; from the fostering influence which a damp heat exerts upon them; from the withering effect of hot dry winds on both; from the similarity of the phenomena of their epidemicity; and from the like manner in which in their homes the miasms annually spring up, grow, flourish, and subside.

But it may be fairly asked how, on this theory of the similarity of the miasm of cholera and malarious fevers, are we to explain the phenomenon of the former finding an abiding home only in the Ganges delta? Why, as is the case with the fever miasm, is it not found in other deltas or like localities? And how is it, if we assume that the nature of the cholera poison resembles that of paroxysmal fever, that it does not manifest itself as almost uniformly fever does, wherever the pioneers of civilisation encounter tropical jungle, whether in Asia, Africa, or America? *In limine*, the question seems to raise a difficulty, one, however, which meets us in the case of a large class of diseases, namely, when and how did the disease originate? Doubtless there was a time when cholera was unknown amongst the population of the Gangetic delta, and if so, by what fortuitous, or unfortuitous, concurrence of atoms was the poison generated? Are we to accept such a view as that satirised by the poet?—

Casual bricks, in airy climb,
Encounter'd casual cow-hair, casual lime;
How rafters, borne through wondering clouds elate,
Kiss'd in their slope blue elemental slate,
Clasp'd solid beams in chance directed fury,
And gave to birth our renovated Drury.¹

¹ *Rejected Addresses*. 'Architectural Atoms.'

or putting aside the idea of chance, and also the question of the 'origin' of cholera, may we look for an explanation of its presence in the history and habits of a people, and so doing to a great extent get rid of the difficulty which some writers have raised to the view in question because of the solitary place which the delta of the Ganges holds as a home of cholera. Only, let it be clearly understood that the identity of the miasms of cholera and fever is not pleaded, but only their similarity, a similarity which is chiefly shown in the external conditions which favour them both. However similar, if specifically distinct, there seems no reason why one should not be present without the other, even under apparently alike external circumstances.

We have also to remember in dealing with this question that fever is not by any means ¹ uniformly present in localities which present all the conditions, so far as we know them, which are favourable to its development. Northern India affords striking examples of the anomalies of malaria, illustrates the impossibility of predicting from the physical conditions of a locality the degree in which fever will flourish there, and affords evidence of the existence of varieties of malaria which flourish only in particular localities.

If then malaria cannot originate or become established in every locality which seems to present favourable conditions, may not the difficulty which in the case of cholera we are attempting to meet, be avoided by the supposition that the poison of cholera needs for its growth a combination of an even more special nature than that necessary for the growth of the fever miasm; and that this is not provided elsewhere than in the delta of the Ganges. After all, we can only say that such or such deltas resemble one another so far as we are able to penetrate their conditions, while we must admit that we only know in a very rough way what those conditions are. However, even supposing that we were able to find a delta possessing by nature precisely the same physical conditions as those of the Ganges, the same meteorology, and geology, and vegetation, with soil and water identical in their chemical composition, even then in order to complete the resemblance we must find upon this delta a dense and most ancient population which has for ages been employed in modifying and defiling the natural composition of its soil. And even beyond this, more is

¹ See papers on 'Malaria and its Effects,' by Dr. Sullivan, in the *Medical Times* for March 1878, and other numbers of that year. Also the article on 'Malaria' in *Ziemssen's Cyclopædia*, and generally text-books on the subject.

needed to make the cases parallel. We must have not men only, but a race of men constituted like the Bengali, for the influence of race upon susceptibility to particular diseases is an undoubted fact, one which is illustrated in Bengal in the case of this very disease, cholera. The exceeding proneness of the non-Aryan aboriginal inhabitant of Chota Nagpore to cholera is well known, a proneness greater than that of the Bengali, far greater than that of the native of Aryan stock of Behar and the North-West Provinces. From his non-Aryan ancestry the Bengali may have derived his degree of proneness to cholera. However, what is insisted on here is, that till we can somewhere else parallel the physical conditions, and the vegetation of the Ganges delta, its history and people, and find that there cholera will neither originate nor abide, we may not adduce the exceptional character of the Ganges delta as the home of cholera as valid argument against the view that the miasm of the disease in its nature resembles that of malarious fever.

Possibly the cholera poison is of the two the more highly organised product or individual, and though the more active and powerful, the one most easily destroyed. For it the human system may present a host in which it can multiply or develop in a manner of which the fever miasm is not capable. And though here again we get into very speculative regions, yet we are not without encouragement to believe that speculation in this direction may not prove profitless, and that the nature of the cause, or rather conditions of development, of these diseases is within the limits of research. And it is even probable that the discovery will result rather through investigations regarding cholera than fever, for although fever in India slays tens of thousands, where cholera slays hundreds or at most thousands, yet, owing to the influence of various causes, the latter disease attracts, or has attracted, far the greater amount of thought and observation.

The year 1877¹ was one of great sickness and mortality from fever and cholera amongst the people of the Madras and Bombay Presidencies, the result of the wide-spread distress and famine which were caused by deficient or untimely rainfall. In Bengal proper, in Assam, and in Burmah also, the cholera epidemic was severely felt. On the other hand the statistics of the British and native troops were very favourable; the diseases which pressed so heavily upon the people affected the army comparatively little.

¹ See *Report for 1877 of Sanitary Commissioner with Government of India*.

The following table compares the mortality from fevers and cholera in the provinces of British India during the year in question :—

	Deaths from fever		Deaths from cholera	
	Total	Per 1,000 of population	Total	Per 1,000 of population
Bengal	711,037	11·85	155,305	2·58
Assam	18,715	4·9	11,377	2·9
North-West Provinces and Oude	574,722	13·45	31,770	·74
Punjaub	219,281	12·54	29	·001
Central Provinces	131,123	17·70	3418	·46
Berar	34,453	15·8	842	·4
Bombay	336,865	20·79	57,228	3·53
Madras	469,241	16·06	360,332	12·2
British Burmah	26,001	8·85	7276	2·47

CHAPTER VIII.

BENGAL.

Province of Bengal. Limits; physical geography; soil; climate; diseases; statistics of mortality; fevers; cholera; bowel complaints. Dr. Coates on improved health of Europeans in India. Small-pox; results of vaccination; goitre. Table of statistics of goitre and leprosy in the districts of Bengal.

THE province of Bengal, excluding Assam and Cachar, which have been lately separated from the Lieutenant-Governorship of Bengal, and together constitute the Chief Commissionership of Assam, lies between east longitudes 84° and 93° , and north latitudes 21° and $27^{\circ} 30'$. The area of the province is in square miles 194,375, and the population 62,706,774.¹

The province geographically and climatically embraces three well-marked divisions: 1st, the delta of the Ganges and Brahmapootra, which extends north and south between the Himalayas and the Bay of Bengal; 2nd, the Lower Gangetic plain which, bounded on the north by the Himalayas, extends westwards from the delta, along the course of the river to the western boundary of the province; and 3rd, the hilly country south of the Ganges, which is bounded on the south by the Central Provinces, and geologically forms a part of ancient peninsular India. On the extreme east of the province the plains of Bengal are continuous with the valleys of Cachar and Assam, and on the north-west with the plains of the North-West Provinces.

The two great rivers of the province are the Ganges and the Brahmapootra; these with their tributaries cover the country with a close network of watercourses. The Ganges, leaving the North-West Provinces near its confluence with the Gogra, enters Bengal, and flows nearly due east at a distance of about ninety miles from the base of the Himalayas for a distance of about 180 miles, when it turns the Rajmahal hills, and takes a south-easterly course to join the Brahmapootra at Goalundo, a point about 130 miles distant from the coast line of the Bay of Bengal.

¹ *Administrative Report of Bengal, 1875-76.*

The Brahmapootra leaves Assam to enter Bengal at that part of its course where it turns the Garrow hills, and changing the direction of its course flows south, under the name of the Jamoona, to its confluence with the Ganges.

Formerly—till about the beginning of this century—the Brahmapootra sent the main stream of its waters through the delta in a more easterly direction than now. The ancient channel remains, and is still known as the Brahmapootra; its stream unites with that of the Soorma, which collects the drainage of Cachar and Sylhet, to form the Megna, a vast river which joins the combined Ganges and Jamoona a little to the south of Dacca.

The surface of the delta, and of the Lower Ganges plain, is almost uniformly flat, and has so low a level that the greater part of it is under water during the rains. Geologically it is a recent alluvial deposit, presenting a surface of loam resting upon beds of clay and sand.¹ The description which Dr. Oldham² has given of the ground on which the Gangetic stations, Calcutta, Dum Dum, Barrackpore, Berhampore, and Dinapore are situated, is applicable to that of a great majority of the towns and villages of these regions. He writes: 'Built on a series of beds of silt, fine sand and clay of immense thickness and varying much in the succession, these beds are generally quite or very nearly horizontal, and the character of the surface varies as the uppermost bed at the place be either of sand or clay. Not one of these places (Dinapore excepted) does or can afford any natural drainage; the soil will of course absorb and drink in a large amount, and of impurities also, but there is no means by which these can pass off, and they therefore accumulate. The ground in fact licks up moisture and sewage as a sponge would, and as a sponge it also loses these by evaporation, only overflowing when full, but nothing more. The fall of the general surface of the country is tolerably constant up to Rajmahal, where the fall begins slightly to increase, but it is everywhere slight. And there is therefore difficulty in establishing any artificial system of drainage. In fact, from the now generally well-known fact that all alluvial rivers raise gradually their banks higher than the surface of the adjoining country, parts of these stations are actually below the high water, or rather flood level, of the river adjoining.'

Higher up, in the Ganges valley proper, 'there are two³ very

¹ See also Chapter ii.

² Rough notes by T. Oldham Esq., F.R.S. &c., on the position &c. of stations for European troops in Bengal with reference to the geological structure of the station. *Indian Annals of Medicine*, No. xxiv. Calcutta, 1868.

³ *Ibid.* I. 268.

distinct deposits of very different ages and probably of very different origin: one may be called the old alluvium, the other the Gangetic alluvium. Below Benares (speaking roughly) the greater portion of the plain of the Ganges, from the foot of the hills to the north to the hills on the south, is composed of the more recent Gangetic alluvium, chiefly soft incoherent beds of fine sand and silt, while here and there through these beds stand up parts of the old alluvium (probably a marine deposit), which for the most part consists of a strongly coherent reddish-yellow clay, generally abounding in *kunkur*,¹ and with only occasionally irregular beds of sand through it. This old alluvium stands up in steep banks along the river course where it exists. It may be seen from Buxar down to near the junction of the Soane and Ganges, forming a narrow bed along the river-bank. To the south it shows again close to Dinapore, and under the city of Patna, under the town of Bhagulpore &c. &c. and still further south forming the elevated tract known as the Madhopore jungle a little north of the city of Dacca. 'The prevailing character of the deposits constituting the great flats of the plains of Upper Bengal and of the North-Western Provinces (as far to the west as Umballa) depends on the spread of this older and very kunkury clay. It is not universal, but it is general, whereas its absence is the general character below Benares. Benares, Mirzapore, Allahabad, Cawnpore, are all on this stiff clay with kunkur. When the kunkur is only occasional in its distribution, and occurs rather in nodules than in sheets, it is not of much injury, but when it occurs in sheets, often not many feet below the surface, drainage becomes very difficult and costly. Further, where it abounds the water derived from these deposits is for the most part very hard. Azimghur, Gonda, Fyzabad, Roy. Bareilly, Lucknow, Seetapore, Futtehghur, stand generally on this clay, but there are modifications arising from the fact that this clay is itself cut away along the river valleys, and the flats filled in with sand and silt which have more of the character of the ordinary Gangetic or more recent alluvium of Bengal.'

Climate. Table No. II. in the Appendix gives the principal meteorological elements of Jessore, a station which may be considered a typical one for Lower Bengal. It is situated about the centre of the Ganges delta, some seventy miles north-east of Calcutta. Notes on the climate and meteorology are given in the account

¹ See note on Chapter ix.

of each district. Briefly the climate of all the districts of Lower Bengal with which the present enquiry is concerned is very similar, for all occupy the region of Northern India in which pre-eminently the south-west monsoon makes its governing influence felt, and in one way or another causes a pervading and perennial damp in air and soil. Add to the watery influence of the monsoon, that of the direct rays of a tropical sun, and we have the climate of a forcing-house, and as the result a population and vegetation rank and luxuriant, and earth and air charged with decaying animal and vegetable matters. Life under such conditions must be unstable, and the quickly matured man must in every stage of his growth and decadence, even under the most happy circumstances, maintain a state of health perilously liable to become one of disease.

Diseases of Bengal. The following table, exhibiting the total mortality, the mortality from the chief diseases, and the seasonal fatality of disease, amongst the population of the Lieutenant-Governorship of Bengal, is compiled from the reports of the Sanitary Commissioner of the province for the years 1874-1877. Average returns of many years have not been attempted, for the registration of the vital statistics of the general circles is confessedly most imperfect. The Sanitary Commissioner was, however, able to state that in the year 1876 very sensible advance in registration had been effected, and during 1877 'substantial improvement in registration was achieved;' 'the returns of many districts are already so far correct as to give important and valuable indications as to the health-condition of the people, and even when the figures are manifestly imperfect, they sometimes give practically useful information from the fact that the admitted inaccuracies are evenly distributed and mutually correct one another.'¹

The *recorded* death rate per 1,000 rose from 3.92 in 1870 to 16.4 in 1876 and 17.96 in 1877.

The second table exhibits the statistics of those of the districts with which the present enquiry is concerned. The statistics are those of the 'selected circles' for 1876, and the general returns of 1877. The selected circles, which were abolished at the end of the year 1876, were 195 in number, 119 urban, 76 rural. Special agencies were employed for collecting their statistics. The combined area of the urban circles was 563.56 square miles, with a population of 3,553 per square mile, 1,028,858 males,

¹ *Report of Dr. Harvey, Sanitary Commissioner for the province, 1877.*

and 973,675 females. Of the rural circles the area was 10,253 square miles, with a population per square mile of 476, of which 2,435,146 were males, and 2,442,850 females.

The year 1876 was, says the Sanitary Commissioner, a fairly healthy one. As in all years, cholera prevailed epidemically in several circles, and fever exhibited high mortality in some, but the general outcome of the year was not affected to any material extent by these or other causes excepting the results of the cyclone in the Backergunge, Chittagong, and Noacolly districts, which, by drowning, cholera, &c. caused 67,060 deaths. The only speciality of 1877 was an unusually extensive and severe prevalence of fever in a majority of the districts, but on the whole the year was not unusually unhealthy (report for 1877).

The principal diseases of the province are the malarious fevers, cholera, bowel complaints, small-pox. Of the fevers, those of the intermittent type are the most common, but in some peculiarly unhealthy localities severe remittents prevail. 'Fevers are worst,' writes Dr. Coates in his official report for 1876, 'in the districts and portions of the district where a damp soil, jungle, and decaying vegetation abound, showing in addition a connection with vegetable organic matter, whether of rapidly decaying vegetation only, or the rapid development of spores of fungi or other low organisms, we know not.'

True typhoid, enteric fever, is rarely seen; but it, and it may be added another infectious disease, namely, diphtheria, are recognised diseases of the province, and probably are more common during the past twenty years than they formerly were; the old statistics, if they were present, did not recognise them. Typhus may be said to be unknown amongst the people of Bengal.

As regards the seasonal prevalence of the malarious fevers, taking the admissions amongst the native troops quartered in Bengal as our guide, we learn that they notably increase in frequency in July, remain very prevalent till October, and thence to the end of the year rapidly decline. There is a slight exacerbation, which is also well marked in the case of the general population, in March and April, after the early rains. The number of deaths registered as due to fever amongst the general population is greatest in November and December.¹ But there is good reason for believing that the large number of deaths in those months must be set down, not to fresh attacks of fever, but to relapses, and to complications, such as respiratory and bowel

¹ See tables Chapter vii.

diseases, attacking those who have suffered from fever during the previous months. And the reason why the mortality diminishes after November, though the weather is actually becoming more trying to those enfeebled by fever, is because the first onset of the cold season has swept away a large proportion of the sufferers.

Cholera. After fever, cholera is the chief cause of mortality amongst the inhabitants of Bengal; the number of deaths recorded to this disease—and the records are more to be depended on for cholera than for other diseases—for the four years ending with 1877 averaged annually above 130,000.¹ Over a large part of the province the disease is endemic, and is present throughout the year, but with two periods of great severity, viz. from March to May in Bengal, and March to July in Orissa, during which it attains maximum intensity; and again from October to December in both Bengal and Orissa, when it prevails, but with comparatively diminished severity. The remaining months are months of subsidence of the disease: the January and February cholera is but a termination of the epidemic winter visitation of the preceding year.

In the Behar and Chota Nagpore divisions of the province, both of which are comparatively high and dry, while the latter division is outside the endemic area of cholera, there is only one period of intense prevalence of the disease, viz. from March to July in Behar, and March to August in Chota Nagpore.

As to the insanitary conditions which foster and propagate cholera, they abound throughout rural Bengal, and have been only partially dealt with in the better class of towns. Soil, water, and air are contaminated by rapidly decaying animal and vegetable substances, the dwellings of the poor, sessile on the damp ground, are crowded, and if perchance clean within, are surrounded by dirt-heaps and dirt-pools. Clothing is deficient, often dirty; the food is largely composed of unwholesome material, such as raw acid fruits, decaying fish, new rice, and too generally is insufficient for the needs of the body. As regards the water² there is a large and remarkable consensus of opinion, amongst medical and other authorities, that impure water is the chief exciting cause of cholera; then want, and ignorance and carelessness, or fatalism, result in neglect of precautions against disease; and almost throughout the country, at certain seasons, cholera-discharges are dissipating in air and water and soil.

Bowel complaints, mainly dysentery and diarrhœa, stand

¹ *Report of Sanitary Commissioner for Bengal, 1876*, p. 17. ² *Ibid.* p. 18.

Bengal, exclusive of Assam and Cachar.

Area in square miles ¹ 144,614·4

Population according to census of 1872.

Males 29,895,025
 Females 30,098,307
 Total 59,993,332
 Population per square mile 415·

TABLE I.—*Ratio of deaths per 1,000 of population.*

A. TOTAL POPULATION.									
Year	All causes	Cholera	Small-pox	Fevers	Bowel complaints	Injury	Remarks		
1874	8·42	·94	·2	5·48	·52	·32	In previous years the returns of Assam and Cachar were included in those of Bengal		
1875	10·01	1·8	·08	6·14	·59	·31			
1876	16·4	3·27	·17	9·36	·97	·9			
1877	17·96	2·58	·13	11·85	·98	·34			
B. SELECTED CIRCLES, COMBINED URBAN AND RURAL.									
							Area in square miles	Population	Remarks
1874	24·72	2·36	·68	14·31	2·42	·54	3500·5	2,509,883	Registration of selected circles discontinued after the year 1876
1875	24·8	2·86	·22	14·58	2·44	·46	3313	2,688,076	
1876	23·15	3·35	·39	13·09	1·86	·99	10,816·6	6,880,529	

The following table is from Dr. Coates's 'Sanitary Report' for 1878, which reaches me just as the MS. is going to press:

Mortality from the specific death-causes.

	RATIO OF DEATHS PER 1,000 OF POPULATION.					
	In 1878			Average of 1873-77		
	Urban	Rural	Total	Urban	Rural	Total
Cholera	3·69	1·49	1·58	3·48	1·87	1·92
Small-pox	1·08	·17	·20	·53	·14	·15
Fevers	18·02	12·14	12·38	13·65	7·38	7·58
Bowel complaints	5·38	·91	1·08	3·43	·62	·71
Injury	·50	·37	·38	·44	·43	·43
Other causes	6·44	1·91	2·08	5·07	1·18	1·30
All causes	35·13	17·01	17·73	26·63	11·63	12·11

¹ These statistics include the registering circles only (1877). The total area of the province is 194,375 square miles, and the population (report of 1876) 62,706,774.

TABLE I.—continued.

SEASONAL FATALITY OF DISEASES, SELECTED CIRCLES PER 1,000 OF POPULATION.

	January		February		March		April		May		June		July		August		September		October		November		December		Year
	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	
All causes . . .	1.72	1.38	1.56	1.33	1.74	1.79	2.01	2.17	1.93	1.88	1.9	1.73	1.95	1.86	2.09	1.89	2.06	1.84	2.32	2.01	2.92	2.9	2.54	2.3	
Cholera . . .	.06	.09	.12	.06	.23	.26	.38	.59	.35	.51	.34	.41	.21	.34	.17	.20	.13	.06	.17	.07	.35	.33	.29	.42	
Small-pox . . .	.01	.014	.01	.03	.03	.07	.04	.08	.03	.07	.02	.05	.01	.03	.01	.01	.005	.007	.005	.004	.008	.01	.01	.014	
Fevers . . .	1.09	.9	.95	.85	.94	1.03	1.02	1.05	1.02	.9	.97	.8	1.13	.9	1.26	1.1	1.26	1.23	1.46	1.41	1.84	1.5	1.68	1.37	
Bowel complaints .	.19	.12	.17	.13	.17	.13	.2	.15	.17	.14	.19	.15	.21	.17	.20	.19	.22	.17	.24	.17	.22	.18	.20	.16	
SEASONAL FATALITY OF DISEASE, TOTAL POPULATION, 1877.																									
All causes . . .	101,796	74,124	73,824	88,689	81,470	67,308	69,440	76,020	82,746	93,209	125,081	143,894	1,077,601												
Cholera . . .	38,142	18,216	11,872	17,187	12,140	5478	4943	4759	5280	5983	13,713	17,592	155,305												
Small-pox . . .	424	633	1196	1518	1292	963	574	350	194	205	261	478	8088												
Fevers . . .	48,400	41,623	45,785	53,458	51,941	45,483	47,116	52,605	58,667	68,013	92,403	105,543	711,037												
Bowel complaints .	4620	4393	4729	5180	4775	3849	4221	4590	4887	5448	5837	6453	58,962												
All causes per 1,000 of population	1.69	1.23	1.23	1.47	1.35	1.12	1.15	1.26	1.37	1.55	2.08	2.39	17.96												
Fevers per 1,000 of population	.808	.694	.764	.893	.866	.759	.786	.878	.980	1.13	1.54	1.77	11.85												

TABLE II.—*Certain districts of Bengal. Deaths per 1,000 of population registered*

District	Area in square miles	Cultivated	Culturable and pasturage	Unculturable, marshes, &c.	Principal crop
Dacca 1876 . . .	2897	Upwards of two-thirds	About one-fourth	About one-tenth	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Mymensingh 1876 .	6291	Upwards of one-half	About one-fifth	About one-fourth	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Tipperah 1876 . . .	2665	2034	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Pubna 1876 . . .	1966	1147	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Bogra 1876 . . .	1501	Somewhat more than three-fourths	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Rajshahye 1876 . .	2234	About one-half	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Maldah 1876 . . .	1813	Somewhat more than one-half	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Rungpore 1876 . .	3476	About three-fourths	—	About one-fifth	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Dinagopore 1876 . .	4126	About three-fourths	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—
Julpigoree 1876 . .	2906	About three-fourths	—	—	Rice
„ 1877 . . .	—	—	—	—	—
„ 1876 . . .	—	—	—	—	—

1876 and 1877 for the total population, and of 1876, selected circles.

Population per square mile, 1872	Male adult agricul- turists	Male adult non-agri- culturists	Cholera	Small-pox	Fevers	Bowel com- plaints	All causes	
400	300,700	248,742	6.06	.04	8.62	1.07	18.97	Total area
—	—	—	4.24	.03	11.45	1.2	20.36	Selected circles Population 132,981
—	—	—	7.34	.08	9.82	2.62	29.65	
733	514,658	212,957	2.3	.38	6.64	.48	11.77	Total area
—	—	—	3.36	.36	7.16	.4	13.8	Selected circles Population 459,982
—	—	—	2.05	.21	6.52	.46	11.13	
788	338,562	144,115	2.45	.02	5.31	.24	7.96	Total area
—	—	—	2.32	.02	7.66	.33	11.49	Selected circles Population 37,576
—	—	—	6.75	1.0	11.49	1.51	29.8	
116	211,253	158,665	3.24	.11	11.66	.3	16.22	Total area
—	—	—	3.03	.1	17.5	.38	22.51	Selected circles Population 35,006
—	—	—	7.34	.19	28.7	.25	38.45	
559	171,420	45,280	.55	.002	13.78	.13	15.63	Total area
—	—	—	2.34	.001	18.72	.18	22.73	Selected circles Population 232,37
—	—	—	1.63	—	18.03	.51	22.42	
887	246,641	141,930	2.07	.05	16.35	.21	19.74	Total area
—	—	—	1.78	.02	23.46	.14	26.82	Selected circles Population 249,959
—	—	—	2.9	.1	22.93	.40	27.80	
773	131,636	72,113	1.29	.1	15.84	.09	18.14	Total area
—	—	—	6.34	.05	26.75	.09	34.10	Selected circles Population 30,679
—	—	—	3.71	.03	31.29	1.2	39.44	
5519	548,997	154,605	.97	.008	5.86	.17	7.64	Total area
—	—	—	.64	.03	11.83	.26	14.1	Selected circles Population 23,124
—	—	—	.56	.08	28.15	3.15	36.23	
864	368,913	113,823	.74	.03	22.05	.64	25.34	Total area
—	—	—	.77	.01	24.31	.30	27.04	Selected circles Population 24,644
—	—	—	.81	.16	32.9	3.53	42.56	
1144	83,021	50,562	2.61	.03	6.29	.37	10.57	Total area
—	—	—	.09	.03	11.2	.54	13.84	Selected circles Population 54,466
—	—	—	3.98	—	13.62	.67	21.84	

TABLE II.—continued.

District	Area in square miles	Cultivated	Culturable and pasturage	Unculturable, marshes, &c.	Principal crop
Hill Tract 1876	962	—	—	—	Rice Tea Indian corn Millets Rice
Darjeeling 1877 . . .	1234	—	—	—	
Terai 1876	272	—	—	—	
Purneah 1876 . . .	4957	About three-fourths	About one-twelfth	About one-sixth	Rice
" 1877 . . .					
" 1876 . . .					
Bhagulpore 1876 . . .	4327	—	—	—	Rice Wheat Oats Gram Millets Oil seeds
" 1877 . . .					
" 1876 . . .					
Monghyr 1876 . . .	3913	About three-fifths	About one-fourth	About one-seventh	
" 1877 . . .					
" 1876 . . .					
Mozufferpore 1876 . . .	2696	Above three-fourths	About one-eighth	About one-eighth	Rice Wheat Barley Oats Gram Oil seeds
" 1877 . . .					
" 1876 . . .					
Darbhunga 1876 . . .	3374	Upwards of three-fourths	—	Less than one-eighth	
" 1877 . . .					
" 1876 . . .					
Sarun 1876 . . .	2654	—	—	—	—
" 1877 . . .					
" 1876 . . .					
Chumparun 1876 . . .	3531	About two-thirds	—	—	Rice Barley Maize Wheat Oil seeds Indigo Poppy
" 1877 . . .					
" 1876 . . .					

next in order as causes of mortality amongst the people. The group probably includes on the one hand many cases which ought to be recorded as cholera, and on the other many which would more correctly have been attributed to fever complicated with diarrhœa or dysentery. Malaria, exposure, unwholesome food, such as unripe fruit and new rice; and above all, foul water, are active causes of this group of diseases. An excellent illustration of the effects of foul water has been recorded by Dr. Arthur Payne¹ in the case of the Calcutta Native Lunatic Asylum, where, up till 1876, the patients suffered very much from diarrhœa, dysentery, and from round worms. Dr. Payne discovered that the patients were in the habit of drinking the water placed in reservoirs outside the latrines for purposes of ablution; they washed, and then took a mouthful of the water. This practice was at once put a stop to, and from that time worms and dysentery almost disappeared from the Asylum, and this though the years 1876 and 1877 were by no means healthy years amongst the people living in the neighbourhood.

Mortality from bowel complaints begins to increase at the same time of the year as that from fevers, and continues great till the end of the year, proving, writes Dr. Coates, 'that the evening and morning damp and chills, and sudden alternations of temperature of July, August, and September, and the extreme cold, night air, and heavy dews of October, November, and December, acting on the poor, ill and insufficiently-clad, badly-fed population, who sleep on damp floors, and of whom a large proportion are, moreover, debilitated and broken down in constitution, subject them, in very large numbers, to the influence and fatality of bowel complaints. Children and the aged are also very liable to succumb to these diseases, especially diarrhœa. Malaria, errors of diet, and bad water, also help very materially to encourage these diseases.'²

'It is worthy of note,' continues Dr. Coates, 'how rapidly and decidedly dysentery and indeed all chylopoietic disorders have ceased to attack Europeans in this country. The old reckless exposure to sun and rain, the heavy tiffins, midnight suppers, and stronger liquor drinking, have ceased in proportion. Agues are getting rarer among them every day. They are better protected.

'Our women are less pale, thin, and lethargic, more muscular and firmer, more energetic, healthier, and happier, since croquet, badminton, and lawn-tennis have given them some real out-door exercise; and in going through Bengal, I find this healthy state to be in proportion to the prevalence of these games, and, where they do not exist, the old pallor and appearance of suffering

¹ *Annual Report on Calcutta* for 1877.

² *Report* for 1876, p. 72.

and exhaustion are more or less present. Altogether, and even as it is, Europeans are freer from disease, longer lived, and healthier than the great majority of the natives themselves.

‘Old Indians do not now retire broken down, to die within the year. The irritable dyspeptic, with huge liver, yellow visage, and attenuated physique, has ceased to be. In his stead we have the veteran of forty years’ service, strong and vigorous to work, and to enjoy life for another quarter of a century. The degeneration of the careful Englishman in India has become the exception and not the rule, as it was in former days.’

Small-pox is another of the principal causes of mortality in Bengal, happily a fast diminishing one, for nowhere perhaps is the efficacy of vaccination more impressive than here. Vaccination by paid vaccinators, under the control of Government medical officers, is being steadily extended over Bengal, and with the happiest effects, while inoculation, formerly all but universal, is fast giving place to it. In the report for 1874 the Sanitary Commissioner gives the statistics of the twelve areas which suffered most from this disease: the mortality per 1,000 of population ranged from $\cdot 31$ to $\cdot 93$, the average was $\cdot 52$. In none of these districts had the circle system of vaccination and superintendence been introduced. On the other hand, in eleven protected districts mortality from the disease was very slight, the deaths per 1,000 of population varying from $\cdot 008$ to $\cdot 07$, the average $\cdot 03$ per 1,000. In 1877 the Sanitary Commissioner reports that in a district, Bancoora, in which vaccination is very systematically carried out, there had been no death from small-pox for three years. The season of greatest prevalence of the disease is from February to May; April and May are the most fatal months. Dr. Harvey (Sanitary Report for 1877) believes that the explanation of the annual outbreak of the disease in February is to be found in the fact that at that time the inoculators begin their work, and that the spread of the disease is encouraged by the huddling together of the people for warmth; that subsequently it spreads independently of such factors as heat and moisture, because of the larger quantity of the poison in the air, and at length ceases, not from the influence of climatic causes, but for lack of fresh victims.

The registered deaths from violence in Bengal during the years 1874–1877 were as follows:—

	1874	1875	1876	1877
Suicide	2149	1987	2183	2291
Wounds	1360	1364	1584	1411
Accidents	7800	6689	40,151 ¹	7428
Snake bite and killed by wild beasts .	8160	9046	10,062	9795

¹ 34,173 deaths reported caused by cyclone and storm wave.

Goitre. The parts of Bengal in which goitre is found are the Himalayan districts; the Sub-Himalayan country; the tongue of land between the Ganges and Brahmapootra; and the districts between the Jamoona and the Megna. West and south of the Ganges the disease is almost unknown, and it is rare in the tract of country immediately along the northern bank of the river, but thence northwards increases in prevalence.

The table (TABLE III.¹) which follows shows the aggregate number of cases of leprosy² and goitre treated in the dispensaries of Bengal during the years 1874, 1875, 1876.

	Leprosy		Goitre	
	Treated	Per cent. of total treated	Treated	Per cent. of total treated
Burdwan	357	·23	5	·003
Bancoora	391	·75	1	·002
Beerbhoom	299	·59	4	·007
Midnapore	383	·46	2	·002
Hooghly	161	·14	1	·001
Twenty-four Pergunnahs	103	·09	3	·002
Nuddea	84	·15	42	·051
Jessore	49	·07	11	·014
Moorshedabad	349	·34	16	·015
Dinagepore	8	·05	46	·28
Maldah	89	·36	117	·5
Rajshahye	96	·13	1991	2·96
Rungpore	408	·31	39,048	26·8
Bogra	35	·17	236	1·12
Pubna	36	·15	698	3·0
Cuttack	387	·65	1	·002
Pooree	270	1·01	1	·003
Balasore	101	·54	2	·008
Dacca	331	·29	2299	2·03
Furreedpore	14	·16	9	·152
Backergunge	151	·24	44	·078
Mymensingh	120	·22	4773	8·26
Tipperah	44	·35	9	·07
Chittagong	112	·36	—	—
Noakholly	23	·18	4	·03
Patna	817	·65	1473	1·17
Gya	275	1·04	12	·045
Shahabad	619	·56	65	·05
Mozufferpore	1354	1·28	38,390	33·97
Durbhunga			26,241	26·0
Sarun	381	·39	21,810	84·6
Chumparun	177	·29	392	·84
Monghyr	259	·59	400	·664
Bhagulpore	256	·55	3169	35·5
Purneah	37	·47	6	·029
Sonthal Pergunnahs	151	·76	566	4·77
Darjeeling	27	·21	405	1·49
Julpigoree	22	·08	37	·057
Chota Nagpore	258	·44		

¹ From *Reports on Charitable Dispensaries under the Government of Bengal for 1874, 1875, and 1876.*

² Regarding leprosy in Bengal see a note to Chapter xxi.

CHAPTER IX.

DACCA AND OTHER DISTRICTS OF EASTERN BENGAL.

Districts of Eastern Bengal. *Dacca*, description of ; soil ; kunkur ; inundations ; people ; climate ; diseases :—cholera ; malarious diseases ; bad water as a cause of disease. Goitre ; Dr. Adam Taylor's opinion as to the malarious nature of the disease ; Dr. Wise on the increasing unhealthiness of the district. *Mymensingh* ; *Jheels of Bengal* ; *Madhopore* jungle ; statistics of goitre in the district. *Tipperah*, *Pubna*, *Bogra*, *Rajshahye*, *Maldah* districts ; goitre in these districts.

DACCA.¹ The area of the Dacca district is 2,897 square miles. Triangular in shape, it has its apex about eighty miles from the sea in the angle formed by the junction of the Megna with the combined stream of the Ganges and Jamoona. The former river separates Dacca from the district of Tipperah, and the latter from Furreedpore. To the north the district is separated from the district of Mymensingh by a boundary which the greater part of its length is artificial, but towards the east is formed by the old channel of the Brahmapootra.

The district is divided into northern and southern portions by the Dulasseree river, which runs from north-west to south-east, connecting the Jamoona and the Megna, and the northern portion is again divided by the Luckmya river, which runs from north to south, connecting the old Brahmapootra and the Dulasseree.

Throughout its whole extent Dacca is intersected by branches or loops of these great rivers, which are, however, constantly changing both their size and position : a small stream may quite suddenly become the main channel of a great river which has deserted its old bed, leaving behind only a succession of pools, and a few narrow channels intersecting a wide sandy tract. Notable amongst changes of this kind are those which have resulted owing to the diversion of the waters of the Brahmapootra which formerly

¹ *Sketch of the Topography and Statistics of Dacca*, by Dr. Taylor, 1840 ; *Administrative Reports* of the Government of Bengal ; and *Reports* of the Sanitary Commissioner, and Meteorological Reporter, of the province.

traversed this district by the Megna, Luckmya, and other rivers. Alterations such as these are amongst the chief of the causes of the extreme unhealthiness of the district, for the loss of the river not only deprives the population along its bank of a supply of good water, but the 'khals' which are thus formed, flooded in the rains, become, as the inundations subside, a series of stagnant pools covered with slimy weeds, the water loaded with rotting vegetable matter, reservoirs for all the filth which the stream once carried away: while the natives, still clinging to the old watering-places, fill their vessels despite the visible foulness of the pools.

The western is the larger of the two subdivisions into which the northern portion of Dacca is divided by the Luckmya. The greater part of it is considerably above highest flood level, and the soil consists of red 'kunkur'¹ and strata of clay, covered in the more elevated parts with a thin layer of vegetable mould, while towards the rivers the clay is much intermixed with sand, and is covered with alluvial earth.

The red formation extends southwards into the angle between the Luckmya and Dulasseree rivers, and upon it stands the city of Dacca, on the northern bank of the Dulasseree, or rather upon a loop which is known locally as the Boorigunga. The space between the rivers is here intersected by numerous creeks and morasses, and during the rains is deeply inundated, but the bank on which the city stands is sufficiently elevated to render the site comparatively dry. North of Dacca, at a distance of about twenty miles, the red formation rises into hilly ridges, twenty feet or so in height, which constitute the southern end of the tract of old alluvium known as the 'Madhopore jungle.'

The eastern subdivision contains a large proportion of alluvial soil, and is inundated more extensively than the western subdivision. It has, too, fewer primitive forests and is in a higher state of cultivation, while those parts that are now uncultivated

¹ Kunkur, impure limestone of very recent formation, still in course of formation in many parts of India by the deposition of carbonate of lime about such nuclei as shells, particles of sand, &c. Its most common form is nodular, the nodules varying in size from a quarter of an inch to three inches or more in diameter. The nucleus is usually pretty pure carbonate of lime, the outer layers a mixture of carbonate of lime and earthy matters. Often the deposit is found in a massive form in thick beds. Kunkur usually contains about seventy per cent. of carbonate of lime, and two or three per cent. of carbonate of magnesia, with from ten to twenty per cent. of siliceous matter. Often it has a red colour, owing to the presence of oxide of iron. Many kinds of kunkur when burnt form an excellent hydraulic cement, and it is largely used in making mortar. In some districts kunkur is employed in road-making and as a building material.

evidence, by the tanks and mounds which abound there, to having been at one time thickly peopled. Kunkur is chiefly found in the northern part of this subdivision, in hilly ridges which run up to the north-eastern angle of the district.

The alluvial soil of the northern portion of Dacca is far more sandy than that of the south, and the churs (sandbanks) of the Brahmapootra, the Megna, and the Luckmya are of a much lighter and drier nature than those of the Ganges—a difference which corresponds to the character of the waters, for while that of the Ganges is opaque and muddy, owing to the large quantity of clayey matter which it holds in suspension, that of the other rivers is characterised by the presence of fine sand, which quickly subsides, leaving the water clear.

The southern portion of the district is by far the most fertile. It consists entirely of rich alluvial soil, and is inundated during the rains to a depth of from two to fourteen feet. The rise of the rivers and the inundation of the lower lands begins in June, and by the middle of July the whole country is under water, presenting the appearance of a wide watery expanse covered with growing rice, through which boats pass uninterruptedly from one place to another. Even the rivers are lost sight of, and their course is to be distinguished only by the lines of trees along their banks, while the villages stand up above the water, elevated upon artificial mounds which secure them against any but very unusual floods.

As the inundation rises the rice and other plants shoot above the surface, covering it with a carpet of vegetation which when the waters subside falls a saturated tangled mass upon the steaming ground, the while emitting a very offensive odour. The inundation continues at its height till the end of September, and then, as the rivers fall, begins to decline, the rice lands pouring out streams which are generally clear and limpid, while those from the morasses are of a dark hue. As the land slopes away from the rivers into the interior, jheels are often found in the central parts which contain water throughout the year; but as these are being gradually filled up by the sand and mud which the floods deposit, the general level is raised, the jheels or lakes diminish in size, and a larger area is yearly exposed, to add to the already widespread nursery ground of malaria which this district provides. In certain localities the site of ancient morasses is marked by deep beds of black mould which sometimes approaches lignite in appearance. Clay and sand are, however, the chief components of the soil of the

southern portion of the district ; the red formation of the northern portion is entirely absent.

The district is densely populated, by the last census supporting in all 1,852,993 souls, or on an average 640 to the square mile. The physique and general appearance of the bulk of the inhabitants differ in no material respect from those of the rest of the inhabitants of Eastern Bengal. They are as a rule of moderate height, slender and weak in make, and incapable of enduring fatigue ; in disposition indolent and cowardly, quiet, inoffensive, and peaceable. As to their diet, boiled rice is the staple, and is often the only food taken ; a little over a pound and a half is the daily allowance for an adult man. With the rice, dāl, fish, vegetables, and spices are commonly taken ; ghee also is largely used in cooking the other articles of diet. Fruits, especially plantains are largely eaten ; milk is much used by those who can afford it.

A small number of non-Aryan people, about 1,200 in number, belonging to the Koonch and Rajbunsi tribes of Cooch Behar, inhabit the jungle tracts of the district ; tracts which to the bulk of the inhabitants are frightfully unhealthy, yet these people suffer much less than do their neighbours from malaria. They are evidently of Mongolian origin ; they eat flesh and drink spirits, are robust and hardy, truthful and courageous, and, armed with spears and bows and arrows, do not fear to attack even the tiger.

Climate. The characteristic of the climate of Dacca is damp heat, which, with a plentiful rainfall and a rich soil, promotes the luxuriant vegetation that is so striking a feature here as elsewhere throughout Eastern Bengal. But though Dacca is within the tropics, the heat is greatly moderated by the abundant vegetation, by the great evaporation which even at the driest time of the year takes place from the watercourses and swamps spread thickly through the country, by the heavy rainfall, by the sea wind which blows most months of the year, and by the clouds which overcast the sky, intercepting the sun's rays during the hottest season. So that the heat is never very great, and is only felt to be oppressive towards the termination of the rains, when the winds are light and variable, and calms frequent, while the atmosphere, loaded with moisture, hinders or almost prevents evaporation from the surface of the body. The climate is, moreover, a very equable one, for the atmosphere is very damp throughout the year, and it is only for a comparatively short time during the winter months that a clear sky allows free radiation from the surface of the earth.

From April to October the winds are from the south and south-east, but in the latter month, when the strength of the monsoon is exhausted, the wind is variable, and often either from the north or north-west, while calms are frequent. From November to February the winds are from the west, north-west, and north, setting round to the north as the cold weather advances, and blowing steadily from that quarter for some days together, when they again become variable towards the west. During this period fogs are common. Even in February the sea wind begins to be felt, and in March obtains the preponderance; during this month thunder and hail-storms are of frequent occurrence.

The average rainfall at Dacca is 74·5 inches, ranging from 95 to 47 inches. After February a week seldom passes without rain, and the rain as a rule begins to fall freely in April; thence on to June the fall rapidly increases, and then gradually diminishes till the end of the monsoon,

There is a Government Observatory at Dacca, from the official reports of which for 1875-6 the table of meteorological data, No. I. in the Appendix is compiled.

Diseases. The principal diseases of the district are malarious fevers, intermittent and remittent, cholera, small-pox, and bowel complaints. Chest complaints, rheumatism, skin diseases, and intestinal worms are very common. Elephantiasis and goitre affect particular localities. Small-pox is not now so fatal a disease as formerly in the district, but as vaccination is strongly opposed by the mass of the people, and as inoculation is prohibited in the district, large numbers of the people are unprotected.¹ Cholera since 1817 has been endemic, and is believed to break forth with special violence every fourth year. Its seasons of maximum prevalence are from the commencement of the hot weather to the establishment of the rains, and after the subsidence of the rains up till the end of the year. During the months of July, August, and September, when eight-tenths of the district is under two or four feet of water, and all the ground not submerged is soaked with rain, there is no cholera. On the fall of the rivers and the exposure of the surface to the sun, cholera begins again to manifest itself. During October cases occur simultaneously in widely separated parts of the district, and in November and December there is scarcely a village of 500 inhabitants that has not cholera. In January, February, and March, without any flooding, there is an evident amelioration of the cholera-conditions, which are again

¹ *Sanitary Report for 1877.*

paramount everywhere in April, to lose their power in May, without any of the country coming under water. Dr. Crombie, from whose notice¹ of cholera in the Dacca district I have just quoted, writes: 'It cannot be said that there is any parallelism between the fluctuation of the subsoil water level and that of cholera in this district. There is a steady sinking of the subsoil level from September to March, while in April the level is practically the same as in March. During that month it fluctuates through two feet, eighteen to twenty feet below the surface of the ground, and yet cholera bursts forth with renewed vigour in many village communities, and in May, the condition of the subsoil water remaining unchanged, cholera is disappearing. In April and May alike there are showers of rain which are often capable in a porous soil of moistening the upper strata, and so favouring decomposition in them. In June, when the subsoil water is rising rapidly, cholera almost entirely disappears.'

Statistics of disease and mortality amongst the civil population of the district, the troops stationed at Dacca, and the prisoners in the Dacca jail, will be found in tables at pp. 84, 99, and 132.

Dr. Adam Taylor, a former Civil Surgeon of Dacca, who in 1840 published an admirable account of the medical topography of the district, states that the diseases are such as for the most part are due to malaria, with which the whole country, in common with all others having a similar climate, soil, and vegetation, abounds. But while the whole country abounds in malaria there exist, says Dr. Taylor, some localities which are peculiarly fertile of it, and these are most abundant amongst the artificially elevated places on each of which a group of villages has huddled, and in the neighbourhood of the Madhopore jungle. In some of these localities ague prevails throughout the year, and its sequela splenic enlargement, and affections of the abdominal viscera, are peculiarly common; while even the natives, who have become in a measure acclimatised to these regions, show by their sallow cadaverous looks, tumid bodies, and emaciated limbs, the noxious atmosphere they breathe.

Rice lands are especially unhealthy, for at the time of the drying up of the rains they become steaming offensive swamps, and the worst are those which lie low, where the rice remains long in a wet state. During October and November a hot vapour rises from these fields, and produces, the natives say, fever and ophthalmia. Even more productive than the rice lands of fever is the breaking

¹ In the *Report of Sanitary Commissioner for Bengal for 1877*, p. 40.

up of waste and jungle lands; and another cause of the disease appears to be steeping of hemp and other fibres in ponds in the vicinity of villages. The cultivators are not particular as to the ponds they use for the purpose; the village or domestic tank, the nearest jheel or backwater, are indiscriminately used; but while the offensive smell arising from the process must render the water nauseous, the native, writes a former Civil Surgeon, Dr. Wise, drinks it without disgust. Fortunately, the steeping process is carried on during the height of the rains, when doubtless the heavy fall lessens the unwholesomeness of the water; yet, writes Dr. Wise, fever is very prevalent in villages where jute is steeped.

Next to malaria, writes Dr. Taylor, stagnant water is perhaps the most frequent source of disease in the neighbourhood, and again and again does Dr. Wise repeat, good water is the most pressing need of the district. Wells are very rare, except in the towns and there they are abominably maltreated, and as large areas of the district are distant from running streams, a considerable proportion of the inhabitants are compelled to use morass water or the water of dirty pools, and to this they ascribe diarrhoeas, splenic enlargements, elephantiasis, and bronchocele—diseases, which, says Dr. Taylor, are certainly most common in situations where this kind of water is used to drink.

Intermittent fever is the most common type of fever in the district, and it is most prevalent at the beginning and end of the rains. Remittent fever prevails in October and November, and this is as a rule the season of greatest mortality in the district from fever;¹ the mortality, however, occurring rather from the after-effects of the disease than directly from the fever.

‘Enlargement of the spleen is the most common chronic visceral disease in the district, and is attributed by the natives to the use of stagnant marsh water as drink. Usually it is preceded by intermittent fever, *but in many cases the fever is slight, and in others the disease arises in a slow insidious manner, without attracting the attention of the patient or being attended with any constitutional disturbance.* Children appear to be more subject to it than adults.’²

Next to intermittent and remittent fever the most prevalent endemic diseases are elephantiasis and bronchocele. Bronchocele prevails most in the northern parts of the district, but it also occurs in the southern division. Out of 106 villages, belonging to two subdivisions, both elephantiasis and bronchocele were found in

¹ Dr. Crombie's *Report*, already quoted.

² Dr. Taylor.

seventy-two villages belonging to the northern division and in twenty-seven in the southern. In the majority of instances the villages in which bronchocele is the most frequent are at some distance from running streams and in situations where the inhabitants make use of stagnant water, while the places are surrounded with fertile sources of malaria. '*Judging from the nature of the localities,*' says Dr. Taylor, '*in which the disease is most frequently met with, it would seem to be rather the effect of malaria than of any cause such as lime in the water.*' Dr. Wise supports Dr. Taylor's statement as to the habitat of bronchocele in the district, and affirms that where goitre prevails in the district elephantiasis also is most common. He accepts M. Boussingault's theory that the cause of the disease is deficiency of oxygen in the water, and the consequent accumulation there of decaying organic matter, a theory which is quite in accordance with the view that some specific poison, a product of decaying vegetable matter—call it malaria or by any other name—is present in the water, and is the exciting cause of the chronic enlargement of the spleen, of goitre, and of elephantiasis, diseases which we find prevailing together in very many of the villages of this malaria-stricken district. The following extract from Dr. Wise's report for 1868 on the sanitary state of the district shows that it has little if at all improved since Dr. Taylor wrote in 1840, and that all the conditions favourable to the development of cholera, fever, and malarious diseases, remain as powerful as ever.

'The city of Dacca and the district have alike been becoming more and more unhealthy, nor is this to be wondered at when the habits of the people are considered. The old villages become buried beneath the heaps of accumulated filth which have been gradually increasing in the course of ages. The sanitary condition of all the towns and of the district generally is most disgraceful. Each village is worse than its neighbour in proportion to its age; a village newly settled on an open chur or plain, is as a rule salubrious. It may be more liable to epidemics of small-pox and cholera, but it escapes the enervating malarious poisoning which older settlements suffer from. Bengalees are so thoughtless and so ignorant of sanitary laws that with their new houses they prepare seeds for future disease. They raise their houses by digging irregular holes which become the household cesspool, privy, and tank. To protect their females from the eye of the stranger, and to provide shade, they surround their plot of land with hedges which in the course of time become forest trees. These trees

generally bear fruit, become valuable, and are never thinned. As years roll on the villages become buried in the vegetation, malaria abounds, the inhabitants are enfeebled and unable to cope with the forest around them, an epidemic fever breaks out, and the survivors migrate to new land where similar habits are followed and equally fatal epidemics recur. Such is the true chronicle of a Bengal village.

‘The villages on the banks of the river are the most healthy, because there the land is highest, but to this rule there are exceptions; it is the new villages on the banks of the river which are healthy ones, and it is here that the inhabitants are prolific. Nor are the villages so situated safe for many years, for very often the river silts up, an unhealthy khal is formed, and as the village grows old it becomes buried in jungle, then the inhabitants become the victims of fever and spleen, and the children are puny and potbellied. Fever and spleen it is which are desolating one after the other the old villages of Bengal.’ Dr. Wise states that from personal enquiry and observation he has found the inhabitants of some villages dying off at the rate of from 19 to 27 per cent. per annum, and he believes that 20 per cent. of the children die off before they arrive at the age of three years.

Mymensingh.¹ This district lies between the Dacca district on the south and the Garrow hills on the north. On the west it is separated by the Jamoona river from the districts of Pubna, Bogra, and Rungpore, while on the east it faces up the Cachar valley, and is bounded by the district of Sylhet. Mymensingh is crossed diagonally from north-west to south-east by the old channel of the Brahmapootra, a river which of late years, owing to the diversion of its waters into the Jamoona, has become a stream of comparatively inconsiderable size, fordable in most places during a great part of the year. At the south-eastern angle of the district the river is joined by the Soorma, and forms the Megna river. The Soorma is of great size; it collects the drainage of the Cachar valley, and returns to the sea the deluge of water which during the monsoon falls upon the southern slopes of the Naga, Cossyah, and Garrow hills.

It is mainly the overflow of this great river that gives origin to the jheels of Eastern Bengal, which form a remarkable feature of this part of the country and exercise a very considerable influence over its climate.² ‘The jheels occupy an immense area, fully 200

¹ For table of statistics of population and disease, see p. 132.

² Hooker and Thomson's *Flora Indica*, p. 241.

miles in diameter from north-east to south-west, which is almost entirely under water during the rainy season, and only partially dry in the winter months. They extend from the eastern extremity of the Cachar district, through the south-eastern portion of the Mymensingh district, over a great part of the Tipperah district, and across the Megna in the Dacca district, southwards to the Soonderbunds, the islands of the estuaries of the Ganges, forming a fresh-water continuation of the Soonderbunds, and allowing free communication in every direction. Extensive sandbanks, covered in winter with a short sward of creeping grasses and annual weeds, run along the raised banks of the largest streams, and shift their position with every flood. The remainder of the surface is occupied by grassy marshes, covered in winter with rice crops and in summer with water, upon which immense floating islands of matted grasses and sedges are seen in every direction, gradually carried towards the sea by an almost imperceptible current.'

To return to Mymensingh. In the north-western angle of the district many large watercourses connect the Brahmapootra and Jamoona, and here, and indeed throughout the western portion of the district, the shifting of the great rivers has given rise to the formation of huge 'churs,' which during the rains are covered with water and during the dry season with rank vegetation. Of these churs Dr. Henry Wilson, a former Civil Surgeon of Mymensingh, remarks: 'Moistened by frequent and heavy showers of rain in April and May, and in a marshy condition after the subsidence of the rivers, they present conditions most favourable to the production of malaria, viz. an alluvial soil with alternations of strata of sand and impermeable clay, mixed with the products of vegetable decomposition, and exposed to the combined action of intense heat and moisture.'

The Madhopore jungle, which has been mentioned as existing in the northern part of the Dacca district, commences in hilly ridges a little to the north of the city of Dacca, and extends thence some seventy miles in a northerly direction traversing the Mymensingh district. This raised tract is about thirty-five miles in breadth at its broadest point, and at its highest point on the well-defined western face reaches an elevation of about 100 feet. Along its eastern face the elevation gradually meets the land of the open country in gentle slopes. Geologically the Madhopore jungle consists of a tract of 'bhangur' or 'old alluvium,' but it is still a mooted question whether the jungle is an upheaved tract, or whether

the area of the Sylhet jheels has sunk in comparatively recent times, leaving the tract which escaped depression at the original level of the Brahmapootra deposits.¹

The surface of this tract is overgrown with dense tree and grass jungle, and is traversed by many small streams, along the banks of which cultivation extends into an otherwise unproductive waste. The soil consists of red kunkur, containing a good deal of oxide of iron, and of strata of clay, covered on the more elevated portions with a thin layer of vegetable mould, and along the streams with alluvial earth. Water is found at a greater depth from the surface than in the plains, and is of a reddish colour, owing to the presence of oxide of iron.

Along the northern part of Mymensingh, at the base of the Garrow hills, there is high land; the remainder of the district, excepting the Madhopore jungle and the banks of some of the rivers, is very low and is intersected in all directions by water-courses. Marshes abound, especially in the eastern and south-eastern portions of the district, and fringe the eastern and western borders of the Madhopore jungle.

The soil of the district is a mixture in varying proportions of sand, clay, and loam. It is very fertile, and yields large crops of rice, which here, as throughout Eastern Bengal, is the staple product of the land. Mustard and oil seeds are also raised in considerable quantity, as are also pulses, vegetables, and fruits. Jute, sugarcane, tobacco, and indigo are cultivated to a considerable extent.

Population. The district is not thickly populated, the average number to the square mile being 373. Like their neighbours in the Dacca district, the people are of weak physical type.

Climate. The following table of mean monthly temperature is taken from Messrs. Schlagintweit's work: that of rainfall is given in Table XXVII. in the Appendix. The observations were made at Mymensingh, the principal town of the district, situated on the west bank of the Brahmapootra, seventy miles north of Dacca.

Mean temperature 1851-1854				Mean temperature 1851-1854			
January	.	.	62	August	.	.	83
February	.	.	66	September	.	.	82
March	.	.	75.8	October	.	.	81.3
April	.	.	74.5	November	.	.	72.7
May	.	.	73.8	December	.	.	65.6
June	.	.	82.3	The year	.	.	76
July	.	.	83.5				

¹ *Manual of Indian Geology*, p. 408.

The climate resembles that of Dacca, but is cooler, and the rainfall is heavier.

*Diseases.*¹ The district is an exceedingly malarious one. The healthiest portions of it are those situated along the Jamoona and Brahmapootra; the unhealthiest the neighbourhood of the Madhopore jungle; a tract along the foot of the Garrow hills; and the swampy south-eastern parts of the district. Malarious disease (fevers and dysentery) is very prevalent throughout the district, and is especially so during September, October, and November. Splenic disease is very common; cholera is endemic in the district, and outbreaks of the disease are frequent; small-pox is still very prevalent. Leprosy and elephantiasis are not uncommon in the district.

Goitre is met with to a slight extent in most parts of the district, and is very prevalent at the foot of the Garrow hills, amongst the churs of the Brahmapootra in the northern angle of the district, and in the sub-district of Attia which lies between the Madhopore jungle and the Jamoona. The following return shows the percentage of cases of goitre treated at the dispensaries of the district for the five years ending 1873 :—

	Number of cases treated	Cases of goitre per cent.
Mymensingh	12,180	·55
Attia	8426	7·0
Ramgopalpore	10,604	·21
Hoshenpore	8021	·55
Sherpore	3652	12·6

Tipperah (Comillah). To the east of the districts of Dacca and Mymensingh, but separated from them by the Megna, is the district of Tipperah. On the north this district is bounded by Mymensingh and Sylhet; on the south the district of Noacolly, some thirty miles in breadth, intervenes between it and the sea; while on the east it is bounded by Hill Tipperah.

The greater portion of the district is an unbroken flat of rice-fields and swamps, intersected in every direction by watercourses which are partially affected by the tides. During June, July, August, and September, almost the whole surface is deeply inundated. Many comparatively small rivers cross the district on their way from the hills to the Megna, and of these the principal is the Goomtee, which divides the district into nearly equal portions. The Sudder station, Comillah, with a population of about 13,000,

¹ *Report* by the Civil Surgeon, Dr. Wilson, in the report of the Sanitary Commissioner, Dr. D. B. Smith, for 1868.

stands on the south bank of this river, close to the foot of the hills, between them and a low isolated range which is about six miles to the west of the station. Near the eastern boundary the country rises slightly and forms undulated ridges of low forest-clad hills which rise in elevation as they approach the district of Hill Tipperah.

The surface soil in the low lands is of a light and sandy character, but in the higher parts a deep alluvial soil alternating with beds of clay and sand is often met with. The land is very highly cultivated, yielding great quantities of rice, and about nine-tenths of the whole of the cultivated area are devoted to this crop.

The people are, for Bengal, a healthy, able-bodied race, their habits are thrifty and industrious, and their condition is one of considerable prosperity.

The climate is mild, equable, and very damp. The months of November, December, January, and February, however, which are under the influence of the north-west monsoon, are cool and bright, and the heat of April, May, and June is very much moderated by the southerly sea-breezes which blow at that time. The rains which last from the beginning of June to the end of September are very heavy; the fall averages annually about 90 inches; and after their termination a season of steamy unpleasant weather succeeds which lasts till the middle of October, and it is then that fevers are most prevalent and most severe. The following table of mean temperature is compiled from that of Messrs. Schlagintweit; rainfall is given in Table XXVII. of the Appendix.

Comillah N. lat. 23° 28', E. long. 91° 14'					Mean of the month 1851-54: Schlagintweit	Mean of the month 1873
January	.	.	.	.	64.7	63
February	.	.	.	.	68.4	71
March	.	.	.	.	75.6	75
April	.	.	.	.	81.1	80
May	.	.	.	.	82.	81
June	.	.	.	.	81.5	81
July	.	.	.	.	81.6	82
August	.	.	.	.	81.8	82
September	.	.	.	.	81.3	83
October	.	.	.	.	80.2	80
November	.	.	.	.	72.2	76
December	.	.	.	.	65.8	65
The year	.	.	.	.	76.3	76.6

Diseases. The district is malarious throughout; sanitation is

almost utterly neglected, and the people drink indiscriminately from tanks, rivers, and marshes, which are all open to every kind of pollution. Notwithstanding this condition, the district, for Eastern Bengal, is accounted a healthy one, probably because the prosperous circumstances of the people enable them to resist the insanitary influences amongst which they live. The Commissioner of the division, writing in 1873, says: ¹ 'There is a curious feature about the Chittagong division, that it contains perhaps the healthiest, and certainly the unhealthiest, district in the province of Bengal. Tipperah is as notoriously healthy as Chittagong is the reverse.' The mortality in the district from various causes is shown in the table at p. 132. Malarious fevers, and bowel complaints which are often distinctly malarious if not the sequelæ of fever, are the most common diseases of the district. Cholera is endemic in the district, and is most severe in those parts which lie to the west near the big rivers, while epidemics of the disease are also frequent. Small-pox is spread every year by the inoculators, but vaccination is gradually conquering the disease. Leprosy, elephantiasis, and skin-diseases are common. Goitre is not a disease of the district, and is rarely treated in the dispensary at Comillah. That it is not unknown is, however, evident from a remark made by the Sanitary Commissioner for 1868, who indeed states in his report (p. 465) that 'goitre is very common at Tipperah.'

Pubna. The tract of country, or 'doab,' which lies between the Ganges and the Brahmapootra, as they near their confluence at Goalundo, is occupied by the districts of Pubna, Bogra, Rajshahye, and Maldah, with a portion of Dinagepore which extends southwards between the latter district and Bogra. The area of this tract is upwards of 8,000 square miles, and its greatest breadth from river to river along its northern boundary is about 120 miles. Pubna is the southernmost of the districts, and occupies the angle formed by the meeting of the two great rivers. North of Pubna, along the Brahmapootra (here called the Jamoona) is the district of Bogra, and along the Ganges is the district of Rajshahye; along the same river north of Rajshahye lies Maldah, with a portion of Dinagepore to the east, lying between it and Bogra.

The whole country is with little exception a low, flat, recently formed alluvium, having water everywhere in the form of jheels, marshes, and rivers. The latter intersect the country in every direction, and they are especially numerous in the eastern portion of the district, the chief of them, from east to west, are the Bengali,

¹ *Selections from Annual Reports, Bengal, 1872-73.*

the Karatoya, which in the southern part of its course is known as the Hurrosagur, the Attrai, and the Mahanuddee. These have a general southerly course, while another great river, the Bural, crosses the southern portion of the area connecting the Ganges and Brahmapootra. As the rivers rise they inundate a very large proportion of the surface, forming vast watery expanses which slowly and incompletely drain off as the flood-level of the Ganges and Jamoona falls. Of the permanent marshes the largest is the Chalan Bheel, situated near the point of junction of the three districts of Pubna, Bogra, and Rajshahye. It occupies a depressed area of country some 130 miles in extent, and during the rains is one sheet of water.

The country is well wooded, and still exhibits many wide tracts of reed and forest jungle. The soil is a mixture in varying proportions of sand and clay, overlaid, where the lands are flooded, by alluvial deposit; it is as a rule very rich, and where cultivated very productive, yielding large crops of rice, the staple product of the country, as well as of jute, oil seeds, pulses, sugarcane, indigo, vegetables.¹ In the Bogra district there is a marked difference in the nature of the soil east and west of the Karatoya river. East of the river the land between it and the Brahmapootra is low lying and waterlogged, the soil being a loose sandy alluvium, while west of the river the surface is generally above flood-level and the soil compact clay resting on sand.

The district is in many parts thickly populated;² the bulk of the people are of Aryan descent, only a small proportion are of aboriginal stock, and these are found chiefly in the northern part of Maldah.

Climate. The climate is very moist and tolerably equable. During May and June, before the setting in of the rains, the weather is often very hot, and hot westerly winds of a mild character are felt during the day along the westerly portion, especially in the district of Maldah, which from its position has a more extreme climate than the eastern districts. In the beginning or middle of June the rains set in heavily, and continue till the end of September or beginning of October. They are considerably heavier over the eastern portion than towards the south-west along the Ganges; thus the annual fall at Pubna, not far west of the meeting of the rivers, averages 67 inches; at Bogra, about sixty

¹ *Statistical Account of Bengal*, vol. viii. p. 134.

² See table of population &c., at p. 132. Statistics of disease amongst the prisoners in the Rajshahye jail, are given in Chapter vi.

miles north of Pubna, the annual fall averages 82 inches; while at Maldah, seventy miles west of Bogra, the fall is only 53 inches, and at Rampore Beaulah, nearly midway between Pubna and Maldah, it is 59 inches. After the rains there is an interval of hot steamy oppressive weather, but the cold season which follows is very pleasant; and is at times sufficiently cold, even to the European's feelings, to render fires and woollen clothing necessary or agreeable. This lasts till the end of January or the middle of February; then the weather begins to get warm, and the temperature steadily increases till the rains. But the weather is not unpleasantly hot till April, and even then and subsequently, though the heat may be great, the season is not unhealthy, unless an epidemic of cholera or small-pox visits the district. This is the period of the maximum intensity of those diseases.

The following table of temperature at Pubna and Bogra is

	Pubna—mean of 3 years	Bogra—mean of 3 years
January	65	62
February	71	68
March	81	75
April	86	82
May	87	86
June	87	84
July	86	86
August	85	84
September	84	83
October	81	83
November	74	74
December	65	65
The year	79.3	77.6

compiled from records in the Surgeon-General's Office, and from Messrs Schlagintweit's work. The annual rainfall at these and neighbouring stations is given in Table XXVII. in the Appendix.

Diseases. Looking to the circumstances of the country—its low marshy character and the warmth of the climate, to the dirty state of the villages and their surroundings, the foulness of the drinking water, and the exposure to which the majority of the people are subjected in cultivating rice—a generally unhealthy condition of the population might be expected, but this is not the case. Commenting on this point, Deputy Surgeon-General G. Saunders says, as regards Pubna,¹ 'I was surprised to see a general appearance of good health amongst the rural population—good health and good

¹ *Report on Charitable Dispensaries of Bengal*, 1869, p. 42.

condition. The village population I encountered had an almost robust look. They are as a body thriving and flourishing, and therefore well nourished.' Fevers, however, both of an intermittent and remittent type, and their sequelæ, are very prevalent throughout these districts, and in parts of them, especially amongst the network of rivers neighbouring the Brahmapootra, and again on the Dinagepore frontier, outbreaks of very severe and fatal fever are only too common. There is a very general belief that the people who suffer least are those residing on the high banks of running rivers. Fever is credited with the greatest fatality in November and December, but, says the Commissioner of the district,¹ 'I believe it is generally those who have suffered from repeated attacks during the rains, and whose liver and spleen have thus become disorganised, that sink during the cold weather, when the range of the thermometer is extreme, and that fresh attacks during this season of the year are rather the exception than the rule.' And no doubt this is a correct statement of the facts. Enlargement of the spleen is exceedingly common throughout the district. Cholera, if not endemic in the district, is pretty constantly present; it is usually most fatal in April and May, and again in October and November. The other common diseases are pulmonic and rheumatic affections, bowel complaints, venereal and skin diseases, and small-pox.² Leprosy and elephantiasis are not very common.

Goitre. In Rajshahye the disease is common about Tanore, a little to the north of Rampore Beaulah, and also in the neighbourhood of the Chalan Bheel. In Bogra the disease is met with in the neighbourhood of Taras along the eastern boundary of the Chalan Bheel, and also in the low-lying country along the Brahmapootra. In Pubna the Civil Surgeon, in a special report made in 1872, states the disease is almost unknown, excepting in certain villages in the Serajgunge subdivision, in the tract of country which is continuous with that in which the disease prevails in Bogra. This tract corresponds with that portion of the district of Mymensingh on the opposite bank of the river, where, as we have

¹ *Bengal Administrative Report* for 1873.

² The Magistrate of Bogra writes (1876): 'The extraordinary dearth of small-pox cases bears the highest testimony to the great and self-sacrificing efforts of Surgeon-Major Lidderdale to introduce vaccination here. When it is remembered that his work was done under the burden of continual attacks of fever, and often in a state of bodily pain and prostration, which would have caused many a man to succumb, I think it my duty to bring strongly to the notice of the Sanitary Commissioner the efforts which have succeeded in practically ridding Bogra of this loathsome scourge.'

seen, the disease is very prevalent. The Civil Surgeon especially mentions two villages, Keokhallea and Bowha Barry, on the Brahmapootra, where from 4 to 7 per cent. of the villagers are affected. The disease is almost limited to the lower classes, who drink indiscriminately river, tank, and jaeel water, and it developes most rapidly during the rains.

In Maldah¹ 'much goitre prevails on the east of the Mahanuddee, and none on the west. There is little leprosy and no elephantiasis.'² The Mahanuddee runs from north to south through the district, dividing it into nearly equal portions. The soil of the eastern portion consists of underlying clay. The country lies comparatively high, is not liable to inundation, and is covered where not cultivated with scrubby jungle; it is inhabited by the Polis, a semi-aboriginal people, who are very healthy and robust; they are good cultivators of the soil, are well off, and live better than either the Hindoos or Mussulmen; they build and inhabit separate hamlets which are cultivated up to the doors; a practice which ensures cleanliness amongst the houses, and prevents them from being crowded together. The country to the west of the river is low-lying and subject to floods in the north by the Mahanuddee itself, and in the south by the Ganges, which as they retire leave the sandy soil covered by a deposit of mud. Here are the extensive swamps and lakes that surround the site of the old city of Gour, exhaling the malaria which is a terror even to the natives of the neighbourhood, and fatal to strangers who venture within its influence excepting during the dry months which precede the rains. Nor is this the only locality in the district terrible for fever; others, not so extensive, yet equally dangerous, may be found throughout it, and are not confined to the western portion; thus the low lands neighbouring Gajole which lie along the Tangan river are notoriously feverish. The fever is the worst, says the Sanitary Commissioner, when the cold nights set in after the rains. Enlargement of the spleen is an invariable accompaniment.

Note on Leprosy in Dacca.—Dr. Crombie reports (letter of August 24, 1877) that 4·6 in every 10,000 of the population of Dacca are affected with leprosy—the proportion varying in the different thannahs from ·208 to 7·25. About one-sixth of those affected are women. The disease is most prevalent in the high laterite parts of the district, which are eminently malarious, and next in the low waterlogged thannahs. Those thannahs return the smallest number of lepers which are alluvial, of moderate elevation, and with comparatively free natural drainage. A certain rough relationship exists between the disease and malaria, but not one which can be traced in all the thannahs.

¹ *Sanitary Report* for 1876, p. 114.

² *Ibid.* p. 115.

CHAPTER X.

ASSAM.

Assam Valley; geography, and physical geography. Statistics of valley, population, death-rates of the province of Assam. Climate of the valley; diseases; sickness amongst troops and imported labourers; excessive proneness of Dhanghur coolies to cholera; use of opium by Assamese. Health of Europeans in Assam; Dr. White's testimony to their comparative immunity from cholera.

ASSAM proper occupies the narrow cis-Himalayan valley of the Brahmapootra; with Cachar and Sylhet it forms, for purposes of government, the 'province of Assam.' The Brahmapootra enters the valley from the Mishmi hills in long. 96° east and north lat. $27^{\circ} 40'$, and is shortly joined by the two great rivers, the Dibong and the Dihong. After a course of about 450 miles, during which it receives from north and south many tributaries, the river turns the extremity of the Assam range of hills, and enters the plains of Bengal. The level of the plain at Suddya, the easternmost of our stations in Assam, is only 440 feet above sea-level; at Dibroogurh 348 feet, at Sebsaugur 319 feet, at Gowhatty 163 feet, and at Gawalparah 150 feet, so that a gentle slope brings the river to its delta.

The main stream is subdivided by numerous islands and sandbanks, which are in a constant state of change both as regards size and position; indeed the greater number of them disappear entirely when the river is in flood, and the navigable channel from time to time changes so greatly that the landmarks of one season may be far away after the next year's floods. The full season commences about April, and in July the river is at its highest, a flowing inland sea spreading far and wide over the low lands along the centre of the valley. Throughout this part of its course the river is closely shut in by hills, to the north by the Bhootan and neighbouring Himalayas, and to the south by the Garrow and other hills of the Assam range. At the eastern end of the valley these ranges approach very closely, and the valley is finally shut in by spurs from the Patkoi range which, from the chief tribe inhabiting them,

are known as the Mishmi hills. The valley is about 400 miles long, and at its mouth only between fifty and sixty miles broad; nowhere does the breadth exceed seventy miles, while in many places it is considerably narrowed by spurs from the opposite hills. At Gowalparah and again at Gowhatty such spurs confine the river to a narrow gorge, and higher up, the Meekhir hills, approaching the southern bank of the river, limit the breadth of the valley to about thirty miles. Above that point the hills recede right and left, and the valley here attains its greatest breadth before it finally closes in. Enclosed in so narrow and confined a valley, the atmosphere of Upper Assam would be altogether cut off from the influence of the monsoons were it not that the Naga hills which intervene between Cachar and Central Assam have a much lower elevation than the western portion of the Assam range,¹ leaving a comparatively free passage for the monsoon winds blowing to or from the upper part of Assam. And again, the gorge of the Dihong, at the upper end of the valley, allows passage to and fro for the winds of the trans-Himalayan plateau.

The eastern and western portions of the valley are locally distinguished as Upper and Lower Assam, and, as Mr. Medlicott² has pointed out, these may be very neatly defined geologically; the latter as 'the area between the metamorphic mass of the Shillong plateau and the Himalayas, where the metamorphics appear occasionally as outliers through the alluvium, and probably underlie the whole at no great depth.' Upper Assam, on the other hand, 'lies on the north-easterly prolongation of the crystalline area, and commences at the Dhunseeree valley, where the sedimentary series lying to the south of the gneiss extends beyond it in the northern ridges of the Patkoi range, to form the south-eastern boundary of the upper part of the great valley.'

A large proportion of the area of the valley is uncultivated, and this is especially the case in the tract of country along the foot of the hills, and again along the banks of the Brahmapootra, for in the one part thick jungle and deadly malaria oppose cultivation, while in the other the land is sandy and shifting, and swept by heavy inundations—not the tranquil inundations of Bengal, but a portion of the great river in its flood. Proceeding up the river,³ writes Dr. Buckle, and leaving the luxuriant and cultivated fields

¹ See Blandford's *Winds of Northern India*, p. 20.

² *Manual of Indian Geology*, p. 699. See also the following chapter.

³ Deputy Surgeon-General Buckle, C.B., in *Medical Report of Native Army of Bengal*, 1869, p. 14.

of Lower Bengal, studded with villages in every direction, on entering the valley of the Brahmapootra the country changes; the low alluvial plain is covered with reeds and grass eight or ten feet high; the spurs of the Garrow hills, clothed with thick jungle, reach in places to the banks; the boat traffic on the river nearly ceases, and the province of Assam is characterised by the want of villages and cultivation, the country covered with jungle, either grass or tree, in every direction. Jheels and swamps abound, while here and there small isolated hills stand up, giving the impression of a valley the inequalities of which have been in the course of ages filled up by the silt of the river, leaving merely the tops of the hills projecting separately from the plain. The province, continues Dr. Buckle, is in the state to make endemic malarious fevers of all degrees of intensity, cholera, dysentery, and other diseases, dependent on poisonous exhalations from a soil laden with moisture and decaying vegetation, being exactly in the condition of the *embouchures* of large tropical rivers. There is a history of outbreaks of murrain and cholera amongst the inhabitants at intervals of a few years. The population is sparse, and a great extent of country is unreclaimed. The river rises yearly, submerging a vast extent of country, leaving, on its subsidence, in the interior jheels and marshes and along its sides, sandbanks interspersed with stagnant pools.

Yet though to the voyager along the river the banks look waste and desolate enough, the plains in the interior of Lower Assam are largely and richly cultivated, reminding one in parts of the richest portions of Bengal; while the opening up of Upper Assam by the tea-planters, and the large immigration of the industrious and thrifty Bengali amongst the lazy inert Assamese, has cleared even in that formerly desolate region many a large tract of jungle land.

The following tables, A. and B., give the latest published statistics of the area and population of the districts which now compose the province of Assam. B., which is compiled from the report of the Sanitary Commissioner of the province, Dr. de Renzy, embraces only those parts of the province in which the registration of vital statistics is carried on, and therefore differs somewhat in respect to area and population from A., which is compiled from the report on the administration of the province for 1875-1876. As regards the statistics of mortality in the different districts of the province Dr. de Renzy¹ remarks, they are so absurd that it would be waste of time to analyse them.

² *Sanitary Report of the Province of Assam*, p. 1.

TABLE B.—Assam. Area in square miles 27319.54. Population (census 1872) 38053.64; per square mile 139.

Districts	Population	Area in square miles	Average population per square mile	Deaths registered per 1,000 of population									
				1877					1878				
				All causes	Fevers	Cholera	Bowel complaints	Small-pox	All causes	Fevers	Cholera	Bowel complaints	Small-pox
Gowalpara . . .	396,508	3961	100	8.5	5.6	1.1	.7	.2	6.9	4.9	.7	.7	.1
Selected areas { urban . . .	6061	1.16	5225	25.4	10.7	—	5.9	.1	—	—	—	—	—
Selected areas { rural . . .	5145	6.	857	32.8	25.	.1	3.4	.3	—	—	—	—	—
Kamroop . . .	551,337	3629	152	10.3	4.9	3.1	1.2	.4	9.	4.9	2.1	1.1	.4
Selected areas { urban . . .	11,492	2.	5746	17.6	4.6	—	11.7	—	—	—	—	—	—
Selected areas { rural . . .	—	—	—	—	—	—	—	—	—	—	—	—	—
Nowgong . . .	248,073	3639	68	15.4	3.6	.9	.8	.3	6.9	3.3	1.8	.7	.2
Selected areas { urban . . .	2883	1.22	2363	23.1	3.8	10.4	3.1	.4	—	—	—	—	—
Selected areas { rural . . .	5434	7.39	727	30.1	11.7	12.8	1.3	1.2	—	—	—	—	—
Durrung . . .	225,708	3359	67	28.8	12.4	9.2	3.9	1.2	21.4	13.1	3.1	3.1	.5
Selected areas { urban . . .	3032	1.	3032	49.7	13.5	11.5	16.5	—	—	—	—	—	—
Selected areas { rural . . .	7269	53	137	31.	17.3	.8	8.5	.1	—	—	—	—	—
Sebsaugor . . .	288,400	2834	101	22.4	11.4	1.9	6.1	.3	25.3	10.2	5.5	7.1	.2
Selected areas { urban . . .	5200	6.96	747	25.7	13	2.3	.5	—	—	—	—	—	—
Selected areas { rural . . .	2989	4.9	610	31.4	22.7	2.	1.3	.3	—	—	—	—	—
Luckimpore . . .	96,831	2591	37	13.7	6.9	1.8	2.9	1.3	16.7	6.2	6.1	2.6	1.3
Selected areas { urban . . .	3870	5.2	841	57.8	18.6	26.6	7.7	.2	—	—	—	—	—
Selected areas { rural . . .	20,566	549	37	15.3	7.1	.9	5.7	.3	—	—	—	—	—
Sylhet . . .	1,680,529	5365	313	5.5	2.2	1.6	.5	.1	4.2	1.9	.8	.5	—
Selected areas { urban . . .	16,846	13.2	127	41.5	14.	6.9	7.0	.1	—	—	—	—	—
Selected areas { rural . . .	22,164	4.4	5037	13.9	5.9	3.7	1.6	—	—	—	—	—	—
Cachar . . .	197,157	1276	154	13.4	6.3	2.9	.8	.3	13.	7.1	1.6	1.1	.7
Selected areas { urban . . .	3729	3.29	1133	21.6	7.2	11.5	1.3	—	—	—	—	—	—
Selected areas { rural . . .	4141	5.62	737	28.6	10.3	8.2	.2	—	—	—	—	—	—

TABLE C.

THE WHOLE PROVINCE—DEATHS REGISTERED EACH MONTH.

		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year
All causes .	1877	2969	2422	2504	3177	5102	5623	4191	3090	2537	3034	3380	3687	41,716
"	1878	2559	2046	2260	2749	3540	3442	3232	2824	2473	2892	3179	3733	34,929
Cholera .	1877	391	370	263	834	2426	2852	1717	535	168	302	628	891	11,377
"	1878	367	281	424	614	1043	930	734	281	112	320	574	1052	6732
Small-pox .	1877	119	107	124	193	200	187	78	73	34	46	36	63	709
"	1878	50	124	170	133	158	98	79	38	26	40	30	68	1014
Fevers .	1877	1676	1372	1421	1401	1590	1629	1511	1611	1423	1638	1673	1770	18,715
"	1878	1413	1083	1088	1287	1465	1605	1554	1629	1443	1487	1605	1739	17,398
Bowel complaints .	1877	382	296	358	431	542	609	569	496	503	541	555	524	5806
"	1878	419	313	310	398	545	519	519	491	462	597	572	544	5689

Statistics of diseases amongst the troops stationed in the province, and amongst the jail population, will be found in the tables appended to Chapter vi.

Climate. The climate of Assam is moderately hot; fairly equable; and during the greater part of the year very damp, for the rainfall is heavy and there is a large expanse of water-surface throughout the valley, while the land is covered with profuse vegetation. November, December, and January are the cold months, but the cold is never great even in Upper Assam, and in February the temperature begins to rise and continues to do so till July and August, unbroken by the burst of the summer rains, so that the heat, if not great, is long continued. Lower Assam is more equable, both as regards seasonal and diurnal variations of temperature, than Upper Assam. A marked feature in the climate, and one which exercises great influence upon the health of the inhabitants, especially strangers, whether natives of India or Europeans, is the stillness of the lower stratum of the atmosphere in most parts of the valley. Medical officers in their annual reports make frequent allusion to the oppressive stillness of the damp warm atmosphere; thus Dr. Curran, writing at Debrooghur, in Upper Assam, says: ¹ 'We are fortunate in not having the temperature for many days together at or above 90° Fahr., though this may not appear very high to people living in the dry climate of Northern India. In a climate like this, where humidity is at its maximum, and where for hours there is scarcely a perceptible movement of the air, the temperature at 91° is almost unbearable. As a rule there are not more than two or three such days at a time, when a heavy shower of rain falls and cools the atmosphere.' From June till the end of September is the trying time of the year: days and nights are close, sultry, and oppressive; the atmosphere is still, and saturated with moisture. Natives and Europeans alike at this period suffer from languor of mind and body, depression of spirits, and inability to undergo exertion. But in October the climate rapidly changes, especially in Upper Assam, and a pleasant cold season ensues. The wind system of Assam is not alike throughout the valley, for, while comparatively lofty hills, as has been already said, shield Lower Assam from the direct current of the south-west monsoon, the less elevated ridges ² to the east allow comparatively free passage, at a lower level, for the monsoon winds blowing to or from the upper part of Assam; and the

¹ *Medical Report of Native Army of Bengal*, 1873, p. 25.

² Blandford's *Winds of Northern India*, p. 20.

gorge of the Dihong affords an open passage to the monsoons to penetrate to the region north of the Himalayas. In Upper Assam the winds from the north and north-east are, on the whole, the most frequent, but in March, or even in February, south and south-west winds begin to be felt, and increase in frequency till June, when they predominate over those from the north and north-east, and so continue till September, when they begin to slacken, and in October have given way to the northerly monsoon. At Gowalpara, at the entrance of the valley, easterly winds predominate throughout the year, but westerly winds are very common in the early months of the year, and are so again, with south-west winds, in June and the succeeding three months.

The rains are heaviest in Upper Assam, commencing early in spring and continuing with increasing force till July, after which they gradually subside; but it rarely happens that even December, the driest month of the year, passes without rain, for an upper current, an anti-monsoon wind, blowing through the winter months, brings the winter rains, which continue till the rains of the south-west monsoon commence. In Lower Assam the spring rains are light; the regular rains attain their maximum in July, and then decline till their termination in October. Tables III. and IV., in the Appendix, show the meteorological data for Gowalpara in Lower, and Sebsaugor in Upper Assam; rainfall of other stations is also given in the Appendix.

Throughout the rains the sky is generally overcast, and indeed cloud is the feature of the sky during the greater part of the year, especially in Upper Assam. November and December are the months of greatest serenity.

Diseases. The principal diseases of Assam are those of malarious origin, small-pox, cholera, and bowel complaints. The conditions which combine to render malaria very active have been already noticed, and, under these, malarious fever and its sequelæ, notably enlargement of the spleen, are universally prevalent in the valley. Probably strict investigation would show that a very large proportion of the cases of dysentery and diarrhoea, classed together under the head of bowel complaints, are either the sequelæ of malarious fever, or caused by the same conditions as the fever. In a recent report¹ upon the sanitary state of Assam, the Sanitary Commissioner, Dr. de Renzy, traces much of the sickness of the people to bad water, damp floors, and general uncleanness. The

¹ *Sanitary Report of the Province of Assam for 1876.*

tanks, which are the principal sources of water-supply, are in many cases mere holes which have been excavated for the supply of building material for the village huts; they receive the drainage of the polluted ground about, and are moreover used for bathing, and washing clothes and household utensils. The wells, which are, however, a less common source of supply, are often dug in a polluted subsoil, and are from the careless habits of the people open to constant pollution at their mouth; even the rivers, draining as they do an area six-sevenths of which is jungle and swamp, if jungle and swamp be the real *fons et origo* of malaria, must be largely charged with the malarial poison. The houses of the poorer classes are very damp, and the villages, writes Dr. de Renzy, are dirty beyond description. There is no hereditary scavenger class in Assam—a want which greatly enhances the difficulty of preserving cleanliness.

The table at p. 161 gives the latest published statistics of the registration of disease amongst the people; ¹ to give averages when the returns are so manifestly absurd would be useless. All that can be said is that as the registration is improving the statistics of the last year may be accepted as the best. In what are called selected areas, the results of registration are better. These areas are for the most part either towns which form the Sudder stations, or rural circles adjacent to them; they come more directly under the observation of the district officers, and under special police inspection.² But though the registered death-rate is considerably higher here than in the General Circles, one fact alone proves that the record is far from reliable, namely the disproportion between the death-rates of the sexes; the female rate is in many areas one-half or even one-third that of the male.

The following table shows the proportion in which the chief diseases contributed to make up the admission rate to hospital amongst the native troops stationed in the Assam valley during the five-year period 1872-76, and the seasonal prevalence of fevers during the same period.

Admissions per 1,000 of strength.

Cholera	10·3	Ophthalmia	23·5
Fevers	872	Rheumatism	73·4
Dysentery	124	Respiratory diseases	91
Diarrhœa	78	All causes	1815
Hepatitis	6·5	Average strength	1510
Spleen	21·5		

¹ *Sanitary Report* for 1876, p. 9.

² Vital statistics of troops and prisoners at pp. 81, 84, and 99.

Admissions for fevers per 1,000 of strength.

January	33·4	July	101
February	24·6	August	121
March	24·1	September	127
April	36·	October	143
May	39·	November	103
June	58·	December	63

‘Diseases dependent on malarial poisoning and malarial cachexia form the chief causes of sickness.’¹ Such is Surgeon J. Wilson’s statement regarding the troops stationed at Gowhatty, and it is quite applicable to the other stations in the Assam valley. ‘The regiment,’ continues Dr. Wilson, ‘has been decimated by its three and a half years’ residence here, and it is to be feared that the ill effects will remain for a long period, the constitutions of the men being so undermined that very slight attacks frequently develop serious organic changes. Recruits brought up last year as well selected and healthy-looking men have become a weedy, enervated-looking lot, with enlarged spleens and consequent anæmia.’ The causes of mortality may be set down in the great majority of cases to malarial cachexia; diarrhœa, dysentery, and acute inflammations of any of the viscera, carrying off men in a low state of health. To men in the state described by Dr. Wilson, the advent of the cold weather is sure to bring relapses of fever, hence the large number of cases which the statistics show are admitted for fever during October.

The effects of malaria in cantonments, grave as they are, are much exceeded when the men become exposed to the malaria of the jungles; thus when, during the Bhootan campaign of 1864–5, some 5,000 troops were marched to the northern frontier, the force lost 480 men from disease on the spot, and nearly as many more subsequently from the effects of the campaign, although 1,300 men were sent away on sick leave.

Labourers also who are imported from the plains of India to work upon the tea-gardens too often suffer terrible mortality when they are employed in opening out fresh clearances. But it is a remarkable fact that the labourers of non-Aryan descent, from the plateau of Chota Nagpore, suffer far less from malaria than the Aryan people of Bengal and Behar, and on this account, no less than because of their docility and industry, they are greatly valued by the Assam tea-planter. The great foe to these abori-

¹ Surgeon J. Wilson, M.D. In *Bengal Army Medical Report* for 1877.

ginal labourers, 'dhanghurs' as they are commonly called, is cholera; to that disease they are terribly prone, so much so that the *colonial* recruiting agents in Calcutta will not receive them unless they are greatly pressed for labour. These people live in the Calcutta depôts side by side with their Aryan brethren, and are mixed with them in the steamers which transport them to the tea districts; they drink the same water, take the same food, breathe the same air; yet while an outbreak of cholera will carry off the dhanghurs by tens and twenties, the people of Aryan race frequently escape altogether. Whether the very frequent outbreaks of cholera which occur in Assam may be traced to the infection of imported labourers is a disputed point. But, independently of this influence, cholera is endemic in the valley, and from time to time assumes an epidemic character. The disease is distinctly endemic in the western portion of the valley, and if not so in the remainder, yet there the disease is so readily received and so quickly propagated, as to prove that its circumstances are such as very closely resemble those of the endemic area.

Small-pox is universal, and causes very great mortality;¹ vaccination has as yet made but little progress, excepting in and about the Sudder towns, for the people generally regard small-pox not as a disease but as the possession of a person by a spirit with which it is not prudent to interfere, and they disapprove therefore of any means for the prevention of the disease. But while the indigenous population suffer most severely from small-pox, the imported coolie population of the tea-gardens are entirely exempt; an immunity which they owe to the care with which vaccination is carried out among them.

Opium-eating is a custom almost universally prevalent amongst the Assamese, amongst young and old, and of both sexes, and it is this custom which, even more than climatic causes, renders them so listless, apathetic, and liable to disease. So long as the opium-eater is able to procure good and nourishing diet, and can provide himself with proper clothing and comfortable lodging, the evil effects of the habit are not so marked as with those who are obliged to stint themselves that they may indulge the vicious habit. But even amongst the richer class, the evil day is only deferred. At length the system gives way; the bowels become torpid, the liver and kidneys congested, the circulation sluggish, and the brain unfitted to perform its functions; torpor of mind and body becomes

¹ *Sanitary Report* for 1876, p. 12 and p. 23.

established and increases, till dropsy or some more acute disease comes to close the scene.¹

Goitre is very prevalent amongst the inhabitants of the upper two-thirds of the valley, and the history of the disease at Poobha Mookh, and amongst the troops engaged in the Duffla expedition, is especially interesting in reference to its etiology.

Elephantiasis and leprosy are occasionally met with in the valley. The people suffer much from intestinal worms and their effects.

The European tea-planters, of whom there are now a large number in Assam, when of temperate habits, enjoy excellent health; but unlike the natives they live fairly well, are careful about their drinking water, raise their houses above the damp ground, and take plenty of outdoor exercise.

A very remarkable fact in connection with the history of cholera in Upper Assam has been pointed out by Dr. White,² namely the immunity from the disease which is there enjoyed by Europeans. 'From 1859 to 1863, while European troops were stationed here, cholera raged for the greater portion of that period. The sick European soldiers were treated in the Station Military Hospital (Dibrooghur), in the same ward in which the cholera cases from the native regiment and battery were received. Not a single case occurred amongst the Europeans. The planters, now a numerous body, are constantly brought in contact with the disease in attendance on their coolies, but not one of their number has ever been attacked. During the twenty years that I have been here, only five cases of cholera are known to have occurred amongst the European population: two were overseers in the Public Works Department; two others were a retired officer and his wife in 1877; and last year a lady, wife of the managing director of Dum Duma Company. The seizure of a European being so rare, I made an enquiry into the last-mentioned case; the following are the leading particulars:—

'About the middle of March, Mr. —, who ordinarily resides in Dibrooghur, went up for a short stay to Dum Duma, taking with him his wife, and two children, aged three years and one year; his brother also accompanied him. They took up their residence at an out-factory, in a bungalow situated about a mile from the river Dibru. About a quarter of a mile to the north, in a direct line, are the coolie

¹ Dr. W. Johnston Long, in Appendix to *Mill's Report on Assam*. Calcutta, 1854.

² *Sanitary Report of the Province of Assam* for 1878, p. 3.

lines of the factory, and running behind the lines and bungalow is a small stream, dry in the cold weather, but which was then full, owing to the heavy rains that had recently fallen. The bungalow is down stream from the coolie lines. A day or two after their arrival at this place, Mr. —'s brother was attacked by exceedingly severe diarrhoea. As it did not yield to treatment, he got alarmed, and hurried down to Dibrooghur, where he recovered rapidly. On the third day the eldest child was attacked with dysentery, and in a few days afterwards the second child with the same disease; the latter died, although a medical man was in immediate attendance. In the second week after arrival, Mrs. — was seized with cholera. I was called to see her, in consultation, and found her in a state of profound collapse. She, however, recovered. Whilst in attendance on her, Dr. Hancock, the medical officer of the Company, and I, one morning found the coolies washing their persons, after defæcation, in the stream referred to. On further enquiry, we found the well attached to the bungalow had fallen in, and that all the water required for the bungalow was drawn from this filthy rivulet.'

'I am able to state,' writes Dr. de Renzy, 'as the result of a personal examination of the premises where the above cases occurred, that the house was a well-ventilated wooden one, with the floor raised several feet off the ground, in Burmese fashion; that it was situated in the midst of a magnificent expanse of tea-bushes, that its precincts were perfectly clean, that there were no sewers in the neighbourhood, and that there was no other apparent case of sickness except that referred to by Dr. White.'

Note on Leprosy in Assam—Leprosy does not exist to any great extent in Assam. The hill tracts within and on the borders are remarkably exempt. The disease is most frequently met with in tracts of country along the foot of the hills, localities rendered unhealthy by jungle and swamps. The distribution of the disease affords no evidence of its being of a contagious nature. The disease is occasionally, though not necessarily, hereditary.—*From Report dated October 2, 1876, by the Deputy Surgeon-General, Dacca Circle, on Leprosy in Assam.*

CHAPTER XI.

ASSAM.

Districts of the Assam Valley: description, climate, diseases of each. *Gowalpara*; *Kamroop*, Gowhatty station; *Nowgong*—goitre in Nowgong; *Sebsaugor*—goitre in Sebsaugor; *South Luckimpore*, Dibrooghur station; goitre at Poobha Mookh; *North Luckimpore*—goitre amongst people and amongst troops employed in the Duffla expedition; *Durrung*, Tezpore station, Cachari Dooars, goitre in the district.

GOWALPARA. The district of Gowalpara stretches across the entrance to the Assam valley, from the outliers of the Bhootan Himalayas on the north to the Garrow hills on the south, and includes a narrow strip of country between the western slopes of the Garrow hills and the left bank of the Brahmapootra. The area of the district is 4,433 square miles, of which about two-thirds lie to the north of the river. Much of the district, especially of the northern portion, is covered with jungle, studded with innumerable swamps and jheels, and intersected by many streams finding their way to the Brahmapootra. The river is here broken up by islands, and on its subsidence after the autumn floods leaves churs of immense extent. At the foot of the northern hills is a tract of land, known as the Dooars, which is an almost uninhabited waste, and indeed the population of the whole district is very scanty.

Gowalpara, the chief place of the district, is situated on the south bank of the river, almost immediately under the Garrow hills. The houses of the European residents and the Observatory are situated on the flat top of a low hill which rises from the river bank, 249 feet above the level of the river, and 336 feet above that of the sea. The native town is a small one, and very dirty, for, says the Sanitary Commissioner in one of his reports, 'the people prefer jungle and dirt to cleanliness, and consequently sanitary measures are difficult to carry out.'

The chief diseases of this low, swampy, jungly district are malarious fevers, bowel complaints, cholera, and small-pox.

Malarious fevers are very prevalent; that known as the Garrow

hill fever is notorious for its intractable character. But the Dooars are the most unhealthy portion of the district; the few inhabitants suffer much at all times from sickness, and in April and May scarcely one individual amongst them escapes fever.

Small-pox is always present, for the inoculators are active, while vaccination is hindered by the prejudices of the people and the difficult nature of the country.

Goitre is known, but is not common, excepting in some localities north of the river.

Gowhatty.

	1872					Rainfall average of 14-16 years
	Mean maximum temperature	Mean minimum temperature	Range	Mean temperature	Rainfall	
January	69	53	16	61	1.7	.69
February	73	57	16	65	.43	1.22
March	83	64	19	73.5	1.99	1.62
April	87	70	17	78.5	2.36	6.26
May	89	73	16	81	11.68	10.13
June	89	79	10	84	12.57	13.18
July	89	80	9	84.5	13.54	11.54
August	88	80	8	84	15.8	11.16
September	90	76	14	83	12.8	7.32
October	85	70	15	77.5	6.2	3.14
November	81	65	16	73	.28	.3
December	74	56	18	65	—	.11
The year	83	68.5	14.5	75.7	79.33	66.67

Kamroop. On the east of Gawalpara lies the district of Kamroop, embracing the country on both sides the river. North Kamroop is a plain, broken by a few low insulated hills; South Kamroop is hilly. Both divisions are intersected by numerous streams, and include vast tracts of marsh and jungle. Only about one-fifth of the district is under cultivation.

Gowhatty, the civil station, is situated on the south bank of the river, shut in by a semicircle of low hills, the rocky terminations of which, about three miles apart, are swept by the river. The one below the station is the Kammachia hill, on which is a Hindoo temple of great antiquity and great repute, a place of pilgrimage from all parts of Bengal. On the opposite bank of the river two rocky hills project into the stream, while in the mid channel are three small islands, one of which, beautifully wooded, is crowned by another famous temple. The south bank is high,

rising in places into hillocks ; on it are built the houses of the European residents, and behind these are the straggling native town and the military lines. Between the station and the hills is a tract of low land which receives the drainage of both, and in addition, during the flood season, back water from the river, and is thus converted into a huge and very pestilential swamp, which during a part of the year involves a portion of the lines. Works are now in progress which it is hoped will in a measure remedy this state of things.¹ Their principle is to concentrate the drainage by compelling it to collect in tanks, while the clay dug from these will be used to raise the level of the neighbouring ground, and to provide for the escape of the water as the river subsides.

Climate. The atmosphere is throughout the year loaded with moisture, which during the cold season is precipitated in dense fogs that hang over the river and the station almost every morning till ten or eleven o'clock. There is no Government Observatory at Gowhatty ; the preceding table is compiled from Mr. Blandford's report for 1875 ; and from Dr. O'Brien's report for 1872. The mean temperature of 1872 agrees with that for 1850-56 given by Messrs. Schlagintweit.

The thermometer rarely exceeds 90° Fahr. in the warmest weather, yet, writes Dr. O'Brien,² 'the heat sometimes appears intolerable. During the rainy season the atmosphere resembles that of a conservatory for tropical plants ; it is hot and steamy. It follows naturally that the cutaneous exhalations become checked, and men begin to suffer from the languor and depression so much complained of by the English in Assam.' Fortunately for the European residents in the station, a north-east wind blows constantly during the day for ten months out of the twelve, but it is felt only on the bank of the river, further inland the closeness of the atmosphere renders the climate very different. 'While the human race languishes, the vegetable world and the lower forms of animal life riot in excessive growth and reproduction. The full supply of rain at a fixed season, aided by the vast river system and accompanied by heat, has stimulated the soil into an activity which can scarcely be exceeded. Except in the immediate vicinity of human habitations, the face of the country is covered with a vegetation of incredible profusion. The roads are cut through tangled forests of tall trees, with a dense brushwood beneath, and covered with creeping plants and parasites in endless variety.

¹ *Sanitary Report* for 1878.

² *Medical and Sanitary Report of the Native Army of Bengal* for 1871, p. 20.

Myriads of living things swarm beneath the impenetrable cover, and if we accept the statement that the salubrity of a place stands in an inverse ratio to the number of amphibians inhabiting it, then we must come to the conclusion that Gowhatty and its environs are unhealthy in the extreme. Yet notwithstanding this marvellous fertility, the province is very thinly inhabited, and agriculture is in a most backward state. The very exuberance and spontaneity of vegetation forms the chief obstacle to tillage.¹

Diseases. The principal diseases are, as might be expected, malarious fever, and its sequelæ, dysentery, diarrhœa, and cholera. Rheumatic affections are also common, and in the cold weather chest diseases, chiefly bronchitic.

Fevers are most prevalent in April, May, June, October, and November. The fever is most commonly of the intermittent type; remittent fever is comparatively rare. Cholera appears periodically in April or May, and usually continues through June. Statistics of disease amongst the troops are given at p. 84.

Goitre is scarcely known in the district on the south side of the river. North of the river the disease is prevalent, especially in the villages which are located along the spurs of the northern hills.

Nowgong. This district extends a distance of about 115 miles along the south bank of the Brahmapootra, from the Kullung river which divides it from Kamroop, to the mouth of the Dhunseeree river. The area of the district is 3,648 square miles, and the population seventy to the square mile, but it is very unequally distributed, for here as throughout Assam an immense proportion of the land is waste. In Nowgong only about one-ninth of the total area is under cultivation.

Projecting into the district, and occupying a considerable portion of its eastern area, are the Meekhir hills, outliers of the Naga hills. These hills have an average height of about 2,500 feet. Geologically they consist chiefly of granite; they are covered from base to top with heavy jungle, and are intersected by many streams. The Meekhirs who inhabit them are described as a powerful, healthy race, simple, peaceful, and truthful, very timid, dreading alike the attacks of men and animals, and deserting their villages on the bare news of a tiger in the neighbourhood.

That portion of Nowgong which is not occupied by the Meekhir hills is irregularly triangular in shape, with its base at

¹ *Medical and Sanitary Report of the Native Army of Bengal for 1871*, p. 20.

the river, and bordered on the east by the hills just named, and to the south-west by the Jynteah and Cossyah hills. The plain, where at its widest, is only about twenty-five miles across. The hills rise boldly like cliffs from the swamps at their base, their craggy sides clothed to the summit with vegetation. The plain is slightly undulating, and bears well-marked indications of having been at some time or other traversed throughout by the Brahmapootra, as it has worked its way northwards from the foot of the hills. Many jheels and water-channels intersect the plain. The soil is a crust of alluvium resting on sand. The main crop is rice.

Intersecting, or rather almost encircling the plain, is the Kullung river, a creek of the Brahmapootra. In the dry weather it is a sluggish shallow stream, but as the Brahmapootra rises it becomes a great river, overflows its banks, and aids the parent stream in flooding the intervening country. Along the banks of the Kullung and other creeks, where the ground is highest, are many villages; the people look thriving and well-fed, and, judging from the number of children, increasing, although living in the midst of jungle and swamps.¹

Nowgong, the civil station of the district, is situated on the south bank of the Kullung river, near the foot of the Meekhir hills, at about 250 feet above sea-level.² The station and its immediate neighbourhood is well cleared of jungle, and is clean and well drained. The soil is a porous sand which rapidly absorbs water. The houses are made of bamboos and reeds, with a grassy thatch, the side walls plastered and whitewashed, and are raised on piles some six or eight feet above the ground. At the back of the station is the Moree-Kullung, a large sheet of water several miles in length, which once communicated with the Kullung river. The water³ is fresh and clear, and full of fish. Along the edge, which is fringed with trees and bamboos, is the station drive. The banks are densely populated, the road passing through beautiful gardens, cultivated fields, and innumerable villages, which bear testimony to the prosperity and comfort of the Assamese inhabitants.

Climate. The following table is compiled from the records in the office of the Surgeon-General at Calcutta. The characteristics

¹ Deputy Surgeon-General Buckle, in *Medical Report on State of the Native Army of Bengal*, 1870, p. 26.

² *Ibid.*

³ See analysis of water in table at p. 14.

of the climate are damp heat and equability. The stillness of the atmosphere, which is so marked throughout the valley, is particularly noticeable at Nowgong.

Nowgong.

	Mean of the three years 1872-1874				Rainfall average of 13 years
	Mean temperature	Mean of maximum	Mean of minimum	Mean daily range	
January . . .	63	69	55	14	1.12
February . . .	68	75	60	15	1.48
March . . .	76	81	68	13	2.89
April . . .	79	84	74	10	6.29
May . . .	83	86	78	8	11.77
June . . .	84	88	81	7	12.27
July . . .	86	89	82	7	16.77
August . . .	87	92	82	10	15.99
September . . .	86	88	81	7	12.21
October . . .	79	84	77	7	4.34
November . . .	72	78	67	11	.5
December . . .	66	72	59	13	.25
The year . . .	77	82	72		85.88

Highest temperature of the year, in July, 96. Lowest of the year, January, 48.

Diseases. Malarious fever and its sequelæ are the most common diseases of Nowgong—and, says Dr. Buckle, ‘ill-health manifested in various forms, caused by the system being saturated with malarious poison.’ Chronic enlargement of the spleen is very prevalent. The fever of the district is often of a low type, causing great prostration; it is very fatal amongst the native population.

Small-pox is present every year, for the natives object to vaccination and largely practise inoculation.

Cholera is apparently never quite absent, and at times commits great ravages. Dysentery and diarrhœa are very prevalent, and add largely to the mortality of the district.

Goitre is exceedingly common throughout the plain portion of Nowgong. Mr. Apothecary Simons, quoted by Major Butler,¹ writing in 1848, says: ‘The endemic disease of the district is bronchocele, by which one-third of the population is affected, and it attacks even those residents who are not natives of Assam. It seems apparently to be confined to females, and males of lax fibre and of a cachectic disposition of body. The cause of the disease is principally owing to the use of stagnant water, and residing in

¹ *Travels and Adventures in Assam*, 1855.

villages which are in the vicinity of extensive marshes.' Out of 2,612 cases treated as out-patients at the Nowgong dispensary during the five years 1866-70, no less than 819, or 31·4 per cent. were for goitre. A special report made on the subject by Dr. Hughes, the civil medical officer, states that the disease is most common along the banks of the Kullung and Moree-Kullung rivers, that the tumours often attain to an enormous size, but that the disease is by no means generally associated with other signs of malarious cachexy, that in fact many of the patients appear to be in good health. They generally ascribe the disease to the use of the Kullung water, and think that the disease is as a rule first perceived when the floods in the Brahmapootra are at such a height that they enter the Kullung river.

Seebaugor. The district of Seebaugor, a narrow tract of country varying from fifteen to thirty miles in breadth, extends from the border of Nowgong, in an easterly direction, between the Brahmapootra and the Naga hills. The district includes the Majolai island, a tract of sand covered by vegetable débris, fifty miles in length and eight in breadth, which separates the Lohit river, a branch of the Brahmapootra, from the main stream. The total area of the district is 2,413 square miles, with a population of 120 to the square mile.

Seebaugor is an alluvial, almost level plain, broken here and there by hillocks, the tops of hills which have been engulfed in the alluvium. The district is intersected by numerous streams, and is still, notwithstanding very extensive clearances for tea-cultivation, covered with jungle over a large portion of its area. The soil is very rich, a stiff clay resting on sand.

Seebaugor, the civil station, is situated on the embankment of a large sheet of water, about eight miles from the Brahmapootra, and twenty from the spurs of the Naga hills. Its elevation above sea-level is 332 feet. It is, says Mr. Blandford,¹ 'full in the course of the alternating currents of the south-west monsoon and the northerly winds blowing through the gorge of the Dihong river, but sheltered somewhat by its depressed position on the alluvial plain.' The climate (see table in Appendix) is cooler but more extreme than that of Lower Assam. The rainfall is very heavy, and almost continuous throughout the year.

Diseases. The principal diseases are, as throughout Assam, malarious fever and its complications, cholera, bowel complaints, and small-pox. Elephantiasis is common.

¹ *Winds of Northern India*, p. 20.

Fever appears in various forms, bilious, intermittent, and remittent; attacks contracted in the neighbourhood of the hills are invariably of a severe remittent type.¹

Goitre is very prevalent throughout the district. From special reports (1872) made by the civil surgeon, Dr. Ahmed Bux, and by Dr. Foster, one of the medical officers of the Assam Tea Company, it appears that the disease is most common in the Majolai Island, and in similar low tracts in the neighbourhood of the rivers and marshes. The disease is often very much localised, and in spots which do not apparently differ in their conditions from others on may be the same stream. The people take their drinking water from marshes or rivers as is most convenient to them. Dr. Foster states that he does not remember an instance of an imported Bengali coolie contracting the disease, a statement which concurs with that of Dr. Eliot, the medical officer of the neighbouring Jorehaut Tea Company.

In the Seebaugor district, as in Nowgong, goitre is ascribed to the use of the soft water of marshes and rivers, and is localised in particular spots in a way which is quite unexplainable on the theory that the cause is a material present generally in the water, but falls in with the supposition that the disease depends upon the local development of a peculiar form of malaria.

South Luckimpore. This district includes the remaining portion of the valley which lies along the southern bank of the river; a large proportion of it is unreclaimed waste, covered with jungle and abounding in swamps, while the whole is intersected by numerous streams.

Dibrooghur, the civil station, and the principal military cantonment of Upper Assam, is situated on the left bank of the Dibroo river, a short distance above its junction with the Brahmapootra, on a level alluvial plain (elevation 348 feet) which, unless during extraordinary floods, is well raised above the flood level of the river. From June to November the river flows in a full stream close to the station, but in the dry season dwindles down to a comparatively small stream, and leaves many stagnant pools and mud-banks which exhale very offensive odours, and are an undoubted source of disease. The site of the military cantonment is throughout the year well drained; but for the rest of the station² the drains, though large and well planned, are reported in a very unsatisfactory state, silted up with mud, and presenting stagnant

¹ *Sanitary Report* for 1874, p. 34.

² *Report of Sanitary Commissioner* 1878, p. 19.

pools of foul water along their course. The water supply for the troops is ample and good, and is so for the native population also during the rainy season when it is taken from the full stream of the river. At other times it is very unsatisfactory, the people taking their water from the stagnant pools in the river bed, and from foul tanks.

The climate¹ of Dibrooghur is cool, and by no means a bad one for Europeans who are well fed and clothed, and live in houses which are sufficiently raised above the damp ground. It is very damp, and in the cold weather the moisture of the atmosphere is precipitated over the river and in its immediate neighbourhood in the form of a dense fog which lasts from daybreak to ten or eleven A.M. The rainfall averages annually 114 inches. The diurnal range of temperature is greater than in Eastern Bengal, and during the cold weather is considerable; hot days are followed by damp cold nights which are very trying to the lower classes, ill clothed and sleeping in damp huts.

The mean air temperature at the station is given as follows by Messrs. Schlagintweit—mean of 1851–53:—

	Mean of 1851–53		Mean of 1851–53
January	62	August	82
February.	63	September	81
March	71	October	76
April	73	November	67
May	77	December	61
June	81	The year	73
July	84		

Diseases. Malarious fever is the prevailing disease of the district; as in other parts of Assam it is frequently complicated with dysentery and diarrhoea. Cholera is not endemic in South Luckimpore. Goitre is very prevalent amongst the natives of both North and South Luckimpore and, as illustrated by the history of the disease at Poobha Mookh, attacks the sepoys also.

Poobha Mookh, an outpost for forty sepoys, is situated on the north bank of the Brahmapootra, forty miles east of Dibrooghur. The post,² says Dr. White, is 'simply a clearance of about forty acres of forest, the forest surrounding it on all sides excepting the river frontage; there is no population or cultivation for miles round; all is an uninhabited waste. The stockade is about forty yards square, the walls of logs and earthwork. The men are lodged in

¹ Dr. Berry White, in *Medical Report of the Native Army*, 1869, p. 20.

² *Medical Report of Bengal Native Army* for 1869, p. 17.

a well-ventilated roomy barrack constructed of wattle and dab, provided with raised sleeping platforms. The river bank at this place is exceedingly high, and not liable to inundation even in the highest floods; the soil is a light sandy alluvial deposit, and rapidly absorbs the heaviest rainfall. The water supply is drawn from the Brahmapootra, for owing to the sandy nature of the soil and to the circumstance that clay for bricks is not procurable within a reasonable distance, a well cannot be constructed. It rarely occurs that a sepoy is reported off duty from sickness, and a few simple medicines in charge of the native officer in command of the post are all that is required for the ordinary medical wants of the place.' 'Were it not for goitre, the place,' says Dr. White, 'would be one of the healthiest in Upper Assam. But any person inhabiting the place for three or four months will have a well-marked goitre, and even after a month's residence an incipient enlargement frequently develops.'

Dr. White attributes the disease to the use of the river water, but it is difficult to reconcile this view with the fact that while the Brahmapootra water is freely used by the sepoys at other river stations in Assam, they suffer from goitre only at Poobha Mookh.

The history is parallel with those already mentioned of the development of goitre in patches by the river side in the Sebsaugor district, and must be read in the light which the history of the outbreak of goitre in the Duffla field force, given in the next section, throws upon the cause of the disease.

North Luckimpore. This district fronts the South Luckimpore and Sebsaugor districts, extending along the north bank of the Brahmapootra from the confines of Assam to the boundary of the Durrung district. Through the eastern two-thirds of its length the district is very narrow, the hills closely approaching the river, but further to the west the breadth increases to an average of thirty or forty miles. The total area of North and South Luckimpore is 3,145 square miles; the scanty population averages 39 to the square mile.

Near its eastern extremity the district is crossed by the two great tributaries of the Brahmapootra, the Dibong and the Dihong, and further west by other large rivers, as the Soobunsiri, the Runga Nuddee, and the Dikrang, besides numerous smaller streams.

The climate is very much the same as that of South Luckimpore; the prevalent winds throughout the year are from the north and north-east, but the south-west monsoon, pursuing its course

in the upper regions of the atmosphere, supplies an abundant rainfall.

Suddya, the extreme frontier post of Upper Assam, is situated on the north bank of the Brahmapootra, at the junction of that river with the Koondil, about fifty miles, in a straight line, north-east of Dibrooghur, and twelve or fifteen miles east of Poobha Mookh. The ground on which the cantonment is situated is a high open chur,¹ the vegetation chiefly grass with a few trees. Being recent chur formation, the soil is simply a few inches of alluvial crust on a subsoil of sand; jungle does not grow here nearly so luxuriantly as in the stiffer clay soils, and owing to the light sandy nature of the soil, rain is absorbed immediately it falls, and artificial drainage is almost unnecessary. Owing to these conditions the place is decidedly freer from malarial influence than any other post in Upper Assam. The Mishmi hills, part of the great Himalayan range which separates our territory from Thibet, are only about twenty miles distant to the north-east; they are capped with eternal snow, and as the prevailing wind is from that direction, the temperature of the post is always three or four degrees lower than that of Dibrooghur. The water supply is excellent, the lines being within a quarter of a mile of the river, and there are also masonry wells in the cantonments which yield excellent potable water. The native population in the neighbourhood is exceedingly sparse.

Such is Suddya, a healthy spot in Upper Assam. In very strong contrast with the foregoing description is that of the country, not far distant on the west of the Dihong river, which is given by Captain Peet² in a very interesting special report on goitre in the district.

Captain Peet writes: 'Goitre is so common throughout the district, that it is difficult to say where it is most so. On the banks³ of the Brahmapootra it is very prevalent, quite irrespective of the nature of the ground on which the houses of the people happen to be erected. In many villages not a single individual above the age of ten or twelve is free from the disease. Perhaps if any localities can be found in the district which are worse than others, they are the high banks of the three largest rivers, the Soobunsiri, the Runga Nuddee, and the Dikrang. Together with goitre,

¹ Surgeon-Major White, in *Medical Report of Native Army of Bengal* for 1869, p. 17.

² Deputy Commissioner of the District.

³ See foregoing account of P. Mookh.

malarious diseases, fever, spleen, &c., are very prevalent. Elephantiasis also is common amongst the people. The whole district is a flat alluvial plain, intersected by numerous streams, some of which are perennial, while others degenerate for a portion of the year into a string of stagnant pools. The whole country, excepting the high banks of the larger rivers, is inundated during the rains, and at other seasons is a series of jheels, swamps, and bogs, alternating with stretches of impenetrable jungle. The soil is alluvial loam, resting on a subsoil which is for the most part sandy, but here and there clayey. The cultivation, where there is any, is chiefly rice, with a little mustard and kulai on the higher ground.

The Assamese who form the bulk of the inhabitants are physically a puny, miserable race, much given to the use of opium. They drink indiscriminately stream water, or the water of dirty shallow tanks, and in some places that of mere holes dug in natural or artificial hollows. The Meeris, a semi-nomadic people, physically a finer race than the Assamese, who invariably live on the banks of the rivers and drink none but the river water, suffer perhaps less than the Assamese from goitre. And amongst the Assamese it is the poor ill-fed classes which suffer most. Captain Peet states that he never remembers to have seen a well-to-do Brahmin suffering from goitre. The people attribute the disease to the use of river water when it is in a dirty state, that is when the rivers are in flood, which perhaps simply means that the disease develops most markedly during the rains.

A very remarkable outbreak of goitre occurred in this district amongst the men of the Duffla field force (natives) which entered the country neighbouring on the Dikrang river in the early part of 1874. The river, at the place where the disease showed itself, is a fine broad stream with a strong body of clear water running over shingle and sand. The water at the time was free from silt; some of it which was sent to Calcutta for analysis yielded the following results:—

	Grains per gallon
Total solids	5.04
Carbonate of lime	1.02
Carbonate of magnesia . . . . .	.28
Chloride of sodium . . . . .	.46

Sufficient proof of the purity of the water, so far at any rate as the mineral matters are concerned. Surgeon-Major Reed writing on March 11, says: 'the rapidity with which goitre develops itself along the banks of the Dikrang is simply alarming. Nearly every man in the ranks exhibits more or less fulness of the thyroid gland.'

The principal post upon the Dikrang is described as follows¹ by Deputy Surgeon-General J. T. C. Ross, F.R.C.S. 'The prospect on arriving at the right bank of the Dikrang river was not pleasing. Our side was in dense shade from tree forest; high thick grass, reed and bush jungle grew down to the boulders in the bed of the stream. The opposite bank was high and in sunshine; but the river was unfordable, and there were military reasons for not occupying the ground opposite. The only available ground on the right bank was a narrow strip of land some five or six feet above the boulder bed, at the foot of the hill we had just descended. The ground was found moist or damp everywhere, swampy in places, and the soil was the débris of the vegetation of centuries. The river was a fine mountain stream running swiftly over boulders, about twenty-five yards wide in its boulder bed of some seventy yards. The water was good. The scenery, although confined, was beautiful. The hills were covered to their summit with fine forest trees; on their sides were also patches of bamboo jungle, tree ferns, wild plantains, &c., amid which wound large creepers and canes, the latter sometimes 200 feet in length. The force remained here ten days. The conditions of this camp were unavoidably bad. The soil damp or even swampy, and composed of decaying vegetation; the clearing of the jungle opened it to the air. The sun was only visible for four or five hours owing to the height of the hill to the southward and the density of the forest; hence perhaps our comparative safety, for experienced survey officers asserted the place would be deadly in May. It was often very cold; for eight days the thermometer at sunrise stood from 34° to 38°. There was generally a fog in the night and early morning, which rendered the cold damp and penetrating. To the last it was a bad and dangerous place, and when the rain began, on the 29th, a very miserable one, and one that told a good deal on the health of officers and men. The health of the camp deteriorated daily during residence. There were many cases of bronchitis, but the chief complaints were of the bowels. If dysentery or diarrhœa were not actually present, there was uneasiness or discomfort felt by nearly everyone in camp, officers and men.'

To return to the outbreak of goitre. It was generally attributed by officers and men to the use of the Dikrang water, yet the water was at the time in its best state, and as shown by the analysis really contained exceedingly little solid matter, and it is

¹ 'Medical History of the Duffla Expedition,' in Appendix to *Medical Report on Native Army of Bengal* for 1874.

very improbable that the water of a clear stream running swiftly in a clean bed of boulders and shingle contained any malarious poison. The conditions of the outbreak were quite analogous to those of Poobha Mookh, where the reliefs from Suddya, on arriving in a small clearance almost surrounded by dense virgin forest, are quickly attacked by the disease in question. Thus it was with the troops of the Duffla force; they suffered, and in the same way, when moved from cantonments into a district notoriously malarious, one in which goitre is almost universal amongst the inhabitants. The force entered the Terai, for such the district really is, at the most healthy time of the year. Had it done so later on in the year, the sad story of the Bhootan campaign would have been repeated; as it was, the men fortunately suffered chiefly from a mild form of malarious disease, *viz.* goitre.

Durrung. The Durrung district extends some 120 miles along the north bank of the Brahmapootra, between North Luckimpore and Kamroop. In breadth the district varies from about twenty to thirty miles. The total area is 3,413 square miles, and the population sixty-nine to the square mile.

The district generally is a very flat one, but the level is broken here and there by low hills, and there is a general rise towards the hills which becomes well marked at from six to ten miles from their base. It is dotted over by numerous swamps and jheels, and is crossed by many streams. Much of Durrung is still uncleared jungle, but the district shows wide expanses of rice cultivation, and the tea-gardens are numerous and large. The soil is alluvium resting on a subsoil of sand or sand and clay; it is in places highly ferruginous, and imparts an ochreous colour to the streams. Lime has been carefully sought for, but has not been found.

Along the northern part of Durrung are the Cachari Dooars, a tract of country ten or twelve miles in breadth, slightly elevated above the general level, and inhabited by the Cacharis. These people are a fine athletic race, living in large villages, plentifully stocked with cattle, pigs, and poultry, and each surrounded by a wide stretch of rice cultivation which is maintained by artificial irrigation from the mountain streams.

Tezpore, the civil station of Durrung, and a military post, is situated on the north bank of the Brahmapootra, some seventy miles in a straight line east and a little north of Gowhatty, 278 feet above sea-level.

Surgeon Bovill thus describes the station. 'It is situated on an elevated plateau of irregular shape and considerable size. The

soil consists of rich red heavy loam, and in many places large rounded boulders of granite appear on the surface. The river Brahmapootra runs at the foot of the low hills edging the plateau, and wherever it washes the soil from their base masses of granite and granitic rock are exposed. The plateau is intersected by several small ravines which contain water during the rains, and are occupied by rice fields or jungle during the remainder of the year. Several of them have lately been converted into tanks by bunds thrown across them, and are thus rendered more sightly and salubrious. On the north and east the plateau ends abruptly, and the Mora Bhosote river runs past on this side, emptying itself into the Brahmapootra about one and a half miles from the station. On the west the plateau slopes off gradually into the jungle. The first hills of the Himalayas are distant about twenty miles in a northerly direction. The climate is generally cool, and there is usually a breeze following the stream of the river, that is from the east.¹ The following table is compiled from the records of the Surgeon-General's office, Calcutta:—

	Mean of three years 1872-74				Average rainfall of 13 years
	General mean of temperature of month	Mean maximum	Mean minimum	Mean daily range	
January . . .	60	71	51	20	·51
February . . .	66	76	57	19	·99
March . . .	70	80	61	19	1·47
April . . .	76	85	68	17	6·92
May . . .	79	83	72	11	10·85
June . . .	83	90	77	13	13·85
July . . .	84	90	78	12	15·19
August . . .	85	91	78	11	13·18
September . . .	82	88	76	12	8·79
October . . .	78	86	69	17	3·14
November . . .	71	80	62	18	·74
December . . .	64	73	54	19	·60
The year . . .	74·8				76·23

Highest temperature, 98 in July. Lowest, 43 in January.

On account of its comparatively high site and proximity to the river, the climate is not unhealthy for Europeans, although the tenacity of the soil renders the site damp. The water supply is from the Brahmapootra.

The principal diseases of the place are malarious fever, and

¹ Dr. Buckle, in the *Report* already quoted, and Surgeon F. Bovill in *Medical Report of the Native Army of Bengal* for 1874, p. 201.

bowel complaints which are also probably of malarious origin. Malarious fever is very prevalent amongst the people of the district, and is often of a very severe remittent type. Cholera is occasionally very prevalent. Small-pox is very prevalent, and is spread amongst the people by inoculation, a system which still finds favour amongst the Assamese. Bowel complaints are very common, and very fatal.

The Dooars, which are more elevated and decidedly less swampy than the rest of the district, with a cooler climate, might be expected to be comparatively healthy, yet such is by no means the case; on the contrary the natives suffer much from fever and spleen, while to Europeans the climate is throughout the year a most dangerous one.

Dr. Imthurn, Civil Surgeon of the district (1872), states in a special report on the subject that goitre is very prevalent throughout Durrung, both amongst the Assamese and amongst the Doooms, a race of people who live on or near the tributaries of the Brahmapootra and are much employed as fishermen and boatmen. It appears too from the evidence of the Rev. Mr. Endle, a missionary who has laboured long amongst the Cacharis of the Dooars, that they also, together with their neighbours, Bhooteas, Meeris and Dufflas, who inhabit the lower slopes of the hills, are very subject to the disease. Mr. Endle agrees with the people themselves in ascribing the disease to the use of impure water taken from the mountain streams or from the irrigation channels. The water of the streams is as a rule bright and clear, but it often runs in a channel lined with a deep black mud which when stirred emits a very offensive odour.

To this evidence regarding goitre in Durrung may be added that of Mr. J.D. Campbell, during many years a tea-planter in the district, who states¹ that the disease is exceedingly prevalent along certain streams in the south-western part of the district. He notices its especial prevalence at Arrung, a low-lying, steamy, densely packed village on the margin of a swamp, and argues from the nature of the place, and from the association there of goitre with fever and spleen, that those diseases must have a common malarious origin.

¹ In one of the special reports.

CHAPTER XII.

ASSAM—*continued.*

The Assam range, and Burail hills. Limits of the two ranges; elevation; general description of the area. Geology of Assam range; gneissic and metamorphic basis of the range; Sylhet trap; cretaceous series; nummulitic series; upper tertiaries. Garrow country; people. Cossyah and Jynteah hills. Shillong; description of; climate; diseases. Naga country; Angami Nagas.

THE 'Assam range' has been proposed by Messrs. Medlicott and Blandford as the name for the western portion of the range of hills which separates the valleys of Assam and Cachar. The range extends between the Dhunseeree river on the east and the Brahmapootra on the west, a distance of about 250 miles, and includes the hills, still named from the tribes which inhabit them, the Naga, the Jynteah, the Cossyah, and the Garrow hills; its breadth averages about fifty miles. On the east of the Dhunseeree river we have the Burail hills, the general direction of which is to the north-east, where they amalgamate with the Patkoi range. Geographically by deep valleys, and geologically by a difference in the character and dip of the rocks, the Assam range is cut off from the Burail hills. The loftiest hills are those of the Cossyah country, which about the centre of the range reach an elevation of 6,500 feet in the hills to the north of the station of Shillong. The Garrow hills, which form the western portion of the range, gradually decline in elevation westwards from the Cossyah hills; their highest point in the Tura ridge, which overlooks the station of that name, does not exceed 4,700 feet. The Naga hills form the eastern portion of the range, and have an elevation some 1,500 to 2,000 feet below that of the Cossyah hills. On the east of the Dhunseeree river, in the direction of the Patkoi range, the elevation of the hills again rises.

On the north the Assam range declines gradually in spurs and low hills to the level of the Assam valley; a somewhat detached

group of hills at the eastern end, outliers from the northern slopes of the Naga hills, are known by the name of the Meekhir hills.

Along the southern face, through the greater portion of its length, a bold scarped face overlooks the Cachar valley, but below this the base of the range is formed by a fringe of low hills of irregular outline, which in position and in geological formation correspond with that of the Siwaliks of the Himalayan range. Along the central and eastern portion of the southern face these outer hills have been removed to a great extent by denudation, westwards in the Garrow country they are more extensively developed, while on the extreme east they develop into the broken, irregular mass of the Burail hills of the trans-Dhunseeree country.

The surface of the Cossyah and of a considerable portion of the Jynteah and Naga country (cis-Dhunseeree) is formed by an undulating plateau. That of the Garrow country on the contrary is very irregular, a maze of hills and valleys, with hardly any level ground, and all at a much lower level than the plateau country to the east.¹ The leading feature of this area is the ridge of gneiss running east and west, which has been already mentioned as the Tura range.

North and south the lower portions of the Assam range are covered by dense forest jungle, but the central plateau is very bare of trees excepting in the many and deep ravines which seam its level; a feature which is due partly to the removal of the surface soil by heavy rains, partly to the effect of the violent winds which sweep the tops of these hills, and partly to the migratory nature of the cultivation carried on by the inhabitants.

Geologically the Assam range² is formed of a basis of very ancient metamorphic and transition rocks, overlapped on the south and south-east by very much newer strata, upper secondary and tertiary, indicating that the range at one period of its existence formed the margin of a great basin of deposition. A very remarkable feature in the distribution of the newer rocks is that in part they rest horizontally in undisturbed position upon the older rocks, and assist in forming the plateau of the Cossyah hills, with a high scarped face along a regular line to the south. But south of this line, along the face of the Assam range, and again to the east of that range, throughout the mass of the Burail hills, the tertiary rocks have been greatly disturbed, and thrown by the disturbing force into hills which in the irregularity of their contour differ

¹ *Manual of Geology*, p. 691.

² *Ibid.* pp. 26, 40, and Chapter xxviii.

strikingly from that of the undisturbed central mass of the metamorphic and other ancient rocks.

The gneissic basis extends from the Dhunseeree river on the east to the Brahmapootra on the west; but with a northerly trending in the latter direction which brings out the termination of its southern face at Singeemaree on the Brahmapootra, about the centre of the western end of the range. It is not, however, confined to the range, for it underlies the lower part of the Assam valley, and in many places projects through the alluvium forming the many little isolated hills which characterise this part of Assam. Of these outcrops the most eastern on the north of the Brahmapootra is the granitic mass of Tezpore, and the most northern is one which is actually within the area of the sub-Himalayas, on the Bhootan frontier, in the valley of the Rydak river.¹ Yet though the Assam gneiss geographically approaches so very closely the gneiss of the Himalayan range, in its geological relations it belongs to the gneiss of peninsular India, for it has the same mineral character, and, as has been just mentioned, secondary and tertiary strata rest horizontally upon it, whereas in the Himalayan regions the recent strata have been greatly disturbed. Moreover we shall see that the character of the transition rocks and of the secondary strata which rest upon the Assam gneiss, affiliate it to that of the peninsular area.

The transition rocks² are very largely developed in the Cossyah and Jynteah hills, and at Shillong, where they have been chiefly studied, they extend from the margin of the plateau, some thirty miles northwards, to the axis of the range, and form the summits, 6,450 feet in height, of the culminating ridge of the range. Their lateral extension has not been ascertained; in the neighbourhood of the southern face of the range they are covered up by the horizontal cretaceous beds of the Shillong plateau. They consist of a thick band of quartzites, overlying a mass of earthy schists, but are very variously metamorphosed, the schistose beds varying from clay slate to well-foliated schists and gneiss. In the neighbourhood of Shillong these rocks are extensively penetrated by granite and trap. In their petrological character, and in their direction, these rocks of the Shillong transition beds affiliate with the series of transition rocks which under the name of the Bijawar rocks stretch across peninsular India from Bengal (Behar) to Nimawur in the Nerbudda valley. A very much less extended deposit is that which is known as the Sylhet trap—a

¹ *Manual of Indian Geology*, p. 27.

² *Ibid.* p. 40.

deposit which probably corresponds in age with that of the Jurassic trap of the Rajmahal hills. It consists of earthy, ashy beds, and of hard basaltic rock, and is found only in the Cossyah country, and there resting against, but not overlapping the ancient rocks. Both this rock and the subjacent crystalline rocks are for the most part covered up by horizontal beds of the cretaceous series which are very extensively developed along the whole length of the southern section of the range between the gneissic basis and the tertiary deposits, gradually thinning out and becoming lost upon the ancient rocks in places at a distance of twenty-five or thirty miles from the edge of the plateau. In the Garrow hills the cretaceous beds are chiefly made up of sandstones, and here no fossils have been discovered, and only indistinct impressions of vegetable remains. At the western end of the range the sandstones in places envelope the gneiss of the Tura range, and here rest in a horizontal position undisturbed upon it. But at the eastern end of that range the same rocks are much disturbed, the strata rising nearly vertically against the gneiss. In this feature and in the disposition of the gneiss there is evidence that this end of the Tura range has been subjected to a violent crushing force, probably of the same date as that which raised the Cossyah hills. 'It would seem as if some greater elevation in the middle region, that of the Khasi hills, to which the trap is limited, had brought up this lowest formation of the extra-gneissic area in this position.'¹

In the Cossyah hills marine fossils, animal and vegetable, are plentiful in the cretaceous beds, and in this region shales, often calcareous and ferruginous, are found above the sandstones. A prominent and widely developed upper member of the series is the Cherrapoonjee sandstone, some 200 feet in thickness; on the plateau it underlies the nummulitic limestone, and forms the edge of the main scarp and broad ledges at the edge of the plateau. The rocks of the same series occupy a large space in the Jynteah hills, and there is reason to suppose are present in the Meekhir hills. Coal basins, never large, sometimes very diminutive, are found throughout the length of the cretaceous beds. In the Garrow hills the principal of these are in the basin of the Soomesaree river, to the north of the Tura range. In the neighbourhood of Shillong the coal is discovered in valleys in the metamorphic rocks in which the cretaceous deposits have formed.

¹ *Manual of Geology*, p. 687.

The nummulitic series is largely developed in the Cossyah country; limestones of the series taking a large part in the formation of the low hills at the foot of the main scarp, and both limestones and sandstones to a great extent covering the cretaceous beds of the plateau. The nummulites have not, however, so far, either here or in the Garrow country, been found extending beyond the cretaceous beds so as to come into direct contact with the gneiss. On the plateau much of the higher ground is formed by the nummulitic sandstone, and in it coal, in small quantity but of good quality, is found and worked. In the Garrow country the series is very extensively spread, extending to its western end, and the limestones are found resting upon the cretaceous sandstone north of the Tura range, but both the limestones and sandstones of the series are neither so thick nor so well defined as in the Cossyah country, and they become mingled with clays and sandstones which in character approach the succeeding upper tertiary deposits. No coal is found in the Garrow area of the series. The eastern extension of the series has not been traced out; its presence in the Jynteah hills is known, but is more than doubtful further to the east in the Naga hills.

The upper tertiaries, like the nummulites, are found above the gneiss in the undisturbed area, and also in the southern area of disturbance. Massive soft greenish sandstone is the most prominent rock of the series, somewhat like the common Siwalik rock, but more earthy and of a darker hue. With this are found grey shales, unlike the brown and ochrey clays of the Siwaliks. The fossils, too, unlike those of the corresponding Himalayan beds, are of marine origin. On the summit of the Nongkulong hill (2,070 feet), near the border of the Cossyah and Garrow countries, sandstones and shales of the series are found resting conformably upon the horizontal nummulitic beds. Along the foot of the Cossyah and Jynteah hills, the upper tertiaries have been almost entirely removed by denudation; along the southern face of the Garrow country they are in greater force, but the main development of the tertiaries is in the broken hill country beyond the Dhunseeree, where they are thrown up into the hills of the Burail and Patkoi ranges, and also compose the off-shoots from the latter range, which under the name of the Looshai and Tipperah hills, form the southern boundary of the Cachar valley. The upper tertiary rocks form the southern boundary of the upper part of the Assam valley, but it is yet undetermined whether they are continuous with the tertiaries of the southern face of the Assam range, or with those of

the Himalayan range which bound the valley on the north. Amongst the clays and sandstones of the series in the neighbourhood of Jaipoor are found the extensive coal-fields of Upper Assam. No fossils, excepting bad impressions of dicotyledonous leaves, have been found in the coal, and the age of the fields remains undetermined.

The area of the Garrow country is 3,390 square miles, and the population of the district is estimated at 80,000. The civil station, Tura, is situated at an elevation of 1,300 feet, on a long spur or ridge of gneiss which runs down to the Brahmapootra from the Tura range of hills. The station commands a fine but distant view of the Brahmapootra as it proceeds on its southerly course at a distance of about thirty miles. On the south the hill country of the district rises abruptly from the plain of Mymensingh, but west and north it sinks gradually to the level of the Brahmapootra.

The tribe of the Garrows who inhabit these hills are a fine muscular race of men, belonging probably to the Tamulian stock of the aborigines of the plains of India. They will eat most things, and have a taste for blood boiled till it is of a green colour, but milk they eschew, looking upon it as a foul excrement. They drink freely an intoxicating beverage made from fermented rice and millet. Their houses are raised upon piles, and the villages are generally situated in the valleys on the banks of streams, for unlike some of their neighbours, the Garrows are careful to have a plentiful supply of good water.

The area of the Cossyah and Jynteah hills is 6,157 miles, and the population of the district is estimated at 141,838. The civil station is Shillong, about one hundred miles due east of Tura. Shillong¹ is a hill station and military post, and important as the sanitarium of these parts, and as the residence of the Chief Commissioner of the united province of Assam and Cachar during the hot season. It is connected by a cart road with Gowhatty, from which station it is distant in a straight line about fifty miles. The station is situated at an elevation of 4,900 feet, on an irregular plateau composed of a series of knolls, shut in on all sides excepting to the north by higher ground. The houses are built on the tops of the knolls, which are cleared, leaving their sides covered with fir trees; while lower down reeds and rank grass flourish and fill up the intervening bottoms, which though artificially improved by

¹ See Deputy Surgeon-General Buckle, C.B., in *Report for 1870 on Medical and Sanitary State of Bengal Army*, p. 34.

drainage, are still very marshy. The water supply is abundant and good, coming from hill streams the conservancy of which is carefully attended to. East of the station and at a lower level is the valley of the Oomerah river. This stream, after having received the drainage of the different heights, flows round the northern face of the station, from which it is separated by a low ridge, and runs on from thence in a northerly direction to join the Brahmapootra. Behind the station to the south is the Shillong ridge, having a general direction from east to west, with an elevation of over 6,000 feet; after throwing off a spur to the north, the ridge terminates in the Shillong peak, the elevation of which is 6,450 feet. The regimental lines are situated on the summits of two long low parallel hills, between which is the parade-ground. The site is well chosen, being open, well drained, free from the immediate neighbourhood of forest and rank vegetation,; close at hand there is a fine hill stream affording an abundant supply of the purest water.¹

About thirty miles south of Shillong and at a little lower elevation, but separated by the Shillong and two other ranges of hills, is Cherrapoonjee which has an annual rainfall of about 560 inches.

Climate. In many respects, says Dr. Buckle, the climate of Shillong is favourable, being bracing and invigorating; it is liable to no sudden or extreme variations of heat or cold, nor is the station subject to the excessive rainfall which characterises Cherrapoonjee. Seven months of the year may be considered as the rainy season; during the other five months the climate is delightful, and the only objection to it is the amount of cloud which almost continually occupies the sky, giving a bleak and comfortless aspect to the hills.²

The following table is compiled from the official reports, but since 1872 Shillong has ceased to be a Government Observatory.

Diseases. Malarious fevers, dysentery, and diarrhoea are very prevalent during the rains and in the autumn amongst the troops stationed at Shillong; while rheumatism and chest affections are the chief complaints during the cold season. But it must be remembered that the majority of the men at the time of their arrival in the station are suffering more or less from malarial cachexia, the result of their sojourn in the Assam valley, and are therefore at first more sensitive to the effects of the bracing

¹ *Report on Native Army* for 1876.

² Surgeon J. O'Brien, M.D., in *Report* for 1877.

Shillong.

	Temperature, 1872							1872						Mean temperature 3 years	Rain-fall, average of 9 years
	Highest of the month	Lowest of the month	Approximate mean of the month	Range in the month	Mean of all highest	Mean of all lowest	Mean daily range	Degree of humidity	Rainfall	Wind, most frequent direction of	Mean diurnal velocity in miles	Average height of barometer	Mean serenity. Clear sky=10		
January .	68.	33	49.8	35	60.3	41	19.3	71	.01	NW.	61	25.253	8.	51.3	.32
February .	67	35	51.4	32.	61.4	42.7	18.7	63	.4	N. & NW.	96	25.205	6.7	54.2	.75
March .	80.5	48.5	63.1	32	73.3	55.1	18.2	57	.01	SW.	151	25.194	7.	61.4	1.78
April .	84.	53.	66.5	31	75.8	59.6	16.2	62	1.85	SW.	202	25.193	4.9	64.5	5.5
May .	80.	58.5	67.4	21.5	75.2	61.2	14.	78	8.01	S.; SW.	101	25.115	3.6	68.4	9.42
June .	82	61.5	69.5	20.5	75.9	64.9	11	83	8.8	S.; SW.	86	25.065	2.2	69.4	16.22
July .	80.5	63.5	68.8	17.	75.4	65.3	10.1	89	24.77	S.	51	25.045	.8	69.4	16.26
August .	80.	62.5	70.1	17.5	76.2	65.7	10.5	88	8.29	WNW.; SSW.	39	25.059	.82	69.2	13.25
September .	82.5	58.5	67.2	24.	73.4	62.9	10.5	89	25.38	W.	55	25.163	1.2	67.3	16.7
October .	74.	54.	63.1	20.	70.9	55.8	15.1	89	4.32	NW.	47	25.229	3.07	63.5	5.69
November .	71.	44.	58.7	27.	66.	49.9	16.1	74	—	N.	49	25.285	6.8	56.	1.28
December .	63.5	32.5	52.3	31.	58.6	41.5	17.1	77	.02	NW.	41	25.270	6.74	50.1	.12
The year .			62.3						81.86					62.1	85.29

climate of Shillong. Yet, writes Surgeon O'Brien, 'most diseases, save hepatic affections, do well here.'

Cholera breaks out occasionally in the hills and commits great ravages amongst the people, but the outbreaks of this disease may, it is said, be generally traced to importation from the plains of Cachar or Assam. Small-pox is also at times very fatal, nor is this to be wondered at, for the people, from superstitious motives, strongly oppose both vaccination and inoculation.

An epidemic of acute dropsy, which prevailed to a considerable extent in Shillong and the Cossyah Hills, is thus noticed by Dr. O'Brien,¹ the Civil Surgeon: 'In the latter part of the year, that is, from the month of November, a new form of disease, viz. acute œdema, prevailing epidemically, came under observation. Several fatal cases of this disease occurred in the station. It prevails widely at present (January) and appears to be communicable from man to man.' The œdema was not accompanied by any eruption on the skin, and the urine was invariably found free of albumen.

Goitre appears to be almost unknown amongst the Garrows, Cossyachs, and Jynteahs. Dr. O'Brien who at the time he was in medical charge of Shillong made personal inquiries, and especially visited the villages on the limestone regions of the southern slopes, could not discover a single case of the disease. It is however common along the foot of the Garrow hills in the Mymensingh district.

The Naga hills in British territory have an area of about 4,900 square miles, and the district comprises a population roughly estimated at 69,000. The civil station, Samoodgooting, is situated on the summit of a low range of hills at about 3,000 feet above sea-level. The people around are Nagas, who with their neighbours the Jynteahs and Cossyachs appear to be of Indo-Chinese origin. They are a wild hill people amongst whom civilisation is only as yet beginning to get a footing. An interesting account of the diseases prevalent amongst one of the tribes, the Angamis, is given by Assistant-Surgeon Hem Chunder Bhattacharjee in the 'Indian Medical Gazette' for January 1869. They live in straw-built houses on the summit of hills from 500 to 3,000 feet above sea-level, holding but little intercourse with the people of the plains, and only rarely leaving their hills on trading expeditions. The prevailing diseases are intermittent and remittent fever, diarrhœa and dysentery, scabies, intestinal worms, a peculiar kind of ulcer called in Assamese 'doomoro,' and affections of the eye.

¹ *Sanitary Report of Province of Assam* for 1878.

As regards the fevers which are prevalent amongst the Angamis, these are seldom of a virulent type, and they suffer but little from the epidemics which rage in the plains of Bengal. They have no medical treatment for their diseases, merely sacrificing a fowl or a pig to their gods, while the sick man, so far as he can, continues his usual mode of life; for the Angamis hold that starvation and abstinence from food during illness do more harm than good.

The Angamis are excessively dirty in their habits, living in close rooms with their pigs and fowls, and only getting rid of excreta when the quantity becomes so large that the space occupied by it is wanted for other purposes. They drink great quantities of rice beer, and partake largely of decomposing fish. As for their drinking water they do not care whether it is pure or impure, and the natural result of all this is, great mortality among them from diarrhoea and dysentery. Scabies is very common, and for the very good reason that they seldom wash, for as they have often to descend some distance to the springs to fetch water for their daily needs they use it as little as possible, and, writes the Sub-Assistant Surgeon, if we say that they are washed only twice, namely at their birth and at their death, it will not be far from the truth; consequently their bodies are dirty in the extreme, and afford an excellent soil for the itch insect. The intestinal worm common amongst them is the round worm, a pest as prevalent in Assam as it is in the Naga hills.

Diseases of the chest, gout, rheumatism, elephantiasis, and goitre are seldom met with; the few cases which occur may be called exceptional. Cholera, small-pox, measles, though not unknown, are rare, probably because the Angami Nagas greatly dread these diseases, and are careful to avoid any infected localities in the plains. Syphilis also is almost unknown among them. Goitre, however, though rare amongst the Angamis is a very prevalent disease amongst other tribes of the Nagas living in the lower ranges bordering on Assam; and in some of the villages about Samoodgooting also it is very common.

CHAPTER XIII.

THE SURMA VALLEY AND MUNEEPORE.

Sylhet, Cachar, Muneepore. Limits of the Sylhet and Cachar districts. Account of Sylhet; people, climate, diseases; Sylhet station. Account of Cachar district; Silchar station; goitre in Cachar. Muneepore state.

SYLHET AND CACHAR. The districts of Sylhet and Cachar occupy the broken plain, or rather broad valley, of the Surma river. The valley, which is some 120 miles in length, is bounded on the east by the Muneepore (Patkoi) hills, on the west by Mymensingh, on the north by the Assam range of hills, and on the south by the Looshai and Tipperah hills. On the west, where the valley opens into the jheel country of Eastern Bengal, it is about eighty miles across, and fully open to the sweep of the south-west monsoon. Narrowing rapidly towards its eastern end, the valley is encroached on by the spurs of the Naga and Looshai hills, more especially by the latter, which run far out into the plain. One of these spurs, known as the Serispore hills, extends very nearly across the valley, and separates Cachar from Sylhet. Immediately to the east of this spur is that portion of Cachar which is known as the Hylakandy valley.

The hills just named as bounding the plain on the south, are low, not averaging more than 1,500 or 2,000 feet of elevation, and, together with the spurs which they throw out, are covered with the densest forest, through much of which neither man nor beast can find or force a way.

The Sylhet district ¹ is for the most part a wide alluvial plain, very little if at all raised above the sea-level. The surface of the country is, however, broken up by numerous detached hillocks, 'teelaks,' as they are locally called; and to the south by the lower spurs of the Tipperah hills; ² in the centre of the district also is

¹ For statistics, see table at pp. 160, 161.

² See account of the Sylhet district, by Deputy Surgeon-General H. B. Buckle, C.B., in the *Report* for 1870 on the Charitable Dispensaries of Bengal.

a detached cluster of low hills—the ‘Ita hills.’ Winding through the plain are many large rivers which communicate freely with one another, and with numerous marshes; on the banks of these, on the teelahs, and on artificial mounds, are placed the villages, almost buried in the midst of the jungle and dense vegetation. Here we find houses, cattle-sheds, and temples, all huddled together in a manner that gives the appearance rather of the temporary abode of fugitives than the settled habitation of a people. From about June to October the whole of the country, excepting the raised positions just mentioned, is under water, and even when the floods subside, very extensive marshes and many permanent sheets of water still remain upon the face of the country.

The Surma or Barak river, flowing from Cachar, enters the district at the north-eastern angle, and shortly after divides into the Surma and the Kooshearah rivers; the former drains the northern, and the latter the southern portion of the district, and finally they again unite in one great stream which eventually joins the Brahmapootra, to form the Megna river.

The civil station and town of Sylhet, with a population of about 17,000 souls, is situated in the northern part of the district, on the right bank of the Surma, at an elevation of only fifty-five feet above sea-level, and is intersected and surrounded by land which is below the flood-level of the river, and is therefore for much of the year in a swampy state. The houses of the European inhabitants, and of the well-to-do natives, are built either upon the cleared and high bank of the river, or upon neighbouring teelahs.¹ But the native town is enveloped in dense vegetation, and is intersected by water-holes and ditches, many of which are choked with filth and decayed vegetation.

The population of the district numbers 1,719,539, including about 6,000 non-Aryan or aboriginal people, Muneepoories, Cacharees, and settlers from the southern hills. Of these the Muneepoories are the most numerous, and are readily recognised by their Tartar faces and fair complexion; but the great mass of the inhabitants are not to be distinguished from the ordinary Hindoos and Mahomedans of Eastern Bengal.

Rice is the staple crop of the district, and may be grown wherever the land is not permanently inundated. The soil is a blue clay, turning to black on the borders of the ‘bheels’ (permanent sheets of water). The teelahs are composed of sandstone rock, the upper portion of which has assumed a disintegrated con-

¹ See Dr. Matthew, in *Sanitary Report* of the Province for 1878.

dition. The oranges for which, in India, Sylhet is famous, are grown upon the limestone strata of the lower Cossyah hills, and it is thence also that 'Sylhet lime,' so much in request in Lower Bengal for building purposes, is brought.

Climate. The climate of Sylhet is characterised by excessive humidity; it resembles that of Lower Bengal, but is more equable, more moderate in temperature, and therefore more healthy. The prevalent winds throughout the year are from the north-east. At the commencement of the rains west or south-west winds prevail for a short time. The rainfall averages 154 inches per year, and in some years reaches 200 inches. During lulls in the rainy season, the weather is often oppressive and trying. Hardly can there be said to be a cold season.

The following table of the temperature at Sylhet is compiled from the reports of the Civil Surgeon for 1872-74. The table of rainfall is from Mr. Blandford's report for 1875.

	Mean temperature of the month	Mean of maximum	Mean of minimum	Mean daily range	Rainfall 16-20 years
January	64°	74°	54°	20°	·34
February	68	76	59	17	1·56
March	75	83	67	16	5·31
April	79	85	72	13	15·
May	80	86	74	12	22·09
June	81	86	77	9	32·15
July	82	86	78	8	25·72
August	82	86	77	9	25·08
September	82	86	77	9	17·67
October	81	87	76	11	8·69
November	74	82	66	16	·57
December	69	75	61	14	·13
The year	76·4				154·31

Diseases. The prevailing diseases of the district are malarious fever, chiefly of the intermittent type, and its sequelæ, diarrhœa and dysentery, cholera, small-pox, and chronic rheumatism.

Statistics of disease and mortality, even when taken from selected areas in the district, are often very untrustworthy; the latest which have been published are included in the table at p. 161.

Skin diseases are very prevalent in Sylhet; elephantiasis is frequently met with; leprosy is not very common; goitre is almost unknown.

Deputy Surgeon-General Buckle, writing in 1870, says Sylhet is a healthy station both for Europeans and natives, and the same

remark applies to most parts of the district. The unhealthiness that does present itself is due not so much to the climate as to the people themselves, whose habit it is, without regard to ventilation or the admission of fresh air, to surround their dwelling-places with a palisade of bamboos and jungle; while each house has but one reservoir of filthy water which is commonly used for the purposes both of drinking and bathing in. There is no lack, however, of readily accessible and good water in the district, for the bulk of the population is located in villages built on the banks of running streams; unfortunately, habit, idleness, carelessness, too commonly lead to the use of the foul supply from the tanks. Dr. de Renzy, writing in 1878, seems to question the healthiness of the station of Sylhet, and points to its high death-rate as proof of its insanitary condition.¹

*Cachar.*² The district of Cachar extends from the Serispore hills on the west to the Muneepore hills on the east, a distance of about thirty-five miles; while from the Naga hills on the north to the Lushai or Tipperah hills on the south the distance is about fifty miles. Low spurs, offshoots from these ranges, run north and south, breaking the district up into numerous rich alluvial valleys, which are for the most part parallel, and are drained by tributaries of the Barak river. The hills to the north and east are the highest, varying from 2,500 to 6,000 feet in height; those to the south average about 2,000 feet; and the Serispore hills to the east from 700 to 1,000 feet. The whole district is, geologically speaking, a valley excavated in the tertiaries which form the surrounding hills. All these ranges, high and low, are covered with forest and dense jungle, excepting where very partial clearances have been made by the tea-planter, or by the natives for their crops; and though cultivation is rapidly spreading, about nineteen-twentieths of the land is still an unreclaimed waste. The lower portions of the country, which are inundated during the rains, are covered with forests of gigantic reeds. Rice is the principal crop in Cachar, but a good deal of mustard is also grown.

The principal river is the Barak, which rises amongst the Muneepore hills, and flowing northwards, forms for some distance the boundary between Muneepore and Cachar; it there meets the Jeeree, coming from the opposite direction, and the combined stream finally takes a westerly course, receiving on the way many

¹ *Sanitary Report of the Province of Assam*, 1878, p. 18.

² For statistics, see table at p. 161.

small tributaries from north and south. One of the principal of these is the Sonai, which drains the valley between two of the southern ranges of Cachar, and flows into the Barak just at the place where that river makes a peculiar U-shaped bend, as if for the purpose of receiving it.

The civil station, Silchar, north lat. $24^{\circ} 49'$, east long. $92^{\circ} 50'$, with a population of 3,729 souls, is situated at about the centre of the district, upon the south bank of the Barak river, on an alluvial plain raised only 88 feet above the level of the sea. Ridges of low, forest-clad hills run southward from the river at intervals of six or eight miles, and the intervening plains, reaching close up to the station, are under water during the rains. The cantonment is on an elevated ridge, surrounded by swamps which are partially covered with water during a great portion of the year; and even within the cantonment is the site of a large, and till recently very offensive jheel, now filled up, leaving only a tank in the centre. The soil is for the upper three feet sandy, then loam for about twelve feet, then three or four feet of laterite, and then again loam.

The water supply is mainly derived from wells and is fairly good; the following are the analysed results of the water from two of the wells which were made by Surgeon Moriarty¹ in the cold season of 1873.

	Hardness in degrees, Clarke's scale		Solids as milligrammes per litre		Chlorine as milligrammes per litre	Total oxidisable organic matter in milligrammes per litre
	Total	Per-manent	Total	Fire-proof		
Old well, right wing	9°·8	7°·35	80	80	22·72	·62 of oxygen required
Old well, left wing.	14°·35	10°·85	100	80	26·3	·74 „ „

Sickness amongst the troops stationed at Silchar is chiefly due to fever, and most of it is of a serious nature, owing to the unhealthiness of the outposts on the Looshai frontier. Dr. Moriarty, in his report for 1874, says: 'In October the detachment from Monierkhale might fairly have been marched bodily into hospital. The majority of the men had enlarged spleen and some enlarged liver, while all had that peculiar earthy appearance, muddy lips, jaundiced eye, white tongue, and depression of spirits, so characteristic of prolonged exposure to the poison of malaria.' Statistics of disease amongst the troops are given in the table at p. 84.

¹ *Medical Report on Native Army of Bengal, 1874.*

Dr. de Renzy¹ gives a very unfavourable account of the civil station, especially of that portion of it inhabited by the natives; the greater part of whom 'reside in a swamp,' and drink the water of foul tanks. As might be expected, they suffer much from dysentery and diarrhoea.

The population of Cachar is 240,027, including from 30,000 to 40,000 imported Bengali labourers attached to the tea-gardens, and a large proportion of Muneepoories, Cacharees, and Kookies from the Lushai hills. The Muneepoories, from the country to the east of Cachar, number 25,000, and are either emigrants or descendants of emigrants. A purely agricultural people of Mongolian descent, they for many years acted as the pioneers of cultivation in the district, clearing the jungle, cultivating the land, and remaining there till a demand for revenue being made they moved off, leaving the fruits of their labours to the Bengalees who followed them. Of late, however, they have discovered that this system is an unprofitable one, and have become settlers on their own account. The women of the tribe are more industrious than the men, and work hard in the fields besides attending to their proper indoor duties.

Climate. The climate is on the whole not unlike that of Eastern Bengal, but less hot. The evaporation from the forest-covered hills, from the jheels, and from the numerous rivers, keeps the atmosphere throughout the year in a high degree of humidity and moderates the temperature. The year may be divided into cold and rainy seasons. The cold season, which extends from the middle or end of October to the beginning of April, is very pleasant, with a clear sky and a frequent bracing wind from the north-east. The drawback to this season is the constant occurrence of cold damp fogs, to which, says Dr. Moriarty,² is attributable the increase of pulmonary and rheumatic affections which takes place towards the end of the year. The rainy season extends from April to the middle of October, but even as early as February there is usually a considerable fall of rain. During this season the range of temperature is small, though greater than in Sylhet, as indeed it is throughout the whole of the year. The prevailing winds are from the east and north-east, often changing in the afternoon to the south-west, excepting during the height of the monsoon, when westerly winds prevail. Table V. in the Appendix exhibits the meteorological data of the civil station, Silchar.

¹ *Sanitary Report* for 1878, p. 18.

² *Medical and Sanitary Report of the Native Army of Bengal*, 1873.

The European residents, both at the station and in the district, enjoy good health, and the same may be said of the police and sepoy, excepting as already stated in the case of those who are stationed at outposts in the uncleared malarious tracts at the foot of the hills.

As regards the diseases ¹ of the district, cholera occurs throughout the year, and at various times has caused great ravages. The subdivision of Hylakandy appears to be most liable to this disease, and according to the belief of the people it is so because of its proximity to the district of Sylhet where the complaint is endemic. It generally prevails much more in the hot season than in the cold, April, May, and June being the worst months, while a heavy fall of rain usually checks the ravages of the disease. Small-pox causes but few deaths in the district. Bowel complaints add little to the registered mortality, but it must be remembered that registration here as in Sylhet is very untrustworthy. Malarious fever and enlargement of the spleen are common in the district, but the fever is not usually of a dangerous character, except in October and November, when a bad type of remittent fever with cerebral complications is apt to occur. Bowel complaints, intestinal worms, and cutaneous diseases, are amongst the common complaints to which the people are subject.

As regards goitre in the district, special reports on the subject by Dr. Moriarty, and by Dr. Monteath, the Civil Surgeon, show that the disease is very much localised. The place where it prevails chiefly is Banskandy, on the Barak, about eight miles to the west of Silchar, just at the bend of this river, where, as has already been mentioned, the Sonai river falls in. The disease is also found in villages along the banks of the latter river. The Sonai rises in the Looshai hills, and in its course to join the Barak runs between two low ranges of hills, through a narrow valley which for the greater part is covered with forests and swamps. The Banskandy valley itself lies very low; indeed it may be looked on as the lowest, central, valley of Cachar, and is surrounded on all sides by hills. The soil is alluvial earth resting on sand, resembling the other inhabited parts of Cachar, from which moreover it does not differ in climate. Nor is the locality otherwise by any means an unhealthy one; indeed malarious fever is less prevalent than in many other places in the district. Goitre in Banskandy, and in the villages along the Sonai, is almost confined to Mussulman Muneepoories, and among them with few exceptions to females. These Muneepoories

¹ See table at p. 161.

are for the most part well-to-do people, well clothed, living in good houses, situated in pleasant villages. They make use for drinking purposes of the same river water which is also drunk by thousands of people along the banks amongst whom the disease is unknown, and Dr. Monteath remarks that he is at a loss to understand why this disease should be thus prevalent among the people in this particular locality.

*Muneeopore.*¹ To the east of the Surma valley, but separated from it by many ranges of hills, is the circumscribed valley of Muneeopore, the seat of the Government of an independent state of that name. Though beyond British territory a brief notice of the valley may be interesting, as in point of climate and the healthiness of its inhabitants, it contrasts favourably with the neighbouring valleys of Assam and Cachar.

The Muneeopore state consists of the valley of that name, the area of which is about 650 square miles, and the surrounding hill country, making up the total area to between 7,000 and 8,000 square miles. The valley is situated almost in the centre of the large tract of mountain country which extends between Cachar and Upper Burmah.

The capital of the state is about seventy miles due east from Silchar, and is connected with that station by a road of tedious length which passes across the Hoorung range of hills to the Jeeree river, the boundary of British territory, and thence across six other ranges of hills, with intervening valleys, to the Simatol range, which attains to a height of about 4,900 feet above sea-level, and overlooks the valley of Muneeopore.

As regards the structure of these hills, on the lower heights friable brown sandstone and ferruginous clay are found. At a higher elevation slate, stratified in thin layers.²

Immediately on crossing the ridge of the Simatol range, a view of the valley, 2,500 feet below, is obtained; the intervening slopes of the hills are destitute of tree jungle, and are either bare or covered with grass.

The object which first prominently presents itself is the Logtak Lake, lying in front and to the right, with the low bare hills which skirt it reflected on its surface. In the cold weather, when all vegetation is comparatively dried up, the general aspect of the valley is far from inviting. To the south of the lake, up to the

¹ *Report on Muneeopore*, by Dr. R. Brown, Political Agent; selections from records of the Government of India, Foreign Department, No. 78.

² *Administrative Report of Assam*, 1874-76, p. 5.

boundary of the hills, the land is almost uncultivated, and is covered with grass jungle. In the distance to the north, in a corner, as it were, under the hills, lies the capital of the state; and here the country is well wooded, and more densely populated than elsewhere. Several rivers from the north and west are seen entering the lake, from which they emerge in one stream at its southern end.

The general shape of the valley is that of an irregular oval, the length of which is about thirty-six miles, and at its greatest breadth about twenty; the level falling steadily to the south. In this direction lies the lake, a large piece of water, the area of which is yearly lessening; indeed, the tradition is that the lake at one time occupied the whole floor of the valley. Other lake-like sheets of water of smaller area also exist in various parts of the valley.

The hills to the east and north are from 5,000 to 6,000 feet in height, while those to the south have a less elevation.

Within the boundaries of the hills the scenery is at its best uninteresting and monotonous, being composed of rice fields, swamps, small rivers, bamboo clumps, low barren elevations, and common-looking villages. The soil, which consists of a blackish loam, is of excellent quality and of great depth in the valley, but on the low hills it is poor, of a clayey nature, and full of pebbles. Lime is found in places about the valley, but not actually in it. Salt is obtained from salt-wells in the valley; the water of one of these yielded Dr. Brown a little more than 2 per cent. by weight of very pure salt.

The chief vegetable productions are rice, wheat in the cold weather in small quantity, pulses, pepper, onions, tobacco, and sugarcane. English vegetables grow well. The fruits are plantains, mangoes, pine-apples, plums, and peaches. Palm-trees are quite unknown.

The climate, situated as the valley is, 2,500 feet above sea-level, is cooler than that of Cachar. During the hottest weather the nights and mornings are pleasant in temperature, and the breezes are so delightfully fresh and cool that punkahs are not used or required.

In the cold weather fogs are a common occurrence, especially in the swampy ground to the south of the valley; they do not, however, last long, disappearing usually about 9 P.M. Hoar-frost may be seen in the early morning, but the temperature does not fall sufficiently low to freeze the surface even of the shallow pools. The rainfall is considerably less than that of the neighbouring district of Cachar.

Thunderstorms and violent winds are very uncommon. The

prevailing wind is from the south-west, and it blows with a remarkable steadiness which seldom varies throughout the year. The following table of temperature and rainfall is taken from the official report of the Resident for 1875.

	Mean temperature	Rainfall in inches
July, 1874	85°	4·3
August	83	4·1
September	84	2·1
October	83	2·8
November	73	·3
December	66	—
January, 1875	63	1·5
February	72	·3
March	78	5·4
April	81	2·1
May	83	4·4
June	82	8·8
The year	79·5°	36·1

Maximum temperature in July 85°. Minimum in December 41.

The population of the valley is about 60,000, and of the hill district about 70,000. The bulk of the people, judging from their facial characteristics, are of the same stock as the Nagas and other surrounding hill tribes.

The houses of the Muneepoories are of wood and bamboos, plastered with mud, resembling those of the people in Cachar. Their habits generally are cleanly; they bathe frequently, and keep their houses clean. Their diet is the same as that of the natives of Eastern Bengal.

Diseases. The valley of Muneepore is decidedly healthy, and many forms of disease common in Bengal and Hindostan appear quite unknown there. This healthiness is evidenced by the large proportion of aged people met with in the country. Small-pox is common, but is remarkably mild in character. Inoculation is but little practised, and vaccination is little known or little valued. Cholera occasionally prevails in an epidemic form, introduced apparently from Cachar, but it is a milder disease in Muneepore than in Bengal, and recoveries are frequent. Fevers are prevalent, especially during August and September, but they are of a mild type. Splenic enlargement is rare. Goitre, Dr. Brown writes, he has never seen there. Leprosy is extremely rare; so also is madness in any form, probably because gunja and other noxious drugs are not used in the country. Eye diseases are few and uncommon. Phthisis does not seem to have any existence in the valley. Skin diseases are not so common as in Bengal, and chiefly affect the young; while all kinds of deformities are of very rare occurrence.

CHAPTER XIV.

NORTHERN BENGAL.

Districts of Northern Bengal: *Rungpore*, *Dinagepore*, *Julpigoree*, *Darjeeling*. Description of each district; their climate, diseases. Extreme unhealthiness of Rungpore; alliance of goitre and malarious diseases recognised by the district medical officers. Dr. Ghose's notes on leprosy in Rungpore. *Dinagepore*; goitre in the district; Dr. Hamilton Buchanan associates goitre and elephantiasis. *Julpigoree*; goitre in the district; *Western Dooars*; *Buxa Fort*; goitre and other diseases amongst troops at Buxa. *Darjeeling*; the district, the station; goitre in the district; Dr. Purves on intestinal worms amongst the people.

RUNGPORE. The Rungpore district lies along the western bank of the Brahmapootra, between Bogra on the south and Kooch Behar on the north; on the west it is bounded by the districts of Julpigoree and Dinagepore. The total area of the district is 3,746 miles, and the population 619 to the square mile.¹ The bulk of the people are of Aryan descent, Hindoos and Mahomedans; their chief employment is agriculture. Rice is the staple crop of the district, but oil seeds, tobacco, jute, and indigo are also largely grown. The people are well fed, and might be said to be well housed if it were not for the dirt which defiles the surroundings of every dwelling.

The surface of the district is an almost perfect level, with a general slope in the direction of its greatest length, that is from north-east to south-west. It is well watered, being traversed by many great rivers on their way to the Brahmapootra; notably on the north-eastern angle by the Rungbursotee and Durlah, and centrally throughout its length from north-west to south-east by the Teesta; in every direction also it is intersected by minor streams, and is studded with innumerable marshes and stagnant sheets of water, which have for the most part been formed in deserted river channels.

The face of the northern portion of the district has been ravaged by frequent changes in the course of the Teesta river, and

¹ See table at p. 132.

abounds in vast sandy plains with low loam and clay rice lands. In the south-eastern portion is a vast extent of chur land which has been formed in the neighbourhood of the confluence of the Teesta and Durlah rivers with the Brahmapootra. Rungpore, the civil station, is situated nearly in the centre of the district, seventy-four feet above sea-level, $25^{\circ}44'55''$ north lat., $89^{\circ}17'40''$ east long., on the north bank of the old bed of the Ghagut river, which now presents a series of stagnant pools. To the north of the town are extensive jheels. The town is a very unhealthy one, but this may be said of the whole of Rungpore. 'The district,' says the Sanitary Commissioner,¹ 'is notoriously unhealthy.' Dr. Ghose, the Civil Surgeon, took steps this year to ascertain the state of the health of the people in different parts of the district. He found on an average that 80 per cent. were anæmic, or suffering from enlarged spleen, or were laid up with illness. Of the 20 per cent. found healthy, one half could not be considered so in the European sense of the word, and they were mostly women, who are less exposed to out-door influences.' The rich were also similarly circumstanced; consequently the unhealthiness of the district is not due to poverty or privation, but is caused, says Dr. Ghose, by something in the air or water, alike in his opinion tainted with some poisonous matter the product of the decomposition of vegetable substances. Mr. Bowser,² a former Civil Surgeon, writes: I consider the district exceedingly malarious. The rate of mortality, especially from fevers, is great. The complications are spleen and bronchocele. In thousands of post-mortem examinations I have always found the spleen larger than the normal size. The water, writes Mr. Bowser, is very unwholesome, and that in the tanks and wells is open to every kind of pollution.

Diseases. It is beyond doubt that malarious fevers are the principal diseases of the district; a severe remittent type is very common. Dr. Ghose, in the report already quoted, states that fevers form eight out of ten cases of disease in the country, and 85 out of 100 deaths are caused by that scourge. The fever period is during and after the rains.

Cholera is endemic in the district, and has its periods of unaccountable prevalence. It is a significant fact, writes the Sanitary Commissioner, that³ during epidemic prevalences sporadic cases occur throughout the district.

¹ *Bengal Sanitary Report* for 1874, p. 55.

² *Ibid.* for 1876, p. 27.

³ *Ibid.* for 1868, p. 202.

Bowel complaints are very prevalent and very fatal; small-pox is giving way to vaccination. Statistics of disease amongst the civil population and the prisoners in jail will be found in the tables at pp. 99 and 132.

Goitre also is prevalent throughout the district. The banks of flowing rivers, says Dr. Ghose,¹ are 'comparatively healthy as regards fevers and dysentery, although they are the favourite sites of cholera, goitre, and cretinism.' He does not think (special report) that age, temperament, or habit of body influence the development of the disease, but rich and well-to-do people seldom suffer; this because, as Dr. Ghose thinks, they are careful as to the water they drink, avoiding that of the rivers. The disease is met with most commonly amongst females; children also often suffer. Dr. Ghose met with one case of a child born with a small tumour.

The association of goitre with malarious diseases in Rungpore is very striking: thus we find one medical officer of the district classing it with spleen as a complication of fever, and another placing it among the malarious disorders, which, together with leprosy, are exceedingly prevalent in certain tracts of the district. The analysis of Teesta water given in the table at p. 22 shows that the water contains a very moderate amount of earthy bases.

Leprosy is very prevalent in Rungpore, and the sanitary report for 1877 includes an interesting report by Dr. Ghose on the circumstances under which the disease prevails there. Dr. Ghose calculates that, taking the whole district, 6 per 1,000 of the population are afflicted with one form or other of the malady. An area of extreme prevalence, in which 11·2 per 1,000 of the population suffer, lies to the north-west and west of the civil station, between the rivers Durlah and Teesta. A second tract, in which the average is still above that of the district, viz. 7·2 per 1,000, is a large portion of country which almost surrounds the area of extreme prevalence, 'extending south and east towards the whole border of the Brahmapootra which lies in the district.' Tracts in which the prevalence of the disease is below that of the average are found in the south and south-west parts of the district, and in the north-west corner between the Rungbursotee and the Durlah.

The tracts of extreme prevalence and of comparative immunity, both as respects their physical features and the characteristics of

¹ *Report for 1874.*

their inhabitants, present marked differences, which Dr. Ghose tabulates as follows :—

Points in which they differ	Tract of extreme prevalence	Tract of comparative immunity
Soil	Almost pure alluvial deposit, with here and there sandy loam.	Hard red laterite soil
Physical features	Abounding in marshes and old river beds of meandering hill streams. Most part of it flooded during the rains. Uncultivated bits overgrown with high and dense jungle. Tolerably high patches are met with which yield a variety of crops.	Extensive level plain, covered with paddy, with here and there wastes grown over with ant-hills. The only cultivation is that of paddy.
Character and condition of people	The semi-aboriginal races converted to Mahomedanism or assimilated with the low caste Hindus. The chief occupation agriculture or fishing, and often both, and in this occupation are much exposed to wet and rain and exhalations of marshes. Extremely home-loving, simple in their habits, very lazy, living in wretchedly built mat or grass huts. They live almost exclusively on rice and fish. They export their fresh fish to better markets in the western part of the district, and even to Dinagepore, and themselves live on the dried fish imported from Sylhet and other places. They are miserably clothed.	The people have a much greater Aryan mixture. Given to other pursuits besides agriculture. Trade pretty active. The rice they get in abundance is exported. They move about more and seem more civilised. The huts are better built and the soil admits of the erection of dry mud walls in them. Their food is more varied, and they use more clothing.
Prevalence or otherwise of other diseases	Diseases of a malarious nature extremely common. Pulmonary phthisis and scrofula prevail to a very great extent, and the skin diseases of parasitic nature and of the squamous variety are very common. Goitre and cholera are endemic.	This tract is not so malarious as the other. Phthisis and scrofula less common, and parasitic skin affections are not prevalent. Goitre rarely seen. Cholera breaks out in epidemics, but does not exist throughout the year.

Dr. Ghose proceeds:—‘ During my travels of inquiry I found the disease more common towards the rivers than in villages far removed from them ; but when the immediate banks are high, it is almost altogether absent from them. A marked contrast of this kind I observed in one part of the river Teesta. Either bank here is inhabited by Hindus of the fishing castes, but being of different sub-castes they do not intermarry or mix in any way. They follow the same occupation and live otherwise under similar circumstances. Among those fishermen on the left bank I could not

find a single case, whereas among those on the right bank, numbering about eighty individuals, there were six lepers. In the laterite tract the majority of the lepers that I found were inhabitants of the alluvial portions of the tract. The villages where I found the disease most prevalent are either on the banks of a river or surrounded by marshes and old river-beds. Dry and high spots, whether near a river or not, enjoy a marked immunity from the disease. Other skin diseases, such as itch, ringworm, and psoriasis of chronic character, are very common in villages where lepers are found. The food-supply in these villages is defective. There is little or no variety in it. They are badly supplied with markets, and the people as a rule live on the rice they cultivate, and consume a large quantity of imperfectly dried fish, as well as the small fish found in bheels which are unfit for purposes of export. Their houses are low mat huts, surrounded by dense jungle and clumps of bamboos. These latter overhanging the yards exclude the sun from them. In the occupation of fishing these people often immerse themselves in muddy water and smear themselves with mud for hours, and pass sometimes a whole day in wet clothes. This constant contact of water with the skin I fancy has much influence in the production of the disease. It undoubtedly is a potent cause of the other skin diseases I found prevalent in these villages. In fact, the atmosphere charged with vapour, their occupation requiring constant immersion in water, their damp ill-ventilated habitations, and the want of clothing, all tend to interfere with the healthy functions of the skin. The people in these villages seemed to be extremely fond of their homes and never emigrated. The population of a whole village I sometimes found related to each other, married and intermarried among themselves and lived and died in it. I found a number of old people who told me that they never spent a night away from home. The low caste Hindus I found suffer more than the Mohamedans or Aryan Hindus, and among the Hindus, *Jalias* (fishermen), and Rajbunghias, a Hinduised aboriginal tribe, given exclusively to agricultural pursuits, suffer a great deal more than men of other castes.

Of the 378 cases which Dr. Ghose examined, and of which he took notes, 253 were males and 125 females, 286 were Hindoos and 92 Mussulmans. By occupation 198 were agriculturists, 56 fishermen, 15 boatmen, 78 beggars, the rest artisans, clerks, servants, &c.

In only eleven cases could Dr. Ghose trace *heredity*, but he has no doubt that others either concealed the truth or were ignorant of the circumstances of their ancestors.

As regards the evidence of origin by contagion, Dr. Ghose writes: 'One cannot look into the circumstances of the origin of the disease in several of these cases without believing in contagion. That personal contact alone will not cause the disease is evident; but it may be said to be contagious in the same sense as typhoid fever or cholera is contagious, though not to the same degree. There is strong presumption that the malady is due to a *contagium* or communicable germ, which takes root and flourishes under favourable circumstances, and these favourable circumstances are climate, soil, and other hygienic conditions. These conditions alone cannot produce the disease, as under similar circumstances the disease does not originate. Again, where the hygienic conditions are good, the disease, if introduced, will not spread, as it does not in some parts of the district, although so close to others infected with it. Numbers of cases came to my notice in which the leprous individual remembered having lived in close proximity to some one else affected, or had distant relationship with other lepers; but there were thirty-three cases in which the persons lived in the same house with other lepers before getting it. In four of these thirty-three cases there was sexual intercourse with leprous individuals before the attack. In one village I found six individuals in different stages of the disease more or less related to each other, and having constant contact. A woman got leprosy first from a leprous husband who lived in another village. Her parents were not leprous. After her husband's death she came to live with her brother, and before she was a year in the house he got the disease. In course of six years three other individuals in the neighbouring houses were affected. The oldest individual in this village assured me that before the woman returned home, after her husband's death, he had not seen a leper in that village.'

Climate. The climate of Rungpore is very damp, the rains are heavy, and subsoil water has a high level, about ten feet from the surface in the dry season; in respect of temperature it is cooler, and the variations are more extreme than that of Bogra and Pubna. Westerly winds prevail from February to the middle of April, when easterly winds, often alternating with southerly, set in. The following table of monthly mean temperature (at the civil station) is compiled from the records in the Surgeon-General's office. The rainfall is from the report of the Meteorological Reporter for 1875.

	Mean temperature Average of 3 years	Rainfall in inches 14-16 years
January	58°	·36
February	60	·33
March	68	·97
April	73	3·1
May	76	9·59
June	78	22·09
July	79	17·25
August	80	13·19
September	80	11·69
October	77	4·98
November	70	·26
December	62	·12
The year	71·7	83·93

Dinagepore. The district of Dinagepore lies to the north of Bogra, Rajshahye, and Maldah, along the western border of Rungpore. Its area is 4,126 square miles, and its population 364 to the square mile.

The civil station Dinagepore is situated in a central position in the district, on the left bank of the Poornabudda river, about 180 feet above sea-level, 25° 38' north lat., 88° 40' 46" east long. The native town, which is contiguous to the civil station, is a very unhealthy one, owing it is thought to the combined influences of the neighbouring marshy land, the dead river Gogra, foul streams, and many ill-kept tanks.

The district is little elevated above sea-level, but it is not perfectly flat, for while parts of it are so low and consequently so deeply inundated as to be considered unfit for cultivation, other parts, especially the northern, rise into undulations one hundred feet or so above the general level; low undulations are also present in the southern portion of the district. Numerous rivers, great and small, all, however, with a general course towards the Ganges, intersect the district in every direction. The Teesta formerly flowed through the district, emptying itself into the Ganges, but in 1789, during a great storm and flood, it suddenly changed its course and found its way through Rungpore into the Brahmapootra. Since that event many of the rivers have diminished considerably in volume, while others have silted up, leaving scattered through the district long stagnant pools or marshes. In addition to the natural watercourses, the southern portion of Dinagepore is intersected by deep ditches which must have been the work of centuries and seem to have been dug with a threefold purpose—to raise the level for the growth of sugarcane, to protect

the crops from stray cattle, and for the sake of the black mud which in the rains accumulates in them and is a valuable manure.

Another noticeable feature in the same part of the district is the multitude of tanks; in an area of 673 square miles as many as 10,638, sufficiently large to appear in the survey map, were counted, a number altogether in excess of the wants of the neighbourhood. In some places indeed a dozen disused tanks may be seen huddled together, choked with rank vegetation, the home, says Major Sherwill, of wild beasts and malaria.¹ In ² the northern portion of the district the land is higher and sandy in character, the country more open, freer from jungle and swamps, and there the villages are larger and the people more healthy than in the southern portion. The population is almost entirely an agricultural one, a miserably puny, timid race, enfeebled by indolence, early marriages, and above all by the unhealthiness of the climate; yet, because their wants are few and easily supplied, the people are in fairly easy circumstances and independent, though not rich. They are of Aryan descent; the aborigines in the district are few in number. The main production of the district is rice, but oil seeds, dhāl, vegetables, and tobacco are also largely grown.

Climate. The following table of monthly mean temperature at the civil station of Dinagepore is from Messrs. Schlagintweit's work. The table of rainfall, average of fifteen years, is from the report of the Meteorological Reporter with the Government of India, 1875.

	Mean Temperature	Rainfall in inches
January	63°	·22
February	68·5	·68
March	80	·75
April	87	2·57
May	90	7·43
June	80·5	18·84
July	83·5	16·09
August	81·5	13·41
September	81·5	12·75
October	80	5·98
November	72	·15
December	66	·04
The year	77·8	78·92

The climate is cooler than that of the southern districts of Bengal, the cold weather lasting longer, and the nights continuing pleasant and cool till the end of April. Dry, hot westerly winds are felt in April and May, and the latter month is very hot and

¹ Major Sherwill, in *Report on Survey of Dinagepore*.

² Beds of kunkur are very common throughout the district.

oppressive. Light rains usually fall in May, and early in June the heavy rains commence and last till the middle or end of September. At this period the prevalent winds are from the south-east. The rains are heavy, and during their continuance the rivers overflow their banks and freely inundate the surrounding country, especially the southern portion. After the cessation of the heavy rains, the weather is steamy and oppressive until the cold weather fairly sets in about the middle of November. During the cold season heavy dew falls at night, and fogs and mists prevail in the early mornings.

Diseases of the district. Cholera is endemic in the district, and outbreaks of this disease are very frequent. On the subject of cholera in Dinagepore the Sanitary¹ Commissioner writes: 'Wherever the disease prevailed the water supply was either scanty or impure, taken from tanks fouled by surface pollution, sewage contamination, decaying vegetation, and decomposing animal matters; in fact the generally insanitary condition throughout this badly drained district, and the generally broken health of the people from malarious poisoning, have been the chief predisposing causes of the disease.' Small-pox, formerly very fatal in the district, is now, thanks to the energetic action of the Government vaccine establishment, far less prevalent than formerly. Bowel complaints are very common and very fatal amongst the poorer classes, especially from the end of the rains up till the end of the year. Leprosy is common in the district.

Malarious fevers and their complications are the cause of the greatest mortality in the district. The part that suffers most is that in the south-east of the district, where marshes are numerous and the Poornabudda river inundates very extensively. Dr. Hamilton Buchanan writes,² 'Fever makes such ample havoc in the district that little room seems left for other diseases.' He reports skin diseases and elephantiasis as being very common, also that goitre is common in some parts of the district, near certain rivers. 'The progress of the disease,' says Dr. Buchanan, 'is nearly the same with that of elephantiasis, but the fever and pain is never so considerable, and the former indeed is often imperceptible.' The natives, he says, consider the two diseases as species of the same genus, and, he thinks, with perfect accuracy. Dr. Buchanan, in his notice of the disease in Dinagepore, refers only to the larger tumours called by the natives 'Gologundo,' in distinction from the smaller tumours called 'Ghega.'

¹ *Bengal Report* for 1877, p. 38.

² *Survey of Eastern Bengal*, 1807-1815.

Doubtless in his day as at the present time, the latter were commonly to be met with throughout the greater portion of the district. They are, however, of more common occurrence in the northern parts than in the open rice-plains of the south.¹

*Julpigoree,*² *Buxa*. On the north of Rungpore and Dinagepore, and between those districts and the base of the Himalayas, lie the native state of Cooch Behar, and the district of Julpigoree. The latter extends along the foot of the hills from the border of Gawalparah on the east to Darjeeling on the west, and then, in a southerly direction, into the plains between Rungpore and Dinagepore. The district thus assumes the shape of an arm, which embraces Cooch Behar; its total area is 2,906 square miles, and its population 144 to the square mile. The northern part of the district has a very considerable slope to the south; thus the difference in level between the foot of the hills and the civil station of Julpigoree, thirty-six miles distant, is nearly 1,000 feet. Moreover, the southern portion of the district slopes on one side pretty rapidly towards the Brahmapootra, and on the other more gradually towards the Ganges. The general surface is level, and is intersected by a few large and by numerous small streams. Owing to the considerable slope of the country there is but little marsh or stagnant water in the district. The soil is light and gravelly, so light as to render the use of an iron plough unnecessary. Rice is the crop most largely cultivated in the district. Oil-seeds, pulses, Indian corn, and tobacco are also extensively grown.

The bulk of the people are of Aryan origin, but the aboriginal and semi-aboriginal population is pretty numerous. The people are chiefly agriculturists, and as the land is easily cultivated and rents are low, their material condition is very satisfactory.

That portion of Julpigoree which intervenes between Cooch Behar and the hills, was formerly known as the Western Dooars. It is a flat strip of country, about 60 miles in length and 25 in breadth; the greater part of it is uncultivated and covered with grass jungle; not far from its eastern border is the hill fort of Buxa, an important military post.

Julpigoree (26° 32' 20" north lat., 88° 45' 38" east long.), the civil station and a military post, is situated on the west bank of the Teesta, considerably above the flood-level of the river, but the

¹ *Special Report* by Dr. Lidderdale, Superintendent of Vaccination.

² For this account of Julpigoree I am much indebted to a report (Appendix of *Report of Sanitary Commissioner for Bengal*), by Surgeon Kenneth McLeod, M.D., late Civil Surgeon of the district.

country around is low, subject to inundation, and is for the most part under rice cultivation, while some ten miles to the north-east lies a considerable area of forest land. Yet, adverse as the surrounding circumstances apparently are, the station is a healthy one, for it stands on a dry sandy soil and is well drained, the barracks are raised from the ground on piles, and the river, here a broad rapid clear stream, flowing in a sandy bed, intervenes between it and the jungly country to the north.

The supply of drinking water for the troops is taken from the Teesta, and is naturally excellent; but its purity is said to be somewhat endangered by the impure discharge of a stream which separates the cantonments from the native town, and after draining the latter opens into the Teesta some 300 yards above the barracks.

Climate. The climate is damp throughout the year, and moderately cool; the range of temperature, diurnal and seasonal, is considerable. Owing to the proximity to the hills, the rains are heavy, averaging at the civil station 128 inches annually; they commence in June and last till the end of September. During that period the atmosphere is cool and clear, and the station of Julpigoree is enjoyable and healthy; the general direction of the wind is from the east with a southerly tendency. Towards the end of September the weather is apt to become muggy and disagreeable, and so continues till the beginning of the cold weather in November. The latter season is pleasant and bracing, notwithstanding the dampness of the atmosphere. The range of temperature is at this time great, heavy falls of dew are frequent, and foggy, misty weather is common. The wind is, as a rule, northerly, but in the afternoon it often veers round to the south. In March the days begin to get hot, but the temperature of the hot season is very bearable; even in May there are but few days of extreme heat, while frequent thunderstorms cool the air, and a strong easterly wind blows all day. The mornings and evenings are cool, and a punkah is seldom needed at night in the hottest weather.

The following table of temperature for 1872, an average year, is from the 'Medical Report of the Native Army' for 1872. Average rainfall is shown in the table in the Appendix.

January	61	August	81
February	65	September	80
March	73·5	October	76
April	78	November	70
May	80	December	64
June	82		
July	81	The year	74·5

Diseases. The climate of the station is favourable both to the European residents and to the native troops; the latter suffer chiefly from intermittent fever and dysentery, and to a less extent from diarrhoea and rheumatism, and also from goitre. The natives of the district also suffer from the same complaints; with them, however, fever is usually of a mild type, though often accompanied by enlargement of the spleen. Dr. McLeod comparing his experience in Jessore and Jalpigoree, has no hesitation in saying that the fevers of the latter district are the milder of the two; they are most rife towards the termination of the rains. Continued and remittent fever are rare, excepting in the Terai portion of the district, where fever is so severe that the villages are deserted during the rains, and detachments of troops garrisoning outposts in those parts have at times suffered fearfully.

Cholera is undoubtedly endemic in Jalpigoree, yet its visitations are not so constant nor so severe as in the more southern districts. Smallpox is less prevalent than formerly. Dysentery is very common, especially at the beginning of the cold weather.

Skin diseases are very common, and cases of leprosy and elephantiasis are met with, but not in very remarkable numbers.

Goitre is endemic, and is very prevalent amongst the natives. The number of cases treated at the dispensaries of the district is not indeed large, but the Civil Surgeon, in forwarding the statistics, remarks that the prevalency of the diseases is notoriously out of all proportion to the number so treated, for the reason, probably, that the form of goitre which prevails does not interfere with the common duties of life. The disease is especially prevalent along the banks of certain rivers, and is commonly ascribed by the natives to the use of river water, more particularly to that of the Teesta; they therefore prefer the foul water of their tanks and wells, and by so doing encounter the very danger which they are endeavouring to avoid.

Goitre is also endemic throughout Cooch Behar, more especially near the Terai, along the Kaljaneer river, and also in localities near the Teesta,¹ where, after the cessation of the floods, large churs and pools of stagnant water are left on the surface of the land.

Buxa Fort, in the Western Dooars which now form a part of the Jalpigoree district, is situated on a spur of the Tehinchula range of the Himalayas not far from the Gawalparah frontier. The Dooars is a level tract of country about twenty-five miles in

¹ *Special Report* from Civil Surgeon, 1872.

breadth, which runs along the base of the Bhootan hills from the Teesta eastwards. Of the whole area, not much more than fifty square miles are under cultivation; the remainder is mainly grass jungle. The fort of Buxa is situated beyond this stretch of jungle at an elevation of about 1,800 feet above sea-level, north lat. $26^{\circ} 40'$, east long. $82^{\circ} 35'$. Near the foot of the hills the land gradually rises to an upper plain about ten miles in breadth, called the Bhabur, or saul forest, a dry, stony, gravelly, unculturable tract of country, throughout which the watercourses are empty the greater portion of the year, the water sinking deep into the porous soil, to re-appear at the margin where the swampy Terai begins. Much of the Terai, unlike the Bhabur, is culturable, but its pestilential character drives away all settlers excepting the malaria-proof Mechis, Garrows, and Totos, who here and there cultivate a small piece of land.

The soil is a rich vegetable mould, resting on gravel, clay, and sandstone.

The Tchinchula range has here a northerly direction, and rises in the immediate vicinity of Buxa to a height of about 6,000 feet. The station is in a valley, between two spurs of the range, in which boulders and gravel, débris from the hills above, have accumulated to form the plateau on which the fort is built. Towards the north this plateau slopes gradually up to the base of the hills, but at its sides, and especially to the south, the gravel has been removed by mountain streams, so that in some parts the face is quite perpendicular, and small streams issue from it during the rains. Except to the south the station is surrounded by lofty hills, covered to their summits with dense tree and shrub jungle. The Tchinchula range is of well-stratified gneiss, thick beds of quartzite occurring in it, being even schistose in places. The eastern of the Buxa spurs is of this formation, but the western is of sandstone, having a light ochrey tint, coarse and micaceous, with here and there waterworn pebbles in strings.¹ Above the station and less than half a mile distant, is a large and very populous Bhooteah village, a most unfortunate situation, for the villagers are filthy in the extreme, and very subject to fever, dysentery, bowel complaints, small-pox and skin diseases, while together with other inhabitants of the neighbourhood they suffer much from goitre.

Climate. The climate of Buxa is mild, and very damp. The seasonal variations of temperature are not great. The year may

¹ Captain Godwin Austen, 'On the Sandstone formation near Buxa Fort,' *Journal of the Bengal Asiatic Society*, 1865.

be divided into two seasons, one cold, comparatively dry, and healthy, beginning in October and ending in March: the other moderately hot, though never sufficiently so to render the use of punkahs necessary, and intensely damp, with a temperature subject to great diurnal variation, dropping suddenly when rain falls from great heat to extreme chilliness. The annual rainfall is very heavy, averaging about 200 inches. The rains begin in April and increase rapidly till July, in which month the fall averages 61 inches; in September they may be said to cease, though not unfrequently heavy and frequent showers occur in October. During this period the air is saturated with moisture; and even during the comparatively dry cold season it contains so much that heavy dews are very frequent. The prevailing wind throughout the year is from the plains, either from the south-east or south-west; while each night a strong breeze sets down the hill, and lasts till sunrise; and it is this night wind, says one of the medical officers in charge at the station, which constitutes the chief reason of Buxa being habitable, for the elevation is so little above the expanse of Terai to the south that malaria would rise and accumulate in the station were it not swept out nightly by the northerly wind. The following table of temperature is calculated from observations (imperfect in some months) of the years 1873-74-75 and 77. The rainfall is the average of five years 1873-1877.¹

	Approximate mean	Maximum	Minimum	Rainfall in inches
January	58°	67°	47°	1·3
February	63	78	51	·4
March	69	81	57	1·7
April	72	85	65	10·3
May	74	83	66	17·9
June	75	84	70	46·3
July	77	84	72	41·
August	77	82	71	33·3
September	75	86	70	34·3
October	73	81	64	6·3
November	68	78	58	·4
December	62	71	51	·2
The year	70·	—	—	193·4

The water supply of the fort and the outlying pickets is from springs the yield of which is abundant,² clear and sparkling, and at

¹ For these data I am indebted to Kenneth McLeod, M.D., Secretary to the Surgeon-General, Fort William.

² Report by Deputy Surgeon-General J. B. Brown, *Medical and Sanitary Report of Native Army* for 1873.

the same time soft. Partial analyses of the water made in 1872 confirm the opinion of the medical officers as to the purity of the water; the results were as follows:—

	Total solids in parts per 1,000	Lime	Magnesia
Spring A	·056	·0157	·0058
„ B	·084	·0224	·01
„ C	·040	·011	·0036
Neighbouring stream	—	·017	—

*Diseases.*¹ Every corps arriving in Buxa seems to have to undergo a sort of acclimatising process, the result of which is that though in the first year the men are exceedingly unhealthy, yet during the second and succeeding years this unhealthy condition assumes much milder proportions. The dyspeptic and cachectic condition induced by the excessively damp and malarious climate, and the difficulty in procuring sufficient quantities of meat, vegetables, and milk in addition to the commissariat rations, combined with the monotony of life incidental to a station in the jungles, act depressingly on all ranks. In this low state of health all sores assume an unhealthy action with greater or less tendency to sloughing; and even leech and flea-bites, or in fact any slight abrasion of the skin, is sufficient to produce such sores. Fevers give far the largest number of admissions to hospital; then local injuries, such as contusions, wounds, blisters of the feet, flea-bites; and to these follow dysentery, goitre, diarrhœa, and rheumatism. The fevers of Buxa are of a very severe nature. Dysentery commonly yields to the use of ipecacuanha, but diarrhœa assumes a more or less intractable form.

The average admissions per 1,000 of strength for fever each month of the five years 1870–74, were as follows:—

January	33	July	40
February	28	August	40
March	30	September	36
April	40	October	32
May	70	November	40
June	45	December	32

The proportion of admissions during May and November is always large, but not quite so large as these figures indicate; for, owing to certain special and temporary causes which operated

¹ *Annual Reports for 1873 and 1874 on Medical and Sanitary State of Native Army of Bengal.*

during one year of the series upon which the average figures are based, the numbers for those months are abnormally high.

Goitre shows itself amongst the men after the first year of their stay at Buxa, and the cases become more numerous during each succeeding year. They get well in about three weeks from two applications of the red iodide of mercury ointment. The men attribute the disease, as indeed they do most maladies, to something in the water; but it is evident that pure water from the spring-head, such as that used at Buxa, cannot be the cause of the disease, which with much greater probability may be ascribed to the malarious character of the place.

Darjeeling. The district of Darjeeling consists of two parts, a mountainous tract of the Sikhim Himalayas, and the Morung or Terai Pergunnahs, which stretch away southwards to the plains of Purneah. Through these Pergunnahs, which for the most part belong to the region of Bhábur or 'Terai, runs the Darjeeling road from Purneah *viâ* Titaliya, traversing in its route a tract of country the whole of which not long since was during many months of the year habitable only by the Mechis and an allied tribe, the Dimals, who were able to live with impunity in these malarious regions, cultivating small clearings for cotton, vegetables and rice, and tending herds of cattle. Few of them are, however, left; the European tea-planter and tea cultivation have supplanted them, and the upper portion of the Terai is now almost as fully cleared as the lower portion which borders on Purneah and has for very many years past been extensively under rice cultivation.

The area of the district is 1,234 square miles, containing a population which numbers 94,712. Of these, according to the Census of 1872, 452 are Europeans, Americans, and Eurasians; Asiatics, others than natives of India, i.e. Nepaulis, &c., 25,781; aboriginal tribes 14,088; semi-Hindooised aborigines 25,022; Hindoo castes and people of Hindoo origin 23,114; and Mohamedans 6,248.

In the hill district are found the Lepchas, who are the aborigines of Sikhim; Nepaulis and Bhootias, the former of whom are emigrants from Nepaul, and the latter from Thibet and Bhootia; and associated with them are aborigines from the lower country, Hindoos, semi-Hindoos, and Mohamedans, all more or less employed in the tea-gardens and in the station. In the Terai Pergunnahs are found the Mechis and Dimals belonging to an aboriginal Cacharee tribe; the Rajbánsis or Kochs, a mixed

Hindoo-Mongolian race ; together with Hindoos and Mohamedans of the plains.

The Hill people¹ are in their persons and habits filthy in the extreme. Their houses or huts are irregular, untidy structures, constructed of wood thatched with straw. They are raised above the ground, and consequently their floors are dry during the rainy season ; their surroundings, however, are usually very filthy. The people of the district generally are well off, for they have plenty of rich land, plenty of water for the nourishment of the crops ; and the introduction of tea cultivation, and the neighbourhood of a large sanitarium, has made money comparatively plentiful among them. Rice is the staple product of the Terai Pergunnahs, jute is also grown to a small extent, and cotton is grown largely by the Mechis along the Upper Terai. In the hill portion the chief crops are Indian corn, millets, mustard, and tea, the latter of which is exclusively cultivated under European superintendence.

As regards the geology² of that portion of the district in which we are chiefly interested, i.e. that in which Darjeeling itself is situated, we have first, fringing the base of the hills, a narrow band of the soft massive sandstone with occasional clunchy clays which in this region make up the tertiaries ; north of these a narrow band of Dámudars, sandstones and shales—the beds are occasionally calcareous.³ The rocks of the series are frequently altered, the sandstones into quartzites, and the shales into slates and graphitic schists. Overlying these is a great thickness of slates and schists of the Daling series, the slates becoming more and more schistose as the gneiss is approached. From Kurseong to Darjeeling the gneiss is continuous, verging in some places towards mica schist, into which the gneiss has a great tendency to graduate. Lime is found in the tertiary deposits, where the clunch beds are very frequently more or less calcareous, and calcareous boulders are found in some of the streams, but the lime which is used in Darjeeling is obtained chiefly from the deposits of calcareous tufa which are found in the ravines and watercourses, and have their origin from the dolomite of the Buxa series, from the calcareous clunches and impure limestones of the tertiaries, and from the calcareous sandstones of the Dámudars.

¹ *Sanitary Report for Bengal*, 1876, p. 121.

² See *Report* by Mr. F. R. Mallet on 'Geology of Darjeeling District' in vol. xi. of the *Memoirs of the Geological Survey of India*.

³ *Manual of Geology of India*, p. 615.

Darjeeling itself, the well-known sanitarium, with a population of 8,523, is situated on a ridge of the Singalalah range of the Sikhim Himalayas, at a distance of about fifteen miles in a direct line from the plains, with which it is connected by a broad level cart road, some thirty miles long. The range takes a northerly direction, attaining its highest elevation of 8,608 feet in the Senchal mountain, about four miles south of Darjeeling; thence it sinks, and at the point where the station is situated, declines steeply to the bed of the Great Runjeet river, about four miles distant. The summit of the station ridge is very narrow, and varies in elevation from 6,300 to 7,500 feet above sea-level; on either side are valleys at least 6,000 feet deep, forest-clad to their bottom, with very few level spots on their side, but with no absolute precipices. From the flanks project innumerable little spurs which are often occupied by native clearings. The soil is a stiff red clay which overlies the gneiss rock, and is in many places itself overlaid by a rich black mould. The houses are placed, at an altitude generally below 7,000 feet, on the crest of the ridge and its flanks, chiefly on the south-western aspect, which is not quite so steep as the eastern. Below the European portion of the station is the Municipal bazaar, and below this again to the north lies the native town.

Within the station sanitation is carefully attended to, and as the slope is great on all sides the natural drainage is excellent, and the station roads quickly dry after the heaviest rainfall. The sewage is carried by a well-contrived system of surface drains into ravine drains which eventually carry it into the Little Runjeet river. Unfortunately, however, it is liable to lodge in the drains during the dry season, and then becomes offensive on the first advent of the rains.

The water supply is mainly from springs situated on the north-western slopes of the Jullapahar hill;¹ hence the water is led by an iron pipe to hydrants distributed about the station. The supply is, however, deficient during the dry season, and must be increased either by extending the pipe to catch the yield of the Senchal springs, or by the formation of a reservoir in the neighbourhood. The water is very pure; late analyses made by the officiating chemical examiner, Dr. Kannye Lall Dey, show that the total solids of the principal springs varied in quantity from 3 to 5·7 grains per gallon; the chlorine from 34 to ·7 grains per gallon. Some of the springs in the neighbourhood contain iron,

¹ Sanitary Commissioner (Dr. Coates') *Report* for 1876.

and are used medicinally. In the case of some of the springs there appears to be a risk of contamination from surface drainage at the commencement of the rains.

The convalescent dépôt for European troops is situated about two miles south of the civil station on the Jellapahar hill, which forms a part of the Darjeeling spur. The barracks are placed on the ridge of the hill, and on its western aspect, at an elevation of about 7,800 feet. One of the roads to Darjeeling crosses the hill, but the main or cart road winds round its base. Darjeeling is freely open to the winds, but lofty hills contract the view in various directions; to the north, however, the view is open, and range after range of mountain rises in succession till in the extreme distance the snowy range is reached with Kinchinjunga—28,178 feet—as the prominent object, apparently rising out of a sea of intervening wooded hills; to the west the view is confined by a lofty range about ten miles distant; to the north-west are a succession of great snowy peaks rising on the shoulder of the black Singalalah mountain; to the north-east is another snowy peak; whilst eastwards, across the Teesta valley, the snowy mountains form an apparently unbroken range; to the south is Senchal, clothed with a dark and sombre forest; a ‘dense damp dripping forest,’ Dr. Hooker calls it (*‘Himalayan Journal,’* vol. i., p. 124); which clothes the whole face of the surrounding country from the plains right away to the snowy range. Near Darjeeling it consists chiefly of oak, chestnut, magnolia, rhododendron, interspersed with maple, birch, laurel, and many other kinds of trees—while below 6,000 feet palms also flourish, with tree ferns, bamboos, and other tropical shrubs. The country surrounding the station up to the height of 7,000 feet is cultivated to a considerable extent, but there is no irrigation in the neighbourhood of Darjeeling itself, and rice is cultivated only in the valleys at some distance from the station. About 20,000 acres of tea are under cultivation in the district. Cinchona is now extensively grown in the neighbourhood, at Rungbee.

Climate. Brighter and more pleasant climates than Darjeeling may be found, writes¹ a former Civil Surgeon of the station, but in point of salubrity it is unsurpassed. Damp and rain are its disagreeable features, and it is probable, says² another Civil Surgeon, that the lengthy rains will always be a bar to the

¹ Dr. Collins in No. xiii. of *Indian Annals of Medicine*.

² Dr. Meadows in *Indian Medical Gazette*, August, 1870.

advancement of the station as a sanitarium, for people seek the hills with a twofold object, health and recreation, and they find themselves during the season at Darjeeling in a region of cloud and rain, shut up for days together in the house. There is, however, a belief there which seems well founded, that owing to the clearances of the forest which are being made in the neighbourhood, the climate is less damp than formerly.

The range of temperature, yearly and diurnal, is moderate, and the climate may be pronounced an equable one, though, as the records of the Government observatory at the station (Appendix, VI.) show, not so equable as is sometimes stated. However, Darjeeling enjoys an immunity from violent atmospheric phenomena; the winds are for the most part light, and amount only in the most exposed situations to a strong breeze. In direction they are very variable, but on the whole those from the south prevail; from January to April they are most frequently from the west and north-west, though even then southerly and easterly winds are common. The rainfall is very heavy, averaging 121 inches annually, and the atmosphere is at all times of the year very moist; fog and mist are common, and the sky more often than not is clouded and overcast.

The winter season extends from the beginning of October to the middle or end of February, and at its commencement the weather is bracing and very genial, the atmosphere clear and crisp. In November, however, the frosts begin, the nights become very cold, and ice forms on the little pools of water, but still the days after the forenoon are warm, with a bright sun. In January and February the weather is as a rule thick and cloudy, accompanied with rain or snow. On the whole, however, winter at Darjeeling is not of a severe character, and may be said to be mild as compared with that of England. Spring commences in March, and generally lasts almost till the time when the rains begin in June. The nights and mornings during this season are still cold, the days warm and balmy, but the weather altogether becomes misty, and storms of hail and rain occur with increasing frequency till the rains fairly set in. From June till the end of September is the season of the rains; the atmosphere is then almost saturated with moisture, and fogs more or less dense are of very frequent occurrence. The rain does not fall heavily, but quietly and with a persistent steadiness day after day, with generally a break during the morning and evening. In September this continual fall changes to showers, which become less and less frequent

as the cold weather approaches. In June and September very violent thunderstorms not unfrequently happen in and around the station.

Diseases. The excessive moisture of the climate of Darjeeling during six months of the year, and the continuous rains, are not, apparently, prejudicial to health. Dr. Meadows, in the paper already quoted, says, 'they may retard convalescence in cases of paroxysmal fever, but those who are in good health when the rains set in, whether children or adults, remain so. Indeed, children preserve, and even gain, condition and bloom in the wet season, though they may sometimes be confined to the house for a week together. A few weeks of the mountain air suffices to transform the pale sickly little visitor from the plains into a ruddy active child, the very picture of health and spirits.' The good health of the children, Eurasian and European, in the schools at the station is proverbial.

Those diseases which are generally understood to be incidental to a damp climate are rarely met with at Darjeeling. Dr. Meadows states that he has not met with a single case of rheumatism, chest affection, or dysentery, which had originated at the station during the rains, and hill diarrhœa, the curse of so many Himalayan stations, is almost unknown at Darjeeling, a fact which Dr. Meadows ascribes to the purity of the water.

Fever originated at the station is very rare, and the cases which do occur are of a very mild type. But severe fevers are very common amongst both Europeans and natives whose occupations oblige them to reside near the foot of the hills; hence it is that the district police suffer much from such attacks. The fevers are most prevalent, and most severe, during and after the termination of the rains,—spleen is an exceedingly common complication. Dr. Purves, Civil Surgeon of Darjeeling, writing in 1875, says: ¹ 'The incubation stage, after exposure to the malarious influences, seems to vary from a week to a fortnight. Some Europeans and natives, who live constantly in the Terai, may only be subject to occasional and slight attacks, which, however, undermine the health and the power of withstanding disease. When the Terai residents visit Darjeeling, however, they are almost certain to get fever, and that to a much more intensified degree than down below. In such cases relapses are common, and it often takes a long time to exhaust the force of the poison which seems to have accumulated in the system. The severe cases soon run into the remittent and often continued type with cerebral complications.'

¹ *Report of Sanitary Commissioner for Bengal, 1875, p. 39.*

Affections of the chest, liver, and bowels, not acquired in the plains, are seldom seen at Darjeeling. Croup has been prevalent during some winters, and hooping-cough, bronchitis, and diphtheria, occasionally prove fatal to children at that season.

Dr. Collins considers the climate of Darjeeling decidedly good for persons who have been suffering in the plains from delicate lungs and general debility. Moreover, in his opinion, by its restorative effect upon the general health, the climate benefits functional diseases of the liver, dyspepsia, diarrhoea, dysentery, and other maladies of the plains, and furnishes the patient with a stock of health which enables him to resist fresh attacks when he is again exposed to the conditions which developed them. Spleen cases also do well, provided the disease has not entered the hopeless stage; when that is not the case the fever abates, the general health improves, and the organ resumes its natural size. The elevation renders the station unsuitable to sufferers from brain diseases.

Statistics of deaths from cholera, small-pox, fever, and bowel complaints in the district, will be found in the table at p. 134. Cholera is rarely absent from the Terai Pergunnahs. Small-pox was at one time the cause of fearful mortality amongst the hill population, but is being conquered by vaccination. Leprosy, elephantiasis, and ophthalmia are rare.

Goitre. This disease is very rare in Darjeeling and the immediate neighbourhood, but it is very common amongst the people of Sikhim, Nepaul, and Bhootan, who are employed in the tea-gardens at lower elevations. Dr. Duka, who was Civil Surgeon of the district in 1872, could hear of the disease only amongst inhabitants of the district at some distance from the station in the Terai Pergunnahs.

The following report upon the prevalence of intestinal worms amongst the hill people, by Dr. Purves, Civil Surgeon of Darjeeling, is taken from the Bengal Sanitary Report for 1877. Dr. Purves writes: 'I had often during my service in various parts of the country had my attention drawn to cases of round worms (*Ascaris lumbricoides*); but during the terrible cholera epidemic in these hills in 1876, I was especially interested in the matter owing to the occurrence of a class of cases of disease which were reported as cholera but were not, and yet appeared to simulate the graver disease in many ways. For example, a man was reported to have died of cholera in the Scotch Mission compound, and the symptoms described certainly led to the suspicion of its

being cholera; but another man got attacked in a similar way, and when I saw him I gave it as my opinion that the case was not cholera. The Rev. W. Macfarlane paid the greatest attention to the cases of sickness in his compound, and I am indebted to him for careful notes of the different phases the worm cases presented, not only amongst his retainers at Darjeeling, but also among the population of Kalimpong, thirty miles from Darjeeling, where the mission has a station, and where the head of the Mission worked hard during the prevalence of cholera there. The cases already referred to which I saw presented the following symptoms. A man aged twenty-five was attacked with severe vomiting, purging, and intense abdominal pain, which continued about two days in spite of all remedies. Relief followed on the expulsion of a round worm. At this time, in 1876, bowel complaints were very common at several places I visited, and I found a large percentage was due to nothing else than round worms, which infested some people in scores. Cholera was reported at a garden some twenty miles from Darjeeling. I visited the place and found several deaths had occurred in a particular set of lines inhabited by some recently imported coolies. They had run away from fright; leaving only a few miserable-looking women and sick children behind, the latter described as suffering from the same disease as had caused the mortality. It was not cholera but the ravages of worms among a class of ill-fed and emaciated individuals. One of the sick children had just vomited six large round worms, which were crawling on the ground close by. Particular attention had now been drawn to the prevalence and symptoms of these parasites in the hill tracts, and subsequent experience has confirmed the opinion then formed, that very few of the inhabitants are free from them.

‘Santonine was found to be the grand remedy for cases of bad diarrhœa and vomiting, which often assumed a choleraic type. Several Europeans have told me that since they have learned the use of santonine, bad cases of diarrhœa are not nearly so frequent among their coolies and servants. Every morning when the Missionary at Kalimpong, accompanied by an Assistant Surgeon, deputed there on special duty, appeared with their stock of santonine, the hill people of all classes and ages surrounded them and were dosed, from the child in arms to the old grandfather, and seldom without the ultimate result of expelling worms. A woman, apparently in perfect health, applied one morning for some santonine for her child, and when giving it to her child, took a little

herself, and afterwards passed worms in large numbers. Santonine is so certain and beneficial in its effects in such cases, and so easily taken, that the people regard it with as much faith as quinine for fever. They have been heard to say that santonine and castor-oil are splendid medicines.

‘These worm cases present some five different classes of symptoms:—(a) many people have worms without feeling any apparent inconvenience, and their presence is only known on their expulsion by chance or remedies; (b) the person may feel griping pains accompanied by headache and giddiness, pains in the limbs and perhaps fever, often of a severe and persistent type; (c) in addition to the above symptoms diarrhœa may set in, which is only cured by the expulsion of the source of irritation, the worm—remedies for ordinary diarrhœa of course being useless; (d) the symptoms may be similar to (c), with the addition of the stools being thin, watery, and containing blood. These cases are often mistaken for dysentery. Santonine followed by castor-oil, and perhaps a little laudanum, generally effects a cure; (e) the worst class of cases is when vomiting and purging, and it may be cramps, occur together; then, in the presence of an epidemic of cholera, the nature of the disease may be mistaken. Of course there might be a sixth variety when any of the foregoing cases is complicated with real cholera, but in such instances the latter disease would soon assert its superiority so as to be unmistakable.

‘The prevalence of these round worms is no doubt chiefly due to the impurity of the drinking supply. Water taken from ravines, which at the same time may be used as latrines, easily accounts for their wide distribution. When the tenacity of life of the ova is considered, and it is borne in mind that one female round worm is capable of producing sixty millions of ova, there seems to be a grand field for their propagation in these hills.

‘Tapeworm is often met with both among Europeans and natives. A Bhooteah patient in the dispensary vomited thirty-nine feet of tape worm. The liquid extract of male fern is no doubt the most certain remedy.’

CHAPTER XV.

WESTERN OR BEHAR DISTRICTS.

The Behar districts of Bengal: *Purneah*, *Bhagulpore*, *Tirhoot*, *Chumparun*, *Sarun*. Description of each district, their climate, diseases. Very malarious character of Purneah; goitre in Purneah. Bhagulpore; goitre in the district. Tirhoot; general prevalency of goitre in the district; Dr. Gayer's statistics of goitre and cretinism. Chumparun; Dr. Coates' observations on spleen disease amongst the children; general prevalency of goitre in the district; Dr. Coates' reports and statistics; connection of goitre and cretinism; treatment of goitre by biniodide of mercury. Clear history of connection of goitre and malaria in Chumparun. Sarun; goitre in the district.

PURNEAH. This district lies along the northern bank of the Ganges between the districts of Maldah, Dinagepore, and Julpi-goree on the east, and Bhagulpore on the west. On the north it is bounded by the Nepaul and Darjeeling Terai. From north to south the breadth averages about eighty miles, and from east to west about sixty-five. The area is 4,957 square miles, and the population 1,714,795 souls (census of 1872).

The district is crossed by two great rivers, the Mahanuddee and the Koosee, the former near its eastern, the latter near its western border. The civil station Purneah is situated midway between these rivers, near the centre of the district, north lat. $25^{\circ} 48'$, east long. $87^{\circ} 35'$. Towards the Nepaul frontier there are slight undulations; elsewhere the general surface is low-lying, flat, in many localities marshy, with a general but very gradual slope from north to south. A line drawn pretty nearly north and south through the civil station would divide the district into two portions presenting very different characters. That to the east has a rich loamy soil and is a great rice- and jute-producing country. Throughout it marshy tracts are numerous, and their neighbourhood usually presents a good deal of scrubby jungle. This portion is crossed by the Mahanuddee, which receives right and left many tributaries; and west of that river by the Panar, another river of considerable size, which enters the Ganges at the south-eastern corner of the district; and again east of the Panar

by the Kala Koossee, which has a south-easterly course from the civil station to its confluence with the Ganges. These rivers overflow their banks during the rains, inundating a considerable extent of country, while low down in the course of the Panar are many stagnant jheels¹ which render the neighbourhood very damp and unhealthy.

The western portion of the district owes its physical characteristics to the persistent westward movement of the Koossee, the course of which a hundred and fifty years since was near the present site of the civil station, but is now some twenty-five miles to the westward, and indeed sends the greater part of its waters through the enlarged channel of the Dáus which marks the boundary between Purneah and Bhagulpore. In its westward movement the river has overlaid the soil with a deposit of sand which has thrown very much of this part of the country out of cultivation. Grass jungle covers the lands recently deposited by the river, while here and there are wide grassy plains, the grazing grounds of vast herds of cattle and sheep.

The town of Purneah, with a population of 16,000, stands on the eastern bank of the Sowrah river, and in the immediate neighbourhood of the former site of the civil station. The latter, because of the unhealthiness of its old site, has been removed three or four miles to a more healthy one on the right bank of the river. The Sowrah and the Kala Koossee join near the station, and by their inundations maintain the marshes and jheels which now occupy the former course of the Koossee river, and by their presence give to the neighbourhood its very unhealthy character.

The great bulk of the people west of the Mahanuddee are of Aryan descent, while to the east of that river the aboriginal element (Rajbunsi), predominates. The people are well off, but suffer much from the unhealthy climate. Rice is the staple agricultural product, oil-seeds also are largely grown, and with these, in the northern part of the district, jute and tobacco, while indigo is largely grown in the southern portion. Wheat also has now become a feature amongst the agricultural products of this district.

The climate of Purneah is more extreme than that of Dinagore; hot westerly winds are felt at intervals during April and May, and the winter cold is sufficiently great to produce hoar frosts which at times seriously damage delicate vegetation. The

¹ *Bengal Sanitary Report* for 1876, p. 120.

hot season lasts from the beginning of April till the setting in of the rains, and though the heat is at times great, is the most generally healthy period of the year. The rains are not so heavy as those of the more eastern districts; but they are heavier along the Nepaul frontier than in the south, and over the eastern than the western portion of the district. During the rainy season the atmosphere and soil are almost saturated with moisture, and as this gives way to the drying up season the district becomes most unhealthy. The cold weather lasts from the end of October to the end of March and is very pleasant to the European, but the cold damp westerly winds are very trying to the malaria-stricken members of the lower classes of the natives.

In 1875 a Government Meteorological Observatory was established at Purneah; the recorded (incomplete) statistics for that year and 1876 are embodied in Table VII. in the Appendix.

Diseases. Purneah is a notoriously unhealthy district. Malarious fevers, intermittent and remittent, the latter often of a very severe character, frequently complicated with hepatic and splenic disease, affect three-fourths of the people from September to the end of the year. This state of things naturally results from the physical condition of a country which is in effect a low-lying flat, covered with vegetation, copiously watered both by a heavy rainfall and many freely inundating rivers, and also abounding in hollows and swamps in which water charged with vegetable matters stagnates and rots for a while, till it finally dries up under a hot sun.

The most unhealthy thanahs are Kulliangunge and Dhumdaha,¹ at opposite ends of the district, the former in the north-east, the latter on the Koossee, west of the civil station.² Again, low down the course of the Panar towards the south-east, the country is damp and unhealthy and the people very sickly. 'Much fever, goitre, and spleen occur in the district, especially along the low and swampy Koossee river,' says the Sanitary Commissioner.³ 'The people in all the villages on either side of the Koossee are constantly suffering from fever and spleen.'⁴ They are potbellied, thin, and stunted in frame. Those living on the high ground near the Ganges are strong, muscular men, and comparatively free from fever. The Koossee runs directly from the hills through the west of the district, bringing down immense deposits of silt, the accumulation of which elevates the bed, obliging the river to overflow and to carve out for itself a new course. It has been observed by

¹ *Sanitary Report for Bengal for 1876.*

² *Ibid.* p. 123.

³ *Report for 1874*, p. 63.

⁴ *Report for 1876*, p. 120.

the people of the neighbouring villages that before the river changes its bed, the water, in the course it is about to take, rises nearer to the surface, becomes covered with a scum, and tastes bad. Then the people get fever and spleen so severely that whole villages are cleared off very rapidly.'¹ 'Cholera prevails much in the low ground to the north at Gungaporshad, and in the south-east at Mynanuggur, when the Ganges overflows and the country is swampy. It is also severe in Dhumdaha (west of the civil station) and west of the Koosee, where the water is bad and the country subject to the overflow of the river.'

Small-pox is gradually being extirpated by vaccination, but epidemics of small-pox, the result of the inoculator's work, are not uncommon. Bowel complaints, dysentery, and diarrhœa are very fatal; especially amongst the people who have been debilitated by fever. Leprosy and elephantiasis are not common in the district. Parotitis of an indolent form, seldom running on to suppuration, is frequently to be met with, as is the case also, it may be added, in Dinagepore. The Civil Surgeon,² commenting on a death caused by this disease, attributes it to malarious saturation of the system.

Goitre. The testimony of the Sanitary Commissioner as to the prevalency of goitre in Purneah has already been noticed. To the same effect is that of the Civil Surgeon, Dr. Picachy,³ who further states that the disease especially affects certain localities, and he mentions two particularly where it is very common, namely along the banks of the Koosee due west of the civil station, and to the south-east in the swampy country which is inundated by the Panar and Ganges. He considers that the disease prevails in the district under such opposite conditions that it is not possible to discover which are those that favour its development. Yet it is instructive to observe that the localities mentioned by Dr. Picachy as the especial *habitat* of the disease are precisely those which the Sanitary Commissioner notices as being amongst the most unhealthy in the district.

Samples of water from the chief supplies of several villages in Purneah were examined in 1872 with a view to discovering if the prevalency of the disease could be connected with an unusual proportion of lime and magnesia in the water; the results, however, were such as to quite negative any such connection (table at p. 22) between the water and the disease.

Bhagulpore. This district is divided into two portions by the

¹ *Sanitary Report* for 1876.

² *Jail Report* for 1868.

³ *Special Report*, 1874.

Ganges, and it is with the northern portion only that the present enquiry is concerned, for goitre is practically unknown in the district south of the river. This northern portion stretches away about eighty miles from the river to the Nepaul frontier; on the east it is bounded by Purneah, on the west by the districts of Monghyr and Tirhoot.

The northern bank of the Ganges is here low, and allows of wide-spreading inundations, which during the rains extend in places some ten miles from the permanent channel. At the south-eastern corner of the district the Ganges receives the Ghugree river, which crossing the district about twelve miles north of the Ganges, collects the northern drainage and joins the Dáus and the Koossee on the Purneah frontier, not very far from its confluence with the Ganges.

The Koossee crosses the north-eastern angle of Bhagulpore before it enters Purneah, and has committed ravages similar to those described as having occurred in the latter district. In its westward movement it threatens to pour the bulk of its waters into the channel of the Dáus. Many other rivers and connecting watercourses cross the district, and during their floods inundate the country very extensively.

The district is an alluvial flat, with no other elevations than such as the bank of a river may present; it is very highly cultivated, and excepting in the Mudehpore subdivision presents very little jungle; marshes are pretty numerous throughout, especially in Mudehpore, where they are connected with the rivers. The main crop is rice, but wheat, maize, millets, barley, and oil-seeds are also largely cultivated. The people are well-to-do, and are more robust than their neighbours in Purneah; a large proportion of them are of mixed Aryan and aboriginal origin.

Bhagulpore, the civil station, population 70,000, is situated on the high south bank of the Ganges, north lat. $25^{\circ} 15'$, east long. $87^{\circ} 02'$. It is a small military post,¹ and, says Surgeon-Major Sanders, offers great advantages to enable a regiment to recruit its health after having been pulled down by fever, dysentery, and spleen in some of the unhealthy stations of Bengal.

The climate of Bhagulpore (northern portion) resembles that of Purneah, but is not so damp. The rainfall at the station averages forty-eight inches; at Mudehpore, fifty miles farther north, it is seven inches greater.

¹ *Report on Native Army of Bengal*, 1873.

	Rainfall at Mudehpore 5 years	Bhagulpore 19 years
January	·15	·47
February	·7	·72
March	·37	·41
April	1·58	1·03
May	2·22	2·47
June	8·76	8·52
July	11·92	11·23
August	10·36	10·07
September	12·82	7·98
October	5·95	4·71
November	—	·03
December	·02	·08
The year	54·85	47·72 .

Diseases. The most prevalent disease in this, as in the neighbouring districts, is malarious fever, but happily it is as a rule of a comparatively mild type, viz. quotidian intermittent.¹ Remittents are rare, excepting in certain unhealthy localities. The fever period is that of the subsidence of the annual floods. The sanitary reports all witness to the extreme unhealthiness of the subdivision of Mudehpore, more particularly those parts of it which are flooded by the Koosee, or more exactly, by the Dáus river. The subdivision is situated centrally in the northern portion of the district; it is crossed by many streams, is notorious for its swamps, and a considerable portion of it eastwards has been laid waste by sands deposited by the floods of the Dáus. The report for 1874 (p. 63) says: ‘The ordinary malarious fevers in Bhagulpore were as usual prevalent during and on the cessation of the rains, chiefly in the south and south-east of Mudehpore; but along the west bank of the Koosee the disease did not assume this year the severe form which characterised it for years past.’ The report for 1871 on Charitable Dispensaries states that though the year was a healthy one for this district generally, malarious fever prevailed severely in the Mudehpore subdivision. It is very noteworthy that goitre in this district is almost if not quite confined to the subdivision just mentioned. This is the evidence of special reports on the subject, and the dispensary returns show that while cases of goitre are very rarely treated at four out of the five dispensaries of the district, at the Mudehpore dispensary the goitre cases are very numerous, 2·5 per cent. of the total cases treated during five years.

Dr. Buchanan Hamilton, writing regarding the Bhagulpore district, which at the time (1813) extended only twenty miles

¹ *Sanitary Report* for 1868, p. 318.

to the north of the river, says: 'The different chronical swellings are now much rarer than in the districts hitherto surveyed. Persons who reside on the right bank of the Ganges seem little subject to the swelling which affects the throat, and most of those in the division south of the river who have this disease have been affected during a residence of considerable length on the opposite bank.' With reference to the cause of the disease he instances the case of a landholder who dug a fine well lined with brick, and while this continued in repair the people in the vicinity suffered less frequently, but when from neglect of the well the water became bad, the disease became as common as ever. This is a case very much in point, and we shall find others exactly resembling it when we are considering goitre in the Chumparun district. Neglect of a well, by allowing the water to become foul and increasing the decaying organic matter in it, brings the water to that state which in the opinion of not a few Indian authorities is productive of malarious disease.

Leprosy, says the Sanitary Report for 1868, is somewhat common in the district. Elephantiasis is very rare.

Cholera is endemic and often epidemic in the district.¹ March to August is the period during which the disease is worst, September and October are months of subsidence, and January, February, November, and December are months of comparative immunity from the disease.

A condition resembling scurvy, distinguishable by sores in the mouth and the appearance of the gums, is very prevalent amongst the poorer classes in the district, and is probably caused by malaria.

Bowel complaints, diarrhœa, and dysentery are very prevalent, especially at the end of the rains, and during the cold season, and prove very fatal.

Stone in the bladder is very commonly met with in all parts of the district.

Small-pox is still spread in parts of the district by the practice of inoculation.

Tirhoot. This district lies between the north bank of the Ganges and the Nepaul Terai. On the east it is bounded by Monghyr and Bhagulpore, and on the west by Sarun and Chumparun; from the former district it is separated by the river Gunduck. The Terai, which is here about twenty miles in breadth, separates Tirhoot from the Nepaul hills. The area of the

¹ *Sanitary Report* of 1876, p. 42.

district is 6,343 square miles, and the population equals 691 to the square mile.¹

Mozufferpore, the civil station, is a large native town with a population of over 38,000. It is situated in the south-western portion of the district, north lat. $26^{\circ} 7' 23''$, east long. $85^{\circ} 26' 52''$; about thirty-five miles north of the Ganges, on the right bank of the Little Gunduck river, at about 300 feet above sea-level.

The general slope of the country is from north-west to south-east in the direction of the principal rivers, namely the Great and Little Gunduck, the Bhagmuttee, the Kumla, and the Bulan. The surface undulates in many parts, and is intersected by numerous streams of comparatively small size as well as by the larger rivers already mentioned. As a rule the channels of the rivers are on high ground, and between them lie parallel depressed tracts in which during the rains water collects till it can break the river bank and so drain off. The surface is also in many parts liable to be flooded by the overflow of the rivers; such is especially the case in the south-west by the Gunduck and the Ganges; in the south-east by the Kumla and Karai, in the north-east by the hill streams, and in the central tract of the district, between the Gunduck and Bhagmuttee, by those rivers. Numerous long narrow lakes, the relics of former streams, are scattered over the district, and add much to the beauty of the scenery. Jheels also are very common, and receive the drainage of a considerable portion of the country. The rainfall is not heavy, averaging annually about forty-four inches, but there is sufficient moisture, supplemented largely by well-irrigation, to encourage very extensive and careful cultivation, which combined with the presence of numerous fine groves of trees, gives to the country a very rich and picturesque appearance.

The soil is alluvial, and consists of a mixture in varying proportions of sand, clay, and decomposed vegetable matter; beds of kunkur are met with in places, and formerly saltpetre was largely manufactured in many parts of the district from the nitrous earth which abounds in the neighbourhood of the villages. The principal crops are wheat, barley, oats, rice, oil-seeds, pulses, millets, maize, indigo, tobacco, and poppy. There is but little waste land, and the grazing grounds bear a very small proportion to the cultivated area. The population is very dense, averaging for the whole district 691 to the square mile, and in the most thickly peopled parts to the

¹ Tirhoot has recently been divided into two districts, Mozufferpore and Durbhunga, comprising respectively the western and eastern portions of the old district.

south-west as much as 855 to the square mile. The aborigines—of whom some are of Mongolian descent, some descended from the original inhabitants of the plains—form only about one-seventh of the population, the remainder being of Aryan descent. The mass of the people are badly fed, clothed, and housed, wages are low and food dear. To the north-east the staple food is rice;¹ in other parts rice supplemented with barley and maize. Millets and pulses are also largely consumed, and wheat by those who can afford to buy it.

Climate. The records of meteorological observations in the district are very scanty.² The following table is compiled from Messrs. Schlagintweit's work; from the report for 1875 of the Meteorological Reporter with the Government of India; and from a table of observations of temperature taken at Pundoul Factory during 1874. Table VIII. in the Appendix gives the meteorological data for Patna.

	Mozufferpore		Dhurbhunga, 30 miles east of Mozuffer- pore	Pundoul, about 12 miles west and a little north of Dhurbhunga		
	Average mean monthly temperature of 3 years (Schlagint- weit)	Average rainfall 17 years, official report	Average rainfall 5 years	Mean monthly temperature 1874	Highest of month at noon 1874	Lowest at sunrise 1874
January . .	58	·85	·36	58	70	37
February . .	65	·47	·21	64	80	44
March . .	74	·61	·21	71	88	50
April . .	82	·53	·66	83	101	62
May . .	87	1·89	1·74	86	102	65
June . .	87	6·5	8·07	81	96	70
July . .	81	10·96	14·78	81	91	71
August . .	80	9·36	10·46	81	89	73
September . .	84	8·33	11·35	78	88	67
October . .	79	3·19	1·44	72	84	58
November . .	70	·03	—	67	75	54
December . .	61	—	·08	59	71	44
The year . .	75·7	42·72	49·56	73·4		

The climate, says Mr. Evans,³ is indisputably superior to most provinces of India, enjoying a delightful medium between the damp and fogs of Bengal and the dry parching winds of the

¹ Hunter's *Statistical Account of Bengal*, vol. xiii. p. 79.

² A Government Meteorological Station has recently been established at Durbhunga.

³ 'Medical Topography of Tirhoot.' *Trans. of Medical and Physiological Society of Calcutta*, 1828.

western provinces. The prevailing wind is from the east, and when from the west is not the arid parching wind of the upper provinces; the hot winds are mild and of short duration, seldom lasting more than a month.

The rains set in early in June, and last till the beginning of October; they are heaviest to the north and east of the district. After the termination of the rains and before the cold weather fairly sets in in November, the heat of the sun continues great, the atmosphere is still and damp, and the weather oppressive and unhealthy. The cold season is very delightful, lasting till the end of March, while even in April the nights and mornings are cool and fresh. Situated as this very large district is, the climate naturally differs considerably in different parts, and might be arranged in tracts or zones, from south-west to north-east, corresponding with the variations in the soil and productions of the district. The south-western portion, on the right bank of the Little Gunduck, is reckoned the best and most fertile in the district.¹ Excepting a small portion which is liable to inundation by the Ganges, the land is high and the surface undulating; the climate is dry and bracing; the soil a rich mould and sand, impregnated in parts with carbonate of soda; and the water is sweet and excellent. The second tract, which lies between the Little Gunduck and the Bhagmuttee, is low and subject to inundation; the climate is moist but healthy; the soil is of a more alluvial character than the former tract, and the crops cultivated are more largely those of the autumn, as rice, than of the spring, such as wheat, barley, oats, or gram. The third tract runs parallel with the former from north-west to south-east, between the Bhagmuttee and the Kumla, but widens out considerably towards the north where it includes a considerable reach of frontier country. The land is low, and towards the Terai marshy; the soil consists of sand and clay with an admixture of iron; water is found near the surface but it is of a brackish nature; the climate is damp and rather unhealthy; and the principal crop is rice. Dhurbunga, the civil station of this portion of Tirhoot and the most populous town in the district (47,500), is situated in this tract, on the east bank of the Bhagmuttee, north lat. $26^{\circ} 10' 2''$, east long. $85^{\circ} 56' 39''$. The town is surrounded by rice swamps and is very unhealthy. Goitre prevails to a great extent amongst the inhabitants. The last tract occupies the eastern and north-eastern portion of the district, between the Kumla and the Bhagulpore boundary, which is formed

¹ *Report of Revenue Survey, 1854.*

in places by the Tiljooga river. It is crossed by the Bulan and Little Bulan rivers, and by others of less size, which, with the Kumla and the Bhagmuttee, are tributaries of the greater Tiljooga river; the land is low and is subject to extensive and long-continuing inundation; the water is brackish, often of a yellow hue and very impure; the produce is chiefly rice, grown in numerous hollows, which abound here. In these hollows the soil is a rich clay mixed with decomposed vegetable matter, and the water is retained till late in the season. The climate of this tract is damp and unhealthy. At Mudhobanee, about its centre, the dispensary returns show that fever and goitre are the most common diseases of the locality.

*Diseases.*¹ Dr. Macdonald,² writing regarding the prevailing diseases of Tirhoot, describes the district as resembling many parts of Bengal in the abundance of its marshy and low lands, and in the luxuriance of the vegetation. 'The inhabitants,' he says, 'are all more or less liable to malaria, the most remarkable phenomena of which are hypertrophy of the spleen and goitre; the large majority of them between five and fifteen suffer from the former affection, which may in some cases be connected with attacks of ague, while in other cases no history of ague can be discovered.' Dr. Mackinnon,³ after remarking, 'where we have stagnant waters and rank vegetation we often have fever, but not always, nor are we able to explain why there is this difference,' remarks, 'in Tirhoot I observed that some of the lakes or lagoons in that district were far more unhealthy than others.' Dr. Gayer, late Civil Surgeon of the district,⁴ describes the district as 'all unhealthy,' and states that all malarious diseases are endemic, as are also dysentery and bowel complaints, having no doubt a malarious origin. The most unhealthy parts are those to the north and north-east, where fevers of the remittent type are common amongst the natives. Dr. Gayer gives a lamentable account of the insanitary state of Tirhoot; 'it is as bad as it can be.' 'The local sources of malaria are numerous; the water-supply from all sources is very bad, wells and tanks are dirty and subject to contamination by the foulest surface drainage; they are full of rotting vegetation. The people bathe, and wash in, and drink from the same source. Cattle are allowed to bathe in the tanks. Human corpses and the carcasses of

¹ For statistics of rates of mortality, see table at p. 134, and for those of the Tirhoot jail, p. 99.

² *Indian Medical Gazette*, November, 1866.

³ *Epidemics of Bengal, Indian Annals of Medicine*, 1856.

⁴ *Bengal Sanitary Report*, 1868, p. 377.

animals are thrown into the river. The people are dirty in their habits and dwellings; the villages are heaped with refuse, while each man preserves his own peculiar dirt, by the help of the thick screen of vegetation with which he surrounds his hut.' With regard to the water supply of Dhurbhunga Dr. MacDonnell,¹ the Civil Surgeon, writes:—'I tested twenty specimens of well water, a few of tank water, and one from the river Bagmutti, about the close of the hot season, and found the first-mentioned rich in the putrefactive products of sewage, there being present in considerable quantity—for the examination was quantitative as well as qualitative—nitric and nitrous acids, ammonia, organic matter of animal nature, sodium chloride, and calcium carbonate and sulphate; tank water only gave traces of these, but on evaporation a deposit consisting chiefly of vegetable débris was found; while river water, notwithstanding its sluggish current, was when filtered prior to analysis chemically purer than either of the foregoing. The microscope showed rotifera and monads in the specimens of well water, the same and other animalculæ varieties in the tank waters, but no life was apparent in the microscopic field in the case of the river water.'

Cholera is during some years very prevalent in the district, and commits great ravages; the disease is perhaps never altogether absent. Small-pox breaks out every year, encouraged by inoculation which is almost universally practised in the district. Chest affections, rheumatism acute and chronic, are also common in the district. Mr. Evans, writing in 1828, says: 'Cutaneous diseases are very prevalent, of various types and characters, from a common psora and herpes to the most inveterate forms of leprosy and elephantiasis.' Mr. Evans also dwells upon the extreme prevalency of goitre in the district, and mentions the general opinion of the natives that the disease is produced by drinking river water, especially that of the Little Gunduck. But he writes, it is not uncommon to see two villages situated on the bank of the river contiguous to one another, the one with scarcely an individual exempt from the complaint, while in the other the inhabitants are perfectly free from it; a fact, as he says, strongly opposed to the idea of its being caused by water. He notices that the disease becomes more common as the Terai is approached.²

In 1868 Dr. Gayer commenced tabulating the cases of goitre treated at the dispensaries in Tirhoot, with a view to discovering

¹ *Sanitary Report for Bengal*, 1876, p. 144.

² For statistics of rates of mortality see table at p. 134, and for those of the Tirhoot jail, p. 99.

the proportion of idiots amongst those who are affected with the disease. This plan was followed by Dr. Gayer's successor, and the results up till the end of 1871 are as follows. Total number of cases treated 22,780, of whom 10,484 were males and 12,296 females. Amongst the number there was but one idiot. The deaf and dumb numbered 293, of whom 163 were males. The stammerers numbered twenty-eight, of whom eleven were males. These figures quite disprove any association of goitre with cretinism and idiocy in the case of the Tirhoot sufferers.

The fact that the well water of Tirhoot is generally hard has been used to support the lime and magnesia theory of the cause of goitre, but the theory is altogether opposed by the peculiar patchiness of the disease mentioned by Mr. Evans, and also by the fact that many of those who are affected drink river water, and in many localities the soft water of tanks and marshes. There can be little doubt that goitre in Tirhoot depends upon a cause which has a nature similar to that which produces the malarious fever and spleen with which it is associated, diseases which, as noticed by Dr. Mackinnon, have a like anomalous distribution.

Chumparun. The Chumparun district,¹ which is about one hundred miles in length, stretches from south-east to north-west, between the Nepaul Terai on one side and the districts of Sarun and Goruckpore on the other. The northern boundary is in part formed by the low Soomeysur range of hills, while the south-western boundary is, for the greater portion of its length, formed by the Gunduck, a river which is now extensively embanked in order to protect the neighbouring country from its ravages. The other principal river of the district is the Little Gunduck, which rises near the northern boundary, traverses for about twenty miles a valley or doon lying between the Soomeysur hills and a still lower range, and then continues in a south-easterly direction through the length of the district, receiving on its way many tributaries from the hills of the Nepaul Terai.

The Bhagmuttee river forms for a short distance the boundary between Chumparun and Tirhoot; and through the centre of the district, between the two Gunduck rivers, runs the Dhunowtee, which, however, during a part of the year, is little more than the half-dry bed of a river.

A line drawn from north-east to south-west through the town of Bettiah, about the centre of the district, would divide Chumparun into two nearly equal portions, which, moreover, in many

¹ Statistics of area and population are given in the table at p. 134.

respects differ considerably from each other. The southern portion is a flat plain which resembles in its physical characters the neighbouring district of Tirhoot; it is thickly peopled, highly cultivated, and richly wooded.

The soil, which is clayey on the north of the Little Gunduck, and light and porous on the other side of the river, is very fertile, and yields, in addition to rice, large crops of barley, oats, wheat, gram, indigo, poppy, and oil-seeds. A large proportion of the land is submerged during the rains, but permanent marshes are rare. Towards the centre of the district is a chain of lakes, extending altogether over an area of 139 miles, which are said to be the survivors of a former stream. These lakes are not found to be in any way sources of disease, for though the water they contain is stagnant, the supply is tolerably abundant at all seasons, and it is well furnished both with animal and vegetable life.¹

The northern half of the district undulates towards the hills, and is crossed by many mountain streams; it is more sparsely populated than the southern portion. A large proportion of the face of the country towards the north and north-west is covered with reed and forest jungle; reed jungle also is plentiful along the banks of the Gunduck river; and the whole of this portion is widely flooded during the rains, owing to the inability of the hill streams to carry off the rainfall. Rice and sugarcane are the chief crops. The surface soil is chiefly composed of clay; kunkur is found in the subsoil throughout the district, and is largely used for metalling the roads and for making lime for building purposes. Much of the soil is saliferous, and is made available in the manufacture of saltpetre, but a great extent of the open country still remains in the state of uncultivated prairie land.

Bettiah, population in 1872 19,708, is the largest town of the Chumparun district; it is situated close to the western boundary, but in a central position when the length of the district is taken into consideration. The country surrounding it is low and generally submerged during the rains. Fifteen miles east of Bettiah, near the right bank of the Little Gunduck (here called the Secrana), is the Segowlie cantonment, the site of which is very low, and requires to be protected by an embankment from the inundations of the river.² The country in the neighbourhood is a dead level, but it is well wooded and the cultivation is rich, though there is a great deal of broken ground interspersed with swamp

¹ Dr. Sconce, in *Sanitary Report* for 1868, p. 383.

² *Report of Medical and Sanitary State of the Native Army of Bengal*, 1869.

here and there. The water in the station wells stands at nine feet from the general surface of the soil during the dry season, and at the same level with it during the rains. Notwithstanding, however, the apparently unhealthy conditions of the site, Segowlie is in reality a very healthy station. Fever of a mild quotidian type is the principal cause of sickness amongst the troops; its seasonal prevalence is shown by the following table of the mean number of admissions into hospital for each 1,000 men during the years 1870-72.

Average strength 295.

January	10	August	23
February	10	September	28
March	2·3	October	34
April	11	November	21
May	8	December	12
June	4·4		
July	6	The year	171·

The water of the wells has an unpleasant earthy taste, and is said to produce goitre, which is very common in the neighbouring villages and frequently shows itself amongst the troops.

Moteeharee, the civil station of the district, population 8,266, is situated in north lat. $26^{\circ} 39' 46''$, east long. $84^{\circ} 57' 29''$, thirteen miles east and a little south of Segowlie, on the eastern bank of a lake of the same name. It stands on comparatively high and dry ground, yet a good deal of the country intervening between it and Segowlie is submerged during the rains; its sanitation is described as excellent.

Ramnugger, the residence of the Rajah of that name, is situated in the jungly country in the northern part of the district, about thirty miles north and a little west of Bettiah, on the west bank of the Little Gunduck, or rather as it is locally called, the Harha river. The place,¹ which is indeed little more than a village, with a population of 1,329, is extremely unhealthy, fever of the severest kind visiting it annually in the autumn, the causes of which may be found in the miasmatic exhalations arising from the Terai; marsh poison from the adjacent submerged lands; and the extreme filthiness of the town; the water-supply is from wells reported by Dr. Sconce in 1868 as being in 'a disgusting state.'

The population of Chumparun is 1,440,815, equal to 408 on each square mile of the total area of the district; but the detailed figures show that it is densest in the southern portion of the district, where it is 589 to the square mile, against 279 in the northern portion. The bulk of the people are of Aryan origin;

¹ *Sanitary Report*, 1868, p. 386.

of whom about one-sixth are semi-aboriginal; the aborigines number about thirty thousand, of whom the greater number are the Tharoos of the Soomeysur Doon. These Tharoos, a people of Mongolian origin, in physical appearance and in language differ entirely from the mass of the population; and they differ also in the prosperity of their condition, for being at the same time both energetic cultivators and careful herdsmen, they rejoice in large herds of cattle and well-filled granaries. The rest of the people are very badly off, and a former Civil Surgeon who knew them well, thus describes their state:¹ 'Every village in this district is said to be, in a sanitary point of view, as bad or worse than in Lower Bengal; houses overcrowded and insufficiently ventilated; their surroundings filthy; the water supply in the wells contaminated by surface drainage; the people—the women and children particularly—uncleanly in the extreme, bathing not more than once a fortnight or month, or in the cold weather not at all; without any conservancy; drainage defective, without outfall, owing to the country being level; food coarse, indigestible, and insufficient; people constitutionally weak and deficient in energy, and very often also in intellect.' The drinking water is taken from rivers, lakes, tanks, and wells, chiefly however from the wells which abound in every direction, while the tanks are not nearly so numerous. The well water is as a rule hard, and often has an unpleasant taste, owing no doubt to the freedom with which the surface drainage finds its way into it.²

Climate. The climate of Chumparun, like that of Tirhoot, forms a medium between the parching heat of the Upper Provinces and the moist atmosphere of Bengal.³ The temperature may be estimated from the following observations made at Segowlie during the years 1871-2:—

	Mean of 1871	Mean of 1872
January	63°	63°
February	69	66
March	74	78
April	82	83
May	85	87
June	89	89
July	86	86
August	86	87
September	82	85
October	81	80
November	70	77
December	64	63

¹ *Report of Sanitary Commissioner, Dr. Coates, for Bengal, 1876, p. 41.*

² *Sanitary Report for 1868.*

³ *Medical and Sanitary Report of Native Army of Bengal for 1872.*

The cold weather extends from November to March, and is delightful, being dry, cool, and bracing, while light winds commonly prevail. Fogs, unless after a fall of rain, seldom occur at this season, and do not continue long. The hot weather does not set in till the end of March, and for a month longer the mornings are pleasantly cool. Hot west winds are occasionally felt over part of the district during April and May, but the nights are as a rule cool, owing to an east wind which generally rises at sunset and blows through the night. The rains set in early in June, and last till the middle or end of September; the annual fall averages 45·73 inches, distributed as follows through the months.¹

January	·3	July	11·04
February	·32	August	10·53
March	·96	September	8·35
April	·38	October	3·07
May	1·76	November	—
June	8·92	December	·1

The rainy season is the most trying of the year, for the atmosphere is often close and stifling, while sudden changes to comparative cold weather are not uncommon.

Diseases. The prevailing diseases of Chumparun are fevers, cholera, small-pox, and bowel complaints, which last, as Dr. Sconce² believes, depend partly upon vicissitudes of climate, but chiefly upon malarious influences. Bronchial and rheumatic affections are common in the cold season. Stone in the bladder is not so common as in Tirhoot. Cholera, which appears to be endemic to the district, is rarely simultaneously epidemic over the whole, but pitches upon unhealthy localities in which to develop itself. Dr. Meadows, a Civil Surgeon of the district,³ states that as soon as cholera shows itself in one of the villages, the majority of the inhabitants shut themselves up in their huts, light a cow-dung fire, and wait till they are attacked or till they hear that the disease has ceased. Nothing will induce them to leave their houses, for they believe they are sure to catch the disease if they do so. A common belief among them is that cholera attacks a village where some corpse is eating its grave-clothes, and that until this is put an end to by digging up the body, cutting it into pieces and scattering them about, the visitation will not cease. Small-pox is

¹ *Report of Meteorological Reporter for Bengal, 1874.* Average of 11–13 years.

² *Report on the district quoted in Report of the Sanitary Commissioner for Bengal for the year 1868.*

³ *Sanitary Report for 1877.*

often very fatal. In 1873 no less than 3,073 deaths were registered as caused by it. Yet, says the Sanitary Commissioner,¹ the people of Chumparun are utterly indifferent to this infliction. They will not isolate the sick, are careless of vaccination, and when operated upon endeavour to vitiate the effects by swallowing a solution of small-pox pustule on the fourth day after operation.

Malarious diseases are most common amongst the natives during the rains and for a time after their cessation. As a rule the fever is of a mild type, but, as Dr. Sconce² particularly notices, it very frequently leaves the patient for a long time debilitated and anæmic. Remittent fevers of a bad type—'the aul'—are very common in the north-western part of the district, especially amongst the inhabitants of the very dirty native town of Ramnugger.

Dr. Coates, while on tour through the district in 1861, found that in some localities a great number of children were brought to him for treatment for enlargement of the spleen, while the strictest enquiry failed to discover any association of attacks of malarious fever with the splenic disease. On enquiring into the habits of the children he found that during the rains they were all engaged daily in netting fish about the corners of the fields and in the ditches, and though the parents blamed the field water which the children drank, Dr. Coates was disposed to think that the constant wading and exposure to the sun, the children often sleeping in the fields, was a more likely cause of the disease. Still, as he remarks, such a thing occurring so generally, and as the parents said periodically, is very interesting. The history supports the view that the malarious poison may precipitate itself upon certain organs, producing apparently purely local disease, or local disease and anæmia, without bringing about the paroxysmal affection of the system which constitutes fever. Moreover this history of periodic disease of the spleen compares with that which will be presently narrated of goitre in this district.

Goitre. The prevalency of goitre in Chumparun has been frequently dwelt on by the Civil Surgeons of the district, especially by Dr. Sconce in the report already noticed, and by Dr. Coates in his annual reports on the district from 1861 to '63. From these, and special reports made by Drs. Cameron and Cullen, it appears that the disease is most prevalent in the north along the Nepaul Terai; in the western tracts, where the country is very low and very extensively inundated; and along the banks of the rivers Secrana

¹ *Sanitary Report* for 1874.

² *Report* already quoted.

and Dunnawtee, which are low, covered with dense vegetation, and connected with many lakes and marshes.

Dr. Cullen calls the latter tracts 'the goitrous area of the district.' Two-thirds of the population are affected, and it is to be noted, he says, 'that while malarious diseases prevail throughout the district, they do so with greatest violence in this area.' The soil of the locality is clayey with a pretty fair admixture of decaying vegetable matter, the drinking water is from the river, and from wells, many of which are in a very bad state, and contain water which is very impure owing to the free entrance of surface drainage.

Dr. Coates' reports are full of interesting information regarding the medical history of the district, and dwell at some length upon the subject of goitre and cretinism. In the course of his enquiries he visited certain wells the waters of which were believed to cure goitre, and were so famous that people came from some distance to take water from them; one, that of the Soogong factory, was especially famous because neighbouring village wells were believed to cause goitre. He found that they were deep, well-built and well-kept wells, which had been dug by indigo-planters, and he was led to think that the good effects of their waters depended upon its becoming 'pure and hard and good during its percolation through the deeper strata of earth, while the shallow village wells collected their water from the surface soil charged with decaying organic matter.'

The people in the neighbourhood of the Terai, where goitre is very prevalent, told Dr. Coates that they suffered an annual attack of the disease; the thyroid gland beginning to enlarge during the rains, and subsiding in the cold season. Dr. Coates connects the recurrence of the disease with the use of the very impure water of the ponds and small streams which the people resort to in the rains, owing to the walls of their wells falling in and rendering the wells useless at that time. For though the well water which he examined was far from pure, it contrasted very favourably with that from the sources just mentioned, which was indeed simply the surface drainage of Terai lands. In the cold weather the people are able to return to the use of their wells, and now if they do not get rid of their goitres they resort to certain perennial mountain streams which evidently contain little or no jungle water.

Writing of another part of the district, Dr. Coates repeats the remark of an intelligent native gentleman, who told him that he remembered the time when the whole of the locality

where he lived was jungle, but now, he said, 'everybody cultivates, there is no jungle water to drink, and goitres and fevers and spleens are much fewer than formerly.'

In his report for 1863 Dr. Coates recurs to what he had learnt regarding the apparent association of cretinism and goitre, and gives some statistics which he thinks afford strong evidence that both diseases are acquired; briefly they are as follows:—

To healthy parents were born 25 cretins, 35 goitred, 38 healthy children; to goitred parents, 67 cretins, none goitred, 202 healthy children; to cretin parents, 26 cretins, 41 goitred, 51 healthy children.

Thus ninety-two cretins must have acquired the disease, as it was not hereditary in them. While the twenty-six who may be said to inherit it had yet ninety-two brothers and sisters who were not cretins.

One thousand goitre patients had 1,576 unaffected brothers and sisters, all born of healthy parents; while 300 goitre patients who were under treatment were born of goitred parents, but they had 298 healthy brothers and sisters.

Then taking the statistics of three years in a lump it was found that 3,452 goitres had 6,493 healthy brothers and sisters, all born of healthy, *i.e.* unaffected parents. While 1,197 goitres had 2,714 healthy brothers and sisters born of goitred parents. Thus according to these figures, affected parents produce more healthy than goitred children.

Dr. Cameron, writing in 1872, states that he had made particular enquiries as to the connection of goitre with the semi-idioey which is so common amongst the people of the district, and as the result arrived at the conclusion that one condition does not depend upon the other. The natives themselves also distinguish between the two diseases, and believe that goitre is not transmissible from parent to child, while on the other hand they hold a very decided opinion that cretinism is hereditary, and moreover that its prevalence is very much increased by marriage amongst blood-relations.

In 1857 Dr. F. Mouat, then Inspector of Jails and Dispensaries in Bengal, communicated to the 'Indian Annals of Medicine' a paper by Major Holmes on the treatment of goitre by biniodide of mercury ointment. Major Holmes' operations were carried on at Segowlie, where he was in command of the troops. The ointment he used was made by mixing nine drms. of the biniodide with three pounds of lard, and the directions for its use were as follows:

‘About an hour after sunrise apply the ointment to the goitre with a spatula made of wood or ivory; rub it well in for at least ten minutes. Let the patient then sit with his goitre held well up to the sun, and let him remain so as long as he can endure it. It is probable that about noon he will suffer severe pain from the blistering effect of the ointment. About two p.m. the ointment should be again applied with a very careful and tender hand, and the patient should be despatched to his home with orders not on any account to touch the ointment with the hand, but to allow it to be gradually absorbed, which absorption will be complete on the second day. This treatment is quite sufficient for an ordinary case. Should the case be a very bad one, the patient is ordered to return next year for the removal of what remains of the tumour, but unless in goitres of the very largest size this is seldom necessary.’ After the application of the second year no goitre has been known to continue. Major Holmes was assisted by Captain Cunningham, who states that during the cold weather of 1854-55 he treated upwards of 20,000 people. He thinks from what people have told him and from the state in which he has seen some of the patients suffering with enormous goitres, that the disease proves fatal in not a few cases. He had seen many cases of goitre patients whose intellect was decidedly affected by the disease, and after the goitre was reduced they appeared much more intelligent and to be more rational creatures than they were before. However, Captain Cunningham says, there were so many idiots about that part of the country only slightly affected with goitre, that it would be difficult to say whether idiocy was actually induced by the disease, or the symptoms increased in those whose intellect was naturally defective. He had known the ointment fail in some cases when the tumour was small and of stony hardness, but had never heard of any instance of danger arising from the use of it.

In the table at p. 24 will be found some notes upon the wells in Chumparun, the waters of which were analysed for lime and magnesia. These analyses so far support Dr. Coates’ theory of the cause of the disease, that the water of the excellent well at Soogong Factory contains absolutely more lime and magnesia than neighbouring village wells, and indeed contains a very considerable amount of those bases.

The account of goitre in the Chumparun district is very instructive in its bearing upon the cause of the disease. For in the first place the use of the Soogoong and similar hard well waters

as a cure for goitre evidences very strongly against lime and magnesia as the cause of the disease. While that malaria is the cause of the disease appears probable from the association of goitre with fever in particular parts of the district; from the evidence, which we shall find agrees with that from other districts, that clearance of the ground, and an improved sanitary state of a locality, diminishes *pari passu* malarious fever, spleen, and goitre; and from the periodicity of the attacks of goitre from which the people in the Terai suffer during the malarious season. In the same direction too is the evidence which may be derived from the circumstance—of the truth of which Dr. Coates seems to have convinced himself—that during the rains, when the inhabitants of the Terai drink surface drainage they suffer from the disease, and are cured of it by the use of a purer water. And though in these cases impure water may not have been the only cause of the disease, for at the season when it develops, malarious influences generally are most rife, yet the history taken in connection with the evidence we possess that malarious poison can be conveyed into the system in solution in water, leads to the conclusion that the people are not improbably right in their belief.

The statistics collected by Dr. Coates go far to prove that goitre is not hereditary—that cretinism is not so, they do not make equally clear; while probably the native belief already noticed is correct, that marriage between blood-relations is one cause of the prevalency of cretinism in many parts of Chumparun.

There can be no doubt that the people of this district do intermarry very closely, and as, where the above-mentioned diseases prevail, all sadly labour under malarious influences, it follows that the introduction of the new and healthy blood amongst them, which the welfare of the race so greatly requires, seldom takes place, and that in consequence idiocy and cretinism abound and multiply.

Sarun. Sarun lies on the south-west of the districts of Tirhoot and Chumparun, and is separated from them by the Gunduck river. The district has an area of 2,654 square miles, and is triangular in shape, with its apex to the south-east at Sonapore, at the confluence of the Gunduck and Ganges, while the base faces to the north-west, and is formed by the artificial boundary which separates Sarun and Goruckpore. The south-western boundary is the Gogra and the Ganges. The district is for the most part an alluvial plain, with its lowest point at Sonapore 170 feet above the sea-level, from whence the country rises gradually towards the

north-west boundary. The Gunduck river where it bounds the district is on a somewhat higher level than the adjacent country, and in former times inundated a large area, especially towards the north-eastern portion of the district, while numerous streams, some of considerable size, carried off the water in the direction of the line of drainage away from the Gunduck towards the Ganges. The inundations are now restrained by a line of embankment which extends for a distance of about one hundred miles along the right bank of the river. The numerous channels of the old drainage still, however, remain, having a general direction to the south or south-east, and are partially fed by the overflow of the Gunduck, but mainly by the drainage of the district and that of the adjacent parts of Goruckpore. Many of these streams during the rains spread themselves out over the surface of the land, enriching the soil with a deposit of silt which enables it to yield splendid crops. Others deprived of the large volume of pure fresh water which they formerly received, and containing but little water in the dry season, have become stagnant and malarious, and so unhealthy that the people have deserted their banks.

The lands along the Gogra and Ganges are protected from direct inundation, unless in exceptional seasons, by the naturally high banks of those rivers, but in the time of floods the water forces its way up the channels of the small streams, and by so doing submerges considerable tracts of the lowlands which lie within the marginal elevations.

The surface of the country is richly cultivated and is beautifully wooded, mango groves abounding in all directions. The soil, well watered by rainfall, inundations, and irrigation from wells and by the streams, yields immense crops of rice, maize, millets, barley, wheat, and pulses, and opium and indigo are also largely grown in the district. In many localities the soil is saliferous, and is worked for nitre; kunkur is abundant, and is largely exported to the neighbouring districts for the purpose of road-making.

There is little or no jungle, or waste land, and the population is very dense, averaging 778 to the square mile, and in some places reaching 859 to the square mile. This district, with the exception of that immediately around Calcutta, is indeed the most densely populated in Bengal. The material condition of the mass of the people is poor, the cost of living having of late years risen disproportionately to the rise of wages.

Chuprah, the civil station, is situated on the north bank of the

Ganges, about a mile from the main channel, $25^{\circ}47'$ north lat., $84^{\circ}47'$ east long., with a population of 46,287. The site is low, being only 173 feet above sea-level, but it is artificially protected from inundation and is sufficiently raised above the adjoining land to allow of improved and effective drainage being carried out. The streets are narrow, and the town itself much crowded, but the Sanitary Commissioner¹ reports well of the condition of the people, and especially of that of the children.

Climate. The following table is compiled from the records of Chuprah which are in the Surgeon-General's Office, Fort William, years 1872-4.

	Mean temperature of month	Mean maximum	Mean minimum	Mean daily range	Rainfall in inches
January	61.5°	76.5°	49°	27.5°	.77
February	66	83	53	30	.53
March	72	93	63	30	1.64
April	86.5	102	71	31	—
May	93	106	81	25	—
June	88	101	77	24	5.45
July	86	96	78	16	14.08
August	85.5	93	79	15	9.12
September	86.5	94	79	15	7.1
October	80	92	71	21	.88
November	74	87	62	25	—
December	66	80	52	28	—
The year	78.8				38.95

Highest recorded temperature of the three years 113° in May and June. Lowest in January, 42° . Prevailing wind from May to September easterly; the remainder of the year westerly.

The rainfall at Chuprah, 16-19 years, averages annually 37.95 inches; that at Sewan, forty miles north-west of Chuprah, 53.96 inches.² From the beginning of April to the middle of June, when the rains set in, westerly winds prevail and the days are very hot, but at night the wind is ordinarily from the east and the temperature becomes much reduced; September, and the beginning of October, are hot, steamy, and unhealthy, but during the cold weather the climate is delightful, and sufficiently cold to be very invigorating.

*Diseases.*³ The district is reckoned on the whole a healthy one, the prevalent disease is of course fever, which chiefly affects people living in the low inundated parts. Bowel complaints, dysentery, and diarrhoea are very common in the cold season, and cholera every year visits the district, and may be said to be endemic in

¹ Report for 1875.

² Meteorological Reporter for Bengal, 1874.

³ See table at p. 134.

some parts of it. Small-pox, which was very fatal at one time, is now yearly diminishing as vaccination spreads.

Goitre is rare in the southern portion of the district, though because of its proximity to more decidedly goitrous regions many cases of the disease are treated at the Chuprah dispensary. In the subdivision of Gopalgunge, which occupies the north-eastern angle of the district between the Goruckpore frontier and the Gunduck, and in the vicinity of Hutwa which borders on Gopalgunge, goitre is very prevalent, but the sufferers from the disease otherwise enjoy the average health of the district.

CHAPTER XVI.

NEPAUL.

Nepaul, geology of; Nepaul valley, description of; people, climate, diseases, Mr. Bramley on goitre in Nepaul. Goitre in the country north of Nepaul.

THE kingdom of Nepaul¹ lies between the plains of British India on the south and the Snowy range of the Himalayas on the north. East and west, between Sikhim and Kumaon, it extends a distance of about 500 miles. Along its southern border is a wide tract of Bhâbur and Terai land.

Of the greatest part of the country little or nothing is known, for the Nepaulese Government jealously exclude Europeans from all but the comparatively small valley in which Khatmandoo, the capital of the state, is situated.

Khatmandoo, with a population of about 30,000, is situated in north lat. $27^{\circ} 42'$, east long. $85^{\circ} 16'$, at an elevation of 4,500 feet above sea-level. The city is about a hundred miles due north of Muzufferpore in Tirhoot, and about thirty-five miles distant, in a direct line, from the foot of the hills. The road from Tirhoot takes a general direction which is almost due north, and traverses the Terai and Bhâbur and then two ranges of Sub-Himalayan hills separated by a doon. The outer range is composed of conglomerate resting on sand. The inner one is of a more compact structure, and has sandstone as its principal component. Beyond the limit of the tertiaries the rocks are those of the Lower Himalayas, earthy schists and schistose slates, which are succeeded by a broad band of quartzites, and these again by a great mass of crystalline limestone. Over a broad area on the north, the limestone and the quartzites are repeated in confused masses, and the series in the opinion of Messrs. Medlicott and Blandford is probably connected

¹ Surgeon-Major Brown on the 'Epidemic of Cholera in Nepaul in 1856,' *Indian Annals of Medicine*, vol. v.; D. Wright, M.D., 'History of Nepaul,' *Cambridge University Press*, 1877, and 'Notes on Nepaul' in *Indian Medical Gazette* for July, 1867; Mr. Bramley on 'Bronchocele in Nepaul,' *Transactions of Medical and Physical Society of Calcutta*, 1833.

with that of the Król and infra-Król of the Simla region.¹ Gneiss and flaggy quartzose schists succeed, and the quartzose schists are continued up into the Chendragiri ridge which overlooks the valley of Nepaul, but here we again come upon calcareous rocks which occupy the whole width of the Nepaul valley. Pure limestone occurs chiefly at the top of the series, and caps Phulchok (9,720 feet), the loftiest of the peaks which surround the valley. Crystalline and slaty schists come in again on the north of the valley, and beyond these follows the gneissic series.

The valley is irregularly oval in shape, about twenty miles in length and sixteen in breadth. The general surface is very uneven, consisting of minor valleys separated by elevations sixty or eighty feet in height, on which the towns and villages are placed. It is well watered by numerous streams, many of which dry up in the hot season, while the water of all is greatly reduced by the system of irrigation which is largely practised by the Nepaulese. The valley is very highly cultivated. Mr. Bramley states that it presents within a given space a greater amount of cultivation than could perhaps be found elsewhere. The whole is under the plough, and devoted chiefly to the cultivation of rice and wheat. The wheat is cut in May and June, the rice in October and November. Maize and vegetables are also largely grown. Many of our English flowers, vegetables, and fruits also flourish in the valley.

The principal river is the Bhagmuttee, of which indeed the valley may be said to form the head-waters; it escapes at the south-eastern corner; a tradition asserts that the valley was formerly a lake which has gradually retired between the banks of the Bhagmuttee, and its probability is quite supported by the present physical aspect of the valley, the wavy surface of which looks as if it had at one time formed the bed of a lake. The soil is alluvial, consisting of a black unctuous clay, covered on the elevated parts by a sandy soil. The sand consists of silicious particles, mixed with mica, and fragments of silicious limestone, and resembles that which is being deposited along the beds of the streams at the present time. Beds of peat occur at various levels in the valley deposits; and there is also a blue clay extensively used for top dressing the fields,² the fertilising virtue of which seems to be due to the presence in it of phosphate of iron (vivianite.) No fossil deposits have been found in the valley.

The mean height of the valley is 4,784 feet above sea-level,

¹ *Manual of Geology*, p. 611.

² *Ibid.* p. 674.

and it is surrounded, except where the river escapes, by well-wooded hills varying in elevation from 500 to 2,500 feet above the general level; one of them, Phulchok, on the south of the valley, attains to 9,720 feet above sea-level.

The valley is densely populated, containing it is said about half a million of people. The race most numerous amongst the inhabitants are the Mongolian Newars, the original inhabitants of Nepaul, a happy and contented, but withal a very dirty race, employed in agricultural or mechanical pursuits, living chiefly on rice and vegetables, but glad enough to eat meat when they can get it, and very fond of indulging in a coarse spirit prepared from fermented rice; yet, notwithstanding this weakness, drunkenness, writes Dr. Brown, is practically unknown amongst them. The Goorkhas form the military class, and are the ruling race; they are said to be descended from Rajpoot emigrants and the women of the hills, and are a brave independent people, priding themselves upon being able to do nothing else but fight. Other inhabitants of the valley are Gurungs, Magurs, and Limboos, all of whom are of Mongolian origin. The residences of the higher classes are airy and clean; of the poorer classes low, close, and devoid of all sanitary arrangements. The towns, including amongst them the capital, are, writes Dr. Wright, loathsome beyond description; seething ditches and accumulations of intolerably offensive filth occupying every street. The dress of the people, even of the poor, is generally good, and sufficiently warm.

The climate, a sub-tropical one, is delightful, and resembles that of the most favoured parts of southern Europe. The year, like that of the Gangetic plains, divides into hot, rainy, and cold seasons. The hills which form the southern boundary are not sufficiently lofty to intercept the moisture of the south-west monsoon, and the annual rainfall is therefore heavy, averaging 60 inches. The rains commence about the beginning of June, and last till the end of September. The cold weather sets in about the middle of October, and lasts till the end of February. Snow lies on the mountains which surround the capital for days together during this season, and sometimes falls in the valley itself. Ice, too, occasionally covers the tanks and pools, and a hoar frost is by no means an unusual occurrence. The mean temperature at Kathmandoo is, according to Messrs. Schlagintweit, as follows:—

General mean of 11 years (1845-56).

January	45.4°	August	73.1°
February	50.3	September	70.7
March	56.6	October	64.7
April	61.6	November	55.6
May	67.5	December	49.6
June	72.1	The year	61.7
July	73.1		

The winds, as might be expected in a valley shut in by mountains, are irregular in their direction and fitful in duration. During the rains their tendency is from the south-east and south-west, but the currents are rarely perceptible within the valley, and except when occasional squalls from the north-west occur, the air is remarkably still.

The diseases of the people may, following Dr. Brown's account, be enumerated as follows. In the hot and rainy season fevers of an intermittent form attack those who are not in the habit of quitting the precincts of the valley, and this type may change to that of a severe remittent form in the case of any individual visiting the low-lying valleys in the vicinity, or the still more dreaded Terai. During this season numerous cases of dysentery, generally however of a mild type, occur, and cases of neuralgia are also very common. In the cold season bronchitis, small-pox, and rheumatic affections are very prevalent; while all the year round cases of atonic dyspepsia, syphilis, and goitre are met with. Leprosy is very common amongst those of the people who are the worst fed and housed, and the dirtiest in their clothing; cases do, however, occur amongst the higher classes. Rheumatism is a terrible scourge to the agricultural labourers, and it and leprosy are doubtless frequently aggravated by syphilis, and the violent mercurial treatment employed by the native practitioners. Eye and skin diseases are also very common. Strumous disease is by no means rare, but tubercle in the lungs is uncommon. Cholera makes its appearance every few years, and causes dreadful mortality. Small-pox, greatly spread by the practice of inoculation, is also very fatal, and hitherto vaccination has not been successfully introduced into Nepaul excepting amongst the higher classes. Typhoid fever is very prevalent towards the end of the hot weather and in the rains, in the crowded, dirty towns and villages. At times, when it becomes epidemic, it is so severe as to depopulate whole villages.

Goitre. Mr. Bramley, in the very full account which he gives of goitre in Nepaul, states that in many of the villages, in and

around the valley, as many as thirty and forty per cent. of the people are affected, and though it is not so prevalent in the cities as in the villages, yet, even there, three or four per cent. of the inhabitants suffer, and he believes that eleven per cent. may be considered a fair ratio of the number of cases amongst the gross population. No period of life is exempt from the disease; children are sometimes born with it. Men, women, and children of all ages, may be seen, the subjects of it, and it is by no means uncommon to find animals, such as the buffalo, goat, sheep, and dog, similarly affected. Women are apparently more subject to the disease than men, but Mr. Bramley is of opinion that the difference is apparent only, for he observes that amongst men the enlargement is often so trivial that without a careful inspection it would escape detection, and the same observation he believes explains a statement frequently made that in some places women only are affected by the disease. Foreigners residing in the valley are, almost equally with the inhabitants, liable to the disease. Thus Mr. Bramley found many of the sepoy's of the escort, men born and bred in various parts of the plains of India, affected, and he learnt that the average ratio amongst them for many years had not been less than fifteen or twenty per cent. Amongst the inhabitants of Nepaul, the higher and middle classes are less subject than the poorer, and amongst the latter those who follow agricultural pursuits, and are exposed to the vicissitudes of the atmosphere, are more frequently attacked than those whose vocations keep them within doors, a fact which may in part account for the far wider prevalence of the disease in villages than in the large towns. Mr. Bramley does not believe that the disease is hereditary, even in the face of the fact that we find bronchocele propagated from the mother to her children, and adhering to future lineages with astonishing regularity, for, as he justly observes, this may be, and probably is, because the children are exposed to the same circumstances as their parents. If however the persons thus affected remove to a non-goitrous locality, the constitutional taint becomes eradicated, and those suffering from the disease are cured, while on the other hand it suffices that a family, as yet untainted, reside but a brief period in a habitat of the disease, for all of them, young and old, to become affected. As regards the predisposing causes of goitre Mr. Bramley hesitates, yet thinks, anything, such as a blow determining blood to the part, may become one. If this be so we find here some foundation for the opinion that exposure of the neck is one of the causes of the disease. Debility,

Mr. Bramley thinks, certainly disposes to the disease, as also does insufficient diet, but no particular kind of diet does so. The Nepaulese unanimously agree that the sole cause of bronchocele is the water, and that it is so because of its being tainted with certain impurities which none of them have attempted to define; and indeed the water which is in use in the valley is to appearance and taste of the purest kind, and contains a very small proportion of mineral matter. As regards the opinion that any one state of climate can be assigned as the universal cause, Mr. Bramley considers that though in a general sense this opinion is supported by the manifest influence of locality upon the disease, and by the greater liability of the poor than the rich, of the dwellers in the country than in towns, and of the agricultural labourer than the artisan, yet that the great differences in the climate of Nepaul, and the neighbouring districts in which goitre is prevalent, puts climate as the common cause of the disease out of the question. But it must be considered that though the local differences in the meteorology of the extensive region to which Mr. Bramley refers are unquestionably great, the whole has in common a subtropical, and very moist, climate, one too in which malarious diseases are eminently prevalent. Mr. Bramley does indeed include the highlands of Thibet, which lie to the north of Nepaul, in the goitrous region, and no doubt we have there a climate which except in a few localities vastly differs from that of the country south of the Snowy range, but then further acquaintance with the people of that region has shown that goitre is not one of their diseases. Dr. Campbell, in his interesting account of Eastern Thibet,¹ dwells at some length on the diseases under which the people suffer, but does not include goitre amongst them; and Dr. Cayley, who was for upwards of two years resident at Leh, says, in a special report on the subject, that 'in Ladak and the other parts of the highlands of Thibet, goitre is virtually unknown. Where a case is seen, it always turns out that the patient had acquired the disease somewhere south of the main range. In Ladak ague and malarious fever are hardly ever met with. The people drink almost exclusively snow and glacier water, from streams which come direct from the snows. The prevailing rocks are granitoid and metamorphic, and clay slates of all kinds. Limestone is less general. In some parts, however, extensive tracts of mountains are composed in a great measure of limestone, but there goitre is equally unknown.

¹ 'Notes on Eastern Thibet,' March and following numbers of the *Phoenix* 1871.

As regards the supposed connection of cretinism with bronchocele, it is instructive to note Mr. Bramley's statement that cretinism, or anything approaching to it, is unknown in Nepaul. Indeed the subjects of bronchocele are not remarkable for weakened or impaired intellect. Nor did a case of congenital idiocy fall under Mr. Bramley's observation while he was resident in the valley. Dr. Wright, however, states, as the result of his inquiries, that cases of cretinism, though few in number, can be found in Nepaul.

¹ Beyond the table-land of Thibet and the Kuen Lun mountains, some 700 or 800 miles north of Nepaul, we again come upon goitre amongst the people of Kashghar. Kashghar comprehends the basin of the Tarim, a river which ultimately becomes lost in a vast stretch of swamps and lagoons known as Lake Lob. The population of the country is massed along the banks of the river and its tributaries in places rendered fertile by a system of irrigation, which has rendered them oases in an elsewhere desert country. Goitre and malarious fevers are very prevalent amongst the inhabitants of such places.

¹ See *Kashmir and Kashghar*, by W. H. Bellew, C.S.I., Surgeon-Major Bengal Staff Corps. Trübner & Co., London, 1872.

CHAPTER XVII.

NORTH-WEST PROVINCES AND OUDE.

North-West Provinces and Oude. Limits of the combined province; climate of the province; its meteorology.

THESE provinces¹ (now combined) extend a distance of some 500 miles along the valley of the Ganges, from the junction of that river with the Gogra on the east to where, on the west, the Jumna divides the North-West Provinces from the Punjaub. On the north they are territorially bounded by Nepaul, Tibet, and native Gurhwal. Oude, lying against the Nepaulese Himalayas, is embraced east, south, and west by the North-West Provinces.

Geographically far the largest portion of the province occupies the plain between the Jumna-Ganges and the Himalayas, yet a considerable tract of British territory extends along the western boundary of Nepaul far into the hills to the Indian watershed, while a band of country of varying breadth lies along the southern bank of the Ganges, between it and the native states of Rewa, Bundelcund, and Rajpootana.

The climate of the province, excepting the mountainous portion, and a narrow sub-montane tract, is throughout very uniform in character, with just that gradual change from east to west which depends upon the relation of the country at one end to the warm damp plains of Bengal and the Bay of Bengal, and at the other to the hot dry plains of Upper India and the regions beyond the Indus.

Mr. Elliott, in his meteorological report for 1874, draws attention to two leading features in the meteorology of the province; the one is that the phenomena appear in grand masses, and are generally of long continuity and are moreover indicated by slow and comparatively small changes in the elements of meteorological

¹ For the material of this sketch I am chiefly indebted to the *Report* for 1874 on Meteorological Observations in the North-West Provinces, by John Elliott, M.A., Reporter on Meteorology to the Government of the North-West Provinces; and to Mr. Blandford's *Winds of Northern India*.

observation. Thus during 1874 the absolute range of the barometer was less than an inch—less, that is, than one-half of what may occur in Lower Bengal during the twenty-four hours of a cyclone visitation. The only change, says Mr. Elliott, which manifests itself with any great suddenness is that in the amount of atmospheric moisture which usually precedes the rains. The other feature to which Mr. Elliott refers is the uniformity in the changes of atmospheric pressure over the whole province, so that a rise or fall of the mercury of more than one-sixth of an inch will be simultaneous not merely in the Gangetic plains, but in the Kumaon hills, and at Ajmere in Rajpootana, some 250 miles distant from the Ganges.

The meteorological conditions of the province depend very greatly upon its wind system, and of this the main features are simple enough, for the province is alternately swept by the winds, which, deflected from their original direction by the great chain of the Himalayas, represent the southerly and northerly monsoons. In the north-west districts of the province, owing to the northerly trending of the Himalayas, the leading winds are from north-west and south-east, whilst in other parts they are east and west. The easterly winds are decidedly on the increase along the eastern edge of the province as early as April; in May they preponderate, and in July they have attained their maximum throughout the country. Then they gradually decline, giving way to the north-westerly and westerly winds of the cold season, but during that season the winds are light and calms are frequent, and it is not till March or April, when the hot weather is setting in, that these winds attain any considerable force.

At this period, in March, April, and May, some diurnal cause intensifies the winds from about ten A.M. till six P.M., and gives rise to the hot dry winds of the season. The velocity of the wind current decreases from east to west. In November, the month of greatest stillness, the average diurnal motion at Benares is 29, whilst at Roorkhee it is 22. From this period it increases till the maximum is obtained in May, when the average diurnal motion at the two stations is respectively 109 and 86 miles. The velocity diminishes slightly during the first two months of the rains, and rapidly in September and October, with the gradual dying away of the monsoon current.

There is throughout the cold season a secondary maximum of winds from south-east or east,¹ and these winds, though quite sub-

¹ *Winds of Northern India*, p. 12.

ordinate to the principal currents from the westward, are of much importance to agriculture, since on them depends the occurrence of the winter rains and the fortune of the rubbee or winter crops; these rains attain their maximum in February. Otherwise noticeable too are these moist easterly winds, in connection with the westerly spread, when they prevail, of epidemic diseases along the Gangetic plains.

The monsoon rains begin about the middle of June, and are heaviest in July. During their continuance the temperature is moderately high and equable; the atmosphere is excessively humid. They cease about the end of September or the beginning of October, when the cold weather rapidly sets in. During the cold season the temperature is moderate and pleasant, but the daily range is very considerable, for the power of the sun is great during the day, and the nights are cold, a clear atmosphere allowing free transmission of heat from and to the surface of the earth. This lasts till the end of February or the beginning of March, when the heat begins to increase rapidly, and attains its maximum towards the end of May, just before the rains set in. During this season the hot winds blow during the day, and dust storms are common.

The barometrical pressure in the plains falls from the end of December when it is at maximum, to the middle of June when the pressure is at minimum, and rises through the same amount, $\cdot 55''$, during the following six months. Periods of slight variation in the half-yearly fall and rise occur pretty regularly during the year, and of these the most remarkable is during the first ten days of February, when a notable depression of the mercury is general through the province. The diurnal oscillations are very marked and regular, the maxima readings occurring about ten A.M. and ten P.M., the minima at four A.M. and four P.M.

Temperature at the end of the rains is very nearly constant over the plains, varying from $81\cdot 5$ at Roorkee to $83\cdot 5$ at Agra and $83\cdot 7$ at Benares. It diminishes steadily and rapidly till the first week in December, when it remains constant or diminishes slowly till the minimum is reached in the first week of January. The mean daily temperature now varies from $56\cdot 5$ at Roorkee to 63 at Benares. Thence onwards the temperature rises till the last week of February, when there is a halt which lasts till after the first week in March; during this ten days or fortnight the temperature actually diminishes from Lucknow westwards, and remains stationary at the more eastern stations. Subsequently the tempe-

perature rises rapidly till the rains set in ; at its maximum the mean temperature is at Roorkee 92·5, Bareilly 94, Lucknow 95, Benares 94·8. The temperature falls suddenly about 8° when the rains set in, and then continues pretty uniform till the end of September.

Daily range of temperature is, during the greater part of the year, mainly because of the dryness of the atmosphere, considerable ; but from about the beginning of June till the middle of September the range is slight and is at its minimum, about 13°, in July and August ; a second minimum occurs at the end of January or the beginning of February. The periods of maximum range (33° at Roorkee, 37° at Benares) occur in April and November. Relative humidity of the atmosphere diminishes from the beginning of the year till April at the eastern stations, when the minimum occurs, while at the western stations the diminution of humidity continues till May. Then the humidity increases rapidly and attains the maximum in July. During August and September it falls slightly, then rapidly till the middle of November, when a second minimum occurs. In January there is a second maximum, corresponding with the winter rains.

The rainfall in the Gangetic plain is greatest along the foot of the hills, and diminishes from east to west ; thus at Goruckpore it averages about 50 inches and at Bareilly 41, at Benares 40 inches, and at Meerut 29. By far the larger portion of the annual fall occurs between June and October, yet the winter rains are very constant. They commence usually in December and end in March, having their maximum in January or February. Though slight in comparison with the summer rains, averaging only about 3½ inches, they are of great importance to the agriculturist, and are connected with atmospheric phenomena which exercise no little influence on the climate of the province.

The period of minimum cloudiness over the plains is in October and November ; a second minimum falls in April and May. In June the cloudiness increases considerably, and is at its maximum in July and August ; that of September is considerable. A second maximum, though slight by comparison with that of July and August, occurs during the first quarter of the year.

CHAPTER XVIII.

PROVINCE OF OUDE.

Oude; limits of, physical geography, statistics of population; climate. Trans-Gogra districts of North-West Provinces—*Bustee, Goruckpore*. Trans-Gogra districts of Oude—*Gonda, Bharaich, Kheri*. Chief diseases of the province; death-rates. Cholera in Oude; seasonal incidence of the disease, small number of villages attacked during an epidemic. Small-pox; fevers; Dr. Cameron's and Dr. Higginson's investigations of fever mortality. Bowel complaints. Goitre in Oude and in Goruckpore. Dr. Butter and Surgeon-Major Greenhow on goitre. Dr. Sutherland's opinion on miasm as the cause of goitre. Goitre in Kheri. Non-association of goitre and cretinism in Oude.

OUDE. The province of Oude stretches for some 160 miles along the northern bank of the Ganges, extending thence northwards to the frontier of Nepaul. On the east it is open to the plains of Bengal, and is separated by an artificial boundary only from the districts of Bustee, Azimghur, and Jounpore. On the west its boundary marches with that of Rohilcund.

The northern frontier, for the first sixty miles to the east, runs along the foot of the lowest range of Himalayas, and from that point advances for some distance into the Sub-Himalayan Terai.

The surface of the province, till the immediate neighbourhood of the Himalayas is reached, is an almost perfect plain; the only irregularities being occasioned by the unequal resistance opposed to denudation by the irregular distribution of kunkur; where that material predominates the soil undergoes abrasion slowly, and may stand up some seventy or eighty feet above the neighbouring plain. The general slope of the country is from north-west, where the highest point is about 600 feet above sea-level, to south-east where the level falls to 230 feet.¹

The province is divided into a northern smaller, and southern

¹ *Administrative Report for 1873-74. Introduction to the Official Gazetteer of Oude, Lucknow, 1877.*

larger, portion, by the river Gogra and its tributary the Chowka. We shall find that the country lying to the north of the river differs considerably in its climate and physical characters from that to the south of it.

The Chowka (or Sarda) river rises amongst the perpetual snows of the Himalayas, and enters the plains ten or twelve miles above the north-western corner of Oude. Entering the province it takes a south-eastern course, and joins the sister river, the Kauriali, about the centre of the province, to form the great river Gogra.

Of the two tributaries the Kauriali is considerably the largest.

The combined stream is of great magnitude, and near the point of confluence has a minimum discharge of from 18,000 to 25,000 cubic feet per second. The Kauriali, like the Chowka, rises amongst the perpetual snows, and enters Oude, about fifty miles to the east of the Chowka, eighteen miles south of the point where it leaves the hills. After leaving the hills the river quickly divides into two streams, the western of which is the Kauriali proper. The eastern stream, the Girwa, was till lately of small size, but now surpasses the Kauriali in the volume of its water. The Chowka formerly took a more directly eastern course within the province than it now does, and entered the Kauriali some ten miles below the frontier, through a channel which is now occupied by a comparatively small stream, the Surjoo, which joins the Kauriali near the point where the latter river and the Girwa recombine their streams. The northern division of Oude is crossed by another large river, the Raptee, which rises in the outer Himalayas, enters Oude about fifty miles to the east of the Kauriali, and after a tortuous course of some ninety miles in a south-easterly direction, becomes for a time the boundary between Oude and the district of Bustee.

The cis-Gogra division is traversed by many streams, the principal of which are the Ool, the Goomtee, and the Sai; these rivers all rise in the marshy lands on or near the Rohilcund border, and take a south-easterly course in the province. The Ool has a comparatively short course, entering the Chowka before the junction of that river with the Kauriali. The Goomtee, so called from its tortuous course, traverses the whole length of the province, as does the Sai also.

Besides the rivers which have been named, Oude is crossed by innumerable streams of smaller size, of which a large number dry up in the hot season. Many of them open into jheels, which abound throughout the country and are of great service to the cultivators

of the land by providing water for irrigation and for the cattle during the hot season.

The area of Oude is 23,930 square miles, and the population by the census of 1872 11,174,287 souls, or on an average 467 to the square mile. The population is almost entirely scattered through villages and small towns, for, with the exception of Lucknow and Fyzabad, there is not throughout the whole of the province a town of even moderate size. The bulk of the people are agriculturists. The proportion of arable soil to the total area is very large, 76 per cent.; and upwards of 68 per cent. is actually under cultivation, while only seven per cent. is barren waste. Six and a half per cent. of the area is covered with water—rivers, lakes, or jheels. During the year 1874 the area approximately under cultivation for the principal crops was as follows in square miles. Rice 2,222, wheat 2,874; other food grains, such as millets and pulses, 6,840; oil-seeds 325, sugarcane 350. Other smaller, though important crops, are tobacco, opium, cotton, indigo.

The soil is for the most part a rich loam, in places clayey, in others sandy. Kunkur is found near the surface almost throughout the province. In places *Reh* efflorescence renders the surface unculturable.

The average distance of the water from the surface has been calculated at twenty-eight feet; but while in the northern division the distance varies from four to fifteen feet, south of the Gogra it ranges from twenty-five to sixty feet.

Along the whole length of the northern frontier runs a broad belt of forest and Terai; prolonged on the tongues of land between the streams into the plains; the forest on the high central ground, the Terai along the low land which skirts it. In the north-western angle of the province the Terai extends far into the plains, occupying the country north of the Chowka river, and stretching beyond that river into the country about the head waters of the Ool and other streams which rise in a jumble of swamp and forest. In places amongst the marshes and jungle of the Terai are found patches of pasture land and cultivation which are occupied by the Tharoos, a people who are able to withstand the pestilential climate.

The aspect of the whole country is, writes Dr. Butter,¹ prodigiously influenced by the season of the year; 'during April and May, and part of June, bare and brown owing to almost all annual plants being withered up by hot winds, while after the first fall of

¹ *Medical Topography of Oude*, 1839.

rain the surface is clothed with a general verdure.' The whole surface, writes General Sleeman,¹ 'is indeed like a gentleman's park of the most beautiful description, as far as the surface of the ground and the foliage go. Five years of good government would make of it one of the most beautiful *parterres* in nature.'

North of the Gogra the soil is of a sandy character; it is, however, fertile, and its yield is proportionate to the water it receives. The rainfall is greater here than south of the river, and the crops are scantily irrigated from streams and jheels. The population is comparatively sparse, and the region has a bad name for fever which is unquestionably justified by facts.

The finest part of the province is the tract of country between the Goomtee and the Ganges which is subdivided by the Sai. Between the rivers is an elevated hollow in which there is a string of jheels, and there are here large plains of bare uncultivated land covered with reh efflorescence. But amongst the jheels and waste tracts are wide stretches of irrigated cultivation, interspersed with fine groves of trees. Outside the central tract the soil is clay and sand, and here the country is a perfect garden, nearly all cultivated, yielding enormous crops, and inhabited by a dense population of the finest race of people of this part of India. Between the Goomtee and the Gogra the land is not equal to that south of the former; the upper part is sandy and the crops which are unirrigated are, comparatively speaking, poor; but the soil of the lower part of the district is clayey, there are more jheels and more irrigation, and the crops are excellent.

Yet though the country south of the Goomtee is the finest and healthiest portion of Oude, it has its unhealthy spots; Dr. Butter describes one which is especially so. This unfortunate locality is eight miles north-west of Manickpore, in the Purtabgurh district. Here is a marshy lake (or jheel) some sixteen miles in length, connected at its eastern end with the Ganges. The town of Bellagaun, situated upon this lake, is, he writes, the unhealthiest spot in Oude, the inhabitants, almost without exception, suffer from severe ague during the rains, and strangers die within a year from the effects of the pestilential air. It is very remarkable, however, says Dr. Butter, that repeated attacks of fever amongst the inhabitants not only does not produce enlargement of the spleen, but their general appearance is not, as in the case of the people of the Sub-Himalayan Terai, affected by the distemperature of the air. And yet buffaloes feeding along the margin of the

¹ *Tour through Oude*, 1850.

jheel suffer greatly from enlargement of the spleen, and speedily die if not removed to other pastures.

The following table exhibits the statistics of population &c. of the districts into which Oude is divided.

Districts of Oude.

Name of district	Area in square miles	Population per square mile	Cultivated in acres	Grazing land, and culturable	Unculturable waste	Proportion that rice bears to wheat cultivation	Agriculturists	Non-agriculturists	Pre-vailing language
Lucknow . . .	988	799	482,840	187,504	228,274	1 to 3 equal	281,655	507,805	Oordoo and Hindi
Oonao . . .	1764	536	450,909	178,112	237,279	—	—	—	
Bāra Banki . . .	1769	627	534,294	96,627	192,090	1 to 1·2	610,572	504,681	
Seetapore . . .	2206	433	914,078	283,672	219,809	1 to 2·3	704,201	216,906	
Hurdui . . .	2292	406	844,560	352,724	269,830	1 to 5	599,696	331,681	
Kheri . . .	3046	242	772,071	521,114	217,531	equal	474,810	263,794	
Fyzabad . . .	1681	608	827,488	243,893	243,898	equal	673,652	349,118	
Bharaich . . .	2710	286	836,441	511,663	189,247	1 to 1·6	495,751	273,889	
Gonda . . .	2745	425	1,054,101	466,859	189,180	1 to 4	753,720	412,795	
Roy Bareilly . . .	1741	536	428,534	203,750	232,285	1 to 2	521,376	467,270	
Sultanpore . . .	1704	584	505,520	185,525	314,160	1 to 7	608,736	387,080	
Purtabgurh . . .	1423	543	534,043	164,490	398,064	1 to 2·4	558,874	225,280	

Climate. The climate of Oude is both a more pleasant and a more healthy one than that of the country south of the Ganges—it is less extreme, cooler and more humid. Along its eastern frontier the province is open to the east winds bringing with them the dampness of Bengal, while along its south-western frontier it is exposed to the west winds of the North-West Provinces, dry and cold, or dry and hot, according to the season of the year; along the whole of its northern frontier are the forest-clad outer Himalayas.

The seasons, cold, hot, and rainy, are very regular. In October the mornings and evenings begin to get cold, and in November the cold season has fairly set in. This is a most delightful time; the sky is for the most part cloudless, the westerly wind cool, dry, and crisp, and though the sun in the middle day is hot, it is not unpleasantly so, and the mornings and evenings are quite cold. The winter rains fall pretty regularly towards the end of December or in January, and heavy night-dews are very common, especially in the northern districts, throughout the season. In March the weather begins to get warm, and the temperature steadily rises till about the middle of June, when the rains set in. The hot winds set in towards the end of April and continue over the cis-Gogra districts till the rains; during their continuance the weather is exceedingly hot, yet this is by no means an unhealthy time. About the middle of September the rains begin to break up and

the weather for a brief period is liable to be trying and disagreeable.

The climate of the country north of the Gogra differs markedly from that of the rest of Oude; it is less hot, more equable, and more humid, a difference which perhaps mainly depends upon the absence or comparative mildness of the hot winds, but also upon the circumstance that the enormous drainage of the southern slopes of the Nepaulese Himalayas passes through the country in numerous streams, many of which, moreover, have from time to time changed their course, leaving low places occupied by lakes or marshes. And another circumstance which tends both to equalise and to moderate the temperature of these Sub-Himalayan districts is the presence of currents of air which, checked in their course, descend the skirts of the mountains and spread out upon the country at the base. This difference of climate between the trans and cis-Gogra country has been frequently remarked on by writers on the climate of that part of India. Thus Dr. McClelland says: ¹ 'The traveller from Calcutta to the Upper Provinces loses at Burdwan the vegetation of Lower Bengal, and fancies he has left it behind him until he is led, perhaps by accident, from Lucknow to Fyzabad, when, within the short distance of seventy or eighty miles, the landscape suddenly changes, and from parched plains he enters a climate of perpetual spring;' 'this fact is brought home to one's convictions by the busy hum and joyous notes of thousands of birds which congregate in the districts east of the Gogra river to avoid the hot winds.'

The Tables X. and XI. in the Appendix show the principal meteorological elements of Lucknow and Goruckpore for the years 1875-76. Averages of temperature and rainfall will also be found in the Appendix. Lucknow is situated very nearly in the centre of the province, at an elevation of 369 feet above sea-level, and about one hundred miles from the base of the hills. Goruckpore is situated in the trans-Gogra country, about one hundred and fifty miles east of Lucknow, about sixty miles from the base of the hills, and 255 feet above sea-level.

On the east of Oude, north of the Gogra, lie the districts of Bustee and Goruckpore, and south of the river, the districts of Azimghur and Jounpore. In climate and soil these districts exhibit the same contrast as the corresponding divisions of Oude, a contrast which has been well drawn out by Dr. Planck.² He writes:

¹ *Medical Topography of Bengal*, p. 42.

² *Report of Sanitary Commissioner of North-West Provinces for 1870.*

‘These districts of the Gogra-Gangetic Doab form together a country of really marvellous fertility; a pretty uniform plain of dark-coloured clayey soil, the spring level comparatively near the surface everywhere, so that to make a tank of permanent utility it only seems necessary to excavate to a depth of from twelve to twenty feet, and such tanks are so numerous as to form quite a feature in the country. The villages, close set, contain a teeming population, and perhaps no part of India sends out more people to service or employment far away from their homes than this, for the Hindoo constitution, favoured land. The many people who remain at home may be said with but little exaggeration to be devoted to agriculture, working so earnestly and successfully that to a casual observer it seems as though no such thing as uncultivated land existed; indeed the impression grows, as you proceed from place to place, that nowhere in all the world could such results of man’s rewarded efforts be seen as are presented here in the up-standing wheat, barley, sugarcane, and poppy; the drooping urhar dhal, borne down by the weight of its own seed, the plants propping each other to form thickets of grain; and so the crops of oil-seeds and smaller dhals and peas and gram and indigo; really an endless and quite marvellous profusion of food plants and useful products. North of the Gogra,’ continues Dr. Planck, ‘is the great Goruckpore country, stretching away to the foot of the Himalayas. It differs from the country south of the Gogra mostly in these particulars, that its villages are more wide-set, its trees larger and more gathered into great groves, the aspect of the country wilder, especially north of the Raptee, as though less cleared for cultivation or more recently cleared. It is more a land too of water-holes, wide stretches of water in lakes and swampy places; the spring level is nearer the surface, the night dews are heavier. But the good land is plentiful, and the crops here also seem to burden the land everywhere; in the cold weather it is especially a land of peas, for the growth of which the soil, a dark clay, seems especially adapted, yet the cereals and pulses come in for careful and prolific cultivation. Sugarcane too, and the poppy, as in the south. Indeed waste places seem only to exist where excess of moisture forbids cultivation; these parts, however, in turn yielding their share of food-products in the rice-growing time of the rains.’

The Sub-Himalayan districts of Oude are Gonda, Bharaich, and Kheri; the two former lie between the Gogra-Kauriali and Nepaul,

while Kheri lies partly between the latter river and the Chowka, and partly on the south of that river.

Gonda is the easternmost of these districts; its eastern boundary marches with Bustee, the northern runs along the low range of outer hills and includes the strip of forest which bounds the cultivated plain. The plain is naturally divided into three belts: the Terai which occupies the northern third of the district,—here the soil is a heavy clay, and water is generally near the surface; the lowlands, which stretch away from the low northern bank of the Gogra, occupying rather less than the southern third of the district, with a light loamy, often sandy soil, and high subsoil water-level; and, intervening, a belt of slightly raised table-land which has a loamy soil, and a water-level from fifteen to twenty-five feet below the surface. Every portion of the plain is fully under cultivation, and is picturesquely wooded with groves of mango and other trees. It is plentifully watered by a rainfall which averages 45 inches per annum, by the Raptee and many other streams, by numerous jheels or lakes, and, when needed, by irrigation from wells. The whole is marvellously fertile, and there is scarcely an acre in the district which would not eventually reward patient labour.¹ The population varies from 730 per square mile in the south-western portion to 161 per square mile in parts of the Terai; the average on the whole district is 444.5. The principal crop is rice, then wheat and barley, then millets and pulses. Fever is very prevalent all over the district, but most so in the eastern portion of the Terai belt. Scurvy² is common in the district, and is said to be produced by the absence of green food and the unvaried grain diet of the lower orders. Goitre is common, and is not confined to the neighbourhood of the hills.

Bharaich lies to the west of Gonda; its northern boundary runs from the east for some distance along the crest of the hills, and then along their base. Like Gonda, the district is naturally divided into three belts of country—the Terai, the central highland, and the lowland along the Gogra-Kauriali. The north-eastern angle of the district is crossed by the Raptee; numerous other streams, some of considerable size, intersect its surface. Only one bit of genuine Terai remains in the district;³ a small tract occupying the north-eastern corner, low-lying, and during the rains almost continuously under water, yet by no means uncultivated, and in fact a great rice-producing area. The rainfall of the district averages about 45 inches, the temperature, like

¹ *Gazetteer*, vol. i. p. 498.

² *Ibid.* p. 503.

³ *Ibid.* p. 99.

that of Gonda, is cooler by several degrees than that of the cis-Gogra districts, but the air as a rule is laden with moisture, and is therefore not so bracing. The population is pretty evenly distributed through the district, and averages 347 souls per square mile, or 639 souls per square mile of cultivation.¹ The principal crop is rice, then Indian corn, barley, wheat. Goitre is very common in the district, especially in the lowlands of the south-eastern portion.

Kheri. This district occupies the north-western angle of the province, separated on the east from Bharaich by the Kauriali, bounded on the west by the Rohilcund districts of Bareilly and Shahjehanpore, on the north by Nepaul, and on the south by the Oude districts of Hurdul and Seetapore. It is crossed diagonally from the north-west by the Chowka or Sarda, which joins the Kauriali a little below the south-eastern corner of the district. Both these rivers are of great size; the Kauriali has a minimum dry weather discharge of 13,700 cubic feet per second, and the Chowka 7,300 cubic feet. The latter is a most destructive river, flooding its low banks every year, and sweeping hundreds of square miles of the land in their vicinity. Moreover both rivers have constantly changed their course, and as a result the northern half or two-thirds of Kheri is seamed with ancient river-beds now occupied by swamps and dense jungle. Many other rivers cross the district, and of these, one, the Ool, is particularly mentionable because it is ordinarily spoken of as dividing the healthy from the unhealthy portion of the district. The course of this river is parallel with that of the Chowka, and about twelve miles distant from its southern bank. The country to the north of the Ool is an elevated plateau, seamed, as has already been mentioned, by numerous river-beds; the larger portion of its surface is covered with huge tree-forests, or jungle or swamp. The people who inhabit it, too few and feeble to cope with the forest, crowd into the lowlands about the river courses, where they maintain a scattered cultivation or watch their herds of cattle. The forests which cover the northern belt stretch away along the rivers through the central and southern portions of the district, and beyond the border into Hurdul and Seetapore.

South of the Ool the great rivers have ceased to sweep off cultivation, but here between each pair of rivers is found a low plain in which are extensive marshes, the head waters of various small secondary streams.² In this part of Kheri is Luckimpore,

¹ *Gazetteer*, vol. i. p. 100.

² *Ibid.* vol. ii. p. 142.

the head-quarters of the district, situated about a mile south of the Ool river, forty feet above its bank, and 480 feet above sea-level, in a well-cultivated and comparatively healthy tract. Of the whole district less than one-half—1,290 out of 2,987 square miles—is cultivated; of the remainder 650 square miles is forest and 1,047 grassy savannah or bush jungle.¹ The fertility of the soil is so uniform that only thirty-seven square miles of the district are recorded as barren. The principal crop is rice, then wheat, barley, and other grains; a good deal of sugarcane and oil-seeds are also grown. The population varies per square mile from 537 in pergunnah Kheri, in the south, to 78 in Kharigarh in the north-east.

The climate of the district north of the Ool is considered very malarious; that of the southern portion healthy. The heat is less than in the surrounding districts; the rainfall averages 47 inches annually. Kheri is, as a whole, the most unhealthy district of Oude, yet the residents of the cleared highlands are robust and energetic, and there no sickness prevails. It is in the Terai lands that fever, a very plague in Kheri, commits such havoc. The same soil prevails throughout the district, but in the forest and jungle tracts it is charged with the products of decomposing vegetation which taints the water that drains from it and the air which rests on the surface. The unhealthy seasons are two, part of April May and part of June before the rains, and part of August September and October at the latter end of the rains. The people believe that the former season owes its unhealthiness to bad water, and the other to bad air. In the hot season bitumen pressed out of the coal-measures of the Himalayan chain beyond the Terai forest is found floating on the waters of the springs, but the poisonous property of the water cannot be ascribed to its presence.² Bowel complaints are very prevalent and fatal in the district. Cholera is frequently present. Diseases of the lungs and rheumatism are very common in the cold season. Skin diseases are very prevalent; leprosy is not uncommon. Goitre is very common in the parts of the district north of the Chowka. The cattle equally with the people suffer from the pestilential character of the climate; the principal disease amongst them is a virulent diarrhœa,³ and it has been noticed that the village site has not much to do with the prevalency of disease if the cattle are allowed to graze in low marshes in the vicinity. Wherever there

¹ *Gazetteer*, vol. ii. p. 144.

² *Ibid.* p. 147.

³ *Ibid.* p. 150.

are marshes cattle disease is more prevalent than elsewhere. This is a state of things parallel to that existing in many elevated and well-situated villages in other parts of India, the inhabitants of which suffer because they have to labour during the day, or during certain seasons of the year, in the neighbouring lowlands or valleys.

Diseases of Oude. The principal diseases of the province are malarious fevers, small-pox, cholera, and bowel complaints.

The following are the deaths per 1,000 of population recorded to each disease during the last five years of the existence of Oude as a separate province.

	Cholera	Small-pox	Fevers	Bowel complaints	All causes
1872	2·37	1·59	11·64	·54	17·0
1873	·35	1·98	9·31	·41	12·8
1874	·01	1·36	9·	·38	11·8
1875	2·09	·5	11·69	·58	16·25
1876	1·84	·47	13·61	·61	18·21

Tables in chapters iv. and v. show other statistics of disease and death amongst the civil population, the troops stationed in Oude, and the jail population.

The Sanitary Commissioner believes that the comparatively high death-rate of 1876 is due not to increased mortality in that year, but to more complete registration. In former years the registration was notoriously very imperfect.

Cholera. The tables in chap. vii. show the seasonal incidence of cholera amongst the civil population of the province. That which follows¹ shows the number of deaths per 1,000 of population during each of the eight years ending with 1877. The table gives the same information regarding the districts of the North-West Provinces, and the number of years in which each district of the now combined provinces suffered. Further the table shows, but only for certain districts from which the daily returns of cholera deaths were received, the number of villages affected by cholera during the prevalence of the disease in the year 1877. Out of 70,180 centres of population in those districts, a death or deaths from cholera were reported to have happened in 3,660. Of these 3,660 villages or towns a marked prevalence of cholera was reported as having happened in only 116.

¹ From the *Report of the Sanitary Commissioner of the North-West Provinces and Oude for 1877.*

Table of Deaths from cholera in the districts of the North-West Provinces and Oude per 1,000 of population.

District	Average of the eight years	1870	1871	1872	1873	1874	1875	1876	1877	Number of villages in each district	Number of villages af- fected by cholera in 1877	Number of years in which each district suffered
Kumaun . . .	.82	—	—	—	4.8	—	—	1.8	—	—	—	2
Garhwál . . .	.22	—	—	—	—	—	1.8	—	—	—	—	1
Tarái . . .	1.0	—	—	1.9	2.4	—	0.1	3.6	—	—	—	4
Bijnor . . .	.12	—	0.1	0.3	—	—	0.5	0.1	—	—	—	4
Moradabad . .	.4	0.1	0.1	1.0	0.6	—	0.7	0.5	—	—	—	6
Bareilly . . .	.4	0.1	—	0.9	—	—	0.4	2.0	—	—	—	4
Sháhjahánpur .	.8	—	—	4.6	—	—	1.1	0.5	—	—	—	3
Budaun . . .	.4	—	0.1	0.9	0.4	—	1.8	0.1	—	—	—	5
Kheri . . .	.6	1.5	—	0.5	0.6	—	0.6	0.7	0.8	1776	47	6
Sitapur . . .	.4	20.0	—	0.5	0.1	—	1.5	—	1.3	3590	112	5
Hardui . . .	.8	0.3	—	3.3	—	—	3.1	—	—	1980	2	3
Dehra Dún . .	.6	—	—	2.1	—	—	3.1	—	—	—	—	2
Sabaránpur . .	.3	0.1	0.1	1.5	—	—	0.5	—	—	—	—	4
Muzaffarnagar .	.14	0.2	0.1	—	—	—	0.8	—	—	—	—	3
Meerut . . .	.2	—	—	0.4	—	—	1.2	—	—	—	—	2
Bulandshahr . .	.4	—	—	0.4	—	—	2.5	—	—	—	—	2
Aligarh . . .	.4	—	—	0.7	0.3	—	2.2	—	—	—	—	3
Etah . . .	.4	—	—	0.4	0.3	—	2.6	—	—	—	—	3
Muttra . . .	.22	0.1	—	0.4	0.3	—	0.8	—	0.2	822	14	5
Farukhabad . .	.7	—	—	2.7	—	—	2.5	0.3	—	—	—	3
Mainpuri . . .	.4	—	—	0.4	0.6	—	2.3	—	—	—	—	3
Agra . . .	.2	—	—	0.4	0.4	—	0.7	—	0.2	1436	48	3
Etáwáh . . .	.4	—	—	2.1	—	—	1.2	—	—	—	—	2
Lucknow . . .	.7	0.1	0.8	1.5	0.2	—	1.6	1.3	0.2	—	—	6
Bara Banki . .	.24	10.4	5.2	1.6	—	—	1.0	0.5	0.4	2102	43	6
Unao . . .	.7	0.3	0.2	2.0	0.2	—	1.7	1.4	—	—	—	6
Cawnpore . . .	.4	—	0.1	1.3	0.1	—	1.0	0.8	—	—	—	5
Fatehpur . . .	.5	—	—	0.7	1.0	—	0.6	1.4	—	1458	5	4
Jaunpur . . .	1.5	0.6	0.4	8.0	0.5	—	1.4	0.8	0.5	3212	58	7
Hamírpur . . .	.6	—	—	0.1	0.1	—	2.2	1.7	1.0	752	54	5
Bánda . . .	.8	0.1	—	0.2	1.1	—	1.6	1.0	2.2	1240	358	6
Allahabad . . .	.7	0.1	0.1	2.6	0.6	—	0.9	1.4	0.1	3813	57	7
Rae Bareli . .	.29	7.9	3.2	2.6	2.0	—	1.5	6.2	0.1	1750	32	7
Sultanpur . . .	.32	12.1	6.1	2.3	—	—	2.8	1.6	0.5	2517	94	6
Partabgarh . .	1.8	1.9	1.4	7.8	0.2	—	1.0	1.6	0.3	2222	56	7
Bahraich . . .	.34	15.0	—	2.9	0.1	—	4.3	2.3	2.6	—	—	6
Gonda . . .	.82	51.2	—	3.0	0.3	—	3.2	4.3	3.8	2835	388	6
Fyzabad . . .	.37	22.8	0.3	0.8	—	—	1.9	1.3	2.2	2552	295	6
Gorakhpur . . .	1.1	1.3	—	1.4	0.2	1.9	1.3	0.4	2.2	8248	417	7
Basti . . .	.23	3.4	—	6.4	—	0.6	2.7	1.6	3.5	7555	1159	6
Azamgarh . . .	.6	0.9	0.1	0.7	0.6	0.2	1.0	1.4	0.9	6363	197	8
Gházípur . . .	.6	0.2	0.1	0.4	0.9	0.0	0.5	2.0	0.9	5206	63	8
Benares . . .	1.3	0.5	0.8	1.7	2.1	0.3	1.3	2.3	1.1	2286	92	8
Mirzapur . . .	1.3	0.8	0.1	1.7	1.2	0.1	2.2	3.5	1.1	5722	54	8
Jalaun . . .	.2	—	0.0	0.1	0.1	—	1.2	0.3	0.1	—	—	6
Jhánsi . . .	.0	—	—	—	—	—	—	—	—	—	—	—
Lalitpur . . .	.1	—	—	—	—	—	—	—	0.7	749	15	2
Total . . .	—	0.7	0.4	1.8	0.4	0.1	1.5	1.1	0.7	—	—	—

As regards the seasonal incidence of the disease, the minimum is reached in February. In March the mortality begins to rise, and reaches its maximum in April and May, or sometimes in June. Usually there is a lull which begins in June and continues through July and August. In September the mortality again rises, and the increase continues till November. In December as a rule there is a marked decrease in the mortality, a decrease which continues through January to the minimum in February. Thus the seasonal prevalence of the disease in Oude approximates to that in Bengal: the only point of contrast, and it is an important one in its relation to the effect of the rainy season on prevalence of the disease, is the later incidence of the period of maximum mortality.

In Oude the disease is more frequently and more severely present in the trans-Gogra districts of Gonda and Bharaich than elsewhere; but even these districts are not affected every year. The table shows that they escaped in 1874. Bustee, the neighbouring district (till lately of the North-West Provinces) shares with those just mentioned the same unenviable pre-eminence. Goruckpore, also a trans-Gogra district, lying between Bustee and the western boundary of Behar, does not show by any means the same ratio of mortality from the disease, though it is one which in its physical conditions resembles the similarly situated districts.

The table shows that the only four districts of the combined provinces which suffered each year from cholera were Ghazeepore, Mirzapore, Benares, and Azimghur, districts which lie along the Ganges immediately to the west of and touching the province of Bengal, a circumstance which points in an unmistakable manner to the communicability of the disease, unless, in spite of their physical characters, we include these districts in the endemic area of cholera. But in evidence against the contagiousness of the disease is another fact which the table brings out, namely the limitation of the disease to five per cent. of the centres of population in the districts where evidence on the point is forthcoming; and this fact is one which must very strongly impress those who are personally acquainted with the habits of the poorer classes of India—the constant intercourse between neighbouring centres of population, and the universal neglect of sanitary precautions, whether by individuals or the public.

Small-pox is a great cause of mortality in Oude, killing indeed more people than does cholera. During the six years

ending 1874 100,242 deaths were registered to this disease.¹ Vaccination has as yet made too little advance in the province to reach the masses. But if proof were needed of the efficacy of vaccination, it might be found in the fact that the mortality from small-pox is almost *nil* amongst the sepoys quartered in Oude, though they are in free communication with bazaars and villages in which the disease exists. As in Bengal, the maximum of death from small-pox in Oude is during the hot weather, in April and May.

Malarious fevers are the fevers of Oude, but contagious fevers are not unknown. The Lucknow Central Jail, otherwise a very healthy one, has twice of late years localised typhus fever, in 1860 and in 1865.

Malarious fevers and their sequelæ are beyond doubt the cause of enormous mortality in Oude, but it is equally certain that the returns of deaths under this head are exaggerated. Systematic observations on the subject have been established in the province, and though satisfactory results cannot be expected till they have been carried on for some years, the partial results obtained are very instructive. Thus, in Sultanpore the Civil Surgeon, Dr. Cameron, and his assistant, made personal enquiries in twenty-one villages regarding the causes of death. During twelve months there were 192 deaths, and of these 22 per cent. were from fever, while the returns of the whole district showed 53 per cent. of deaths from fever. The deaths from bowel complaints were nearly as numerous as from fever. In the district of Seetapore, where the enquiry was carried on in selected areas during the months of October, November, and December, the deaths from fever were 40 per cent. of the whole mortality, while the returns for the whole district during that period showed 75·2 per cent.

In Kheri Dr. Higginson found the deaths in selected areas 11 per thousand of population, while the assigned rate for the whole district was 17·66 per thousand. Dr. Higginson sums up the evidence to be derived from his inspection as follows.

1. That the greatest number of cases, and the highest mortality, occurred in the months of August, September, and October.
2. That in villages situated on low-lying lands the prevalence and virulence of the disease was greatest.
3. That the cultivation of particular crops did not appear to exert any influence. In regard to sanitary condition, state and

¹ *Sanitary Report*, 1875.

repair of wells, comfort &c. of the inhabitants, these villages were similarly circumstanced with the rest of the district.

Dr. Higginson's observation that fever is most prevalent and most fatal from August to October is a noticeable one; it agrees with what is established as to the seasonal prevalence of fever amongst the native army in Oude, but contradicts the usually accepted dictum that fever is most fatal in the last quarter of the year. Probably the explanation lies in the fact that fever is directly most fatal during those months, but indirectly most so in the cold months which follow, for it is then that the sequelæ of fever, aggravated by cold, kill off individuals who have become debilitated by the primary disease during the autumn. And the question arises whether after all there is great exaggeration in the record of deaths from fevers, if deaths indirectly due to them are allowed to count.

Bowel complaints are very fatal in Oude, but the term includes no doubt many deaths which ought to have been registered to cholera; a vast number of deaths from malarious dysentery and diarrhœa following on fever; and those deaths from diarrhœa proper, caused very much by the larger consumption in the spring of unripe fruits and vegetables and new grain, and at all times of badly cooked food.

Deaths from snake bites and wild animals averaged, during the three years 1873-75, 1,453 per annum.

Goitre is excessively common in that portion of Oude which lies on the north of the Gogra and Chowka rivers, and in the adjacent districts of Bustee and Goruckpore which formerly belonged to the North-West Provinces. The habitat of the disease in the latter districts is not limited, as has been stated, to the region of calcareous soil in the neighbourhood of the Gunduck river.¹

Dr. Butter, writing in 1839, notes that 'the country north of the Gogra is noted for its insalubrity; it is low, abounding in springs, permanent shallow pools and watercourses highly charged with decaying vegetable matters. Its inhabitants suffer much from intermittent fever, and also from goitre and scrotal diseases. They attribute their ailments to drinking the water of the natural ponds and rivers, believing them to be filled with poisonous dead leaves, and believing that the exclusive use of rain water or even of well water will secure immunity from disease.'

¹ McClelland's *Medical Topography of Bengal*, p. 118 et seq.

More recently, Surgeon-Major Greenhow¹ makes a very similar observation. He observes, speaking of the trans-Gogra country: 'The principal disease there is fever; and there can be little doubt that in this district of Oude there is much more miasmatic fever than in the cis-Gogra region. This is easily accounted for by the jungly and marshy nature of the country, which is indeed but a series of undulations of which the hollows are jheels and marshes, and the ridges cultivated patches or bits of jungle.' It would be interesting, continues Mr. Greenhow, to make out whether in other localities fever and goitre are commonly found prevailing side by side. However, his own observations, coupled with those of Dr. McClelland and other observers, taken with the conviction of the people that the water they drink is the cause of their goitres, led him to the conclusion that drinking water containing much lime is the main cause of the disease.

Dr. Sutherland, Sanitary Commissioner for Oude, in a short note on goitre in the province, written in 1872, corroborates the observations of Drs. Butter and Greenhow as to the prevalency of goitre in the trans-Gogra country, and its association there with fever and spleen. But investigating the occurrence of goitre amongst the prisoners in the jails of the province, he found that amongst 124 convicts with enlargement of either spleen or thyroid gland, in no case were both glands affected; and looking to the distribution of goitre in the province he was led to infer that goitre, like spleen, may be caused by a miasma rising from inundated tracts along the course of rivers, and that spleen may prevent the formation of goitre, and *vice versa*.

Turning to the returns from hospitals in the districts of Oude and Goruckpore, we find the percentage of goitre cases treated during the five years ending with 1873 as follows:—

Trans-Gogra districts.

Goruckpore	26
Bustee	13
Gonda	38
Bharaich	38

Cis-Gogra districts.

Fyzabad (opposite Bustee and Gonda)	12
Baribanki (opposite Gonda and Bharaich)	·04
Seetapore (opposite Bharaich)	·04
Kheri (opposite Bharaich)	·3
Azimghur (North-West Provinces, opposite Goruckpore)	·03

¹ *Indian Annals of Medicine*, vol. vi. 'Observations on Goitre.'

The history of goitre in the districts of Kheri is very interesting. It must be noted that the disease is far more common there than the recorded hospital statistics indicate, but it is prevalent only in that part of the district, the trans-Chowka, which corresponds with the trans-Gogra tracts. At Singahi,¹ a town in the northern part of the district, Dr. Higginson found goitre very common, and he observed that almost all those who were affected drank the water of a *cutcha* well, the shaft of which was formed of the hollowed-out trunk of an old tree, while those who drank the water of good masonry wells were comparatively free. At Dhowruha, in the same tract of country, some twenty miles south of Singahi, is a dispensary, and there also great numbers of goitre cases are treated. In the comparatively healthy south-western portion of the district there are three dispensaries, at Kheri, Gola, and Muhumdee, at none of which is goitre amongst the notably common diseases.

The table shows that a large number of cases are treated at the Fyzabad dispensary, on the south side of the Gogra, but as Fyzabad is the chief town of the division which includes Gonda and Bharaich, it is probable that many of the cases are natives of those districts. However, goitre is rather common in the district along the bank of the river; thus at the dispensary at Tanda, a town about thirty miles east of Fyzabad, many cases are annually treated, whereas the disease is rarely seen at the dispensaries of Shahgunge and Ukburpore, two towns at some distance from the river. The Civil Surgeon, in a special report 1872, states that even in the places where goitre is most common in Fyzabad, it is far less so than across the river in Gonda, and this in his opinion is due to the fact that the one bank is low and subject to inundation, whilst the other is high.

Throughout the goitrous districts the belief is general that the disease is due to bad air and bad water, and that it disappears as the country is cleared and cultivated. The poor suffer more than the rich, women more than men. Suckling infants rarely suffer; there is neither evidence nor belief that the disease is hereditary; the disease is most active during the rains and cold season.

The association of cretinism and goitre is very irregular. In some places where goitre is excessively prevalent there is no cretinism; in other places the diseases prevail together. Cretinism shows itself at an earlier age than does goitre, and there is evidence of its being in some cases inherited.

¹ *Special Report*, 1874.

CHAPTER XIX.

GANGETIC PLAINS CONTINUED.

Rohilcund; limits, physical geography; khadir of Ganges; people; Dr. Planck's notes on the district; climate; military stations: *Bareilly, Moradabad, Shahjehanpore*. Diseases of Rohilcund: fevers; small-pox; cholera; leprosy. Goitre in the district; outbreak of goitre amongst native troops at Bareilly. Table of statistics of death-rates of the North-West Provinces, and of certain districts.

ROHILCUND.¹ North-west of Oude, the remainder of the country between the Ganges and the Himalayas is occupied by the Rohilcund districts of the North-West Provinces. The extreme length of Rohilcund from north-west to south-east is about 180 miles, and its greatest breadth, near the Oude frontier, about ninety miles. The level of the plains in the north-west angle of the district is about 830 feet above that of the sea, while in the south-east the level is some 320 feet lower. In Rohilcund, as in Oude, Terai and Bhâbur tracts intervene between the plain proper and the hills; the Terai, however, is not so well marked along the greater part of the Rohilcund frontier as further to the east, and is rapidly being diminished by clearance of the jungle and extended cultivation. There is still, however, in the north-eastern part of the district, especially along the early course of the Chowka river in the plains, a good deal of swamp and forest jungle which is known locally as the Pilibheet swamps. Moreover, in the Terai subdivision of Rohilcund, which extends for some distance westwards from Pilibheet, there is much low ground, the swampiness of which is increased by excessive irrigation.

The subdivisions or districts into which Rohilcund is divided are, from east to west along the Ganges, Shahjehanpore, Budaon, Moradabad, Bijnour, the latter filling the north-west corner between the Ganges and the hills. In the very centre of the province is

¹ Rohilcund is fully reported on by the Sanitary Commissioner to the North-West Government (Dr. Planck) in his *Report* for 1868. To that report I am indebted for much that follows.

the native state of Rampore, to the east of it is Bareilly, extending into the north-east corner between the Chowka and the hills, and between Bareilly and Bijnour, north of Rampore, is the Terai subdivision. The area and population of the district is shown in the table at p. 294.

Rohilcund is, as a whole, a very flat country; only here and there is the level varied by undulations of sand or sand and kunkur. It is traversed by numerous streams finding their way to the Ganges, but, away from the Terai, swamps and jheels are rare. Water is found at a distance of from fifteen to twenty feet from the surface, and well irrigation is in full force over much of the district. Excepting in the Terai, canal irrigation is but scantily employed, and in some parts of the district the soil is so retentive of moisture that cultivation of the crops can be carried on without irrigation of any sort. Regarding the geological formation of this part of the province Dr. Oldham says ('Rough Notes,' p. 270; see p. 125): 'To the north of the general lie of the Ganges and Jumna we have a group of stations, Shahjehanpore, Bareilly, Moradabad, Roorkee, Meerut, all of which have much in common. The beds under them to a large extent partake of the characters of the deposits near to, and derived from, the great range of hills to the north. There is, as distinguished from the deposits lower down, a greater prevalence of coarse gravel and consequently a greater facility for the passing off of surplus water. The natural slope also of the country is greater, and several of these stations have the same general river-bank conditions as those on the Ganges, partly on the recent river-flat, partly on the more elevated level.' The surface soil may be divided into, first, a narrow strip of stiff dark-coloured clay, skirting the foot of the hills, then a broad expanse of friable mould, intersected here and there by thin beds of kunkur and clay; and next, extending along the Ganges margin of the district, a strip of sandy soil of considerable breadth, in which low hillocks of sand are not uncommon. Between this sandy strip and the stream of the Ganges is the *khadir* or valley proper of the river. The khadirs of the Ganges and other rivers influence very greatly the medical topography of neighbouring districts, and as reference will be frequently made to them, it may be well to transcribe Colonel Cautley's¹ description of the khadirs of the Ganges and Jumna. 'These rivers run in khadirs or troughs of widths varying from one to ten or even thirteen miles. The khadir or low country has been gradually scooped out at

¹ *Report on Ganges Canal.*

early periods through the higher lands, below which it is situated at considerable depths. The boundaries are marked either by high banks or scarps on one side, with shelving slopes on the other, or by well-defined scarps on both sides. This khadir is the wide channel within which the river is restlessly employed in changing its position—one year here, another year there—but its movements are strictly confined within the limits that have been assigned to it. In the boulder and shingle region to the north, the rivers are divided into widely detached streams by islands covered with sissoo trees, and are not unfrequently in parts well cultivated, whilst the low land on the flanks is marked by morass and reed jungle, the resort of elephants, tigers, and other wild animals. Through the whole tract the surface is reticulated by nullahs and swamps. Large tracts of the khadir are under cultivation, and it is in part studded with villages, holding the richest and best lands in the district. These villages are, where it is possible, placed on an elevated spot, but although the general level of the surface is above the high-water mark of the usual rains, a slight rise caused by severe floods which periodically happen, does much damage and inundates enormous tracts. The rich soil, so valuable to the agriculturist, is entirely superficial; it is underlaid by sand to immense depths, the whole extent of the khadir being in fact a basin of sand, with here and there beds of a more fruitful soil on its surface.' Such being the conformation of the khadir, it is not a matter for wonder that along its course villages are very frequently found inhabited by miserable-looking wretches, saturated with malaria, yet loath to quit the rich and easily cultivated lands about. Nor is the malaria confined to the khadir; there is plenty of evidence that it is dispersed east and west across the country on either side the river.

Of the total area of the province about four-sevenths is cultivated, and of the remainder one-half is culturable and the rest barren. In some parts cultivation is so general that the villages are without grazing ground for their cattle, the crops are chiefly wheat, barley, gram, dāl, sugarcane, mustard, and in the northern part of the district rice. Western and central Rohilkund is scantily wooded, though sprinkled with large groves of mango trees, but the greater part of Bareilly is well wooded, and along the Terai and to the north-east in Pilibheet, forest jungle is plentiful.

The population of the district averages about 440 to the square mile. The people are well fed and clothed, according to their needs,

and are robust and healthy, yet for the most part badly lodged in ill-roofed mud-walled huts, with the bare earth for a floor. But, writes Dr. Planck, 'most of the villages have beautiful shady trees either close to them or amongst the houses, and I have often thought the owner cared not how small or untidy his house was, if only he could get it under a shady tree.' In some villages sanitary knowledge has made this much progress, that the manure heaps are placed outside the village—a precaution, however, which in this as in other parts of India is too often neglected; and as to other sanitary matters the simple and long-established custom of using an open spot outside the village as a retiring place is in full force everywhere in the district, a practice to which the inhabitants are wedded for many reasons, and for one, that they say the sun quickly dries up and deodorises all impurities. 'Nevertheless,' writes Dr. Planck, 'it is a practice which is greatly to be condemned as a spreader of infection, and which will only become a safe one when the inhabitants have learned to dig for themselves a hole in the ground for daily use, and to cover up the contents with earth.' The water supply of the people is, for drinking purposes, chiefly from wells, and is very good, for the people are, observes the same authority, great connoisseurs of water, and as a rule they dig their wells on a raised site, and are careful to protect them from the entrance of surface drainage by raised walls about the mouth. Dr. Planck states that he must have drunk water of at least a hundred wells during his tour of inspection, and found the water universally sweet and good, clear and cool, and in every respect pleasant to drink. But from this satisfactory account of the water supply he excepts that of the Terai. Partial analyses of the water from some places in Rohilcund will be found at p. 30. 'The general aspect of Rohilcund,' writes Dr. Planck, 'is that of a carefully cultivated country, the well-cropped fields interspersed with groves of mango trees, scarcely a weed to be seen anywhere, unless the doubt grass, so valuable a plant as food for cattle, is to be counted as such. Here and there, where the hard soil cannot be cultivated, are patches of jungle of an open and dry character, while sandy patches exist towards the Ganges, but the character of the country is certainly that of a clean, clear, open land.'

Of one part of Rohilcund, however, Dr. Planck gives a very different account; this is the Terai, including not merely the Terai subdivision, but also parts of Bareilly. He writes: 'I have before mentioned the Terai as the strip of land with dark-coloured clay soil which lies immediately beneath the Himalayas. Very

praiseworthy endeavours have been made during the past few years to push the forest and jungle, which naturally clothes these pergunnahs, as far as possible back to the mountains, and I have no doubt the general health of the division has been improved by the measure of success which has attended these endeavours, for the jungle has been greatly curtailed in extent and much valuable land has been reclaimed. This has been brought about, and is still continuing, by means of settlers, mostly from other parts of the division, who are induced by favourable settlement terms to come and take up Terai land. The indigenous inhabitants of the Terai, a jungle people some 17,000 in number, also assisting in this good work; and these do not suffer in health. The population of the Terai, according to the last census, is 91,802, so that about 74,700 of the inhabitants may be counted as settlers, or descendants of settlers, to whom the Terai partakes of the character of a foreign country. For it is very full of dense jungle, its water is close to the surface, the land has many watercourses, and the practice of cultivation by means of irrigation, the watercourses being banked up for the purpose, is in full exercise to so extravagant a degree that the land is prepared for ploughing by being first saturated with water. By means of frequent irrigation the hard clay soil is made to grow flourishing crops of rice and barley which no other mode of treatment would cause it to produce. But the result of so much moisture spread over the country is hurtful to the health of the people, who have also to struggle against the ill effects of the drinking water of the country, which is frequently impure, separating an oily film when left to stand, and loaded with the products of decaying organic matter. To these two causes in particular, I think is due the very large amount of fever disease which troubles the inhabitants, the amount, severity, and nature of which is sufficiently proved by the frequency of enlarged spleen, especially amongst the young children and lads.'

Climate. Further removed from the sea, and considerably nearer than Bengal to the arid plains of Upper India and the trans-Indus country, Rohilcund has a climate drier and more extreme than that province, but with the same three seasons, the cold, the hot, and the rainy. The cold season begins with the close of the rains in the middle of September, and in October is well established. It lasts till the end of February, but through March and even into April the nights are cool and the day heat is not extreme. During this season the winds are chiefly from the west and north-west, the sky is clear, the air dry and bracing, and

the climate as a whole delightful, though in the middle of the day the power of the sun is great. During the night the temperature often falls so low that ice forms upon the surface of the shallow pools. The diurnal range is therefore very considerable, especially during November and till the middle of December, when it usually lessens on the occurrence of a few cloudy days and the slight rain which constitutes the winter rains of Rohilcund. The hot season succeeds, and the temperature steadily rises till the first or second week of June; the wind is chiefly from the west and north-west, hot and dry. About the middle of April the hot winds begin, at first blowing only in the middle day, but later on commencing earlier; they rarely blow at night. These hot dry winds alternate with southerly and easterly winds, which at Bareilly in April herald the south-west monsoon. The atmosphere is during the hot season very dry, and the range of temperature, especially in April, great. So soon as the rains begin the temperature falls rapidly, but steadies about the first week of July, and remains moderately high and pretty uniform till the middle or end of September. Should the rains break up early the weather is apt to be close and unhealthy for a time. During the rains the wind is from the east and south-east, and very damp. The diurnal range of temperature is only about one-half of what it is during the dry months. The rainfall is heaviest along the foot of the hills, diminishing thence into the plains, and diminishing also from east to west; thus along the foot of the hills it averages from 50 to 40 inches, and along the south-west frontier of the division from 40 to 30 inches.

The Tables XII. and XIII. in the Appendix are compiled from the reports of the Meteorological Reporter to the Government of India for 1875 and 1876. Stations Bareilly and Meerut.

Bareilly, elevation above sea-level 568 feet, is a Sub-Himalayan station, sixty miles from the foot of the hills, about 130 miles north-west of Lucknow.

Meerut, elevation 739 feet above sea-level, is about 110 miles west-north-west of Bareilly, in the Doab, some twenty miles outside the western boundary of Rohilcund, and eighty miles south of the foot of the Siwalik hills.

In Rohilcund there are three military stations for European and native troops. The principal of these is Bareilly, which is about sixty miles west of the Oude frontier, and the same distance from the foot of the hills. Fifty miles south-east of Bareilly is the small military station of Shahjehanpore, and at the

same distance to the north-west is Moradabad, a larger military station. The average number of native troops at Bareilly, Moradabad, and Shahjehanpore, is, in round numbers, respectively 900, 400, and 200. All three are reckoned very healthy stations, with a fine climate, well situated, well drained, and with good water supply. Bareilly cantonment¹ stands on the extremity of an elevated plateau, bounded, east by the valley of the Nukuteah river, and west and south by the valley of the Ramgunga river. The plateau ends rather abruptly towards the south in a succession of hillocks composed entirely of loose sand which has gradually blown up from the khadir of the Ramgunga; on the west the ground slopes more gradually towards the Nukuteah. The general level of the cantonment is 560 feet above sea-level, whilst that of the low country on the south is thirty feet lower. The drainage is consequently excellent, while the cantonment is very spacious, well laid-out, and pleasantly wooded. The geological formation is entirely alluvial so far as borings have extended; the strata consisting chiefly of soil and sandy clay for about thirty feet, and afterwards of coarse white and gray sand, alternating with thin layers of kunkur, clay, boulders, and sheet sand. The climate is somewhat damp, approaching Bengal in humidity, but it is a very healthy one, and the autumnal fever so prevalent in most military stations is here little marked; the cases are few in number and of a very mild type. See tables in Chapter vi.

The large native city of Bareilly, population 110,000, is situated about two and a half miles north-west of the cantonments; it is a crowded and very dirty place.² Dr. Planck, the Sanitary Commissioner (Reports for 1874 and 1875) reports its sanitary aspect very unsatisfactory. Moradabad³ is situated about forty-eight miles south of the foot of the hills, on a ridge of ground some twenty or thirty feet above the level of the surrounding country, and has excellent drainage towards the Ramgunga on the north and to the Gunghun on the south and west. The station is well wooded, and generally unexposed to malaria. It is, says Surgeon-Major C. Johnson, one of the most salubrious stations in the Bengal Presidency. The climate is a most delightful one. The country about is flat, highly cultivated, but, unlike the cantonments, is very bare of trees. The native town of Moradabad,

¹ Surgeon-Major Tuson in *Medical and Sanitary Report of Native Army of Bengal*, 1874, p. 104.

² Surgeon-Major C. Johnson, in *Medical and Sanitary Report of Native Army of Bengal*, 1868, p. 65.

³ Statistics of Bareilly Jail, see p. 99.

population 57,000, is situated to the south of the cantonments, about two miles off. Dr. Planck (Report for 1875) speaks of it as an improving city, and well cared for in respect to its sanitary state.

Shahjehanpore¹ is situated in the south-eastern corner of Rohilcund, near the Oude frontier, and is one of the healthiest, as well as one of the prettiest stations of the North-West Provinces. It is placed on a narrow ridge of elevated land which rapidly slopes into a valley on either side; that to the south is the valley of the Kunáout river. The surrounding country is flat, thickly wooded with groves of mango trees, highly cultivated, and well watered by means of wells which are usually not more than fifteen feet in depth.

The native city of Shahjehanpore lies to the south-west of the cantonments, about half a mile distant, also on the north bank of the Kunáout river; its population is 75,000, and it is, says Dr. Whitwell, one of the cleanest cities in the north-west, and has enjoyed of late years a most gratifying immunity from epidemic diseases. About three miles to the north of the city is the river Gurrah, a beautifully clear stream which rises in the outer Himalayas. Three miles below the city it receives the Kunáout, which has its origin in a series of jheels forty miles north-east of Shahjehanpore. The water supply of the cantonments is excellent; analyses of the water of some of the wells of this station, of Bareilly, and of Moradabad, are given in the table at p. 30.

Diseases of Rohilcund. Rohilcund as a whole enjoys a naturally fine climate, a good soil, and good water, yet owing to its position, bounded to the north and north-east by Terai, and to the west and south-west by the khadir of the Ganges and the low unwholesome tract in the neighbourhood, it is in many parts much exposed to the sources of malaria. And this danger is greater here than in some other parts of the North-West Provinces because of the abundant moisture which is engendered by a comparatively heavy rainfall, and by the numerous streams which carry the drainage of a large tract of the Himalayas through Rohilcund to the Ganges. In the Terai districts, too, naturally superabundant moisture is vastly increased by over-irrigation. Any danger arising from too great moisture might indeed be prevented by effective drainage, but we have Dr. Planck's evidence that what artificial drainage exists is in many towns and villages worse than useless, as it is into holes amongst or neighbouring upon the houses.

¹ Surgeon-Major Whitwell, in *Sixth Report on Analysis of Water of Bengal Cantonments*, 1870

‘Moisture, decaying vegetation, and heat, never altogether absent, and together for many months of the year, act with extraordinary urgency as causes of malaria in the province.’ Dr. Planck presses the fact that in Rohilcund heavy rainfall is followed by large mortality from fever, but more especially when, as has too often occurred, the year of heavy rainfall has succeeded one or more years of deficient rainfall, with the attendant short crops, scanty food, and a debilitated population. Deaths from fever are, as a rule, twelve or fourteen times more numerous than those from any other cause; the mortality is greatest in the autumn months, then in the cold weather, and least in the hot months, and at all times, is greater in the Terai than in other parts of Rohilcund. Next to fever bowel complaints cause the greatest mortality. Diseases of that class are most prevalent in fever areas, and are most fatal in times of scarcity, when the people are obliged to live on inferior and scanty food.

Small-pox is exceedingly prevalent in all the Rohilcund districts, excepting the Terai, and Dr. Planck (Report for 1874, p. 21) doubts if vaccination has as yet done much in these districts to diminish the intensity of the disease. The same remark applies to the districts of the Upper Doab (Report for 1877). But in the Terai, Gurhwal, Kumaon, and the Dehra Doon, districts in which vaccination is thoroughly effected, the recorded mortality from small-pox is almost *nil*.

Cholera. Few years pass in which cholera does not appear in an epidemic form in Rohilcund, and though the disease can scarcely be said to be endemic there, yet, writes Dr. Planck, ‘hardly a year passes without some cases of the disease coming to the notice of every Civil Surgeon in the province.’¹

Leprosy is not uncommon in Rohilcund, and about two hundred deaths are annually registered as caused by it.

Goitre, writes Dr. Planck, is not a disease of Rohilcund outside the Terai country. Indeed, we now take leave of goitre as a disease widespread in the plains; henceforth we shall find it in the plains only in circumscribed localities where circumstances natural or artificial have engendered conditions which resemble those prevailing in many low damp tracts of country hitherto considered.

The proportion of cases treated at the several Rohilcund district dispensaries during five years was as follows:—

¹ See table at p. 293.

Bareilly	2·6	per cent. of total cases treated
Moradabad	·5	" "
Bijnour	·13	" "
Shahjehanpore	·06	" "
Budaon	·22	" "
Rampore (Native State)	·5	" "

The Terai district has no dispensaries, and the inhabitants suffering from the disease chiefly resort for treatment to Buheeree, a town in the Bareilly district near the Terai frontier. Here, during the five years, the percentage of goitre cases to the total number of cases treated was as high as 9·2; at Bareilly itself it was 3·2. The Civil Surgeon of Bareilly, Dr. Corfe, in a recent note, states that most of the goitre cases come from malarious villages, especially those situated in the vicinity of the Terai. The water in these villages is very impure; he names Beesulpur, Pillabeet and Buheeree, as places where the disease is especially prevalent; even dogs and birds are there affected. In 1869 the surgeon of a native regiment stationed at Bareilly, reported an outbreak of goitre amongst the men; thirty-eight were admitted to hospital for treatment. The cases were slight, the tumours soft, and readily yielded to the use of biniodide of mercury ointment. The report does not attempt to account for the outbreak, but it incidentally notices that owing to the dryness of the season the water in some of the cantonment wells had fallen very low, and that the natives objected to drink it on account of the number of animalculæ which were present.

We find, then, that the history of goitre in Rohilcund quite supports the theory of the malarious origin of the disease, for the disease is scarcely known over far the greater portion of the province, and prevails only in the low swampy districts of the Terai and in the north-east corner of Bareilly, which are pre-eminently malarious, and where the conditions of the locality are identical with those of the goitrous trans-Gogra districts of Oude.

The tables which follow exhibit a portion of the recorded statistics, of the years 1874-76, of disease and mortality amongst the civil population of the North-West Provinces (excluding Oude), and of those of the districts of the province which come under consideration in the course of the present enquiry.

Tables of disease and mortality amongst the native troops stationed at Bareilly and Meerut, and amongst the prisoners in the Bareilly and Meerut jails, are given in Chapters iv. and vi.

North-West Provinces (exclusive of Oude).¹ Area 8,140 square miles. Population (census 1872) 30,769,056. Proportion of cultivated land, 51.9 per cent.; unculturable, 33.4 per cent.

DEATHS REGISTERED FROM ALL CAUSES PER 1,000 OF POPULATION.

	January	February	March	April	May	June	July	August	September	October	November	December	The year, per 1000
1874	1.62	1.36	1.58	1.71	1.85	1.57	1.54	2.08	2.21	2.53	2.04	1.66	21.84
1875	1.34	1.08	1.20	1.7	1.83	1.84	1.6	1.91	2.6	2.52	1.96	1.8	21.82
1876	1.57	1.42	1.76	2.	2.07	2.21	1.78	1.98	2.52	2.4	1.95	1.66	23.39
DEATHS FROM FEVERS PER 1,000 OF POPULATION.													
1874	1.14	.90	.91	.85	.90	.82	.94	1.48	1.64	2.02	1.63	1.32	14.61
1875	1.03	.87	.86	1.08	1.16	1.17	1.	1.16	1.61	1.79	1.8	1.8	14.83
1876	1.17	1.06	1.3	1.39	1.31	1.29	1.08	1.27	1.7	1.73	1.45	1.45	16.1
DEATHS FROM BOWEL COMPLAINTS PER 1,000 OF POPULATION.													
1874	.152	.115	.118	.120	.136	.129	.167	.227	.233	.217	.198	.160	1.98
1875	.127	.104	.108	.156	.178	.184	.191	.278	.399	.36	.295	.22	2.61
1876	.193	.158	.179	.207	.216	.215	.20	.298	.38	.364	.272	.198	2.88
DEATHS FROM CHOLERA.													
1874	35	19	41	97	190	237	123	379	1559	2910	736	70	.2
1875	35	160	1099	6031	5610	5420	4255	5417	8415	3407	855	402	1.33
1876	21	185	531	1671	3865	7593	4672	2611	3559	1320	245	31	.85
DEATHS FROM SMALL-POX.													
1874	5381	6714	13,165	19,120	20,560	14,034	7249	3434	1148	670	661	1111	3.03
1875	1551	1755	2473	4032	4946	4394	2617	1333	805	639	524	750	.83
1876	1032	1392	2982	5451	7291	7924	4465	1893	941	539	461	803	1.14

Deaths from snake bites and wild beasts, 1874, 3832; 1875, 4090; 1876, 3790.

¹ In the *Annual Report* (sanitary) for 1877, the statistics combine those of the North-West Provinces and of Oude, and they are not therefore included in this table.

North-West Provinces, certain districts.

District	Area in square miles	Percentage of cultivated area	Population	Average per square mile of population		Deaths per 1,000 of population				
						All causes	Fevers	Cholera	Small-pox	Bowel complaints
Goruckpore .	4578	79	2,019,350	441	1874	29.5	17.	1.97	6.8	1.27
					1875	19.9	14.3	1.3	.3	1.1
					1876	20.9	16.	.44	.37	.62
					1877	25.8	18.6	2.2	.02	.75
Bustee . .	2789	86	1,472,994	528	1874	13.2	9.3	.65	1.4	.39
					1875	13.6	8.8	2.7	.28	.45
					1876	18.5	13.9	1.6	.68	.47
					1877	25.1	17.1	3.6	.02	.47
Rohilkund .	11,805	80	5,249,903	460	1874	21.3	13.	.04	2.23	3.09
					1875	23.1	13.4	.94	1.17	4.4
					1876	30.3	16.9	.66	3.4	5.9
					1877	—	—	—	—	—
Statistics of mortality exclude those of the Terai which follow										
Terai . . .					1874	28.5	24.4	—	.81	2.1
					1875	31.8	28.	.16	.47	2.3
					1876	41.2	32.	3.6	.54	3.5
					1877	26.8	21.9	—	.31	3.5
Kumaon . .	6000	7.7	432,888	72	1874	15.8	7.1	—	.04	3.5
					1875	20.2	9.4	.02	.01	4.8
					1876	21.3	8.4	1.9	.03	4.6
					1877	17.4	8.	.03	.05	4.5
Gurhwal . .	5500	4.7	310,282	56	1874	19.6	9.9	—	.1	6.5
					1875	21.4	8.9	1.9	.05	7.7
					1876	21.2	10.5	—	—	8.1
					1877	18.6	8.8	—	—	6.6
Dehra Doon .	1020	22.4	115,711	114	1874	16.1	9.8	—	—	4.1
					1875	24.	13.4	3.2	—	5.
					1876	20.	9.4	—	.01	7.
					1877	17.6	8.9	—	—	5.8
Saharunpore .	2217	56.7	883,782	399	1874	18.9	11.4	.02	2.02	3.4
					1875	23.	13.2	.57	2.6	4.6
					1876	25.5	15.3	.01	2.6	5.
					1877	20.0	11.6	—	.89	3.8
Mozuffernuggur	1659	85.6	690,082	416	1874	22.8	18.8	—	1.3	1.5
					1875	27.8	21.	.81	2.5	2.3
					1876	27.7	20.2	.01	2.7	3.7
					1877	26.2	16.5	—	3.7	3.
Meerut . . .	2360	86.	1,273,914	541	1874	26.8	22.7	—	.8	1.6
					1875	31.	24.	2.5	.7	2.6
					1876 ¹	15.5	13.5	—	.09	.76
					1877	15.7	13.3	—	.34	.8

¹ 'Great neglect of registration in certain portions of the district this year.'—Sanitary Report.

North-West Provinces.

DEATHS REGISTERED EACH MONTH FROM FEVERS, PER 1,000 OF POPULATION.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year
Shahjehanpore, one of the Rohilcund divisions	1874 1.04	.70	.84	.92	1.14	.87	.99	1.62	1.41	1.81	1.43	1.12	13.8
1875 .8		.69	.67	1.04	1.11	1.01	.82	.93	1.3	2.38	2.34	1.94	15.1
1876 1.43		1.43	1.62	2.13	1.9	1.59	1.37	1.69	1.90	1.93	1.65	1.16	19.8
Mean of the 3 years.	1.09	.94	1.04	1.36	1.38	1.16	1.06	1.41	1.54	2.04	1.80	1.41	16.2
Goruckpore . . .	1874 1.66	1.42	1.39	1.22	.95	.88	1.29	1.71	1.74	1.98	1.43	1.23	16.9
1875 1.06		.84	.9	1.07	1.03	1.02	1.02	1.07	1.22	1.49	1.89	1.65	14.3
1876 1.31		1.14	1.35	1.36	1.44	1.34	1.19	1.26	1.54	1.46	1.24	1.34	16.0
Mean of the 3 years.	1.34	1.13	1.21	1.22	1.14	1.08	1.17	1.35	1.50	1.64	1.52	1.41	15.7
Terai, one of the Rohilcund divisions	1874 1.8	1.2	1.2	1.5	2.2	1.6	1.3	1.3	1.9	3.4	3.8	2.8	24
1875 2.4		2.1	1.9	2.3	2.2	1.6	1.1	1.1	1.6	3.	4.8	3.7	28
1876 3.0		2.9	3.6	4.	3.	2.1	1.2	1.8	2.6	2.7	2.8	2.1	32
Mean of the 3 years.	2.4	2.1	2.2	2.6	2.5	1.8	1.2	1.4	2.	3.	3.8	2.9	28.
Mozuffernuggur . . .	1874 1.36	.94	.98	1.04	1.46	1.4	1.31	1.82	2.07	2.56	1.87	1.84	18.7
1875 1.65		1.43	1.25	1.75	2.37	2.21	1.78	1.43	1.92	2.10	1.60	1.46	21.
1876 1.43		1.29	1.38	1.53	1.46	2.04	1.41	1.4	2.27	2.49	1.87	1.60	20.2
Mean of the 3 years.	1.48	1.22	1.20	1.44	1.70	1.88	1.5	1.55	2.09	2.38	1.78	1.63	19.9

CHAPTER XX.

THE DOAB.

The Doab, and Dehra Doon. Extent of the Doab; the Siwalik hills; khadir of the Ganges and Jumna; *Saharunpore*; Roorkee; soil of the Upper Doab; diseases; canal irrigation; Drs. Muir, Cutcliffe, Planck, on the epidemic fever of the Upper Doab. Goitre not a disease of the Doab. *Dehra Doon*, description of; Eastern and Western Doons; climate; diseases. Prevalency of goitre in the Doon not caused by hard water.

THE DOAB. On the west of Rohilcund, separated from it by the river Ganges, lie the districts of Saharunpore, Mozuffernuggur, Meerut, and Boolundshuhur, which, in that order from north to south, constitute the upper portion of the Doab. The Doab (Doab = space between two waters) is the great diluvial plain which stretches between the Ganges and the Jumna from the base of the Siwalik hills to the meeting of the rivers at Allahabad. The Ganges enters the plains near the town of Hurdwar, north lat. $29^{\circ} 57'$, east long. $78^{\circ} 14'$, and the Jumna at Kharra Head, forty-six miles to the north-west of Hurdwar. The Siwalik range which separates the Doab from the Dehra Doon is about six miles in breadth and forty-six in length, and consists of an uninterrupted range of high broken ridges or hills, the extreme elevation of which above sea-level does not exceed 3,140 feet. At the western extremity the range terminates in perpendicular cliffs which bound the bed of the Jumna, but the eastern extremity is more open and allows of communication between the Doon and the plains by means of a carriage road. An upheaved portion of the plain at the foot of the Himalayas, the range is formed of the débris of those mountains which at this point, in pre-tertiary times, consisted of shingle and boulders brought down by the Ganges and Jumna, and of these the most characteristic rocks of the range are composed. The range consists, writes¹ Colonel Cautley, of a series of boulder beds, sands, and clays, upheaved at an angle of 15° to 25° ; and with the exception of that portion near Hurdwar, at which there is a remarkable fault by which the dip is

¹ *Report on Central Doab Canal.*

reversed, the inclination is towards the Doon, or to the north-east. 'In the sandstone remains of the larger mammalia have been discovered, and in the clay bed underlying the boulder and sand strata remains of both mammalia and reptiles were collected by me in the Kalowala Pass (about the centre of the range) accompanied by lignite.' The slope of the hills is to the north; to the south they rise from the plains with an abrupt mural front. On the southern aspect the slopes are sparsely clothed with trees, amongst which there is a dense undergrowth of grass and shrubs. The forest, and beyond its limits the jungle alone, extends southwards into the Saharunpore district. Of late years, however, the jungle has been steadily encroached on by advancing cultivation, with great benefit to the health of the natives, who now live with impunity in localities which not many years since were the home of the most deadly malaria.

At the town of Hurdwar, and at Kharra Head, where the Ganges and Jumna leave the mountains, their dry weather discharge may be estimated at 8,000 and 4,000 cubic feet per second respectively.¹ The water of both rivers during the dry months, and when undisturbed by floods, flows in a clear and rapid stream in a bed of boulders and shingle. Some twelve or sixteen miles below their debouch, the boulders and gravel disappear, and the rivers flow on a much reduced slope, over a bed of coarse sand, each in its trough or khadir, the wide channel of low ground within which the rivers are constantly changing their position. The khadir of the Ganges is the most extensive of the two, and occupies the whole of the north-east angle of the Doab, extending about half-way along the base of the Siwaliks. It is bounded by a bank which, leaving the hills, extends in a south-easterly direction past the town of Roorkee, and approaches the main stream near the town of Bhokurheree, about thirty miles south of Hurdwar. The depression of the khadir below the crest of the bank is generally about eighty feet, but here and there within its limits are elevated tracts on which many towns and villages are situated; while it is intersected by the channels of many minor water-courses, the principal of which are the Solani river and its tributaries, which carry down the drainage of the eastern half of the Siwaliks to the Ganges.

The water parting of the great rivers is a low range of sand-hills, which stretches southwards from the town of Roorkee, and divides the upper part of the Doab into a larger western and a

¹ Colonel Cautley's *Report*.

smaller eastern portion. Both are intersected by many streams, each flowing in its own stretch of khadir or low marshy ground; those of the western portion collect into the Hindun, which finally carries their streams into the Jumna, while the East Callee Nuddee collects those of the eastern portion.

Besides the natural rivers, the upper part of the Doab is crossed by two great artificial streams, the Ganges and the Eastern Jumna Canals; the former discharging about 4,000, and the latter about 1,000 cubic feet of water per second over the surface of the Doab.

The district of Saharunpore extends about twenty-five and fifty miles along the course of the Ganges and Jumna respectively; its breadth averages about fifty miles; its area is 2,217 square miles, of which about 56 per cent. is cultivated. Saharunpore, the civil station, is situated some twenty-two miles from the foot of the hills and seventeen from the left bank of the Jumna, at an elevation of 980 feet above sea-level. The general slope of the district south of this point is in a southerly direction and at the rate of about 1·8 foot per mile, but between Saharunpore and the hills the slope is far more acute. There is a subordinate slope on either side of the central ridge, towards the khadir of the Ganges on the east and that of the Jumna on the west.

Strictly speaking there is no Terai along the base of the Siwaliks, yet conditions to form one exist, were it not that the natural drainage is better than in the corresponding tract to the east of the Ganges. Thus at the foot of the hills spring water rises to the surface, sometimes exhibiting itself in mere pools, at others in small streams and rills which flow for a short distance and then disappear in the sand and shingle. South of this line and parallel to it is a belt varying from five to ten miles in breadth, in which water can only be found at a great depth; and in advance of this dry belt the springs rise again to or near the surface. In the neighbourhood of the Ganges the surface is still further assimilated to the Rohilcund Terai by the presence of detached jheels and marshes (Cautley). The subsoil of the northern part of the Doab is composed of sand and clay in beds of varying extent and depth; near the hills boulders are met with, and beds of marl and kunkur are found in many places. The latter underlies the surface at a depth of from two to four feet, generally in thin layers, but sometimes in layers thick enough to allow of its being dug out in blocks suitable for building purposes, or it is burnt, and then forms an excellent material for mortar and for road-making.

The soils vary very much, so much so that no more than a general idea of them can be conveyed: in parts they are heavy, clayey, and retentive, and in close proximity they are often light, sandy, and porous.

The level of the subsoil water varies very greatly in different parts of the Doab, and is much influenced by the rainfall, and by the quantity of water which is poured upon the Doab. In the khadir lands of the Jumna and Ganges, in those of the numerous minor streams, and elsewhere, the water stands very near the surface, while in many places considerable tracts of actual swamp exist. Dr. Cutcliffe, writing in 1868, states 'it is the general opinion of canal officers, of engineers, and of the people residing near the canals, that the spring levels of many portions of the Doab have been very considerably raised.' This opinion is corroborated by the water levels which have of late years been carefully registered at Meerut. In 1870 the mean distance of the subsoil water from the surface of the ground was 12·7 feet; in 1871 11·6 feet, in 1872 10·9 feet, in 1873 11·2 feet, in 1874 9·7 feet, and in 1875 nine feet; the rise of the water level during the six years amounted to 3·7 feet. During 1875 the level ranged from its highest, six feet, in October, to its lowest, 11·4 feet, in July.

About twenty-six miles to the east of Saharunpore is the important station of Roorkee, north lat. $29^{\circ} 52'$, east long. $77^{\circ} 56'$, fifteen miles from the foot of the hills and not far from the edge of the bank already mentioned, as bounding the khadir of the Ganges. The Ganges Canal runs through the station and is here a swift stream, running in a bed the bottom of which is of boulders and shingle. To the north-east of the station is the Solani river, which receives a good deal of the surface drainage of the station; like all the neighbouring streams, which are fed by the drainage from the hills, it is for the most part of the year a small sluggish stream, but during the rains spreads out over a considerable extent of the low-lying land which borders it. The elevation of Roorkee station is 886 feet above sea-level; from its site the country slopes away to the south, so that at Meerut, sixty miles distant, the level is 140 feet lower. The water supply of Roorkee is from wells in which the water stands at a depth of about thirty feet from the surface, and the water-bearing stratum rests upon the kunkur which underlies the sandy soil.

Climate. Owing to the comparatively high latitude of Saharunpore, its elevation, and the neighbourhood of the hills, the heat of the climate is neither very great nor is it long continued.

About the middle of March a marked rise in the temperature occurs, and thence on till the middle of June hot winds blow with considerable force during the day; at this time trees and shrubs wither up, and it is now that the advantage of artificial irrigation becomes so striking. However, though the heat during the day may be great, the nights, at any rate in the northern part of the district, are rendered pleasantly cool by descending currents from the hills. The position of the district with reference to the Himalayas renders the direction of the winds very regular, either from the north-west or the south-east; the winds belonging to those quarters constituting 66 per cent. of the total winds. From June to October the south-east winds predominate, coinciding with and bringing the summer rains, while the anti-monsoon of January and February contributes the cold weather rains. The rainfall averages 42 inches annually. The cold weather extends from the end of October to the beginning or middle of March, and is a delightful season; the temperature at night often falls in the shade to near the freezing point, while in exposed places it may fall as low as to 25° or 26° Fahr.¹

The climate of the northern portion of the district, in localities which have been improved by removal of jungle and extended cultivation, is healthier than that of the southern portion, and this both because the natural drainage is better, preventing any extensive lodgment of water, and because the rapid streams on their yearly rise effectually scour their channels, removing any accumulations of noxious organic matter. Further south not only is the natural drainage generally less effective, but there is a greater extent of low-lying khadir land, and, moreover, the natural moisture of the land has been largely increased by canal irrigation.

Diseases. Statistics of disease and mortality amongst the civil population, native troops, and jail population are given in the tables at p. 294, and in Chapters iv. and vi.

Cholera. The table at p. 294 shows that the four districts which constitute the upper portion of the Doab, notwithstanding their physical character, have not, as compared with other districts of the province, suffered either frequently or severely from cholera. Dr. Cutcliffe² states that everywhere throughout the division cholera (in 1867) accompanied the pilgrims on their retreat from Hurdwar, though the disease seems very generally to have restricted itself to those who had been to Hurdwar, and almost nowhere to

¹ For meteorological table, see Appendix.

² *Report on Sanitation of Meerut Division*, p. 53.

have made its appearance out of the line of march of the pilgrims; and he states his utter inability to explain why the disease did not spread amongst the people after the pilgrims had returned to many of the filthy places which he describes, places in which every conceivable abomination polluted soil and air and water.

Small-pox is very prevalent and fatal in these districts; in Mozuffernuggur especially it is epidemic every year.

Fever. The prevalence of malarious fevers in the upper portion of the Doab has been much discussed of late years, mainly with reference to the question of its dependence or otherwise upon the effects of canal irrigation. Valuable reports upon the subject have been written by the Sanitary Commissioner to the North-West Provinces in his annual reports, and by Drs. Garden, Cutcliffe, and W. Moir;¹ these latter have been discussed by Dr. Bryden in his recent report on the statistics of the troops and jail population of Bengal. So far back as the medical history can be carried, very severe epidemics of malarious fever have visited the district every few years. Dr. Garden has collected records of the following epidemic years in Saharunpore—1809, 1817, 1829, 1834, 1843-45, and 1850. Dr. Moir writes: 'As far back as our records go, malarious fever has presented itself in these districts in an epidemic form in cycles of eight or ten years.' The outbreak which appears to have terminated in 1875 began in 1867, and was specially reported on, under the orders of Government, by Dr. Cutcliffe in 1868. The following table shows the ratios of mortality from fever in the four districts during the height and decline of the epidemic.

Districts	1872	1873	1874	1875	1876	1877
Saharunpore . . .	29·8	23·8	18·8	13·2	15·3	11·6
Mozuffernuggur . . .	23·9	24·9	22·8	21·	20·2	16·5
Meerut . . .	35·6	25·8	26·8	21·	13·5	13·3
Bulundshuhur . . .	32·2	32·3	36·9	24·	18·9	15·2

Dr. Cutcliffe in his report attributed the extreme prevalence of fever in many places which he visited to the rise of the spring level under the influence of canal irrigation.² He, however, believed that in those towns which suffered most severely the disease was greatly aggravated by the very exceptional filthiness in which the people lived, but he noted that the effects of the malaria were

¹ See Dr. Moir's *Reports* in Appendices to *Reports of Sanitary Commissioner of the North-West Provinces* for 1874 and 1875.

² *Report*, p. 86.

manifested altogether apart from canal irrigation, *e.g.* in the low swampy khadirs of the streams, and indeed wherever there was a stiff retentive soil saturated with water, or stagnant surface water on clayey lands.

Dr. Moir supports the view that the recent outbreak of fever is a malarious epidemic similar to others which have in historical times visited the Doab, and that like them it has now passed through its stages of invasion, maximum intensity, and decline. He writes: ¹ 'The sum of the whole matter is that we have records of epidemics of malarious fever in this district before the introduction of canals into it, and it is therefore unsound reasoning to maintain that the recent epidemic was due to the influence of canal irrigation. Comparison of irrigated with non-irrigated parts of the district made in 1875 for the years 1871-73 gave fewer deaths *per mille* in places under the influence of canal irrigation than in those distant from it, and the examination of the returns for 1875 gives exactly the same results, and proves that the epidemic is subsiding. The figures are in harmony with previous history, and tend to show that canals are not the cause of the fever. Neither is the cause to be found in the elevation of the spring level, for with an increase of the level in 1875 there was a marked diminution of fever. Among the European troops stationed at Meerut the fever admissions fell from 1,436.5 in 1874 to 823.9 in 1875 per 1,000 of strength; and among the native troops from 1,655 in 1874 to 361 in 1875. In the Civil Hospital the decrease in the admissions for fever was 36.1 per cent., in the Central Prison 63.3, and in the District Jail 52.6 per cent.'

The Sanitary Commissioner (Dr. Planck), in his official report for 1877, states that the Northern Doab districts, formerly noticeable, for a series of years, as the peculiar home of excessive fever mortality, now provide returns of mortality showing that that unenviable characteristic can no longer be applied to this fairest country of all the province.

'In all these districts the great sanitary endeavour of the past few years has been the removal of excessive moisture from the lower-lying portions of land to the natural drainage channels of the country. The projects above mentioned are the last outcome of that endeavour. The result, as I have seen, is the discharge from the land of a quite extraordinary amount of water, to the creation in some places of continuous flowing streams, fed by water formerly stagnant in and on the land.

¹ Report for 1875.

‘I do not say that this continuous and really effectual removal of water, to the change of much moist into much dry land, has been the only cause of the decrease of fever mortality on the Upper Doab, for I pay much heed to the opinion of my friends Drs. Moir and Garden, to the effect that a lessened epidemic influence may have helped the good cause. But I do say that this considerable change of condition is the result of good work rightfully performed. The change not only assuredly reducing the number of fever attacks likely to happen in years of ordinary disease prevalence in many centres of population, but potent, by means of improved general health, to shield many lives against the onset of fever, of epidemic force, in years to come.’

Goitre is almost unknown in the upper part of the Doab, a circumstance which is the more remarkable as we shall find it excessively present in a district further to the west, Goordaspore, which in many points of its medical history and physical characters, closely resembles Saharunpore.

*Dehra Doon.*¹ The Dehra Doon is at the same time the largest and best known, and the most beautiful and luxuriant, of the valleys which intervene between the Sub-Himalayan ranges. In length about forty-five miles, and in breadth from ten to fifteen miles, it lies south-east and north-west, between the Ganges on the east and the Jumna on the west. The former river separates the valley from Gurhwal and Bijnour, and the latter from Sirmoor.

The outer Sub-Himalayan range, here known as the Siwalik hills, slopes gently into the Doon, and owing to the elevation of the floor of the valley the component hills look mere hillocks when compared with the gigantic mountain masses which rise from the opposite side of the valley; they are on this aspect well clothed with wood, chiefly sāl and pine, and are pierced by several passes, the principal of which are, the Mohan Pass about half-way between the Ganges and the Jumna, and the Timlee some seven miles distant from the latter river.

The northern, or rather north-eastern boundary of the valley, is formed by the Mussourie range of the outer Himalayas, some of the peaks of which are of considerable height, one reaching to 8,565 feet above sea-level. An elevated ridge which runs nearly north across the valley from the mouth of the Mohan Pass, divides it into two portions, the Eastern and Western Doons, each with its

¹ For this account of the Dehra Doon I am largely indebted to a *Memoir* on the district by G. Williams, B.A., B.C.S., published at Roorkee in 1874.

drainage slope away from the ridge. In the Western Doon the inner ridge of the Sub-Himalayas, sandstones and conglomerates, is well marked, but in the Eastern Doon it is wanting or covered up by the detritus of the main range. On the above-mentioned ridge, near the centre of the valley, is situated the town of Dehra, at an elevation of 2,369 feet above sea-level. The level of the Ganges at the eastern end of the valley is 1,080 feet above the sea, that of the Jumna at the opposite end is somewhat higher.

The only isolated hill in the valley is that of Newada, a few miles south of Dehra, with an elevation of a little over 2,600 feet. But the general surface is very undulatory, being raised here and there by spurs projecting from the northern and southern ranges.

On the central ridge, half-way between Dehra and the Mohun Pass, is an artificial lake, the Bheem Tāl, near which rise the two rivers, the Sooswa and the Asun, which drain the valley, and fall respectively into the Ganges and the Jumna. Both receive numerous tributaries on either side from the Himalayas and Siwaliks; of the former the greater number have no water in the lower part of their course, but nearer the hills sufficient to supply extensive irrigation, while the latter are mostly dry excepting during the rains, when they fill with great rapidity and rush down with tremendous force. One of the tributaries of the Sooswa, the Song Nuddee, is of considerable size; it rises at the foot of the hills north of Dehra, receives the drainage of the large extent of marshy land which exists in the northern part of the Eastern Doon, combines with the Sooswa some seven or eight miles from the Ganges, and gives its name to the combined stream.

The characters of the Eastern and Western Doons differ very much. A comparative absence of swamp, and of forest, excepting along the foot of the hills, characterises the latter; indeed throughout but little land remains unreclaimed, and tea-cultivation is energetically pushed in many parts. Of the Eastern Doon a very large portion, that which lies beyond the Song Nuddee, is low and swampy, covered with reed and forest-jungle, the resort of tigers and wild elephants, and presenting here and there large expanses of jheel. The climate of this portion is a most pestilential one; but a good deal of the western portion has been reclaimed, and here also tea-cultivation is extending.

The geological conformation of the valley is chiefly alluvial, and consists of black earth, sand, clay, gravel with pebbles, and then boulders, an arrangement which is common throughout the valley; but not a small portion of the surface is made up of the

shingly beds of present or former mountain torrents. Close under the Himalayas, water is found near the surface, but towards the centre of the valley, excepting in the swampy portions of the Eastern Doon, it can be found only at great depths, so that irrigation from wells is impossible. In ancient times irrigation was extensively effected by means of canals which took their water from the mountain streams and from great tanks the remains of which are still very numerous. Since the Doon came under British rule canal irrigation has again been introduced, and one of the canals which has its origin from a torrent at the foot of the Himalayas, north of Dehra, carries water to the town, supplying irrigation works in its course.

Owing to the warmth of the valley and its plentiful rainfall, vegetation abounds to a wondrous extent, whether as plants, shrubs, or trees. The valley is richly productive of fruits, flowers, and vegetables—tea is largely produced, chiefly under European management—while the native cultivators produce large crops of rice, wheat, barley, and various pulses. The population of the valley is sparse, averaging in the Eastern Doon about fifty, and in the Western Doon about 150 to the square mile. The people are chiefly of the same race as those of the plains, but in the Eastern Doon, Mehrahs and Dhooms, low caste people, who appear to be descendants of the aboriginal tribes, are numerous. The people generally are not a healthy race, and are inferior in physique to their neighbours in the plains, a circumstance which may be explained partly by the unhealthiness of the climate of a great portion of the valley, partly by the consanguineous marriages which have resulted from the little intercourse which the natives formerly had with the outside world, and partly by the intemperate character of the race, and their addiction to the use of spirits and intoxicating drugs.

Climate. The Siwaliks, though a low range, shut off the Doon from the plains and give it a local climate, a feature which comes out very clearly if we compare the meteorological elements of Dehra with those of Roorkee 32 miles to the south, on the other side of the Siwaliks.

As compared with that of the plains, the climate of the Doon is cool and equable, but very damp; the winds are very variable and light, and calms are frequent; with great moisture there is sufficient heat to render vegetation very luxuriant, and decay very rapid. During April and May the heat is indeed at times extreme, and would be very oppressive were it not tempered by thunder-

storms, and by the cool currents of air which at night descend from the hills, rendering the nights cool after the hottest days. Hot winds are not felt in the valley except at its western end, where they at times blow with some force. The rainfall is heavy and occurs chiefly between June and September; the winter rains, though comparatively slight, are very regular in January and February. Snow has been known to fall at Dehra, but never lies there. The Meteorological Table, XV. in Appendix, is compiled from the official reports of 1875-76.

Dr. Wallich, writing about thirty-five years ago regarding the climate of the Doon, says: 'During the dry season, and in cleared situations, the climate is as healthy as that of any part of India. During the rains, however, and in consequence of the rich and rank vegetation with which the valley is clothed, from being under the action of numberless small streams, from the formation in the lower ground of extensive and stagnant marshes, and more especially from the miasma exhaled from the growth and increase of the underwood, as also of the trees themselves composing these mighty forests, fevers somewhat peculiar and local are generated; and in fact for a European constitution at the above period even a journey through, far more a residence in these wilds, would be certain of producing fever.' Dr. Cutcliffe, writing in 1868,¹ remarks, 'that though the subsoil water in the Doon lies very deep, and owing to the formation of the valley, lodgment or stagnation of surface water is impossible excepting in the case of certain swamps, yet the Doon used to be, and in some parts now is, a notoriously malarious place. But the salubrity of the place has of late years been vastly improved, and people, natives and Europeans, live all the year round with impunity where formerly after the first fall of rain a day or a few hours spent was followed by an attack of jungle fever. The only changes that have occurred in the physical condition of the place are clearing of high grass and jungle, cutting trees, cultivation, limited irrigation.' 'Formerly,' says Dr. Cutcliffe, 'the valley seemed to contain so vast an amount of malaria, that it was believed to be blown by the east wind from the Eastern Doon into Dehra itself, but I failed to detect any evidence of fevers being now produced in this way. Fevers are common enough in Dehra, but in every instance some local cause about the dwellings of the patient could be discovered sufficient to account satisfactorily for the illnesses.'

¹ 'Sanitation in the Meerut Division,' by H. C. Cutcliffe, Esq., F.R.C.S. *Selections from Records of Government of the North-West Provinces*, 1869.

Throughout the valley malarious affections, fever, dysentery, diarrhœa, are very prevalent; enlargement of the spleen is commonly met with. Tubercular disease is very prevalent amongst the lower classes, as are also syphilitic affections. Rheumatism also is a common disorder. Small-pox, which was formerly very prevalent, has been almost stamped out by the labours of the vaccination department.

Dr. Planck writes:¹ 'The great necessity of Dehra, from a sanitary point of view, is a better water supply. The water now carried through the town and consumed by all the inhabitants may be and probably is very good when it comes out of the hills; but in its passage to the town and its distribution in open channels amidst the habitations, it becomes impure. The surface drainage mixes with it in large quantity at times of rainfall; for example, the 'ganj'-surface is drained deliberately to the nearest water channel. At all times something of impurity is finding its way into the water, but in time of great rainfall the channels fill to the brim with a turbid stream, and for days together, as I saw at the time of my inspection, the water is unfit for human consumption. I think a good and sufficient supply of drinking water could be found at a place called *Nala Pani*, some three miles distant from the town, but the essential element of success is that it should be carried after collection, and distributed, in iron pipes. From its situation Dehra might be expected to be a very healthy town, but it is not so, on account of the prevalence of bowel diseases. It is probable that a pure water supply would provide a potent remedy or safeguard against these complaints.'

The site of the cantonment of the N.I. regiment stationed at Dehra is on the watershed, about three miles north of the town. The site is elevated and has excellent drainage into deep water-courses on either side, and into a central ravine which communicates with one of them. The site, says Surgeon-Major Allen (1869) is well chosen in all respects, and in point of beauty of scenery, few in India can equal it. The water supply is good and abundant, and is brought to the lines by a covered masonry channel from a main canal which is itself fed by a mountain stream. The soil is similar to that of the rest of the Doon. Statistics of disease amongst the troops are given in the table at p. 84.

Goitre is very common in the valley, especially along the base of the northern hills. The dispensary returns of the five years

¹ *Annual Report of the Sanitary Commissioner of the North-West Provinces, 1874.*

hence the very considerable permanent hardness of the waters—hardness which will persist even though, as in the jail, the water be boiled and filtered before it is drunk by the prisoners. It is therefore very interesting to note that, as reported by Dr. McLaren, ‘the very numerous cases of goitre amongst those confined in the prison have all, with one exception—a case of very hard fibrous goitre—got rid of their goitres simply owing to the good regimen of the jail. Of twenty-seven cases, twenty-six vanished, after a residence of six months in the jail, without any treatment whatever.’ But goitre is not the only disease that vanishes from amongst the prisoners undergoing confinement in the jail, for Dr. Cutcliffe, who preceded Dr. McLaren in charge of Dehra, writes: ¹ ‘In the Dehra jail, which is in the easternmost part of the town, malarious fevers were at one time very common, and it was supposed that these diseases were produced by the malaria blown in from the Eastern Doon. Seeing no reason to look so far for a cause, I obtained permission to make some simple arrangements in the jail, connected chiefly with air and water, and the result was an end of malarious fever, and an empty hospital.’

The prevalence of the disease amongst the residents in the unhealthy tract along the foot of the hills, its absence in the healthy central tract, the absence of the disease amongst the troops, and the disappearance of the tumours in the case of the prisoners in the jail, all point to malaria as the cause of the disease.

¹ *Sanitation of the Meerut Division*, p. 79.

While these pages are passing through the press I have received a series of *Reports*, submitted by officers of the Indian Medical Department to the Government of India, upon leprosy in the several provinces. The reports from Bengal, Oude, the North-West Provinces, and the Punjaub, may be briefly summarised as follows:—

Bengal. Surgeon-General Beatson, M.D., February 12, 1878. Reports of the district medical officers establish the fact that the disease prevails excessively in certain localities, and that a well-marked leprosy area is embraced by the Burdwan division, the area including portions of Moorshedabad and the Sonthall Pergunnahs. This observation confirms the returns of the census of 1872, which showed that the proportion of lepers to the population in the Burdwan division was 16·5 per 10,000 of population against 5·4 per 10,000, the ratio for the whole province. Evidence regarding the physical peculiarities of the leprosy areas is quite indefinite; the relations of the disease to geology and physical geography are, as far as these reports are concerned, as obscure as ever. Nor do the reports throw much light upon the influence of sanitary and domestic conditions upon the prevalence of the disease. Filth, overcrowding, poverty, are not peculiar to, nor at their worst in the leprosy areas; and the leprosy and non-leprosy in those and neighbouring areas consume similar articles of food. Fish diet has evidently no influence. The most malarious tracts are certainly not the most leprosy.

is certain that syphilis and salivation are not necessarily or specially causative of the disease. Race and caste are not shown to have any influence on leprosy.

The reports support the hereditary character of the disease. 'In a large proportion of cases of leprosy, a family history can be discovered.' The reports do not afford any definite information on the manner of transmission, *e.g.*, whether more frequent in the female than the male line. The evidence as to contagion is 'too indefinite to bear critical discussion.' The reports quite support the conclusion that the disease is far more frequent amongst men than women, and that it is one of adult life. As regards the varieties of the disease, the reports agree in affirming that the anæsthetic is more commonly prevalent than the tuberculated.

Oude. Report by Officiating Sanitary Commissioner A. Garden, M.D., July 14, 1876. Over one or two per cent. of the population of Oude are leprous, but data are wanting to show its exact degree of prevalence, or its relative prevalence in the districts of the province. There is as yet no evidence of the existence of leprous areas in Oude, nor is there any evidence as to peculiarities of life and surroundings upon the production of the disease. The disease is undoubtedly hereditary—probably far more so than the available statistics represent, viz. 18·9 per cent. The disease does not spread by contagion, and is not connected with syphilis; evidence as to its connection with malaria is indefinite.

North-West Provinces. Sanitary Commissioner, C. Planck, Esq., Surgeon-Major, October 19, 1876. Leprosy is known in all parts of the province, but is best known in Kumaon, Gurhwal, Banda, and probably in Goruckpore. Places where first attacks occur are so scattered as to almost preclude the idea that local conditions have any influence as a cause of the disease. Leprosy affects men far more frequently than women, and is a disease of adult life. Prevalence is not affected by employment, religion, social condition. The disease is essentially hereditary. The contagious nature of the disease, even from husband to wife, is very questionable. There seem to be undoubtedly some cases in which the disease has arisen *de novo*.

Punjaub. Officiating Sanitary Commissioner H. W. Bellew, Esq., C.S.I., June 12, 1877. The disease does not appear to exist to any great extent in the Punjaub, nor is it anywhere localised in the province. The evidence of the district medical officers which is appended to Mr. Bellew's report agrees in the main with that of the medical officers of Bengal, Oude, and the North-West Provinces as regards the etiology of the disease.

CHAPTER XXI.

KUMAON AND GURHWAL.

Kumaon and Gurhwal. Limits of the combined districts. Description of the districts; geology, climate, diseases. Mr. Traill on the diseases of the district. Prevalency of goitre in the district. Dr. McClelland on goitre in Kumaon. Leprosy in Kumaon. Mahamári plague. *Nynce Tal, Almora, Mussoorie, Landour, Ranee Khet, Chuckrata.* Malaria and goitre amongst the people, and working parties on the Chuckrata road.

KUMAON AND GURHWAL.¹ These districts embrace the mountainous tract of country which lies to the north of Rohilkund, and extends a distance of about 190 miles from the Nepaulese frontier on the east to the neighbourhood of Simla on the west. The breadth of the district is about eighty or ninety miles. It is traversed by innumerable streams which are fed by the rainfall on the hills, and by the melting of the snows which during the winter cover much of this elevated region, and are in many elevated localities perpetual. These streams combine to form several large rivers which eventually feed the Ganges and the Jumna; thus, to the east, separating Nepaul from Kumaon, is the Kali, an affluent of the Gogra; west of this the Ramgunga drains a large area of the province; still to the west are the Alakmanda and the Bhagiruttee, which combine to form the Ganges; and still further to the west, the Jumna and its tributary the Tonse complete the river system.

Proceeding from the plains into the interior of the district, the marshy Terai and waterless Bhábur tracts are first crossed, and then the Sub-Himalayan hills; but excepting on the west, in the neighbourhood of the Ganges, the outer range of these hills is wanting. The inner range,² formed of the massive sandstones of

¹ Paper on Kumaon and Gurhwal by General Richard Strachey, R.E., in *Journal of Royal Geographical Society*, vol. xxi., 1851. Also a series of papers by B. H. Hodgson, Esq. 'On the Physical Geography of the Himalayas,' December 1871, and following numbers, of the *Phœnix*. Captain Herbert 'On Geology of Gurhwal and Kumaon,' in vol. xi. of *Journal of Asiatic Society of Bengal*.

² *Manual of Geology*, p. 543.

the Lower Siwalik (Nahun) group, on the other hand, is very prominent. To these succeed the region of the Lower Himalayas, some sixty or seventy miles in width, the mountains of which rise abruptly along its outer limits to a height of about 7,000 feet, but nowhere exceed 12,000 feet in height. This region is succeeded by that of the great Snowy range, a region so elevated that the passes are some 18,000 feet above sea-level, while of the peaks one exceeds 28,000 feet in height, and many run up above 20,000 feet. These great peaks are grouped together in masses separated from one another by deep depressions through which flow the streams that drain the valleys beyond, for this line of peaks does not form the watershed, but is separated by lofty plains from a lower but more continuous range of mountains which, according to General Strachey, constitute the watershed of India.

To return to the Lower Himalayas of Kumaon and Gurhwal. The valleys which lie within this thoroughly mountainous country are very narrow, being indeed little more than gigantic ravines opening out here and there into alluvial flats adapted for cultivation, which however never exceed and seldom equal half a mile in breadth. The level of the valleys gradually rises to about four or five thousand feet at a distance in a direct line of some ten miles from the great peaks; but then the level rises suddenly, and a very few miles carries the river-beds up to an altitude of nine or ten thousand feet.

Owing to the very limited area of the valleys, the quantity of land naturally fit for cultivation, in addition to the small alluvial flats already mentioned, is extremely small, but this is largely supplemented by an artificial system of terracing the slopes of the mountains.

As regards the geology of the region. Along the outer edge, in the neighbourhood of Nynsee Tal, limestone and slate rocks (probably Krol and Blaini) prevail; the limestone forming the summits of many of the hills. North of the limestone range is a great dislocation where the line of fracture is filled with basic eruptive rock, numerous dykes of which occur in the range about Nynsee Tal. The width of the area of the slate series is much less here than in the Simla region, and immediately beyond the dislocation just mentioned 'we come at once upon metamorphic strata, genuine schists like the older series of the Simla region, rather than like any known metamorphic condition of the slates.'¹ South of Almorah a broad band of granitic rock occurs in the schists, and has a con-

¹ *Manual of Geology*, p. 610.

siderable range to south-east and north-west. Mica schists occur again north of the granite; then comes a line of disruption, with 'copious intrusion of trappean rock, and the introduction of new strata—slates, conglomerates, quartzites, with limestone in force. Beyond these again there is a region of crystalline schists at the base of the great Snowy range.'¹

Iron, lead, and copper ores are found in some localities in the district; other valuable minerals are graphite, gypsum, asbestos, limestone, and slate. Lignites are found amongst the sandstones of the outer hills, and carbonaceous shales in the middle region, but true coal has not been found.

Climate. The climate of the province varies greatly in different localities, and speaking very generally it may be said to embrace the three ranges of tropical, temperate, and arctic temperature as we pass from the lower to the upper regions. Elevation is of course the principal factor in determining the temperature, and a difference of 1,000 feet in height makes a difference of three or three and a half degrees of Fahr. (Hodgson); with the increased elevation there is less moisture, more sunshine, and a diminished vegetation, and yet at the same time a greater power of ripening grain. Again, the temperature and the climate are notably influenced by the position of the locality, whether situated in a valley or on a mountain slope, or whether it is on the northern or southern side of a mountain range; at elevations above 15,500 feet there is perpetual snow on the southern slopes.

The general course of the seasons is, in the outer and central regions, very much the same as in the plains; the cold season extending from October to March, and the hot season from thence to the commencement of the rains in June. The summer rains, however, usually commence a little earlier than in the plains, and end about the middle of September. Usually a few showers fall in October, and then follows the driest month of the year, November. December also is usually without rain till towards its termination, when the winter rains may be expected, these are generally at their maximum in February. October, November, and the early part of December are the most delightful periods of the year; the air is very cold, dry, and crisp, and the climate very invigorating. From December to the middle of February the weather is usually cloudy, cold, wet, and disagreeable. The rainfall of the province is as a whole very heavy, though it of course varies much in different localities, according as they are on one or

¹ *Manual of Geology*, p. 610.

other side of a mountain range. The wind through the greater part of the year is southerly during the day, while at night a current of local origin descends in an opposite direction. In April and May the north-westerly winds, which at that period predominate in the daytime in the plains, are felt over the outer and central tracts, and violent storms attended with thunder and hail are common. Tables XVI. and XVII. in the Appendix exhibit the meteorological elements of two stations in the district.

The vegetation of the forest along the foot of the outer hills is strictly tropical, though not of a rank or very luxuriant character, and a scanty vegetation of the same description extends up to a level of about 4,000 feet on the face of the hills. But if we follow the same zone of elevation into the interior of the mountains along the confined beds of the rivers, we find that, fostered by the heat and humidity of those localities, the richest tropical vegetation prevails. Up to an elevation of from three to six thousand feet, *Pinus longifolia* clothes the slopes of every hill, often to the exclusion of every other tree; but above 4,000 feet, oaks and rhododendrons increase in number and mark the commencement of the temperate zone. Still, even in the higher parts of the mountains, the climate, partaking of the extreme heat and wet of the tropics, produces corresponding peculiarities in the vegetation, so that even at 8,000 feet a palm (*Chamærops*) is still common. At about 11,500 feet the forest ends, but a luxuriant herbaceous vegetation still clothes the mountain sides, and vegetable life does not finally cease till an elevation of seventeen or eighteen thousand feet is attained. Wheat and barley are cultivated during the summer months on the ranges of the central region up to a height of 8,000 feet, and in the valley at the back of the snowy peaks the same cereals are cultivated at elevations of 11,500 feet; while the rain crops of the plains, such as rice and other grains peculiar to hot climates, together with cotton and the sugarcane, flourish up to an elevation of about 5,000 feet.

The population of Kumaon is 43,288, or about 72 to the square mile; that of Gurhwal is 310,282, or 56 to the square mile. The Cossyabs, an agricultural people, originally of Hindoo race, but now presenting a considerable mixture of Mongolian blood, comprise about nine-tenths of the population; their villages are small, and are scattered along the base and sides of the mountains wherever facilities for cultivation are afforded; at a higher level on the mountains live the Bhooteeahs, a people of Tibetan origin, who are chiefly employed as porters in carrying loads

about and across the province. The food of the people chiefly consists of coarse grain and the inferior kinds of pulse, together with what animal food they can get; they smoke and drink freely, but intoxication is rare. However, their chief beverage is the water of the innumerable mountain springs, which is as a rule very pure, and, as will be seen from the results of the analyses of the waters of the different hill stations of the province, contains but little solid matter. The habits of the people generally, their houses and villages, are exceedingly filthy.

Diseases. The description of Kumaon and Gurhwal has been given somewhat at length, partly because the province includes no less than six hill sanatoria, and partly because the physical peculiarities of the country, the nature of its climate, the distribution of its vegetation, and the employments of the people, throw light upon the causes of the diseases from which they suffer, and especially upon the prevalency of malarious disease amongst those of them whose houses are situated in very elevated localities. Diseases of that class are exceedingly common throughout the province, and in some localities the fever is of a very severe and fatal type, and it may be instructive to introduce here the account which Mr. Herbert¹ gives of one such locality which is a peculiarly dangerous one. 'About thirty miles north-west of Almorah there is a small tract of rather greater extent than those presently to be noticed, and more uniformly level in surface. It is watered by the Gaomuttee and its several feeders, which are very numerous, and the glens in which they rise being broad with a level terrain, form, by their inosculation with the principal one, the appearance of a considerable tract of open and almost level country. The lowest point of the valley, where there is a temple of some sanctity, is 3,800 feet above sea-level. The villages around are situated on the lateral ridges which divide the subordinate glens. The forest is not too thick, and yet from some unexplainable cause, the tract is unhealthy in a high degree, so much so as to be in a measure neglected and allowed to run to waste. Other spots in the beds of different rivers are of more limited extent; in width seldom more than half a mile, though the length may be considerable. These spots generally occur in an advanced part of the river's course, and being therefore the lowest places in the mountains, are the hottest; in general they are fertile and fully cultivated, yet are all considered more or less unhealthy, particularly at the breaking up of the rains, and when narrower than usual are so notoriously

¹ 'Survey of Himalayas,' *Journal of Asiatic Society of Bengal*, 1842.

subject to the "awal" or jungle fever as to be entirely neglected.'

Mr. Traill, an early Commissioner of the province, who paid great attention to the condition of the inhabitants and the diseases from which they suffered, writes as follows on the subject: ¹ 'The mildness of the temperature of the hills would lead to the expectation that the inhabitants would enjoy an exemption from most of the diseases incident to less favoured countries, and that a different state takes place is doubtless to be attributed in a great measure to the people themselves. By their avocations the labouring classes are occasionally compelled to descend into the valleys, the air of which is invariably noxious throughout half the year. The purity of the natural atmosphere is also counteracted by the state in which the villages are kept; the dung-heap forms a prominent object in front of and contiguous to every house; the villages are commonly buried in dense crops of gigantic hemp, while the houses are enveloped with a profusion of scandent vegetables. From the united operation of these causes, during the worst season of the year general sickness prevails throughout the hills in the shape of quotidian, tertian, and quartan fevers. Contagious and typhus fevers and plague occasionally break out; rheumatism is common during the cold weather. Cutaneous eruptions of various kinds are universally prevalent amongst all ranks, and are ascribed by the inhabitants to the use of spring water. Leprosy is common, especially in Kumaon. To the above must be added affections of the spleen and of the lungs, bowel complaints, stone, dropsy, all of which are frequent.' Small-pox was formerly very common in the province, but it has been almost stamped out by the labours of the vaccine department. 'Goitre,' says Mr. Traill, 'is common in these hills, although it is here a disease which injures only the personal appearance, and not the bodily health or mental faculties of the subject.' Mr. Traill observes that the disease occurs amongst all classes, whether living in the valleys or high up on the mountain slopes, and amongst those who drink river water as well as amongst those who drink spring water only. He conjectures that the goitre may be produced by the exposure of the part to the keen mountain air, and he thinks that this conjecture derives support from the fact that a covering for the part, generally of some fur, is used by the natives as a preventive of the disease, and for the cure of incipient cases. The returns of the dispensaries of Kumaon and Gurhwal, given at page 32, show that a very

¹ *Asiatic Researches*, vol. xvi. 1828.

large proportion of the cases treated are of goitre. Dr. J. Fleming¹ corroborates Mr. Traill's statement that goitre is not associated with cretinism in the province, for though he saw numerous cases of the former disease, he could succeed in finding only two cretins, and they had no enlargement of the thyroid gland.

Dr. McClelland, in his well-known work on the geology of Kumaon, dwells at length on the question of the cause of goitre, and his researches are often quoted as an authority for the view that the disease depends upon an excess of lime in drinking water. But he seems to have been very much misunderstood in this respect, for neither in that, nor his later work,² does he assert this opinion. Thus at p. 110 of the latter work he writes: 'The exciting cause has been traced to certain strata of the earth, under circumstances calculated pointedly to suggest that water is the medium by which it is conveyed to the bodies of men; although the analysis of such water has proved insufficient to detect any ingredient to which we can directly ascribe their effects except lime. Finally, that having thus far traced the source of the endemic, we have reached, in regard to the exciting cause of goitre, the utmost limit of our knowledge: but whether there be any other strata capable of yielding this peculiar contagion than those we have described, and whether the water is the only medium by which it can be conveyed, are points which still remain to be determined.' Dr. McClelland believed that by comparing the statistics of goitre as he found it existing in a large number of villages in Kumaon, agreeing in external aspect, altitude, and climatology, but differing in geognostic relations, he was able to establish the position that the strata which may be spoken of as goitre-bearing are characterised by the presence of limestone rocks. Thus he found goitre absent among the inhabitants of those villages which were built on formations of granite, gneiss, mica slate, hornblende slate, or steatitic sandstone. In the villages built on clay slate only one in 176 of the inhabitants were affected, in the case of those built on transition slate only one in 249 of the inhabitants were affected, while as many as one in three of the people who lived in villages built on calcareous rocks suffered from the disease. But that there must be some fallacy underlying this reasoning appears almost certain when we consider an observation lately made by Dr. Stoliczka with reference to a neighbouring region, viz. that goitre is prevalent in the Sutlej and neighbouring valleys, where

¹ 'Landour to the Snowy Range,' *Indian Medical Gazette*, February, 1867.

² *Medical Topography of Bengal*, London, 1859.

the geological formation consists entirely of gneissous and other metamorphic rocks, while in the Spiti valley, where the rocks are calcareous, not a case of the disease is to be met with, and when we remember also the account which has been given of the prevalency of goitre in localities, such as those in Assam, the soil of which is singularly free from lime.

But what is in truth the actual cause of the disease appears plainly enough when we follow Dr. McClelland in the comparison which he makes of the diseases from which the troops in Kumaon suffered at the not far distant stations of Petoraghur and Lohooghat. Lohooghat is in a small valley about 5,562 feet above sea-level, surrounded by hills elevated from 500 to 1,000 feet above the cantonment, excepting on the west side, where the circle is broken. The rocks are clay slate, containing small beds of gypsum and quartz, covered by a stratum of ferruginous clay and a layer of vegetable mould. The water of the numerous streams in the neighbourhood only contains a little earthy matter, together with a small quantity of chloride of sodium and sulphate of lime.

The mean annual temperature of the cantonment is about 60° Fahr. In December 1831 a detachment of native troops was sent to the station, of whom, after three years' residence, not one in the detachment, which with women and children numbered about 400, had the slightest affection of the thyroid gland.

The other station, Petoraghur, is about fifteen miles in a northerly direction from Lohooghat. Dr. May, who visited the place and analysed the waters, in 1871, describes it as situated in the centre of a long, well-watered, and very fertile valley. The cantonment is about 5,462 feet above sea-level, about 500 feet above the general level of the valley. The mean annual temperature is about 1.4° higher than that of Lohooghat; the rocks are of clay slate, supporting extensive deposits of transition and floetz limestone. The lower beds of the valley are composed of gravel cemented with calcareous matter. This post was occupied, at the same time as Lohooghat, by a detachment from the same regiment, numbering also about 400 men, women, and children. During the first year no cases of goitre occurred; at the end of the second year four cases had been under treatment, and at the end of the third year fifteen cases in all had been treated. The annexed table, which is taken from Dr. McClelland's work, shows that Petoraghur proved a more sickly place than Lohooghat, and that its comparative unhealthiness was especially marked, as Dr.

McClelland notes, by 'the greater intensity of endemic diseases generally.'

	Lohooghat	Petoraghur
Diarrhœa	32	5
Dysentery	7	88
Fevers	167	232
Enlarged spleen	1	2
Goitre	—	15
Other diseases	74	144
	281	486

Dr. May found that the Petoraghur waters contained a considerable amount of lime in solution; his results showed from eighteen to twenty grains of solid matter to the gallon, of which nine to eleven grains were lime, and about two grains magnesia. But with the knowledge we now possess of the prevalency of goitre in localities the water of which is extremely soft, we cannot connect the hardness of the Petoraghur waters with the prevalency of goitre there, unless we are prepared to maintain generally a connection between hard water and the endemic occurrence of malarious diseases. There can, however, be little doubt that the local conditions, whatever they were, which rendered malarious diseases more common at Petoraghur than at Lohooghat caused the greater prevalency of goitre at the former station.

Leprosy¹ is very prevalent in the Kumaon division; indeed this is one of the three districts in British India—the other two being Beerbhoom and Bancoorah, in Lower Bengal, and the Deccan and Konkan divisions of the Bombay Presidency—in which the disease prevails to an extraordinary extent. In Kumaon the disease is most prevalent in the country lying between Almorah and the Nepaul frontier, where the number of the diseased is constantly recruited by sufferers who cross from Nepaul in order to obtain the humane protection of the British Government. At Almorah is a Leper Asylum which has been in existence upwards of thirty years, and had received, up to June 1876, 211 patients; 127 males, 84 females. When Drs. Lewis and Cunningham visited the Asylum, they found there 80 patients, of whom 49 were cases in which anæsthesia presented the most prominent feature, 12 in which the pre-

¹ 'Leprosy in India,' a *Report* by T. R. Lewis, M.B., and D. D. Cunningham, M.B., special Assistants to the Sanitary Commissioner with the Government of India. *Report of the Sanitary Commissioner with the Government of India* for 1875. See also note at end of the last chapter.

sence of tubercles of the skin was the most marked peculiarity, and 15 were mixed cases. Messrs. Lewis and Cunningham remark that the history of the Asylum gives no support to the doctrine that leprosy is contagious, but bears strong evidence to the important influence of hereditary taint in the transmission of the disease.

*Máhámari.*¹ Both in Gurhwal and Kumaon a disease prevails which is known to the people as Máhámari (or the great plague), a name which, however, they also apply to cholera. More specifically the disease is known as 'Gola' or 'Phutkia,' both words signifying 'bubo.' The disease is asserted by Dr. Planck, and by other observers who have studied it, to be identical with the plague of Egypt and the Levant.

'The first recorded outbreak of the disease occurred in 1834-35; but according to local tradition the disease originated in 1823 in the person of the Ráwal of the famous temple of Kedar-nath in the Snowy range, who, with the Brahmins associated with him, were smitten with it in consequence of some ceremonial omission in the performance of the temple rites. In 1849 another outbreak occurred, and others in 1851-52, 1860, and 1876-77. Since 1823 the deaths of 3,600 people have been officially recorded to the disease, but, as Dr. Planck remarks, the deaths have doubtless been far more numerous. The disease is excessively fatal. Dr. Planck found that during 1876-77, 291 people, living in forty villages, were attacked, and of these 277, or 95 per cent., died. In all the villages which Dr. Planck inspected, the outbreak occurred between October and the end of April, and as a rule Máhámari disappears in the hot weather.

The disease is never epidemic over the whole country, but assumes an endemic form in widely scattered villages; nor does it tend to spread from one village to another, even where the lands are contiguous. It is, however, most clearly communicable from the sick to the healthy, the first case occurring in a village giving origin to those that succeed it in the neighbourhood. This absence of epidemic tendency, writes Dr. Planck, would appear to exclude any supposition that the prevalence of the disease may be due to any cause affecting things enjoyed in common by the people, such as the air they breathe, or the food they eat, or from any peculiarity in their common habits. And the enquiry becomes

¹ Proceedings in reference to Máhámari disease by Dr. Planck, Sanitary Commissioner of the North-West Provinces, in his *Annual Report* for 1876. Paper on the same subject which is appended to Dr. Planck's report, by Dr. Watson, Superintendent of Vaccination.

narrowed to a consideration of the local condition or peculiarities of the centres of population in which the disease is found to prevail.

The germs of the disease are, in Dr. Planck's opinion, widespread over Gurhwal and Kumaon, owing in a great measure to the fact that the custom of the people is to bury those who die of pestilence in shallow trenches, instead of burning the bodies, as is their practice in the case of death from other diseases. And he considers that the active principle of the disease, though at times dormant, is ever ready to affect persons suitably prepared by any circumstances which give rise to a low or bad state of health.

Such a condition is very liable to be caused by the unwholesome state of the villages and of the towns in which the inhabitants live, a state which even the often beautiful and wholesome site of the dwelling cannot redeem. To the detriment of their own health, and it may be added to that of the cattle, they use the house for the combined purposes of a dwelling place, a granary, and a cattle-shed. On the upper floor in which the family lives, damp, unripe, and often steaming grain is stored in open vessels or baskets, while in the lower floor the cattle are huddled together in a place encumbered with manure, the fluid part of which sinks into the earth, while its gaseous portion rises into the floor above and is valued for its warmth.

These insanitary conditions conduce not only to outbreaks of plague, but also of a severe contagious fever called '*Sanjar*' by the people, who distinguish between it and Máhámari. Dr. Planck thinks, from the character and general result of *Sanjar*, as described to him, that it may be plague ending in death before the characteristic swellings appear.

The symptoms and causes of Máhámari are described by Dr. Planck as follows. The attack is preceded by an unmistakable appearance of lassitude and anxiety, but usually the first symptom of actual disease is shivering followed by intense fever. After about twelve hours' continuance of the fever, pain in the head becomes a prominent symptom. The pain continuing, by the evening of the second day the sufferer will be delirious, and by the evening of the third day will be insensible, and death will follow that night. This is the course of the disease in by far the greater number of cases, and in such no characteristic appearance of plague will be found on the body after death. But there are two well-marked exceptions to this general course of the disease; the patient may die, overpowered by the violence of the disease, within

twenty-four hours of its onset. Or, after delirium or insensibility has continued for some hours, glandular enlargements may appear in the groin or armpit or neck; these may appear as early as the fourth day, or they may not be prominently apparent till as late as the seventeenth day. Such glandular swellings, or in some cases boil or carbuncle-like swellings, mark a favourable crisis in the disease; and their appearance indicates that some hope of recovery may be entertained. The ultimate favourable result appears to depend upon the progress made by the swellings towards suppuration, and the discharge of matter from them; but in two cases witnessed by Dr. Planck, recovery occurred without suppuration. No appearances of petechiæ were found upon the sick, nor could Dr. Planck obtain evidence in any case of such appearances; but he adds, 'it is likely that this absence of visible petechiæ may be due to the fact that the people affected were all dark-skinned.' The period of incubation of the disease is certainly less than twenty-four hours (Watson).

Dr. Planck made careful enquiry regarding the death of rats in infected houses, and as the result he thinks it may be true that the death of rats preceding an outbreak of the disease points to certain local conditions or peculiarities as giving rise to the outbreak, and that, in the case of villages in which the rats have not died, infection, rather than any specific local conditions, has given rise to the outbreak.

Dr. Watson, who investigated the disease about the same time as did Dr. Planck, considers that Máhámari originates owing to some peculiar fungus being generated in old and decaying grain, and that this happens in out-of-the-way villages, on high mountains, where the people, owing to the distance from a market, keep their grain for many years; and that it spreads from thence by infection to other villages. He points out that Northern Gurhwal is divided into four pergunnahs, one to the north-east, another to the north-west, a third in the centre, and the fourth to the south; the habits of the people are identical, and the climate very much the same in all, yet while the disease is very prevalent in the north-west and southern pergunnahs, it is very rarely present in the others, though they lie between and separate the plague districts. This anomalous distribution of the disease Dr. Watson attributes to the want or otherwise of a market for grain, in the absence of which in the plague districts the grain is long kept in store, and hence the development of the poisonous fungus in it. He attributes the immunity of European officers

who have investigated the disease, and that of their servants, to their not making use of the grains peculiar to the hills. The pilgrims too who pass in thousands through the district, are but very rarely stricken, and their freedom from attack Dr. Watson considers may be explained in the same way. But he also notices that another explanation might be found in the circumstance that they generally wear cotton clothing, not woollen or hemp as the hill men do, and that they enter the hills only in April, and then follow a route which keeps pretty close to the valley of the Ganges, where from April until October the temperature of the air, even at night, rarely falls below 75° F., a temperature below which the disease is not, in his opinion, infectious.

As regards the earlier history of the Kumaon plague, Dr. Planck expresses an opinion that the specific poison has probably been extant for many generations past in Gurhwal and Kumaon. The account of its appearance for the first time at Kedarnath in 1823 is simply the belief of the existing generation amongst a people who have no records or knowledge of previous times.

In the second number of the 'Indian Annals' (1854) there is a very interesting account of the first appearance of the 'Pali plague,' which is essentially the same disease with the 'Máhámari' of the Himalayas, in Kutch and Kattywar, in the Bombay Presidency, in 1815, and of its subsequent appearance in Rajpootana, where it broke out in the town of Pali in 1836. The same article embodies Drs. Pearson and Francis's report upon the results of their enquiries on the subject in Kumaon during 1852-3.

The hill stations of Kumaon and Gurhwal are *Nynsee Tal*, *Almorah*, *Mussoorie*, *Landour*, and *Raneekhet*. To these may be added *Chuckrata*, near the western confines of Gurhwal.

*Nynsee Tal*¹ is situated on the Gagur range of the Himalayas, which may be said to rise here straight out of the plains. Near the point at which the range attains its highest elevation in the Cheenur peak (8,732 feet), it sends off a spur called the Ayar Pata in a south-easterly direction, and in the valley between this and the main range, known locally as 'Sher-ke-Danda' and 'Luria Kanta,' lies the lake from which *Nynsee Tal* takes its name. In a straight line, *Nynsee Tal* is about fifteen miles from the plains, communicating with them by two roads which enter the hills at the villages of Huldwanee and Kaleedonga respectively.

The length of the valley is about two miles, its breadth about

¹ See Mr. Batten's *Report* in vol. iii. of *Report on Sanitary Establishments for European Troops*, Calcutta, 1862.

half a mile, and it is shut in on all sides excepting to the south by lofty hills. These, however, do not prevent a free circulation of air through it, direct currents of air entering the valley to the north between the main range and its spur, and from the south by means of the gorge through which the surplus waters of the lake escape. The lake occupies the lower end of the valley, at an elevation of 6,409 feet above the sea-level, and is about a mile long and a quarter of a mile in width. It is fed by springs, and by the drainage of the surrounding hills, and has an average depth of about eight fathoms; the surplus water supplies a mountain stream which escapes through the gorge already mentioned. On the south side of the lake the rocky precipices of the Ayar Pata descend abruptly into the deep water below them; but on the opposite side the slopes of the Sher-ke-Danda are far from steep, and here is the station mall. To the west of the lake an open space or esplanade spreads itself out, above which is situated the native town or bazaar, and from this point to the base of Cheenur are placed the majority of the houses, dotting the sides of the hill up to an elevation of 1,200 feet above the lake. The slopes of the Sher-ke-Danda and the Ayar Pata are beautifully wooded with oak and rhododendron, while the sides of the lake are picturesquely clothed with a combination of maple, ash, poplar, birch, alder, and other trees.

The rocks consist chiefly of shaly slates, associated with limestone which forms the summit of many of the hills. The water supply is mainly derived from the lake, but some of the houses make use of the springs which emerge from the mountain side. The lake is moreover a good deal used for boating, and affords a plentiful supply of fish. The large body of water which it contains, and the constant current passing through it, prevent any objectionable effects arising from the uses, not always strictly sanitary, to which it is put. The water was analysed by Dr. May in December 1870, with the following results:—

Total hardness	. . . . .	17°·3
Permanent hardness	. . . . .	13°·
Total solids in grains per gallon	. . . . .	21·6
Mineral matters	. . . . .	18·7
Lime	. . . . .	4·1
Magnesia	. . . . .	4·3
Silica	. . . . .	Traces
Chlorine	. . . . .	1·27
Sulphuric acid	. . . . .	5·25

The barracks of the convalescent dépôt for European troops

are situated at an elevation of 6,400 feet, on a ridge which is a spur of the Luria Kanta, away from the valley, and about a mile off from the lake. This ridge is composed of argillaceous schist, and is well timbered, but with little underwood and no rank vegetation. The drainage is excellent, and the water supply, which is derived from the lake, is abundant for all purposes. The situation of the depôt is, however, exposed to the masses of vapour rolling up from the valley below, and is consequently during the rains damper than Nynee Tal, but is warmer in the winter.

Climate. The temperature (average of 1851-54, Schlagintweit) and the rainfall (average of seven years, Blandford) are as follows :—

	Mean temperature	Rainfall in inches
January	42·5°	6·39
February	46·4	4·09
March	55·5	4·47
April	59·3	2·08
May	64·1	2·82
June	69·6	13·2
July	65·3	19·26
August	66·	20·18
September	63·2	7·88
October	58·1	3·51
November	55·	·09
December	48·4	2·61

The highest temperature in the shade, noted during a period of eleven years, was 88° in June 1851—while the lowest was 19° in January 1847.

The rains last from the middle of June to the end of September, and at this time the air is saturated with moisture, and as a natural result fogs are very frequent, and the weather is often oppressively close and hot. The cold weather does not commence till towards the middle of October, and from then until the end of December is the most pleasant and invigorating time of the year at Nynee Tal, the days being bright and sunny, and the atmosphere bracing and delightful. At the end of that month, and during January and February, there is generally a good deal of rain, and snowstorms are not uncommon, the latter month especially being disagreeable, windy, cold, and foggy. In April the weather becomes warm and pleasant, and continues so till the time again arrives for the setting in of the rainy season. From the observations continued for nine years by Sir W. Richards it appears that in each year the average number of clear days was

227 ; of cloudy days without rain 68 ; and of days with rain, hail, or snow, 70.

Dr. Pinkerton, R.A.,¹ considers that the climate of Nynee Tal is not merely prophylactic, and that, provided no organic disease is present, it is well adapted to the beneficial treatment of certain diseases amongst Europeans. This, in his opinion, applies chiefly to the cold and dry months, but at the same time he considers it is an error to suppose that even the wet season is of no benefit to sick men.

Intermittent fever rarely originates amongst Europeans at Nynee Tal, and hill diarrhoea and dysentery are almost unknown. Catarrhal affections of ordinary type are very common, but severe chest affections are rare.

Almorah. This small hill station is situated about twenty miles north, and a little east of Nynee Tal, at an elevation of 5,400 feet above sea-level.² The station is built upon a bare ridge, running from south-west to north-east, composed of coarse micaceous rock interspersed with outcrops of quartz veins ; the surface soil is scanty ; what there is consists of the crumbled-down rock mixed up with vegetable mould. Immediately below the ridge on the west and east are the depressions marking the valleys of the rivers Koosi and Sawul. Owing to the rocky character of the ridge, the vegetation upon its surface, whether tree or shrub, is very sparse ; the trees are chiefly fir, oak, apricot, plum, and cherry. In the hot weather, whatever there may be of surface vegetation, becomes, owing to the want of shade, completely burnt up, and at this time the heat is so excessive that residents are in the habit of moving away to higher and better wooded localities ; one of these is the Binsur hill, which lies about twelve miles to the north of Almorah, and is about 2,000 feet higher ; it is richly wooded, and the temperature during the hot season is from six to twelve degrees lower than at Almorah itself.

The water supply of Almorah is derived from several springs, and is abundant in quantity and of excellent quality.³

Climate. The only unhealthy time of the year is that which precedes the setting in of the rains ; at this period, writes Dr. Govan, European children and others are apt to suffer from bilious fevers and dysentery. After the rains have fairly set in, Almorah becomes cool, and is then as a general rule remarkably healthy,

¹ *Annual Report*, Army Medical Department, 1862.

² Surgeon-Major E. Govan, M.D., in *Medical Report of Native Army* for 1871.

³ See table at p. 32.

and continues so till the end of the year. The cold season is bracing and healthy, especially during its earlier part; but in January and February, the time of the winter rains, when snow falls heavily on the higher ranges in the vicinity, and to some extent in the station also, the damp cold becomes trying, and bronchitic and rheumatic affections are common. The rains commence in June and end in September; the average annual fall is 38·7 inches. The mean temperature is given by Messrs. Schlagintweit as follows:—

January	47·5°	August	72·6
February	54·3	September	72·4
March	58·4	October	66·4
April	65·3	November	59·8
May	71·3	December	53·2
June	75·2	The year	64·2
July	73·2		

The temperature in May and June commonly rises in the shade to 85° or 87°, and in January falls to 43° or 41°.

Almorah is at present the head-quarters of a local corps—the 3rd Ghoorkha (Kumaon) Regiment. The barracks are situated on the north-eastern slope of the hill. The table at p. 84 shows the proportion in which the chief diseases ordinarily contribute to the admissions to the regimental hospital at Almorah. Cholera visited the regiment in 1873, and caused two deaths. The following was the seasonal prevalence of fever (mean admissions per 1,000 of strength) during the years 1872–74:—

January	6·2	July	36·5
February	10·1	August	45·5
March	12·9	September	47·1
April	21·2	October	35·3
May	20·2	November	23·
June	36·	December	29·1

Raneekhet. This military hill station is situated on the road from Mussoorie to Nynsee Tal. In a direct line Raneekhet is about thirty-five miles distant from the plains, the road thence winding for some distance along the valley of the Koosi river. The station occupies a plateau, the summit and sides of which have been levelled to form the sites of the buildings. The highest point is 6,250 feet above sea-level, and the average elevation of the station is about 6,000 feet. Hills of moderate height surround the plateau; these are well wooded with oak and rhododendron, which give place to a growth of fir on the higher elevations. In the neighbouring valleys and on the sides of the hills there is a

good deal of native cultivation. The soil is composed of the disintegrated mica schist which is the main component of the subjacent rocks; and the glare and dust resulting from this description of surface are unpleasant features of Raneeekhet.

The water supply is not over-abundant, but is sufficient for present wants. It is generally considered of excellent quality, and the results of analysis made by Dr. Murray Thomson in May 1868 confirm the belief.

	Spring No. 4	Spring No. 6
Total hardness	3°	2·27
Permanent hardness	3	2·27
Total solids of one gallon in grains	7·72	5·96
Lime, calculated as carbonate	2·88	2·
Salts of the dry residue soluble in water	3·76	2·96

Climate. The site is more exposed than that of the other hill stations of British troops; the climate is reported an excellent one, excepting during the rains, when the weather is foggy and damp. The cold season is very bracing, but at that time sudden and trying changes of temperature are not uncommon. Even during the months of May and June, when the temperature is at its highest, the heat is moderate, and is rarely sufficient to cause discomfort. The Meteorological Table, XVI. in Appendix, is compiled from the official reports for the years 1875-76.

The station has proved, as might be anticipated, a remarkably healthy one for European troops, and rapidly invigorates men coming from the plains in a depressed state from heat or fever. The following table shows the proportion in which the chief diseases contributed to the admissions to the hospital of the regiment stationed at Raneeekhet during the years 1872-74.

Average strength 633.

	Per 1,000 of strength
Cholera	—
Heat-apoplexy	1·2
Fever	143
Dysentery	28·7
Diarrhoea	114·4
Hepatitis	32·3
Rheumatism	62·3
Venereal diseases	217
Diseases of the respiratory organs	99
Ophthalmia	9·3
All other causes	297·6

Number of admissions for fever each month.

January	3·7	July	12·5
February	3·	August	7
March	4·7	September	11
April	6·	October	8
May	10	November	6·0
June	13·	December	4·

Though the station itself and its immediate neighbourhood are very healthy, yet the portion of the road from the plains which runs through the valley is quite the contrary,¹ and, indeed, during the rains so unhealthy, that even the native inhabitants are obliged to abandon this locality for the hills.

Goitre is common among the villages in the neighbourhood of Raneekhet.

Mussoorie, a hill station, and *Landour* the adjacent convalescent depôt for British troops, are situated upon one of the outer ranges of the Himalayas which lie to the north of Dehra Doon. The approach to them from Dehra is by Rajpore, a large native village seven miles distant from Dehra, and at an elevation of about 3,000 feet. The old road from Rajpore to Mussoorie is too steep and too narrow for carriages, and the new road is therefore very convenient for the cartage of heavy stores to the station. About half-way up is Jerrapanee, a halting-place where there is water and a bazaar; and here, at an elevation of 5,000 feet, the houses of European residents are first met with. The hill on which Mussoorie is built rises from the plains in the form of a horseshoe, gradually ascending to the centre, and enclosing in the hollow a number of ridges which lose themselves in the mass above. Ridges also run down from the back of the hill to a valley in which flows a tributary of the Jumna; between the ridges, north and south, are deep wooded gorges. The greater number of the houses are situated at an elevation of from 6,000 to 7,200 feet above sea-level, mainly on the southern side of the hill.

At its eastern end the Mussoorie hill is connected by a narrow spur with the more lofty Landour hill. The spur is from twenty to thirty yards in breadth, with a sheer precipice of from eighty to one hundred feet on either side. Its length is about 200 yards, and its northern end rises rather abruptly to the Landour hill, the highest point of which is about 900 feet higher than the average altitude of the Mussoorie ridge.

The houses and barracks are built upon the ascending slope of

¹ Surgeon F. M. Mackenzie, in *Medical Report of Native Army of Bengal*, 1870.

the spur, and upon the precipitous slopes of the ridge. The barracks face the south; one is on the ridge, the other 500 feet lower, and to the latter, as the least exposed, the invalids are usually removed during the winter. The very limited area of Landour, which cramps the space that can be allotted for military exercises and for out-door amusements, is no small disadvantage to the station.

The view from Mussoorie over the valley of the Doon and across the Siwaliks to the plains is very beautiful, as also is the view towards the north, where the mountainous country seems bounded by the peaks of the Snowy range. The drawback to the scenery is the nakedness of the hills; the visitor misses the pine and deodar forests which form so beautiful a feature in the landscape at Simla and some other Himalayan stations. On the side of the hill nearest the plains which is exposed to the prevailing winds, there are, above a certain height, scarcely any trees excepting in sheltered or cultivated spots. To the north, however, not far below the ridge, trees are plentiful and fill many of the valleys. The trees are principally oak, rhododendron, firs. In sheltered places apricots, apples, pears, cherries flourish, together with many English annual and perennial plants.

The Mussoorie rocks are chiefly clay slate, into which trap occasionally intrudes, and limestone (Król). The latter commences near Jerrapanee, and continues upwards in strata of great thickness to form the crest of the hill. The strata dip to the north-east, and present a steep and abrupt front to the south. In places great beds of gypsum are found with the limestone, and below Landour sulphate of baryta is met with. Ferruginous sulphate is also found with the gypsum, and this accounts for the sulphur and chalybeate springs of the neighbourhood. At Landour the limestone is mixed with quartzose sandstone.

The water supply of Landour is solely from a spring at a considerable distance down the valley between the two hills. The water collected thence is stored in a tank, and is carried by mules to the station above. The Mussoorie supply is entirely from springs, which are kept in a cleanly state and are not liable to the defilement which too often vitiates the water supply of the Himalayan stations. Dr. May, who analysed and reported on the Mussoorie waters in May 1870, pronounces the supply singularly good, containing little organic matter, and that of a harmless nature. (For analyses, see table at p. 32.)

Climate. In March the frost and snow of winter disappear, and the spring sets in, not uncommonly with rain, hail, and thunderstorms, after which the weather for a time becomes settled. The

mornings in May and June are apt to be hot and oppressive till relieved by the southerly wind, which blows every forenoon and continues till sunset, when it gives place to one from the opposite direction. The rains begin about the middle of June, and are usually ushered in by terrific thunderstorms; they last till the middle of September, and are heavier at Landour than at Mussoorie. With the rains come heavy mists, chilly and wetting, which envelope the station more or less for about ninety days during the rainy season. These are rolled up from the plains by the winds which during the daytime are from that direction; towards evening, however, they disappear, carried off by the evening breeze which comes down from the hills. After the termination of the rains, an equable and beautiful season begins; the climate is now delightful and most enjoyable, the sky blue and clear, the air crisp and invigorating, continuing so till about the end of December.

In October the weather gradually becomes cold, and in November is frosty; snow generally falls towards the end of the month, and occasionally through the succeeding three months.

Landour is about four degrees colder than Mussoorie, and complaints are made of the high winds the station is subject to, and of sudden draughts and changes of temperature. The following table¹ is compiled from the data published by Staff-Surgeon Kellett, and from the Messrs. Schlagintweit's work:—

	LANDOUR. Kellett, 1864-69								Schlagintweit	
	Mean of the month	Highest	Lowest	Absolute range	Mean of maxima	Mean daily range	Mean humidity	Rainfall in inches	1852-54	1855-56
									Mean of the month, Landour	Mean of the month, Mussoorie
January .	38.5°	61.3°	28.3°	33.°	46.9°	11.5°	49°	2.01	37.8°	45.2°
February .	38.7	59.3	29.7	29.7	47.4	11.4	65	2.1	43.2	48.2
March .	46.2	74.3	36.	38.3	56.4	14.5	45	3.62	48.6	53.5
April .	56.7	80.2	40.8	39.3	68.	16.2	42	1.87	56.5	65.1
May .	63.	86.3	50.	36.3	74.4	14.5	53	2.61	63	68.2
June .	67.4	87.7	57.7	30.	77.2	11.5	58	6.24	67.5	64.7
July .	63.2	82	58.2	23.8	73.9	9.	78	19.48	64.5	66.7
August .	61.6	79.3	56.4	22.9	70.2	8.3	88	33.26	63.9	64.2
September .	60.4	78.3	56.2	22.2	69.4	10.7	78	5.88	62.8	64.9
October .	54.2	75.	45.5	29.5	65.2	12.7	65	.41	54.6	62
November .	45.4	65.8	36.5	29.3	56.2	14.4	57	.04	49.3	53
December .	40.9	58.3	31.51	26.8	55.	12.9	54	.84	41.7	54.6
The year .	53	—	—	—	—	—	—	78.44	54.5	58.5

Rainfall of 1874 at Landour was 107.45 inches; of 1875, 137.78 inches. Mean height of barometer, 1874, 22.746; 1875, 22.791.—*MS. Reports of Army Medical Department.*

¹ *Annual Report for 1871 of the Army Medical Department.*

Diseases. Mussoorie and Landour have, in comparison with other Himalayan hill stations, an excellent character for healthiness. Malaria,¹ however, proves its presence even at this great altitude by the occurrence of attacks of intermittent fever amongst visitors who have not previously suffered from the disease. The malaria is feeble, seldom causing enlargement of the liver or spleen, and it should be added that patients suffering from malarious taint brought with them from the plains as a rule shake it off during their stay at Mussoorie. Yet though malaria is feeble in Mussoorie itself, miasma of the very worst description abounds in the neighbouring valleys; every year visitors suffer from bad attacks of malarious fever, engendered during an excursion to one or other of those dangerous spots, while cases of jungle fever of the severest type happen to Europeans who venture on shooting expeditions to such places during the rains.

Next to fever diarrhoea is the most common disease at Mussoorie and Landour, but the residents suffer less from both this complaint and from dysentery than at any other of the Himalayan hill stations, a fact which Dr. Kellett ascribes, in the case of Landour at any rate, to its situation on a long precipitous hill which is thoroughly washed down during the rains, and also to the sparseness of private houses.

Chest affections are common amongst the European children, especially amongst those living on the north side of the hill, but the cases are usually of a mild character. Croup is not uncommon, and recurrence of the attacks may necessitate removal to Dehra. Rheumatic attacks, brought on by exposure, are pretty common during the rains.

Dr. Kellett considers that fever cases and cases of hepatic disease do well at Landour, if not complicated by organic mischief. The same may be said of cases of phthisis if no large amount of lung-tissue has been destroyed.

The Paharees, a people of the neighbouring hills, are Hindoos by religion, but of mixed race. Hardy and vigorous, they are much employed in carrying burdens amongst the hills. They are very unwilling to leave the hills, hence perhaps their exemption from cholera. Small-pox, which formerly committed great ravages amongst them, has succumbed to vaccination. They do not suffer from hill diarrhoea. Though filthy in their habits and homes, and badly fed, the climate of the mountain villages is so

¹ Dr. Farquharson, article on Mussoorie, in the *Indian Annals of Medicine*, 1861, an article to which I am much indebted.

excellent, that although the people suffer much from malarious fever and spleen when they descend into the valleys at the time for cultivating rice, they quickly throw off the effects of the malaria so soon as they reach their homes, and become, writes Dr. Kellett, healthy and vigorous in mind and body, independent and self-reliant.

Goitre is very common amongst the Paharees, and very many cases of the disease are annually treated at the Mussoorie dispensary.¹ Nor is the disease confined to them, for Europeans and natives of the plains, both residents and visitors, occasionally suffer. The cases are of a mild character, and are readily amenable to treatment.

Chuckrata. The district of Dehra Doon includes, besides the valley which has been already described, the Jaonsar Bawar, a mountainous tract which stretches from the Doon due north about thirty miles, along the western boundary of Gurhwal, between the rivers Jumna and Tonse. The surface is throughout hilly, the hills rising in elevation to a central chain, the Pokri range, which at its highest point has an elevation of 7,700 feet. The surface level of the district diminishes gradually, though irregularly, towards the south, where at the confluence of the Jumna and Tonse, it is reduced to 1,700 feet. The whole country is well watered; many streams running down on either side from the central chain to the rivers which form the boundaries of the district.

Situated towards the centre of the district is the military hill station of Chuckrata, having an elevation of about 7,000 feet above the sea-level. The station is in a direct line, only eight miles distant from the plains, with which it is connected by an excellent cart road. It is about twenty miles north-west of Mussoorie, the road from thence to Simla passing close by. The Pokri hill is that portion of the range which is nearest to Mussoorie, then comes the bleak exposed mass of the Chilmaree hill, and next the Kylanah hill, prettily wooded, with a spur stretching out from its south-west side, where a sheltered position for barracks is obtained at about three hundred feet below the crest of the range.² Beyond Kylanah is the beautiful and picturesque portion of the range which is known as Chuckrata. This consists of a ridge with spurs stretching out from it, and affording ample space upon its crest and southern slopes for the various buildings and other requisites of a cantonment, while the oak-trees and rhododendrons, though

¹ *Special Report* by Dr. Odevaine, Civil Surgeon of Mussoorie, 1874.

² Dr. Fraser in *Report* for 1865 of the Army Medical Department.

not numerous, add greatly to the picturesque appearance of the locality. The geological formation of the hill consists of metamorphic rocks, chiefly clay slate, which affords excellent stone for building purposes, as well as slate for roofing, while in the neighbouring Deobund hills there is plenty of limestone (Król). These hills are covered with considerable forests of oak and fir, which supply the station with fuel.

On three sides the aspect is open ; to the south and west almost uninterrupted to the plains. On the east and south-east it is bounded only by the distant Snowy Mountains, but to the north, the Deobund Mountains (9,347 feet), in which the Pokri range terminates, overlook the station and close the view.

About 1,000 feet below Kylanah the road is crossed by a fine perennial stream, and from this and another neighbouring stream the water supply was drawn in the early days of the station, but it is now obtained from five rather distant springs, which emerge above the level of the station on the side of the Deobund Mountains. The most distant of these rises about six and a half miles away at an elevation of 7,700 feet, and the nearest is four miles from the station. A covered masonry channel leads the combined streams to a reservoir above Chuckrata, whence the water is distributed to the cantonment by means of iron pipes.

In May 1870 the waters of these springs were analysed by Dr. May, with the following results:—

	Total hard- ness	Per- manent hard- ness	Total solids in grains per gallon	Lime in grains per gallon	Chloride of sodium	Remarks
Spring A.	7°·2	3°·7	14·3	3·4	·7	} Lime mostly present in form of sulphate
" A'.	8°·5	4°·7	16·1	5·6	·3	
" B.	9°·3	3°·8	24·9	7·6	·8	
" B'.	14°·8	7°·5	24·	8·	·8	
" C.	8°·7	7°·	16·8	5·8	·6	
Stream below Chuckrata .	2°·1	1°·5	4·3	—	·7	

The Table, XVII. in Appendix, of meteorological elements, is compiled from the Reports of the Meteorological Reporter with the Government of India for 1875 and 1876.

Climate. Medical officers speak of the climate of this station in the highest terms of praise. One of them describes it as almost perfect during the greater part of the year. The cold, however, is sometimes very severe in January and February, when heavy snowstorms are not unfrequent, and the snow may lie upon the ground to a depth of two feet or more ; but the temperature does

not at this period rise high during the day, and the cold is not found to affect the troops injuriously.

The following table shows the proportion in which the principal diseases contributed to make up the admission rate, per 1,000 of strength, to the hospital of the European regiment quartered at Chuckrata during the years 1871-74.

Average strength 777.

Cholera	—
Heat-apoplexy	—
Fevers	103·
Dysentery	11·5
Diarrhœa	26·4
Hepatitis	30·6
Rheumatism	76·6
Venereal disease	101
Diseases of respiratory organs	116
Ophthalmia	11·5
All other causes	253

Fever was most prevalent from April to September.

In the reports on the medical state of the Bengal army for the years 1868, 1869, and 1870, are a series of very interesting reports by Surgeon-Major J. P. Walker, M.D., who held medical charge of the Sappers and Miners, Europeans and natives, engaged in making the road from the plains to Chuckrata, and in other works connected with the establishment of the military hill station there. Dr. Walker speaks in the very highest terms of the climate and general healthiness of Chuckrata and Kylanah, and contrasts them with the extreme unhealthiness of the other stations on a lower level in the valley of the Umlawah, the river which runs beneath the Chuckrata hill and finds its way into the Jumna near Kalsee. In the report for 1870, Dr. Walker remarks as follows upon the prevalence of ague at and about Chuckrata. Among the prevailing diseases ague was as usual the chief cause of sickness. Of the 116 cases, or 39·69 per cent. of the total admissions, 95 were quotidian, 20 tertian, and only one of the quartan variety. The seasonal prevalence was as follows :—

January	3	July	15
February	—	August	10
March	5	September	27
April	2	October	7
May	9	November	12
June	4	December	22

It appears that the disease was prevalent over a very extensive

hill region around Chuckrata, affecting those who lived at an elevation of from 5,000 to 7,000 feet above the sea-level, and producing anæmia and general debility, though splenic complication was exceptional.¹ 'The prevalence of ague at such elevations is not satisfactorily accounted for. Considering the general scarcity of water in the upper regions, and that the general slope of the mountains is thirty degrees, the want of subsoil and surface drainage can scarcely be a principal factor in its causation. As the disease increases in intensity as the valleys of the Umlawah and Kootnoo rivers are approached, it is possible that the malarial influences generated there are wafted into the higher regions with the same facility and speed that clouds formed in the valleys during the rainy season are transported to the mountain tops.'

The unhealthiness of the Umlawah valley has already been mentioned.² The road from Kalsee to Chuckrata formerly ran along this valley close to the river, and proved so exceedingly unhealthy during the rainy and post-rainy seasons, that travellers ran the risk of contracting a severe form of remittent fever even by exposure for three or four hours to the malaria of the gorge-like valley; even the native postmen were constantly unfitted for duty by fever contracted while traversing it. To avoid all this a road has been made, running wherever possible at a height of many hundred feet above the level of the river; at one place, however, Siah (eleven miles from Kalsee, and 3,200 feet above sea-level) the road descends to the level of the river, which it crosses by a bridge, but it then finally leaves the valley, and ascends by a gradual slope of one in twenty to Chuckrata.

The sappers and miners engaged in constructing this road suffered much from fever, and also from pneumonia, which Dr. Walker considered had a malarious origin. At Siah especially there was a great deal of sickness, and here many cases of goitre occurred amongst the men and the camp-followers. The disease was attributed to the use of the river water. Goitre is very prevalent amongst the people who inhabit the Umlawah valley and the neighbouring mountain region. They attribute the prevalence of the disease to the use of the river water; a belief which probably has its foundation in the fact that those of them whose avocations, especially during the season for cultivating the rice crop, take them into the neighbourhood of the river, suffer from the malaria of the valley.

¹ *Report for 1870*, p. 153.

² Dr. Walker, in *Report for 1868*.

CHAPTER XXII.

THE PUNJAUB.

The Punjaub; extent of the province; the rivers; the Doabs. Dr. Oldham on the structure of the plains. The climate of the Punjaub. Tables of area, of population and of mortality of the province, and of certain districts. Diseases of the province, contagious fevers, malarious fevers, value of the statistics of fever mortality upheld. Rainfall and fever prevalence; canal irrigation; bowel complaints; cholera; table comparing fever and cholera mortality in the districts of the Punjaub; smallpox, great benefits of vaccination in the province; respiratory diseases, prevalence of respiratory diseases in the Punjaub compared with that in other provinces; question of the infectious nature of certain respiratory diseases.

PUNJAUB. The Jumna when it leaves the hills separates the North-West Provinces from the Punjaub. On its right bank the river receives the local drainage of the immediate neighbourhood, but a few miles further west the slope of the surface is to the Indus basin, and here we enter upon a region of which the surface and, though less abruptly, the climate differ greatly from those of the Gangetic valley.

The Punjaub proper,¹ the country of the five rivers, was in old times bounded on the east by the Sutlej, and extended from the base of the Himalayas to the confines of Sindh, but to this great tract of country has now been added for purposes of government the districts north of Rajpootana, which are embraced between the Sutlej and the Jumna; the districts of Kooloo, Spiti, and Lahool, which stretch away far to the north-east into the heart of the Himalayas; and the trans-Indus districts of the province. The Punjaub of the present day is therefore bounded on the south by the desert, almost rainless, expanse of Bikanir, Jesalmir, and Sindh, which intervenes between it and the Indian Ocean; on the west by the Suleiman range rising abruptly from the Indus valley; on the east, where it is freely open to the Gangetic valley, by the

¹ *Administrative Report of the Punjaub, 1872-73. Report of Dr. De Renzy, Sanitary Commissioner of the Punjaub, for 1873.*

Jumna; and on the north by ranges of the Western Himalayas. The plains of the Punjaub are bounded on the north by the outer Himalayas as far west as the Jhelum river, and thence onwards to the Suleiman range by the Salt range, and its continuation in the hill series of the Kohat and Bunnoo districts.

The extreme length of the province is about 800 miles, and its extreme width about 650 miles. The total area is over 200,000 square miles, of which, however, more than half is the territory of Feudatories. The area under British government is close upon 104,000 square miles, of which less than one-third is cultivated: of the remainder about one-fourth is culturable, and the rest is for the most part a sandy, almost rainless desert plain, to which there is no counterpart in the Gangetic valley.

A remarkable feature in the topography of the Punjaub is given to it by the great rivers the Sutlej, the Beas, the Ravee, the Chenaub, the Jhelum, and the Indus, which collect the drainage of the western portion of the Himalayan ranges, debouch upon the plain country, and divide it into several 'Doabs' before they finally become one great stream near the south-western angle of the province. These great rivers, swollen by the melting of the snow upon the mountains, and by the rainfall, periodically overflow their banks, in places to the extent of many miles around, and in the autumn contract, leaving wide-spread beds of fresh alluvium, which are then brought under cultivation. This river system in its direction with regard to the Himalayas altogether differs from that of the Gangetic plains. Thus in the North-West Provinces, and in Northern Bengal, the main river runs parallel to the mountain range, at no great distance from its base, and receives therefrom numerous tributaries fed by the abundant rainfall upon the outer slopes, which water plentifully the intervening tract of country. But in the Punjaub the rivers debouch in direction at right angles to the general direction of the range, and maintain it through the plain country, receiving in their course scarce any tributaries, for the minor streams which collect the comparatively scanty drainage of the outer hills, with two or three exceptions, run but a short course before they are absorbed by the sandy plains on which they enter. Hence in the Indus plain, the cultivation of the country outside a narrow zone which skirts the base of the hills is limited to the neighbourhood of the great rivers, and to localities which enjoy canal irrigation.

But it is not merely in their capacity as water channels that the great rivers influence the surface of the Punjaub, for they

bring down from the hills vast quantities of sand as well as of water, and this, either by the influence of the wind, or by changes in the channels of the rivers, or by the inundations, becomes distributed over the surface of the plains, converting some localities into barren wastes, and in others altering the quality of the soil by mixing the sand in greater or less proportion with the clay and loam. The whole plain must indeed be looked upon as a deposit brought down by the great rivers from the Himalayas—a deposit which near the base of the hills is still in course of being deepened by the hill streams. How thick the deposit may be it is impossible to estimate. At Umballa a boring passed through 700 feet of successive layers of sand and clay, and finally ended in a bed of clay which precisely resembled those near the surface. Layers of kunkhur are met with in the subsoil of many localities.

Dr. Oldham, in his 'Rough Notes' (see pages 125 and 284), remarks, regarding the structure of these plains: 'Owing to the greater fall of the natural surface than in Lower Bengal, the rivers of the Punjab do not deposit over this country the finer silt which constitutes the mass of the plains of Bengal. The prevailing character is fine sand, open and highly absorbent, producing a very dry and thirsty soil. For the most part also the beds of the rivers are more deeply cut than in Bengal, and there is therefore a greater fall from the country round to the level of the streams. This scarcely applies to Mooltan and D. I. Khan, which are placed at a much greater distance down the line of drainage, where the slope of the country has become much smaller, and where the conditions are more like those of the flats of Bengal.'

The Doabs which the rivers form one with another are, with the exception of the Julundhur Doab, much alike in soil and in their general features. Thus in the sub-mountain portion of each is a zone of comparatively luxuriant cultivation, while lower down cultivation is almost limited to belts of land along the banks of the rivers. Outside these belts are lands of varying quality, while as the high central tract of each Doab is approached we meet either with *Bār*, that is uncultivated land covered with brushwood and stunted trees, mere grazing ground for cattle, or with *Thul*, an undulating desert of sand. Towards the lower extremities of the Doabs, where the rivers approach one another, the country becomes nearly level, and is entirely alluvial, while pretty general cultivation is maintained by numerous canals which spread as it were the periodic inundations of the rivers. The Julundhur Doab, between the Sutlej and the Beas, differs from the others in extend-

ing but a comparatively short distance from the hills, and in being almost wholly under cultivation.

The crops which are chiefly grown in the Punjaub are for the spring harvest, wheat, barley, pulses, oil-seeds, vegetables, tobacco, and poppy; and for the autumn harvest, millets, maize, rice, cotton, sugar-cane, pulses, oil-seeds, vegetables, and indigo.

Climate. The climate of these plains is more extreme than that of the Gangetic plains. The cold season begins earlier, and lasts longer, and the cold is greater, partly because the province being in a higher latitude feels earlier the southing of the sun, and is farther removed from the moderating influence of the sea, and partly because, owing to the clearness of the atmosphere and the many cloudless nights, much heat is lost from the surface by radiation; moreover, the occasional showers which fall during the cold season contribute somewhat to lower the temperature at that time. In January the mean temperature of the Punjaub stations is 55° Fahr., that is, 11° lower than the mean temperature of Eastern Bengal during that month. During the hot weather and the rains the greater part of the Punjaub is exceedingly hot, for the surface is now fully exposed to the hot west winds coming down from the arid country west of the Indus, while with scanty rainfall, scanty water surface, scanty vegetation, and cut off from the cooling influences of sea winds, it is comparatively destitute of those influences which moderate the temperature of neighbouring latitudes. Owing, moreover, to the lateness and the scantiness of the summer rains, the summer heats are here far more prolonged than in the Gangetic valley.

As regards the winds of the Punjaub those from the west or north-west preponderate during the cold season, while at the same time easterly winds, a portion of the upper current of the anti-monsoon, descend on the plains, and bring the winter rains, which are more copious and more regular here than in Lower India, and are at their maximum in January.¹ Not till June, when the monsoon rains are setting in over the greater part of India, reducing its temperature, while the northing of the sun has transferred the *locus* of greatest heat to the Punjaub, do the easterly winds increase in frequency, and it is not till July or August that they preponderate in the central and northern portions of the province. At Mooltan, however, easterly winds never gain the upper hand. Even during the height of the summer monsoon the wind is from the south-west, but this is not a rain-

¹ Blandford's *Winds of Northern India*, p. 24.

bearing wind, for coming from the arid plains to the south-west, and heated in its course, no precipitation of its vapours occurs, and Mooltan receives in consequence, during the hot season, only about five inches of rain; and this rainless character is, from the same cause, that of the plains lying to the north of Mooltan, westwards from the Jhelum river.

The rainfall of the province, even excluding the Himalayan stations, varies immensely in different localities. The periodical rains are felt along the northern tract as far west as the Jhelum, the fall steadily diminishing in that direction. At Umballa, Hoshiarpore, Gujrat, the average fall for the years 1870-73 was respectively 40·9, 36, 25 inches; while taking stations a little further from the hills, and proceeding in the same direction from east to west, we have the rainfall at Kurnaul, Julundhur, Gujranwallah, respectively 35·4, 27, and 20·4 inches. Still further away from the hills the fall diminishes in a rapidly increasing ratio, so that at Mooltan the fall averages only 7 inches. The area over which the annual rainfall does not amount to 10 inches is 28 per cent. of that of the province. For its rains the province is indebted to both branches of the monsoon, that from the Arabian Gulf and that from the Bay of Bengal. Here, and in the Upper Gangetic valley, the two currents seem to coalesce, and around the plain of the five rivers the tendency of the winds is distinctly cyclonic.¹ October² is the month of greatest serenity, the average proportion of cloud over the plains being not more than 5 per cent.; in November serenity increases, and reaches a maximum in January and February, after which it diminishes again till May or June.

Great diurnal range of temperature is a marked feature in the climate of the Punjaub. Thus at Mooltan, Rawul Pindi, and at some other stations, the range may amount in April and November to as much as 40°. The minimum occurs, as elsewhere, in July and August, but the range at this time is considerably greater than at the same period in the Gangetic plains, and it increases rapidly at the close of the rains, when a cloudless sky allows of rapid nocturnal radiation from the earth's surface.

Although great diurnal range of temperature is usually looked upon as being unfavourable to health, yet, remarks Dr. De Renzy, when this condition is associated, as it is in the Punjaub, with great dryness of the air, it is probably productive of comparatively little injury. Indeed, in the hot weather months the cool nights

¹ Blandford's *Vade Mecum*, p. 84.

² *Ibid.* p. 112.

are eminently favourable to health, affording refreshing sleep, which would be impossible did the intense heat of the day continue.

The greatest annual extremes of temperature occur in the most southern part of the plains; thus at Mooltan and Dera Ismael Khan the temperature in the shade ranges from 29° to 126° . But notwithstanding the great summer heats of the Punjaub, the mean annual temperature is lower here than at stations in the Gangetic plains; thus it is respectively at Mooltan, Allahabad, and Calcutta, 72° , 77.2° , and 79.4° . The Punjaub is, at opposite seasons of the year, mainly on account of the great seasonal variation of temperature, the seat of the highest and lowest atmospheric pressure, due allowance being made for altitude, in Northern India.

Another very marked feature of this climate is its dryness. Thus, while the mean humidity of Calcutta is 76, and of Allahabad 53, that of Lahore is 44.5, and of Mooltan 43. During May the humidity of the air at the two last-mentioned stations is only 34 and 28 respectively. In a large portion of the province, where the summer rains are light, while the cold of winter is great, the dampness of the atmosphere during the latter season equals, or may surpass, that of the rains.

The dryness of the soil compares with that of the atmosphere. Only very rarely do we find the ground presenting impenetrable strata to arrest the descent of water, while the rainfall over the greater part of the surface is scanty, and the rivers are widely separated; moreover, the intense heat of the sun speedily dries the surface after rain or inundation.¹

In the Appendix, Tables 18-25 exhibit the meteorological elements of seven stations in the province. The rainfall and mean temperature of some other stations are also given in the Appendix, Tables 26 and 27.

Diseases. Malarious fevers, respiratory diseases, bowel complaints, and small-pox are the chief causes of death amongst the troops and civil population of the Punjaub. Cholera is not endemic in the province, but frequently visits it in an epidemic form. Typhus fever and diphtheria are among the occasional diseases of the population, and especially of that portion of it which inhabits the western and north-western frontier.²

The following tables (I. and II.) show the death rate from the principal diseases of the population of the province as a whole; also the death rate from the chief diseases, and the seasonal

¹ Blandford's *Vade Mecum*, p. 80.

² See Chapter vii.

TABLE I.—*Punjab. Area over 200,000 square miles. British possessions in the province, 103,748 square miles, 33.2 per cent. of this area cultivated; 40 per cent. unculturable. Population (census 1868)¹ 17,487,125.*

DEATHS REGISTERED PER 1,000 OF POPULATION IN THE PROVINCE (BRITISH) FROM ALL CAUSES DURING THE YEARS 1874-77.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year		Remarks
													Per 1,000 of popu-lation	Total deaths	
1874	1.59	1.24	1.26	1.14	1.57	1.35	1.21	1.46	1.54	1.98	1.82	1.9	18.1	316,713	'An unusually healthy year.'— <i>Sanitary Report.</i>
1875	1.95	1.74	1.51	1.64	1.8	1.62	1.52	1.68	2.61	4.	3.12	2.32	25.6	447,208	'Very unhealthy year.'
1876	1.73	1.26	1.25	1.18	1.36	1.4	1.36	1.76	4.1	6.	4.06	2.85	28.4	496,844	'Very unhealthy year.'
1877	1.87	1.47	1.51	1.34	1.73	1.94	1.61	1.45	1.42	1.69	1.94	2.1	20.07	350,932	'An exceptionally healthy year.'
DEATHS REGISTERED FROM FEVERS 'PER 1,000' OF POPULATION.															
1874	.98	.72	.71	.65	.89	.76	.64	.83	.93	1.3	1.19	1.22	10.9	190,361	
1875	1.23	1.05	.9	.92	1.01	.92	.81	.86	1.6	2.8	2.27	1.53	16.	279,841	
1876	1.1	.78	.72	.68	.77	.8	.73	.99	3.05	4.98	3.26	2.13	20.09	351,286	
1877	1.28	.96	.94	.8	1.03	1.22	1.0	.90	.85	1.6	1.21	1.23	12.54	219,281	
DEATHS REGISTERED FROM BOWEL COMPLAINTS.															
1874	1225	735	768	901	1642	1408	1369	1845	1762	1763	1562	1427	.94	16,407	
1875	1088	890	829	1443	1860	1540	1620	2333	3634	5828	3976	2508	1.57	27,550	
1876	1477	984	906	1033	1551	1562	1440	2217	4529	5045	3808	2709	1.56	27,271	
1877	1442	871	890	1007	1851	2075	1628	1412	1391	1576	1759	1762	1.30	17,664	
DEATHS REGISTERED FROM CHOLERA.															
1874	1	1	3	12	9	10	6	11	16	3	4	2	.004	78	
1875	4	4	4	10	41	310	747	1515	2117	1358	129	1	.36	6246	
1876	4	7	2	6	8	236	1696	1396	1421	1277	280	3	.33	5736	
1877	2	2	2	3	7	3	2	1	4	1	2	—	.001	29	
DEATHS REGISTERED FROM SMALL-POX.															
1874	953	953	1244	1261	2382	1979	1263	579	265	209	351	582	.69	12,026	
1875	874	1176	1310	1942	2578	2182	1504	606	367	284	301	487	.78	13,594	
1876	722	770	1127	1430	1824	1374	1090	502	340	315	307	451	.59	10,254	
1877	705	620	778	1074	1642	1470	975	518	307	394	1283	2630	.70	12,296	

¹ Judging from the increase of the population between the census of 1856 and 1868, the general population must have increased by about 9 per cent. in that period, and taking the same rate of increase for the years 1868-1877, the population in the latter year would be 19,060,966, and the rate of mortality for the year, calculated on this increase, would be 18 instead of 20 per mille.—*Report of the Sanitary Commissioner for 1877*, p. 21.

TABLE II.—

District	Area in square miles	Cultivated	Culturable	Unculturable	Population			Deaths per	
					Total	Per square mile		Cholera	Small-pox
Kurnaul . . .	2352	1069	846	437	610,927	260	1874 1875 1876 1877	·003 ·12 — —	3·75 1·94 ·95 1·72
Umballa . . .	2621	1479	418	719	1,008,860	385	1874 1875 1876 1877	·01 ·34 ·01 —	2·9 1·9 ·7 ·42
Simla . . .	18	15	3	—	33,995	1885	1874 1875 1876 1877	·06 4·7 — —	·15 ·06 ·62 —
Jullundur . . .	1326	1025	122	179	783,020	590	1874 1875 1876 1877	·002 ·08 — ·001	·18 ·09 ·04 ·01
Hoshiarpore . . .	2086	1174	102	810	938,890	450	1874 1875 1876 1877	·002 ·25 — —	·12 ·19 ·03 ·01
Kangra . . .	8988	915	429	7045	743,758	83	1874 1875 1876 1877	·003 ·95 ·004 ·002	·08 ·08 ·03 ·04
Gurdaspore . . .	1818	1318	146	354	906,126	498	1874 1875 1876 1877	·005 1·63 ·02 ·01	·09 ·25 ·03 ·01
Sealkote . . .	1955	1290	289	376	994,458	508	1874 1875 1876 1877	·005 ·29 ·46 ·001	·06 ·27 ·1 ·02
Gujranwála . . .	2563	894	1086	578	550,576	215	1874 1875 1876 1877	·002 ·02 ·49 ·003	·16 ·13 ·13 ·13
Rawul Pindi . . .	6218	1496	325	4391	699,647	112	1874 1875 1876 1877	·001 ·001 ·89 ·001	·38 ·21 ·13 ·37

Punjab.

1,000 of population			Deaths registered each month from fevers during 1876, a very unhealthy, and during 1877, a very healthy, year											
Fevers	Bowel complaints	All causes	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
10.5	.91	20												
12.2	1.4	21												
12.2	1.7	21	492	488	552	467	504	632	425	429	872	880	846	889
10.1	1.05	20	548	510	574	495	572	697	583	592	365	423	641	516
10.2	1.32	20												
11.8	1.37	22												
17.	2.1	27	661	521	541	745	672	839	723	914	3208	4125	2573	1664
9.6	1.1	16	989	821	870	711	875	1149	789	693	656	603	729	697
3.8	1.6	12												
6.3	2.1	22												
4.8	2.17	18	9	3	12	16	14	13	16	13	22	22	12	10
4.5	1.81	15	9	14	8	12	12	25	9	17	19	11	19	15
12.6	.83	22												
21.5	.97	32												
48.5	2.15	58	1181	630	565	564	887	922	801	2028	7699	12,308	6972	3395
18.7	.54	24	1776	987	1029	899	1142	1155	1119	1058	990	1394	1519	1164
10.4	1.73	20												
25.1	3.5	39												
36.2	5.4	50	1152	657	630	579	769	964	723	1411	8099	10,469	5636	2908
13.9	1.71	22	1277	1024	985	853	1081	1304	971	1095	876	1147	1441	973
9.1	2.3	17												
15.3	2.8	26												
14.1	3.8	25	689	513	512	560	630	766	732	763	1470	1701	1105	1031
12.1	1.8	20	703	688	668	580	645	717	680	618	1005	995	825	862
10.6	.82	17												
28.5	3.98	42												
27.7	2.1	35	1590	792	646	508	668	703	654	891	3688	8011	4278	2668
15.1	1.2	21	1510	1395	1208	859	1368	1356	1131	861	853	923	958	1121
9.7	.71	17												
17.5	1.8	28												
32.8	1.18	40	809	518	492	379	598	568	522	1265	6657	11,326	6399	3060
12.	.57	17	1462	895	835	703	1060	1358	1214	867	724	850	918	954
10.6	.59	16												
15.4	.8	23												
34.7	1.02	43	724	490	363	395	611	557	515	766	2647	5695	3840	2522
17.4	.55	23	1373	811	706	573	861	939	811	617	536	655	770	900
10.8	.71	16												
12.8	.68	20												
11.5	.56	19	598	463	499	555	579	580	633	695	787	1033	905	741
13.4	.44	21	626	530	536	526	711	999	889	677	646	948	1085	1132

TABLE II. continued.—

District	Area in square miles	Cultivated	Culturable	Unculturable	Population			Deaths per	
					Total	Per square mile		Cholera	Small-pox
Jhelum . . .	3910	1194	407	2310	500,988	128	1874	·002	·1
							1875	·002	·09
							1876	·6	·01
							1877	·002	·08
Gujrat . . .	2029	1166	517	354	616,347	303	1874	·003	·05
							1875	·003	·03
							1876	·93	·02
							1877	—	·03
Shahpore . . .	4700	500	3411	787	368,796	78	1874	—	·26
							1875	—	·79
							1876	1·37	·83
							1877	—	·89
Mooltan . . .	5927	976	1118	3788	459,765	77	1874	—	·04
							1875	·002	·27
							1876	·07	1·1
							1877	—	1·15
D. Ismael Khan . .	7096	846	2078	4172	394,864	56	1874	—	·005
							1875	·005	·6
							1876	·61	1·95
							1877	—	2·76
D. Ghazee Khan . .	4740	1658	1666	862	308,978	65	1874	·004	·69
							1875	·003	·01
							1876	·02	·44
							1877	—	·33
Bunnoo . . .	3171	725	91	2334	287,547	91	1874	—	·02
							1875	—	·06
							1876	3·47	1·36
							1877	—	5·54
Peshawur . . .	2497	1269	511	588	500,443	200	1874	·002	·24
							1875	·002	2·03
							1876	1·27	1·25
							1877	—	·53
Hazárá . . .	2835	646	29	2298	367,218	129	1874	·003	1·36
							1875	—	·97
							1876	·67	·48
							1877	—	·04
Kohat . . .	2839	251	44	2543	145,419	51	1874	—	·87
							1875	—	·32
							1876	·16	2·17
							1877	—	·93

The figures in the second, third, and fourth columns are taken from the *Administrative Report of the Punjab* for the year 1872-73. Those in the first, fifth, and sixth columns, from the *Report* for 1877 of the Sanitary commissioner of the Province.

Punjab.

1,000 of population

Deaths registered each month from fevers during 1876, a very unhealthy,
and during 1877, a very healthy, year

Fevers	Bowel com- plaints	All causes	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
10.7	1.05	18												
11.7	1.3	22												
10.4	1.05	19	417	253	290	263	343	357	297	347	581	833	678	534
10.8	1.01	20	386	318	337	294	427	536	478	420	409	511	646	647
8.	.35	12												
11.1	.74	18												
16.4	.58	22	604	334	325	415	368	409	496	600	1822	1966	1392	1362
11.9	.44	17	597	482	523	426	574	796	667	541	605	677	524	867
13.4	1.42	23												
12.3	1.5	24												
11.5	1.23	23	327	233	237	187	190	281	285	228	413	679	556	637
11.1	1.22	22	355	318	300	246	305	517	318	310	219	284	482	543
15.9	.75	22												
21.	1.2	28												
21.5	1.24	30	1253	850	829	730	557	507	419	381	645	1137	1176	1390
17.9	.6	24	1023	830	812	626	578	664	464	384	494	584	747	844
14.	.3	17												
13.4	.33	16												
12.2	.5	9	510	458	390	316	276	257	276	168	320	503	638	709
13.	.47	20	500	412	416	360	405	578	358	271	363	347	419	580
10.9	.94	18												
9.8	.46	13												
12.4	.7	17	331	266	283	227	204	188	175	188	292	578	578	519
10.1	.33	13	437	359	308	241	332	297	214	181	197	172	203	239
9.4	.93	13												
9.1	.7	12												
9.4	1.02	19	232	211	158	154	172	150	192	151	184	416	407	285
8.1	1.15	18	238	173	192	198	212	225	175	153	142	201	200	210
4.95	.41	8												
6.97	.43	13												
7.4	.46	14	272	188	247	329	406	344	285	173	234	481	388	349
6.	.29	8	305	260	286	250	350	437	253	179	198	256	279	325
9.5	.57	14												
10.9	.87	16												
11.6	.81	17	319	321	264	267	240	230	320	368	570	576	360	439
9.9	.64	13	394	346	405	290	283	326	293	241	232	278	295	257
5.4	.29	8												
6.	.38	9												
5.2	.51	10	84	62	58	50	61	44	32	47	81	75	82	72
5.	.18	7	76	86	41	77	62	39	52	81	58	66	51	45

mortality from fever, amongst the people of such of the districts as are included in the scope of the present inquiry.

In Chapter VI. statistics are given of the disease and mortality amongst the troops and jail population of the province, and it has been there shown that typhus fevers—both spotted and relapsing fevers—are but too well known amongst the civil and jail populations and the troops in the Punjaub. Specific typhoid (enteric) fever is, so far as we have evidence, a more rare disease: if it were commonly prevalent amongst the poorer classes of the people, the fact would be reflected in the statistics of the army and jails. This, however, is not the case. Thus during the five years 1872-6, though the attention of medical officers had been designedly drawn to the subject, only seven deaths from enteric fever were reported from the native army of the Punjaub, with an average strength of about 15,000, and only four deaths from the jails, with an average population of about 13,000. A vast number of cases of ordinary malarious fever, especially during epidemic years, do indeed end fatally with typhoid symptoms and diarrhœa; but while on the one side evidence of a specific character—specific signs, resistance to quinine, *post mortem* appearances—is absent, on the other there is abundant carefully collected evidence that these cases are truly of malarious fever.¹

Malarious fever in the Punjaub, as in the other provinces of Northern India, is the principal cause of sickness amongst all classes; but in the case of the native troops stationed there it stands second to respiratory diseases as a cause of death, and to it about one-fourth of the deaths from disease amongst them are due. Amongst the civil population, if the official records may be trusted, upwards of one half the deaths are due to fevers. But, says Dr. De Renzy, in his official report for 1873, 'it would be a great mistake to suppose that under this head are included only deaths from one disease, or even one class of diseases. Any acute disease marked by increase of the bodily temperature is ascribed by the natives to fever. Ailments essentially different in their causes, as, for example, inflammation of the lungs, intermittent fever or heat fever, and typhus fever, are all included under the common head of fever.' Indeed the recorded opinions of some medical men who have dealt with the subject go beyond that of Dr. De Renzy in asserting that but a small proportion of the deaths amongst the civil population are from fever, and that respiratory diseases ought

¹ The evidence of the late Dr. Cutcliffe on this point, in his *Report on the Sanitary Condition of the Meerut Division*, will well repay perusal.

to be credited with the largest share in the mortality of the province. But though the strict accuracy of the records of death from fevers of this class amongst the people may very reasonably be questioned, their substantial truth is supported by the comparison which may be made between them and the reliable statistics of death and disease amongst the native troops. Thus we find that the admissions to hospital amongst the troops from fever constitute about one-half, from bowel complaints about one-twelfth, and from respiratory diseases about one-twenty-fourth of the total admissions; and fever being thus prevalent amongst the troops, we may be certain that it is far more so amongst the poorer classes of the natives. And though it is true that the mortality amongst the troops from fever is in proportion to the admissions very small, yet we have good reason for believing that fever must commonly be of a more severe type, and the mortality be far greater, in proportion to the numbers attacked, amongst the ill-fed, ill-clothed, and badly housed people of those classes than amongst the troops, who are for the most part in good physical condition, who enjoy when sick all the comforts and safety that a well-provided hospital can afford, who are under medical treatment from the first onset of the disease, are well supplied with anti-periodics, and moreover when convalescent are carefully tended till they are thoroughly fit for duty, or, if need be, are sent away for change to their homes.

Again, the chief mortality amongst the native troops, excluding epidemics, is from respiratory diseases, fevers, dysentery, and diarrhoea; and we may safely assume that it is so with the civil population also. But it is very improbable that dysentery and diarrhoea are a cause of error on the side of increasing the returns of death from fever, for these are each recognised diseases amongst the natives—household words even with the poorest classes—rather is it likely that death is often recorded to dysentery or diarrhoea which would more properly have been set down to malarious fever. The class of diseases that is liable to be confounded with fever is that of the respiratory organs, bronchitis, pleurisy, and pneumonia. But if diseases of the respiratory organs caused death in anything like the numbers that fevers do, we should find the maximum of deaths recorded not in October, November, and September, but in December, January, and February, for, as will be seen from the following table, that is the period when respiratory diseases are most fatal amongst the troops and the police serving in the provinces. Column C of the following table arranges the months in the order of their fatality from fevers amongst the native troops

and police, and shows that that order does not agree with either that of column A, which exhibits the monthly fatality from respiratory diseases amongst the same classes, nor with the order of column E, which exhibits the gradational fatality from fevers of the months amongst the civil population. Yet it agrees more nearly with the latter than with the former.

	Respiratory diseases				Fevers				
	Number of deaths, Native Army of the Punjaub, 1867-76	Deaths, Punjaub Frontier Force, 1867-76	Number of deaths amongst the Punjaub Police, 1871-76	Admissions, Native Army of the Punjaub, 1867-76	Number of deaths, Native Army of the Punjaub, 1867-76	Deaths from fevers, Punjaub Frontier Force, 1867-76	Deaths amongst the Punjaub Police (Intermittent and Remittent Fevers), 1871-76	Admissions per 1,000 of strength for Intermittent Fevers, Native Army of the Punjaub, 1867-76	Recorded Deaths per 1,000 of civil population, Punjaub, mean of years 1874-75-76
January .	137	123	33	223	65	52	15	35.4	1.1
February .	81	106	31	262	49	28	5	25.2	.85
March .	53	36	24	199	37	17	12	23.7	.78
April .	45	30	25	154	29	22	11	24.7	.75
May .	26	12	17	136	19	14	8	31.4	.89
June .	10	6	3	114	25	19	12	36.5	.83
July .	10	4	6	95	17	16	8	38.7	.73
August .	10	3	3	106	16	14	14	78.4	.89
September	9	7	5	97	16	23	12	159	1.86
October .	18	4	13	176	48	28	33	203	3.03
November	61	43	37	186	92	51	33	142	2.21
December	128	108	44	217	76	51	17	63.3	1.66
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓</div> </div>									
THE MONTHS ARRANGED IN ORDER OF MORTALITY AND DISEASE PREVALENCE									
A		B		C		D		E	
Jan		Feb.		Nov.		Oct.		Oct.	
Dec.		Jan.		Dec.		Sept.		Nov.	
Feb.		Dec.		Jan.		Nov.		Sept.	
Nov.		March		Oct.		Aug.		Dec.	
March		Nov.		Feb.		Dec.		Jan.	
April		Oct.		March		July		Aug.	
May		April		April		June		May	
Oct.		May		Sept.		Jan.		Feb.	
Sept.		June		June		May		June	
July		Aug.		Aug.		Feb.		March	
June		Sept.		May		April		April	
Aug.		July		July		March		July	

Columns A and B, which place the months (A) in the order of their fatality from respiratory diseases amongst the troops and police, and (B) in the order of the proportion of admissions from respiratory diseases amongst the troops and police, agree pretty closely, an agreement which might be *a priori* expected, as respiratory diseases when fatal are quickly so, and are not very much more

fatal, in proportion to the numbers attacked, one month than another. But columns C and D, which place the months respectively in the order of mortality from fevers amongst troops and police, and prevalency of fevers amongst the same classes, do not at all compare, and this again is a circumstance which might be expected; for though large numbers of the men are admitted for fevers in the early months of autumn, they do not die from that disease in any numbers then, but by hospital care and treatment are cured or patched up, and the largest mortality amongst them takes place later on in the season. On the other hand, column D, showing monthly prevalency of fevers amongst the troops, agrees more closely with column E, which shows the fatality of the months from fevers amongst the civil population; and this also might be expected, for fever breaks out amongst the poorer classes at the same time as amongst the troops, but from want of care and food and quinine, a comparatively large number of those attacked die early in the outbreak.

The death rate from fever amongst the civil population is at its minimum in July—thence it rises slightly into August, and then with a great leap through September to October, when the maximum is reached. After October, in ordinary years, the death rate steadily declines till March or April of the following year. In May there is a slight rise, followed by a fall, which continues till the time of the minimum in July. The monthly admission rate for fever amongst the native troops very closely corresponds¹ in its periods of rise and fall with that of the civil death rate. This synchronism is very remarkable if we compare the statistics (see tables at pp. 61 and 344) of the three districts of Hoshiarpore, Jullundhur, and Sealkote, in which, as the Sanitary Commissioner testifies, great attention is paid to registration, with those of the troops stationed at Jullundhur and Sealkote (pp. 62 and 84). And the concordance of the records of death amongst the civil population with that of the periods of rise and fall of fever admissions in cantonments, is another piece of strong evidence as to their value, and that fever is, as they represent it, far above all others the great cause of death amongst the people of the province.

In the Punjaub the commencement of the fever season follows after a month or six weeks the commencement of the rains, for it is seldom that there is any notable increase of the fever admissions till towards the end of August; and it must moreover be noted that the fever season begins at the same time in the eastern

¹ See p. 58.

districts, *e.g.*, in Umballa, which enjoys an ample rainfall, in the comparatively rainless plains of Mooltan, and in the almost desert plains which bound the province on the south, plains over which vegetation is at its minimum, and where not only is there no marsh, but where the water in the wells stands some 150 or 200 feet from the surface.

In the Punjab Sanitary Report for 1877 the Sanitary Commissioner (Surgeon-Major H. W. Bellew) gives a table showing the duration of illness in cases of death from fevers, compiled from the civil registers of a few unimportant towns and rural circles, with a total population of 15,432, taken without selection as they came in the course of his inspection. Dr. Bellew arranges the duration of illness in three periods, within fifteen days, between fifteen and thirty days, and more than thirty days, and shows that 63 per cent. of the deaths occurred within the first period, 23 per cent. in the second, and 17 per cent. in the third. Of the total number of deaths, 23·8 per cent. were of children under five years old, and of these deaths by far the greatest number took place within fifteen days of illness. If we deduct these deaths, and allow for deaths amongst boys and girls, the greater number of which also would come within the early period, we should have the proportion of deaths amongst adults in the first period reduced probably to about 30 per cent. of the total deaths. But the period registered is that of 'duration of illness,' and as the commencement of illness amongst the poorer classes would be generally dated from the time when they were actually obliged to give up, or shorten their work, we may safely conclude that in a large majority of fatal cases of fevers amongst adults death resulted above a month from the date of the positive commencement of the illness. And in correspondence with this we find that, where the statistics can be most satisfactorily compared, the rise of the death rate from fevers amongst the civil population follows with an interval of about a month that of the admission rate from that class of disease amongst the native troops.

The question of the connection¹ of the degree of rainfall with the amount of fever sickness is a very complex one, for, beyond the mere amount of rainfall, its seasonal distribution has an important bearing on the time and prevalency of fever. Thus heavy winter and spring rains have little, if any, influence on the degree of fever sickness. Then in the case of some stations, where the annual fall is as a rule considerable, a few inches more or less can make

¹ See on this point Chap. v.

but slight difference in the development of malaria. Again, in other stations the question of the influence of heavy rainfall is complicated by the coincidence of wide-spread inundations; or it may happen that one year though the rainfall is heavy the inundations are unusually slight. Moreover, though heavy rainfall may increase the production of malaria, it may, by cheapening food, or, more particularly in the case of Europeans, by cooling the atmosphere, put the inhabitants into better condition to resist malaria. However there seems to be pretty general agreement amongst those who are in a position to give an opinion upon the subject—witness the annual reports of civil and regimental medical officers employed in the Punjaub—that the autumnal fever sickness is influenced by the wet or dry character of the season, and, as has been already pointed out in Chapter v., the statistics of the case so far support the generally received opinion as to show that a dry autumn is a healthy one. When examining the influence of heavy rains it must not be overlooked that with the rainfall the nature of the soil and the natural and artificial drainage of the locality, must be considered; a rainfall which at Jhelum would not perceptibly affect the surface beyond a few hours, would convert the Mooltan cantonments into a swamp for days. Where the drainage is bad, excessive rainfall, or excessive inundations, are almost invariably followed by extraordinary fever sickness amongst the people, and this correspondence of increased fever with the conditions which experience teaches originate and intensify such disease, is worthy of note because it bears no slight evidence to the value of the recorded statistics of mortality from fever.

As an example of the effects of a superabundant supply of water where the drainage is defective, the case of many villages watered by the Western Jumna canal might be adduced. Another example is the one mentioned¹ by the Lieutenant-Governor of the Punjaub in his remarks on this subject, namely, that of the country in the central and southern part of the Jullundhur Doab. In the summer of 1875 the country became waterlogged, the height of the water in the wells rising two or three feet. Owing in part to heavy rainfall, and in part to the inundations of the Beas being interfered with, and diverted by the railway embankments, a great part of the country about Jullundur became inundated, and a most fatal outbreak of fever occurred amongst the people. In the town of Jullundur 500 people died in a single week out of a population of

¹ *Sanitary Report* for 1875, p. 3.

33,673.¹ The troops suffered at the same time, the maximum number of admissions for fever amongst them preceding the maximum death-rate amongst the people by a month.

The question of the influence of canal irrigation has been as keenly debated by the Punjaub Sanitary authorities as by those of the North-West Provinces, and has been made the subject of at least three special reports, namely, those ² of Major Baker's Committee and of Dr. Adam Taylor on the Western Jumna canal, and that of Dr. Fergusson on the Baree Doab canal. These reports will be noticed in connection with the districts which were their scene. In the official Sanitary Report for 1877, the Sanitary Commissioner, Dr. H. W. Bellew,³ again takes up the question, and concludes, from a comparison of the statistics of towns in the irrigated and non-irrigated areas, that canals do exercise a direct influence upon the prevalence of fevers in the direction of their greater development and fatality as compared with the prevalence and fatality of such diseases in places where there are no canals, and that the influence is, so far as it relates to malarious fevers, mostly if not entirely due to the extra humidity of soil and atmosphere produced by their agency.

In certain localities, of which that bordering upon the town of Kurnaul is a conspicuous instance, the irrigation canal did most unquestionably produce the result indicated by Dr. Bellew, and did so by obstructing the drainage of the country and causing permanent and extensive swamps in the vicinity of the town.⁴ In other localities similar mischief has been caused by an equally unmistakeable cause, but of a different sort, namely, the lavish distribution of canal water over lands already low, swampy, and without natural drainage. On the other hand, however, the reports in question affords ample evidence that, to use the words of one of them, 'canal irrigation of itself is perfectly innocuous, and that it is possible to provide it in such a manner that it shall be of real and immense advantage to the cultivator.'

Bowel Complaints. This heading includes as its principal components dysentery and diarrhœa. The Tables I. and II. show that in the Punjaub diseases of this class kill more people than any other diseases excepting fevers. The tables also show the close connection between the class of cases placed under the head of

¹ Surgeon Grant's *Report in Medical and Sanitary Report of the Native Army of Bengal* for 1875, p. 137.

² Chapters xxiii. and xxxvi.

³ *Punjaub Sanitary Report* for 1877, p. 40.

⁴ Dr. A. Taylor's *Report*, p. 23.

‘bowel complaints,’ and those classed as ‘fevers.’ Curves marking the seasonal prevalence of the two classes of disease would be almost identical; while the yearly and monthly ratios of deaths from bowel complaints and fevers amongst the civil population rise and fall together year by year. There can be little doubt that the diseases included in both classes depend upon the influence of similar insalubrious conditions.

Probably a very large proportion of the deaths from bowel complaints ought to be included under the head of fevers, or, with fevers, under one heading, ‘malarious diseases.’ The most common history of fatal malarious fever is this—the patient lingers on for a while with fever till dysentery or diarrhœa supervenes, and then he dies. And Dr. Bellew writes:¹ ‘It is a mere matter of chance whether their victims are registered in the mortuary returns under the one or the other head.’

Regarding the immediate cause² of these diseases, Dr. Bellew writes thus:—

‘They (bowel complaints) are found to prevail in localities of very different and opposite characters in point of soil, humidity, and altitude, but have one special period in common in which they flourish altogether independent of sanitary conditions of locality. This period is the autumn season from September to December, and the prime factor in the production of these diseases is ‘chill,’ which is more common from alternations of temperature and atmospheric moisture during this season than any other of the year. From personal experience, confirmed by long-continued observation, I am convinced that a vast majority of cases of malaria fevers and bowel complaints in this province are attributable more to neglect of proper precautions against exposure to ‘chill,’ than to any other causes, and the terrible mortality from these preventible diseases is a warning index of the miserable conditions of life of the people of this country, especially in respect to clothing and habitation. Until the people are taught to clothe themselves in a manner calculated to protect their bodies from the effects of sudden atmospheric changes, and to build their houses in a manner to exclude night air from pouring in upon the occupants like water from a spout as it were, it is hopeless to look for any material improvement in their proneness to such diseases, be other sanitary measures carried out to such perfection as they may.’

¹ *Report* for 1876, p. 56, by Dr. H. W. Bellew, Officiating Sanitary Commissioner for the Punjab.

² *Ibid.* p. 56.

Table showing Deaths per 1,000 of the Population of the Punjab from Cholera and Fever.¹

Districts	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876	Average of 10 years	Number of yearly visitations
Gurgaon .	4.5	.04	.92	.12	.03	.23	.11	.01	.75	.02	.673	10
Delhi .	2.2	.02	.08	.02	.09	10.8	10.	8.8	13.2	11.	.328	10
Rohtuk .	2.	.01	.08	.02	.01	.36	.02	.02	.47	.003		
Hissar .	6.7	.02	.62	.01	.01	18.5	22.3	18.3	17.5	13.	.26	8
Sirsa .	5.1	.03	.34	.03	.01	—	—	.002	.44	.03		
Karnaul .	2.7	.05	.06	.03	.03	12.3	12.2	16.	17.5	13.7	.78	8
Umballa .	2.5	.03	.05	.03	.03	.15	—	.002	.29	—		
Simla .	8.3	.04	.07	.06	—	10.4	7.4	9.5	11.	8.4		
Ludhiana .	2.6	.03	.03	.02	.02	.47	.01	.01	.12	.005	.612	10
Ferozepore .	4.	.02	.04	.01	—	15.	8.7	9.2	13.	10.9	.48	9
Jullundhur .	.9	.016	.01	.01	.01	1.78	.01	.003	.12	—		
Hoshiarpore .	.9	.02	.03	.01	.01	12.	10.9	10.5	12.2	12.2	.41	9
Kangra .	2.5	.15	.1	.08	.03	1.11	—	.01	.34	.01		
Gurdaspore .	.4	.02	.17	.03	.03	13.8	10.3	10.	11.8	17.	1.34	7
Umritsur .	3.3	.07	4.33	.03	.02	.15	—	.06	4.7	—		
Lahore .	2.6	.02	.38	.05	.05	3.7	3.9	3.8	6.3	4.8	.408	9
						1.23	—	.005	.14	.003		
						17.5	9.7	9.9	13.6	17.1	.107	6
						.6	—	—	.002	—		
						11.6	7.	6.5	10.7	17.8		
						.52	—	.002	.08	—	.155	8
						18.3	13.7	12.6	21.5	48.5		
						.77	—	.002	.25	—	.2	8
						17.6	12.5	10.4	25.	36.2	.405	9
						.23	—	.003	.95	.004		
						10.3	9.4	9.	15.3	14.	.326	9
						.95	—	.005	1.63	.02		
						17.6	14.	10.6	28.5	27.7	.94	8
						.11	—	—	1.52	.04		
						15.3	16.6	12.7	23.	30.5	.524	10
						.81	.02	.01	.37	.93		
						25.	22.5	14.5	20.2	25.		

Montgomery	Cholera	1.4	.01	.04	—	—	.01	—	.005	.003	.147	6
Fever							15.3	10.8	21.7	17.8		
Mooltan	Cholera	1.3	—	—	—	—	—	—	.002	.07	.137	3
Fever							13.5	12.4	20.9	21.5		
Muzuffernuggur.	Cholera	3.9	.03	—	—	—	.01	—	—	—	.394	3
Fever							17.2	13.8	15.8	20.7		
Jhung	Cholera	.3	—	—	—	.01	—	—	—	.01	.032	3
Fever							11.4	11.	9.5	10.4		
Gujranwala	Cholera	2.9	.04	.16	.02	.02	.64	—	.002	.49	.5	9
Fever							15.6	14.	15.4	34.7		
Sealkote	Cholera	.6	.01	.03	.01	.01	.28	—	.005	.46	.17	9
Fever							18.7	15.9	17.5	32.8		
Gujrat	Cholera	.7	.06	.1	.07	.04	.11	—	.003	.93	.202	9
Fever							9.6	10.3	11.	16.4		
Shahpore	Cholera	1.7	.03	—	.02	.01	.12	—	—	1.37	.325	6
Fever							28.3	17.7	12.3	11.5		
Jhelum	Cholera	1.7	.025	.01	.01	.03	.56	—	.002	.6	.294	9
Fever							19.4	13.8	11.7	10.4		
Rawul Pindi	Cholera	3.8	.003	.02	.01	—	.21	—	.001	.89	.494	8
Fever							11.8	11.5	12.8	11.5		
Hazara	Cholera	4.2	.02	.03	.02	.04	.18	—	.003	.67	.516	8
Fever							8.3	7.	10.9	11.6		
Peshawur	Cholera	3.6	.03	5.99	.03	.01	.78	—	.002	1.27	1.17	9
Fever							9.5	7.	7.	7.4		
Kohat	Cholera	8.4	—	3.62	—	.01	2.41	—	—	.16	1.46	5
Fever							6.9	4.9	5.9	5.2		
Bunnoo	Cholera	2.2	.01	.43	.01	—	.01	—	—	3.47	.613	6
Fever							14.7	10.2	9.	9.4		
Dera I. Khan	Cholera	.6	—	.01	.02	—	.05	—	—	.61	.129	6
Fever							22.6	16.7	13.4	12.2		
Dera G. Khan	Cholera	2.8	.003	.01	—	—	—	—	.01	.33	.316	6
Fever							8.6	6.8	9.8	12.4		
The Province	Cholera	2.4	.03	.53	.03	.02	.5	.008	.004	.33	.42	
Fever							15.1	12.6	16.	20.1		

¹ Returns for fever given only for the last five years.

Cholera. In an epidemic form cholera visits the Punjaub about every third year. It has been noticed that these epidemic years usually coincide with the epidemic activity of cholera in the Gangetic plains; and that cholera years in the Punjaub are as a rule those of unusual mortality from fever in the province. The latter observation is, as shown by the foregoing table, applicable as a rule to particular districts; not, however, uniformly so: thus in 1876 the districts of Jullundur, Hoshiarpore, and Goordaspore, which suffered severely from fever, escaped cholera.

Though not endemic in the Punjaub, the disease visits some of the districts yearly, and in the greater number of the districts is more often than not annually present. The arid south-western districts are those which suffer the least frequently. The average yearly number of deaths in the province from cholera is between 7,000 and 8,000, a number which may appear large to those unaccustomed to Indian statistics of mortality; yet really a number very small as compared with that which represents the yearly record of deaths from fever in the province; and one which does not equal the average annual number of deaths from cholera in many single districts of Bengal.

Nothing,¹ remarks the Sanitary Commissioner of the Province, in the meteorological condition of the cholera years distinguishes them from other years. The epidemics occur under the most diverse meteorological conditions, whether temperature, moisture, or pressure be considered. June, July, August, September, and October are the cholera months. The cholera season is as a rule early in the eastern districts; later—not establishing itself till August or September—in the south-western districts.

*Small-pox.*² The table at p. 343 shows the mortality in the province from small-pox during the years 1874–77. The mortality has vastly decreased of late years, a result which must be ascribed to the active operations of the vaccine department and the steady subsidence of the prejudice against vaccination in most of the districts. The subjoined table³ shows the mortality from small-pox during ten years in four districts in which vaccination is readily accepted, and in four others in which it is persistently opposed:—

¹ *Report for 1875*, p. 3; and for 1876, p. 39.

² Dr. De Renzy's *Reports for 1873–75*.

³ *Sanitary Report for 1877*, p. 28.

Deaths registered from small-pox during ten years.

Districts	1868	1869	1870	1871	1872	1873	1874	18 5	1876	1877
Jullundur . . .	605	4339	1498	118	380	1103	141	77	34	8
Goojranwála . .	1610	480	47	573	695	138	87	73	70	45
Hoshiarpore . .	1028	3222	1344	92	439	789	117	177	30	11
Goordaspore . .	949	4163	622	181	1479	1983	80	230	26	8
Goorgaon . . .	1599	7139	420	775	1878	945	1022	2741	1263	1611
Kurhnaul . . .	589	770	1195	1212	473	939	2292	1184	580	984
Rohtuck . . .	258	2937	484	369	141	866	554	217	19	1023
Hissar . . .	141	722	712	1545	92	409	920	546	123	466

The latter districts are situated along the Jumna river, in the south-eastern angle of the province, and the opposition is due to the preponderance of the Hindoo element in the population. In Goorgaon is a famous temple to Seetla, the goddess of smallpox, to whom thousands of victims are literally sacrificed year by year.

Of the total deaths from smallpox during 1877 (12,296), 2,934 occurred amongst children under one year of age; 9,835 amongst these were one year old and under twelve; and only 517 were amongst adults.¹

Dr. de Renzy, in his report for 1873, points out that the disease year by year attains its maximum of fatality in May, and then steadily declines until the minimum is reached in October, when the disease again becomes gradually more fatal month by month till the maximum is reached.

Respiratory diseases. This class of diseases is the principal cause of death amongst the troops stationed in the Punjaub, and more especially amongst those stationed along the frontier. In the jails too respiratory diseases are very fatal, and there is evidence that they are so also amongst the general population, especially amongst those who have been weakened during the autumn by repeated attacks of malarious fever; but on this point accurate statistics are wanting, as diseases of this class are beyond the diagnostic powers of the masses.

The following table² compares the mortality from respiratory diseases amongst the men of the Regular Native Army in the several divisions of Northern India, and illustrates their very fatal character along the North-West frontier.

¹ *Sanitary Report* for 1877.

² From *Report* for 1875 of the Sanitary Commissioner with the Government of India, p. 99.

Mortality from respiratory diseases per 1,000 of strength.

	Mean of 10 years, 1864-73	1874	1875
Bengal proper and Assam	1.77	.66	1.18
Gangetic Provinces	1.09	1.25	.74
Meerut and Rohilcund	1.88	2.14	2.29
Agra and Central India	1.31	1.85	3.13
Punjaub	3.23	3.57	5.41
Punjaub Frontier Field Force . . .	3.44	6.30	11.19

The most commonly fatal disease of the class is pneumonia, or rather pleuro-pneumonia, and the most fatal period is that from towards the end of December to the end of February. About the cause of the disease there is considerable difference of opinion amongst the medical officers who have reported specially on the subject; but perhaps the best, as it is unquestionably the most generally supported opinion is, that amongst the native troops the disease, though it has frequently an epidemic character in a station or regiment, is not contagious, and that it is due to cold impressing itself upon the men, either through the skin or bronchial tubes, whilst on night duty, or even still more commonly when off duty, owing to the need of sufficiently protective undress clothing.

In Appendix II. to the Report for 1870 on the medical and sanitary state of the army of Bengal is a very interesting report by Surgeon E. A. Birch on the exceptional sickness and mortality which affected the 35th N.I. stationed at Meerut during the years 1869-71. The deaths from November 1869 to May 1871 were 92 in number, and were chiefly caused by chest affections, mainly pneumonia. Mr. Birch shows from the previous history of the regiment that the men were saturated with malaria, and suffered severely from fevers of a distinctly malarious character. The pneumonia patients had in nearly all cases suffered from malarial fever. After describing the symptoms of the fatal attacks, Mr. Birch continues, 'I have yet to allude to a most important point connected with the subject,—I mean the infectiousness or otherwise of the disease. My own impression is that it is infectious, that is, communicable by means of the air, but that close proximity is necessary. I can unfortunately only bring forward one fact bearing upon the point. During December, when the hospital was crowded, seven attendants upon the so-called pneumonia cases were attacked with the disease. Now, the daily average number of men attending upon chest cases was about nine-

teen; that is, a proportion of 1 to 2·7 of the total number was attacked; whereas the total admissions for chest complaints during the month (minus the seven) to the daily average strength of the regiment (minus daily average nineteen attendants) was about one to thirteen. The attendants attacked were serving bad cases, in all of which there was copious purulent expectoration, and of these seven men, three died. It is also to be noted that these attendants enjoyed an advantage in not being exposed on night duty to undue cold.

I by no means wish to contend that the statement contained in the last paragraph proves anything incontestably, but, so far as facts went, they contributed to support my very strong general impression. In such a limited field coincidence, and not a reliable average, may have been the result. The idea of the infectiousness of the complaint also possessed the men.

In certain jails outbreaks of pneumonic typhus have occurred during typhus periods; and, as has been already mentioned (p. 95), apart from these, the association of outbreaks of pneumonia with contagious diseases such as diphtheria and erysipelas, suggests the probability that the pneumonia also was due to contagion. Civil Surgeons, as those of¹ Mooltán in 1870 and of Lahore,² do not question the infectious nature of the lung disease which occurred in the jails under their charge. The Civil Surgeon (Dr. Gray) of Mooltan, writing regarding the outbreak in that jail in 1875, a year in which pneumonia was very prevalent and very fatal on the Punjaub frontier, says, 'There is nothing in the meteorological phenomena of the year to account for the fact (the prevalency of lung diseases amongst the prisoners), for the present cold season has not been more severe than, if it has been ever as severe as, the previous one; and so far as I can discover, the prisoners have been subjected to no new conditions which can have favoured the production of pneumonia. The theory that pneumonia or pleuropneumonia is infectious would furnish an easy explanation of all the facts of the case. But then is it infectious? I must state that, so far as I can judge, the past year's experience of the disease in the Mooltan jail affords no proof of that doctrine.' The question remains an open one.

¹ Dr Gray's predecessor.

² Quoted in Dr. Bryden's *Report*, p. 174.

CHAPTER XXIII.

UMBALLA—WESTERN JUMNA CANAL.

Umballa and the Western Jumna canal. Description of the Umballa district; city of Umballa, cantonments. Goitre in Umballa district; excessive prevalence in the Munee Majra subdivision; evidence from its history there to the malarial origin of the disease. The *Western Jumna canal*; Colonel Baker's committee; Dr. Dempster's spleen test; Dr. Dempster on malaria. Dr. Adam Taylor's *Report*. Goitre along the head waters of the Western Jumna canal.

UMBALLA. The district of Umballa stretches in a north-westerly direction, for some eighty miles, along the base of the Sub-Himalayas, between the Jumna and the Sutlej. Only at one point does the district occupy any considerable portion of the hills; this is in the Kotaha Pergunnah, an area of about one hundred square miles, which will be presently noticed.

The surface of the district is very flat with a general but imperceptible slope to the south. Near the hills the surface is slightly undulatory, and is broken by the wide beds of the many streams which carry off the drainage of the outer hills. These streams during the rains attain considerable volume, but for the greater part of the year they have a very short course in the plains, the water being either absorbed by the sands or led off for irrigation. One only, the Ghuggur, contains a flow of water throughout the year, and struggles on beyond the southern boundary of the district to lose itself eventually in the sands of Rajpootana. The Ghuggur escapes from the hills as a considerable stream almost due north of the city of Umballa, but the waters are at once consumed so largely for irrigation purposes that, where the stream crosses the trunk road about three miles to the west of that place, its volume is extremely small. The use of this water either for irrigation or drinking is said¹ to cause fever, spleen, and goitre; but this only within the limits of the irrigated area. Dr. Shepherd,² who examined the water taken from a point in the river twenty-

¹ *Settlement Report*.

² *3rd Report on Analysis of Waters of Cantonments of Northern India, 1868.*

one miles north of Umballa, describes it as 'an excellent water in every respect,' very free from organic matter, and containing only 15·16 of total solids in a gallon. The stream at the time (December 21) was fifty feet wide, and about eight inches deep.

The Sutlej, where it forms the north-western boundary of the district, flows in a wide bed in which the stream is constantly changing its course, between banks so deep and abrupt that the native cultivators are unable to make use of the water for the irrigation of their fields; but the works of the Sirhind canal, which is to draw its supply from the river, are now in progress, and when completed will water 783,000 acres of the tract of country between the Sutlej and the Jumna.

The soil of the district is a mixture of sand and clay, more sandy in the southern than in the northern parts. The surface is richly cultivated, the cultivator depending mainly upon the rainfall to water his crops, for wells fail, and irrigation from the streams, owing to their evanescence, is almost confined to the neighbourhood of the Ghuggur. For the spring harvest the crops are chiefly wheat, barley and gram; and for the autumn, rice, millet, Indian corn, cotton and sugar-cane.

The district is fairly wooded, especially in the southern parts, where fine mango groves abound. Along the base of the hills is a scanty jungle, the representative of the Terai forest of more eastern districts, and the slopes are sparsely wooded.

The city of Umballa, population 24,000, is situated on the Grand Trunk Road and Railway, about thirty-five miles west of the Jumna and about twenty-five miles south of the hills; its elevation is 1,026 feet above sea-level. Umballa is an old fortified Punjabi city, brick-built, with narrow irregular streets. Of late years much has been done in the way of cleaning it, and great scarcity of water is now the principal sanitary defect of the city. The country around is an almost level plain, broken only by the course of five or six nullahs, which vary according to the season of the year from dangerous torrents to tiny rivulets, or mere dry sandy channels. The soil is a light sandy loam, and the subsoil, to an unknown depth, alternating beds of sand and clay. There is no canal irrigation in the neighbourhood, and no marshes or swamps; the soil, fertilised by the rainfall, by well irrigation, and by the help of the streams when in flood, yields abundant crops of various kinds of grain besides sugar-cane and cotton. The military cantonment is on the open plain, about four miles to the south-east of the native city. Cultivation approaches it on every side,

but not sufficiently near to be a source of unhealthiness to the troops. The northern end is fairly wooded with mango topes, and trees are planted along the lines; yet the greater part of the area is, like the surrounding country, rather bare of trees. The drainage is into the watercourses, one of which, the Tangri nuddee, touches the cantonment on the east, while the other, the Tangra nuddee, is about a mile distant on the north. The surface water runs readily away, so that the heaviest rainfalls clear off in the course of a few hours.

The water supply of the cantonments till recently (1876) was very defective both in quantity and quality, and was moreover open to pollution owing to its distribution in open, ill-defended channels. The water is now obtained from wells which feed a covered-in reservoir situated about five miles to the north of cantonments; thence it is brought by an aqueduct and the supply is now both ample and of good quality.

In the city the supply is still very scarce, for, owing to the depression of the water-level which has been progressing for some years past, many of the old wells have become permanently dry, and a scanty supply only can be obtained from deep wells supplemented by tanks which are annually replenished by surface drainage. During the hot season water sells in the city at a high price.

The seasons are as a rule very regular; the hot season commences in April and lasts till the end of June, when the rains begin, and continue till September. On the termination of the rains the cold season gradually sets in, and while it lasts the weather is exceedingly pleasant and invigorating. Towards the end of February, or in March, there is usually about a fortnight of rain, and shortly after the hot weather, with its scorching winds and dust storms, commences. During June, which is the hottest month of the year, the thermometer in the shade often registers 105° Fahr. The rainfall at Umballa averages 37 inches, but is considerably greater a little to the north, along the base of the hills.

Diseases. Umballa is reckoned a healthy station for the troops. Fever, which is the principal cause of admission to hospital, is usually of a mild type. Statistics of disease and mortality amongst the native troops and prisoners are given at pp. 88 and 99.

Goitre is not a disease of the district generally. Amongst 99,047 patients treated at the Umballa dispensary, and 35,623 treated at Thanesur, a town twenty-five miles south of Umballa, during five years, only one case of goitre is recorded. But it is

Umballa	Approximate mean of month 1850-56, (Schlagintweit)	1874 ¹									Prevalent direction of the wind	Average rainfall 9 years (Blandford)
		Mean of the month	Mean of maxima	Mean of minima	Mean daily range	Highest of the month	Lowest of the month	Absolute range	Relative humidity	Rainfall		
January .	54.5°	53°	62	45	17	73	37	36	80	1.75	W.	.6
February .	61°	60	70	51	19	77	48	29	57	.1	W.	1.4
March .	69.9	68	78	58	20	92	50	42	56	2.15	W.	1.2
April .	78.4	79	91	67	24	101	60	41	39	—	W.	.8
May .	86.5	90	102	78	24	108	69	39	39	1.12	W.	.9
June .	91.1	88	98	78	20	108	71	37	61	14.4	SE.	4.7
July .	85.8	83	90	77	13	96	73	23	85	15.2	SE.	13.1
August .	85.7	84	90	78	12	97	76	21	76	5.5	SE.	8.3
September .	84.3	81	91	72	19	95	66	29	67	4.9	NW.	5.1
October .	75°	75	90	60	30	95	53	42	53	—	NW.	.2
November .	63.2	63	80	47	33	88	41	47	55	—	NW.	—
December .	56.2	57	70	44	26	76	37	39	61	1.2	NW.	.4
The year.	74.3	73	84	63	21	92	56		60.7	45.3		36.7

prevalent in certain circumscribed localities of the district—thus it is common in the north-east corner near the head of the Western Jumna canal; and since 1870 has prevailed (p. 378) amongst the inhabitants of certain villages lower down in the course of the canal, in the subdivision of Jugadhri. Another very interesting and instructive local development of the disease is found in the subdivision of Munee Majra at the foot of the hills, almost due north of Umballa. We are fortunate in having a full account of goitre in Munee Majra in a report² which the Civil Surgeon (Dr. Bateson) was called on to make in 1868 upon the excessive amount of disease, fever and spleen, in that subdivision.

‘The subdivision³ contains sixty-nine villages, and is irrigated by the Ghuggur river, which meets the villages immediately on its exit from the hills. The lands look very much like an ancient alluvial deposit from the river. The characteristic of the locality is the lowness of the land, so that all the villages can be reached by streams carried along ducts called “kools” from the Ghuggur, and the supply of water from the river is perpetual. The villages are frightfully underpopulated. Fever is extensively prevalent, and every third person has a distended spleen. Goitre also is

¹ Observations very carefully taken in verandah of Military Hospital, British Troops. In calculating the dew-point I ventured to take the mean temperature of the month instead of that of the dry bulb, as a typographical error was apparent in the latter.—F. N. M.

² *Supplement to Punjab Gazette*, February 10, 1870.

³ *Settlement Report*, Lahore 1859.

very prevalent, and cretinism also is common. The people have no heart and no strength.'

The Superintending Engineer of the circle writing in 1874, states his opinion that the prevalence of so much sickness at Munee Majra is due to the abuse of Ghuggur water for irrigation. The soil has become water-logged, owing to a considerable body of water, beyond that needed for good irrigation, being diverted from the river.

Dr. Shepherd analysed the water of the Ghuggur river in December 1870, and, as has already been mentioned, pronounced it an excellent water. But the natives objected that drinking it 'made their skins black,' an opinion on which Dr. Shepherd remarks: 'I opine that the continued presence of malaria rising from the irrigated lands about produces frequent attacks of fever, which may render the skin of the sufferers darker, for he writes, 'I cannot ascribe such an effect to the excellent water of the river.'

The following account of the chief place of the subdivision is from the Report of the Sanitary Commissioner of the Punjab for 1871: 'Visited Munee Majra May 4, a town in the Umballa district, a few miles to the left of the road to Simla, not very far from the foot of the hills, twenty-two miles north of Umballa; population 6,045. A good deal of irrigation from the river Ghuggur, and rice cultivation, occurs in the neighbourhood. It is a wretched-looking country village, all the houses being mud huts, and many of them in a tumble-down state. The streets are irregular, and have no paving or drainage. The town has been cleaned up on account of the cholera which was then prevailing, but heaps of manure and rubbish of all kinds were still lying about everywhere.

'There were only two wells for the population of this town of 6,045 inhabitants, and it is difficult to understand how they can all obtain water from them. There can be no doubt, in fact, that, though I was told the water of the irrigation cuttings was little used by the people, it must be largely used by them. The two wells are large and deep, with masonry shafts, old and rent. The shaft projects about two feet above ground, and forms all the protection which the water has. On this low surrounding wall the people stand in crowds, drawing water; and the washings from their feet flow partly into the puddle which surrounds the well, and partly back into the well itself. The drain from a house near one of the wells discharges itself into the pool which surrounds it.'

Dr. Bateson's account of the villages which he visited and described in the above-mentioned report may be epitomised as follows:—

Mowlee, two miles south of the town of Mune Majra. The village ground is slightly higher than the neighbouring country, the ground all about is cultivated, and is irrigated by 'kools' from the Ghuggur. The drinking water of the place is from a good masonry well. No disease at all was prevalent at the time of Dr. Bateson's visit, but a good deal of fever in the rains; thirteen per cent. of the people suffered from spleen; about twenty-three cases of goitre in the village.

Pubhat, five miles south of Mune Majra, 1,630 inhabitants. This village, like the previous one, is on high ground, but this is the higher of the two, and appears to be upon a ridge. Ground about cultivated and irrigated by 'kools' from the Sookhna, a tributary of the Ghuggur. The people drink from eleven wells; the water in those which are at the bottom of the slope, on which the village is built, is very near the surface. The inhabitants suffer much from fever during the rains, not one house escaping, but at the time of Dr. Bateson's visit they were remarkably fine-looking and healthy, cheerful and happy; very few spleens—seven per cent.; no goitre amongst the natives of the place.

Abhepore, about three miles south of Mune Majra, 393 inhabitants. The village is on the flat. Ground all about cultivated, and irrigated by 'kools' from the Ghuggur—a large one runs close to the village. Further off on the other side the village, about a quarter of a mile distant from it, is the one village well with water forty feet from the surface. Ordinarily the people get their water thence, but owing to the distance and the bad road, which during the rains is impassable, they at that season take their water from the 'kool.' Much fever during the rains, not a house escapes; two and a half per cent. of the people suffered from enlargement of the spleen at the time of Dr. Bateson's visit, and he found eleven cases of goitre in the village.

Kalee Bar, a village on the other side the Sookhna; grounds not irrigated; cultivation dependent on the rains; neither goitre nor spleen in the village.

Bara Ferozepore, three miles south-east of Mune Majra—247 inhabitants. The village is on the flat; lands irrigated by 'kools' from the Ghuggur. The water in the village well is sixty feet from the surface; it quite dries up in the hot season, and nearly overflows during the rains. Something happened to the well years

ago, and anyone who now drinks of it dies ; the people therefore drink the water from the irrigation channels. The miseries and woes of the people are heartrending—no one who can help it stays in the village, the children almost all die young, or grow up deaf and dumb and daft. 'In the rainy season everybody's belly swells with spleen, and men and women and children are disfigured with goitre.'

Munee Majra—6,045 inhabitants. Lands about famous for production of rice, irrigated by 'kools' from the Ghuggur. Fever and spleen rife in the rainy season, about six per cent. of the people with goitre. The people drink from wells, but attribute disease to Ghuggur water : they say, 'according as the Ghuggur water is, so is the amount in their wells.' They also say that when, as was the case for some years, irrigation from the Ghuggur was stopped, the decrease of goitre was notorious ; when the Ghuggur water came again to the town, the disease increased. To cure the disease they send the afflicted away, when they can, to villages out of the influence of the Ghuggur.

Chundee, on the Simla road, seven miles from Kalka. A scattered place consisting of clumps of huts, part of these on the hills, where the people drink from a tank ; part on the plains below, where the people drink from kools ; no wells above or below. No goitre, only one spleen above. Below, both goitre and spleen prevail.

Dura, on the slope of a spur of the Siwaliks, just above Chundee. The land of Dura comprises—that above, rocky and brambly around the village with little soil, cultivation dependent on rain ; and that below irrigated from the Ghuggur. Water for nine months of the year is taken from the village tank, but during the dry season from the kools below ; this water is, however, used as sparingly as possible, for the villagers have learnt that it is dangerous, and they substitute milk so far as they can. There is a good deal of fever and spleen at the end of the rainy season amongst the people, but these affections are temporary only, for at the time of Dr. Bateson's visit they were all healthy, no spleen amongst them and no goitre ; indeed the latter disease is unknown in the place.

In the case then of the Munee Majra subdivision, we are presented with a low-lying tract, at the foot of the hills, the surface of which is maintained by undue irrigation in a semi-waterlogged state. The water which the people drink is mostly taken from open irrigation channels, so that they have every chance of drink-

ing as well as of breathing malaria. Most of the villages suffer frightfully from fever and spleen of undoubtedly malarious origin, and, according to the rule in such circumstances, suffer most during the rains. Where the villages are on elevated sites, and especially where the people can avoid the use of 'kool' water, they suffer comparatively little from the evils which afflict their unfortunate neighbours. The connection of goitre with malarious diseases in these villages is very unequivocal. In one of the villages, Chundee, which has high and low grounds within its boundary, there is little or no goitre or spleen on the high ground, while both together prevail in the low grounds. Throughout the subdivision those diseases are associated, and we find goitre developing and increasing during the rains *pari passu* with splenic disease. At that most miserable place, Bara Ferozepore, where in the rainy season 'everybody's belly is swollen with spleen,' the throats of the women and children become disfigured with goitre.

It cannot be the hardness of the Ghuggur water which causes the goitre, for indeed the water is much softer than that of the wells, nor can it be the Ghuggur water in its natural state which is the cause of the disease, for the water is excellent; but unfortunately, in one way these poor people get too much of a good thing, and hence their miseries. Doubts might be raised whether at Mune Majra, as elsewhere, malaria has a material existence; but there can be no doubt that the artificial conversion of this bit of country into a swamp has made it the wretched place it is, and scarcely can there be less doubt that the conditions which are here the cause of fever and spleen are the cause of the goitre also.

We meet with a precisely similar association of diseases—goitre, spleen, and fever, in the valley which forms a part of the Kotahā Pergunnah of the district. The valley lies to the north-east of Mune Majra, between two ranges of Siwalik hills, and is traversed by the Ghuggur river before it leaves the hills a little above Mune Majra. The valley is irrigated wherever the ground will admit by 'kools' leading from the river, and at higher levels by the water of mountain springs. But disease is limited to the people inhabiting the villages in the low ground which is irrigated by the river, and as at Mune Majra is currently ascribed to the unwholesome properties of the water.

Crossing the Jumna from the Saharanpore district, we enter the region between the river and the western continuation of the Siwalik hills, in which are the head waters of the Western Jumna

Canal, a canal classic to those who are interested in the question of the influence of canal irrigation upon the health of the people, owing to its having been the scene of the labours of the first committee which was appointed to report upon that much-vexed question. Both the report of that committee (Colonel Baker's), and the subsequent one by Dr. Adam Taylor, who went over the same ground, should be studied by anyone who is interested in this subject. However, it is not intended here to do more than to refer to that portion of the first report which will serve to introduce Dr. Dempster's remarks upon the general question of malaria, and the spleen test for malaria; and to so much of the second as bears upon the prevalence of goitre in the country at the foot of the hills, near the west bank of the Jumna river.

The Jumna, where it escapes from the Siwaliks at Kharra Head, flows in a deep bed of boulders and gravel; in the rainy season a prodigious volume of water, but in the dry season a stream of only about one hundred yards in width, discharging some four thousand cubic feet of water per second. During the dry months it occasionally happens that the whole of this water is taken off into the eastern and western canals, bunds being thrown across the bed of the river to effect that object. On the down side of these bunds the bed may be perfectly dry, the water that remains escaping through the shingle bed, yet long before the latitude of Saharunpore is reached, water again appears, and boats are required for the transport of luggage from shore to shore. The boulders and shingle gradually disappear, and about sixteen miles from Kharra Head the river flows through its khadir, on a much reduced slope, in a sandy bed. The khadir on the west of the river extends to a ridge of high ground which runs for some distance parallel with the stream, but near the hills diverges from it, trending in a north-westerly direction to their base, along the western bank of the Somb torrent. This khadir is a most fertile tract, fully under cultivation, and owing to the closeness of the water to the surface, needs no irrigation.

The Western Jumna Canal has its origin from the right bank of the river, at a point about two and a half miles from the foot of the hills, and is carried along the khadir beneath the ridge already spoken of as far as Kurnaul, some sixty miles from the foot of the hills, where it diverges from the river, and enters upon the high land. The canal was to a great extent excavated about the middle of the fourteenth century, and was restored by the British Government in 1823, and developed between that year and 1843. In Sep-

tember 1845, the Government appointed a committee, with Colonel Baker, R.E., as president (now General Sir W. Baker K.C.B.), and Surgeon-Major Dempster, and Lieutenant Yule, R.E. (now Colonel Yule, C.B.) as members, to report on the causes of the unhealthiness which existed at Kurnaul and other portions of the country along the line of the canal, and to report as to whether any injurious effect would be likely to be produced on the health of the people of the Doab by the then contemplated Ganges Canal. In March 1847 the Committee submitted their report. They had travelled about one thousand four hundred miles to-and-fro along the canal and its branches, had visited more than three hundred villages or towns, and had personally examined about twelve thousand inhabitants. The endeavour of the Committee was to ascertain what relation existed between certain physical conditions of different districts and the liability of the inhabitants to miasmatic fever. But at the commencement of their enquiries the Committee were met by the difficulty of obtaining reliable testimony on the latter point. In this difficulty Dr. Dempster suggested that the condition of the spleen in any number of individuals would be a fair test of the probable frequency and degree to which they had suffered from malarious influence, and this test the Committee determined to adopt, and on the results obtained by its use based the most important of the conclusions at which they arrived. Thus was established the test now familiarly known in India as 'Dempster's test,' one which has been of the greatest service in many subsequent enquiries of a nature similar to that which engaged Colonel Baker's committee.

The conclusions to which the Committee came may be briefly summed up as follows. That an extensive epidemic influence had of late years prevailed over a large portion of the North-West Provinces, and especially during and after the rainy season of 1843, and to this the Committee attributed in part the sickness in the canal-irrigated districts. But in their opinion it was also certain that the disease was more generally, though not universally, more prevalent and severe in these districts than in other situations. Yet during the period under consideration there were some localities not at all under the influence of canal irrigation, as for instance the khadir of the Jumna, where fevers prevailed to an extent and with an intensity as great as in the worst of the canal villages. The season of the year at which the fever prevailed, its symptoms, progress, and consequences, marked it everywhere of the same type, viz., the endemic remittent and intermittent fever

of the rainy season, greatly aggravated by the peculiarity or constitution of the period.

By far the greater part of the evils which the Committee observed were not, in their opinion, necessary and unavoidable evils of canal irrigation, for in all situations where mischief was prominently marked, the natural drainage of the country had been checked or interfered with; stiff and retentive soils had been saturated with water, and natural disadvantages of site enhanced by excess of moisture. The effects of canal irrigation, moreover, appeared to be excessively local, restricted probably to a distance of three miles from the site.

The Committee had reason to think that in some localities where well irrigation was habitually practised, the inhabitants were in a slight degree more subject to malarious influences than in totally unirrigated districts. Yet they hesitate in ascribing this difference to the mere circumstance of irrigation, as it might perhaps be due to the abundance of springs, and the limited depth of wells, which are essential conditions to well irrigation. The Committee dwell upon the differences between the circumstances of irrigation by means of wells and by means of canals. Well irrigation is chiefly resorted to during the healthiest season of the year; the water, obtained with labour, is used with economy, and the natural moisture of the soil is not increased by the water being transferred from the lower to the higher stratum.

In connection with the enquiry in which the Committee were engaged, Dr. Dempster found that it would be necessary to meet an argument raised by some people interested in canal irrigation against the doctrine of malaria—an argument based upon the fact that marshes are known which do not to any extraordinary extent cause fever in the neighbourhood; and that on the other hand many very dry localities exist where fevers of a malignant nature abound. Dr. Dempster's reasoning on the subject is quoted almost in full, because it not only meets the objections which he was called upon to reply to, but may be extended to answer the objection that goitre cannot be a disease of malarious origin, as it is very frequently absent in localities where other malarious diseases are notoriously rife. Dr. Dempster writes: 'That certain local peculiarities are generally connected as cause and effect with certain diseases of the human body is no hypothesis of any set of medical speculators, but a belief which has forced itself on the conviction of mankind in various ages and countries. What those conditions are which are essential to the production of endemic

diseases, and what are accidentally associated with them, how the poison is evolved, and what are its sensible properties and chemical composition, have indeed furnished ample grounds for medical speculation; but the general proposition itself is as fair and legitimate an induction from observed facts as any within the whole range of science.

‘Exceptions do not confirm a rule, but neither do they overturn a fair induction; they only show that our knowledge is incomplete, and the whole law of the case not fully understood. If in the exact sciences residual phenomena are constantly recurring; something happening which was unlooked for; something expected which does not take place; how much more may they be anticipated in such a science as medicine, where the sources of every error are at once so numerous and perplexing?’

‘Mankind, not physicians alone, have agreed that typhus fever is a highly contagious disease. Suppose (which would not be difficult) that I collect a dozen authentic cases of persons who have freely exposed themselves to this contagion, and who notwithstanding entirely escaped the disease, am I therefore to shut my eyes to the thousands of instances in which the complaint was communicated under like circumstances, and to reject the whole doctrine of contagion as untenable? Surely this would be generally condemned as a dangerous and inexcusable error. The human race have at least as deep a concern in the laws of malaria as in those of contagion.

‘It is a remarkable and most important fact, that the diseases believed to arise from malaria are, beyond all comparison, more prevalent during and immediately after the periodical rains in India than at any other season of the year; and that this is precisely the time when the conditions everywhere alleged to be necessary to the production of that poison are also beyond all comparison most abundant. At some places there may be more, at others less; in some years more and in others less; but the truth of the general remark may be verified in this country at all places and in all years.

‘When we remember the feeble affinities which hold together the constituents of vegetable matters, the numerous and totally dissimilar combinations into which they enter, and the seemingly trifling accidental circumstances which may determine the nature of the new compound, it is not unreasonable to believe that a *something* capable of causing human disease may be evolved during the decomposition of such substances, under the action of

heat, moisture, and electricity; or to conceive that inappreciable or at least unnoticed modifications of these conditions, or of the chemical state of neighbouring bodies, may alter the nature of the expected product, and obstruct the formation of the poison when most confidently looked for. For instance, we may make all the usual arrangements for vinous fermentation; an unexpected and unobserved change takes place in the temperature or electric condition of the atmosphere, and vinegar, not wine, is the result. Is malaria alone to be a constant and unvarying product of such complex operations, even though all the ordinary conditions are apparently present?

‘Again, if we admit that a certain class of fevers arise from malaria, does it necessarily follow that all endemic fevers must originate in the same cause? or that all malaria is necessarily one and the same? or who has demonstrated that malaria may not be evolved under several, and very different, apparent conditions?’

‘All I contend for is that the question be tried and decided by the facts strictly bearing on the one before us, and not by a few exceptions, however striking or inexplicable, found in other distant situations or countries.’ With reference to the difficulty which met the Committee in their attempts to decide the salubrity or otherwise of various districts, it occurred to Dr. Dempster ‘that the native inhabitants of malarious districts often carry in their own persons a record of past suffering which can at all times be easily read, and which no one can falsify or suppress, viz. the enlargement of the spleen—a disease to which the native of India is peculiarly liable, and which if not the invariable consequence of miasmatic fever, is so constantly associated with it that the one may be (on the large scale) safely taken as the measure of the other; or at least of that malaria from which both unquestionably spring.’ In support of his view, Dr. Dempster adduces the chief authorities of the day, and then goes on to say:—

‘Although the intimate connection between malarious fever and organic disease of the spleen is established beyond a doubt, it never was supposed that these diseases bear an exact proportion to each other, or that the number of enlarged spleens in any particular situation should correspond precisely with the number of attacks of fever suffered by its inhabitants. Many fevers occur (especially if the attacks have been slight, and not often repeated) without being followed by enlargement of the spleen, and many tumid or slightly enlarged spleens become natural in size and structure soon after the fever has passed off. On the other hand,

the spleen may become enlarged from other causes, and in persons who have had no distinctly developed paroxysm of fever, although living in a malarious locality. Such cases, however, according to my experience, are comparatively rare.' 'It must not, however, be supposed that this disease exists *everywhere* to a considerable extent among the inhabitants of the North-West Provinces. Places in close proximity, but in otherwise different local circumstances, exhibit the most wonderful differences in this respect, and in some extensive tracts of country the complaint is scarcely to be met with. On the other hand it is important to guard against exaggerated notions of the physical condition of the inhabitants of certain situations where so large a proportion are affected with this description of organic disease. Enlargement of the spleen is the least formidable of all organic diseases of the viscera, and is chiefly important as a symbol of another complaint, which has generally preceded, and may come after it. The lesser varieties may consist with every outward appearance of health and vigour. In some places where the disease is most common, some strikingly healthy-looking men and children were found with decided enlargement of the spleen.' 'I have no wish to exaggerate the value of the spleen test, nor do I venture to assert that it will indicate the presence of the remote causes of *all fevers*, or even of all pure endemic diseases of this class. There may be different kinds of malaria, giving rise to forms of different types and having different complications and consequences, but from what I have lately witnessed I am fully persuaded that it will be found a true and faithful comparative measure of marsh malaria in its extended sense, and with that alone canals and canal irrigation have any proper connection.' Dr. Dempster goes on to notice that while without the walls of Delhi, and especially in the low khadir lands in the immediate neighbourhood, the test at once pointed out malaria in its highest intensity, within the walls and especially in the most dense and crowded quarters, comparatively few indications of malarious disease presented themselves. But, continues Dr. Dempster, 'this accords with what has often been remarked in other countries, viz. that the high walls, and narrow, crowded, smoky streets of great cities are frequently a safeguard against marsh miasm, even though other causes of disease may abound in such situations.'

In August 1867 Dr. Adam Taylor, of the Indian Medical Service, was directed to make another sanitary survey of the villages irrigated by the Western Jumna Canal. His report, a

very full and interesting one, was published in No. 6 of the 'Selections from the Records of the Government of the Punjaub.' However, far the greater portion of it deals with villages situated below the point where goitre ceases to be prevalent, and it will therefore be quoted here only so far as it bears on the subject in hand. Still it may be well to record Dr. Taylor's opinion as to the value of the spleen test. He says: 'I believe the test to possess nicety and accuracy; I adopted it when I commenced my enquiries, and the experience I obtained by the work I performed has quite assured me that I was correct in my choice. I found, it is true, that in many villages the results obtained were not precisely such as were anticipated; but I believe that when I was unable to account exactly for the immunity from, or prevalence of splenic enlargement, it was not the test that was at fault, but my imperfect powers of observation that led to the discrepancy; in most cases a careful examination showed that I had overlooked some important feature in the situation or condition of the villages which accounted for the result at first unexpected. I invariably found that stagnant swamps with reeds, vegetation in abundance, a spring level near the surface, extensive flooding by irrigation such as is used in rice cultivation, produced pallor of complexion, languor and depression of manner, stunted and shrivelled forms in the inhabitants of the villages in close proximity; that *there* also were the complaints of fever most loud, and the percentage of spleen disease highest. Moreover, these observations applied not only to irrigated districts, but also to unirrigated.'

Dr. Taylor states that the wells which supplied drinking water were in many of the villages in a filthy state, often excavated in hollows, or in clayey ground, in which the water spilt in washing utensils &c. lay and putrefied, causing an unbearable stench. Many of the wells too were spoiled, the water brackish, owing to contamination by 'Reh' salts. Yet the natives prefer the well water, dirty though it be, and holding in solution, as Dr. Taylor believes, the paludal poison, to canal water, ascribing the ills which they suffer to the use of the latter, knowing or considering only the effects which its imbibition can produce. On this part of Dr. Taylor's report, Dr. de Renzy, the Sanitary Commissioner for the province, remarks: 'If the salts of the soil, the reh, are carried in solution into the drinking water, there can be no doubt that any malaria which it may contain must also be carried by the same vehicle, for malaria is beyond all question capable of being held in solution or suspension in water.'

Dr. Taylor considers that the returns which he collected prove that canal irrigation produces disease exactly in the proportion in which natural conditions of locality, soil, &c. prevent the land from getting rid of the excess of moisture which may be brought by irrigation, or to the degree¹ in which the canal or its watercourses impede the natural drainage of the country, and thus prevent the land from ridding itself of the water brought on its surface, whether that be artificially as by irrigation, or naturally as by rainfall.

Dr. Taylor states that goitre is very common about the head waters of the canal; here the canal runs down a rather steep incline, and resembles in fact a river with a rapid stream and pebbly bed. The irrigation is but slight, the drainage of the country good, the water in the wells some distance from the surface, the soil sandy, and the water in the canal some distance below the level of the ground. Below Dadopore, a village about eight miles from the foot of the hills, in the khadir between the canal and the river, goitre is, according to Dr. Taylor, very rare. But perusal of Dr. Taylor's report shows that the district above Dadopore, where goitre is very prevalent, is only by comparison a healthy one. Thus, taking the statistics of four of the villages which the report gives; at Khiderabad, in the undulating country at the foot of the hills, 35 per cent. of the people suffered from fever in 1867, but there was no spleen in the village at the time of Dr. Taylor's visit; at a neighbouring village 7·5 per cent. of the people had spleen, 20 per cent. suffered from fever in 1867; at Choochurpore, two miles south of Khiderabad, 7·5 per cent. of the people had spleen, 40 per cent. suffered from fever; at Goo abghur, close to Choochurpore, 15 per cent. of the people suffered from spleen, 50 per cent. from fever; and at Dadopore, eight miles south of Khiderabad, 12·5 per cent. of the people suffered from spleen, 40 per cent. from fever.

From two to seven miles south of Dadopore on the high bank just above the canal is situated a group of villages, the inhabitants of which suffered a good deal from spleen and fever. In one village, Dealghur, six miles south of Dadopore, 25 per cent. of the people had spleen, and 45 per cent. suffered from fever, in 1867. Not far from Dealghur, about a mile or so north of it, is the large native town of Jugadhri, the centre of the subdivision in which the group of villages just mentioned is situated. Here there is a dispensary, and a remarkable and very instructive fact,

¹ Page 33 of the *Report*.

mentioned by the native medical officer in charge, is, that since 1870 goitre has prevailed endemically in certain villages of the Jugadhri subdivision, lying on the Jumna Canal, and he gives the following as the number of cases treated at the dispensary during five years :—

	Total cases	Goitre cases
1869 . . .	10,379	12
1870 . . .	9079	240
1871 . . .	7705	514
1872 . . .	8178	387
1873 . . .	8255	528

CHAPTER XXIV.

SIMLA STATES AND SIMLA.

Simla and the neighbouring hill stations. Districts of *Bussahir*, *Lahoul*, *Spiti*, *Kooloo*. *Simla* district and sanitarium; geology, climate, diseases. *Dugshaie*, *Subathoo*, *Kussowlie*. Goitre in the *Simla* district. *Bussahir*. Comparison of medical topography and climate of the districts of *Kooloo*, *Lahoul*, and *Spiti*, and inference therefrom as to the malarial origin of goitre.

BEYOND the north-eastern frontier of the Umballa district is a mountainous tract of country which lies between the Tonse river and the Sutlej, and is mainly occupied by a group of small native states in the midst of which lies the *Simla* district. This district is very small, consisting of several plots of territory which together aggregate only eighteen square miles, with a population of 33,995 souls; but it includes the important hill station of *Simla*, neighbouring upon which are other hill stations, viz. *Dugshaie*, *Subathoo*, and *Kussowlie*.

The watershed between the rivers just mentioned is a great chain of the Himalayas which traverses the *Simla* states in a direction from north-east to south-west. Some few miles north-east of *Simla* this range breaks up into two main branches, one of which follows the line of the Sutlej, here flowing to the north-west, while the other continues in a south-easterly direction to the neighbourhood of *Subathoo* where it strikes the Sub-Himalayan system. It is on this branch of the range that *Simla* is situated. Twenty-five miles south-east of *Simla* is the great *Chor* mountain (11,982 feet) with spurs radiating from it which to the north connect it with the *Simla* range; these *Chor* mountains form a secondary watershed which divides the drainage of the *Giri* and the *Tonse*, both tributaries of the *Jumna*.

The ridge on which *Simla* is built runs east and west, in a crescentic form open to the south. To the east the ridge culminates in the massive peak of *Jako* (8,100 feet), and to the west in another peak of inferior height which is known as *Prospect Hill*.

Close to the western base of Jako the ridge gives off a spur to the north which is known as Elysium; another spur runs eastwards from Jako connecting the hill with the Muhassoo ridge, five miles distant. The latter, more lofty than Jako, runs from south-west to north-east, and shuts off from Simla in that direction the view of the Snowy range. The principal road from the plains enters the station at its west end, runs along the ridge, and makes the circuit of Jako, about five miles, from 500 to 1,000 feet below the summit of the peak.

The bazaar or native town is situated pretty centrally in the station, on the south side of the ridge at the western base of Jako. The houses of the European residents are distributed at elevations varying from 6,800 to 8,000 feet round the skirts of Jako, along the ridge to Prospect Hill, on the Elysium spur, and on other minor spurs which are given off from the ridge.

Simla communicates with the plains at Kalka by two roads—one the old road, a bridle path viâ Kussowlie, 40 miles in length, and the other the new road, a fine broad cart road, 54 miles in length. In a direct line Simla is 22 miles distant from Kalka.

Between the plains and Simla the hills are almost devoid of trees, and the change is very remarkable when, after making the last ascent on the old road, the traveller finds himself under the shade of the beautiful forest of pine, oak, and rhododendron which crowns the ridge and covers the broader parts of the range, especially the northern slopes, stretching down in many places 2,000 feet to the bottom of the valleys, and extending upwards upon the sides of Jako, covering all but the very summit of the hill.

The views from Simla are very fine. The valleys immediately north and south are beautifully wooded; across the latter the Kussowlie and Subathoo hills appear close at hand, while beyond these the plains of Umballa are on a clear day distinctly visible. To the south-east is the great Chor mountain. To the east the Muhassoo ridge, clothed with Deodar forest, confines the view, but to the north are seen the ranges on the other side the Sutlej valley, covered with dense forest, and backed in the distance by the peaks of the Snowy range.

As regards the geological formation¹ of the Simla hill, the lower strata are of Simla slate (Infra Blaini), an indurated shale; above this is found grit, conglomerate, and limestone (Blaini); and again, above these, thoroughly foliated metamorphic rocks (con-

¹ Medlicott, in *Geological Survey of India*, vol. iii.; *Manual of Indian Geology*, p. 605; see also Chap. i.

verted Infra Król, shales, and flags); mica schist predominates on Jako, siliceous elsewhere—these are traversed by large seams and veins of quartz. The surface is covered with a very fertile soil, composed of decayed vegetable matter mixed with débris of the outer rocks. It supports, besides the forest, a dense undergrowth of rank jungle which keeps the surface constantly damp. Were it not for this surface soil and the vegetation, the sides of the hills, even during the rains, would retain but little moisture, for, owing to their steepness, water refuses to lodge, and the drainage is quickly removed by the watercourses which run at the bottom of each of the numerous ravines. But though the natural drainage is good, the arrangements for the removal of the sewage of the now densely populated and overgrown station are utterly ineffective, and the more so as the scanty supply of water which the station possesses renders it quite impossible to flush the drains effectually. Both the drainage and the water supply of Simla have been over and over again condemned,¹ but at length an outbreak of cholera led to the appointment of a committee in September 1875, to inquire into the sanitary defects of the station and to recommend measures for their removal. The now scanty and dirty watercourses will be superseded by an abundant supply from a gathering ground fed by several perennial springs which has been taken up in the territory of the Rána of Koti to the north-east of Simla. The water will be led in iron pipes to reservoirs in or near Simla, and from these will be distributed in pipes over the main roads of the station. The drainage and conservancy of the whole station, and especially of the now filthy and overcrowded native portion, will be remodelled, and then Simla, it may be confidently hoped, will again become the wholesome place that it was during the early years of its history, and which by climate and natural situation it ought to be.

The following table gives the results of analyses of some of the waters which were made by the chemical examiner to Government during the epidemic of 1875; it sufficiently indicates both the natural purity of the water, and the excessive contamination to which it is subjected.

Climate. The first three months of the year are cold, damp, and showery; snow may fall heavily in January and February. Spring cannot be said to begin till April, when the days become warm and bright, though the nights are still cold. Thence on-

¹ See especially the successive *Annual Reports* of Dr. De Renzy, Sanitary Officer to the Government of the Punjaub.

	Sources				
	Chota Chelsea reservoir	General Roberts' reservoir	Combermere bridge reservoir	Governor-General's reservoir	Boileau Ganj reservoir
Total hardness	2·9°	2·9	2·9	1·95	1·65
Permanent hardness	1·5	2·2	1·35	1·3	0·75
Total solids, grains per gallon	12·6	14·7	10·08	9·8	9·1
Volatile organic matter, grains per gallon	·7	·35	·7	·7	·7
Chlorides, as NaCl, grains per gallon	·84	1·4	·98	1·4	2·8
Free ammonia, grains per gallon	·021	·0245	·021	·014	·0525
Albuminoid ammonia, grains per gallon	·028	·028	·042	·028	·028
Amount of oxygen, grains for easily oxidisable matter, per gallon	·00028	·00098	·00098	·00098	·00098
Amount of oxygen, grains for less easily oxidisable matter, per gallon	·00398	·00448	·00378	·00448	·00238
Reaction	Alkaline	Alkaline	Alkaline	Alkaline	Alkaline
Physical quality	Good	Good	Good	Good	Good

wards till the beginning of the rains, that is till towards the end of June, the weather is on the whole warm yet changeable; at times it may be cold and damp, with thick mists and heavy storms, at others sultry and oppressive, but the heat of the summer is moderated by the moist exhalations from the thickly wooded surface and by the shelter which the trees afford. The rains last, with occasional interruptions which rarely exceed a week, till the middle of September; in July and August the downfall is very heavy and continuous. The annual fall averages 63 inches. At this season the atmosphere is almost saturated with moisture, and dense fogs and clouds load the air and often envelope the station. Towards the end of September the cold season sets in, the morning air becomes cold and bracing, and the atmosphere dry, clear, and bright. The following three months is the most pleasant and invigorating time of the year at Simla, and it is then that invalids who can endure the cold, which is never very severe, may expect most positive benefit from the climate. For the rest of the year the most that can be said for the sanitarium is that it affords relief from the oppressive heat of the plains.

The Table XVIII. in Appendix of Meteorological Elements is from the official reports for 1875 and 1876.

Diseases. The plague of Simla is the hill diarrhœa, which more or less affects the majority of those who visit the station

during the rainy season. Dr. A. Grant ('Indian Annals of Medicine,' October 1853) finds the cause of the disease in malaria diluted or changed by the effects of elevation, cold, and excessive moisture. This indirectly may be so, but it is probable that more direct causes of the disease are to be found in the damp chilly atmosphere of the rains, and in the foulness of the drinking water.

Intermittent fever of a mild type is not uncommon amongst the visitors during the rainy season, and cases of a more severe type often occur amongst natives in the bazaar. In 1875 both cholera and fever caused considerable mortality in the station, and it was the extreme unhealthiness of this year which led to the appointment of the committee which has already been mentioned. The following tables show the mortality at the station during the years 1874-1877 :—

Average population of the Sanitarium 14,848.

DEATHS.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1874	10	8	11	7	10	10	9	15	5	13	11	8
1875	5	8	8	14	34	36	154	58	20	24	11	8
1876	7	6	14	24	16	29	32	19	30	16	18	17

DEATHS PER 1,000 OF POPULATION.

	Cholera	Small-pox	Fevers	Bowel complaints	All causes
1873	—	·13	2·49	1·48	10·
1874	·13	·27	2·69	·6	8·
1875	9·5	·14	6·26	2·02	25·
1876	—	·40	4·98	2·09	15
1877	—	—	5·5	1·5	14

DEATHS FROM FEVER PER MONTH.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1874	3	3	2	4	2	4	4	6	—	3	5	4
1875	3	2	2	6	8	16	14	15	8	10	3	6
1876	4	2	5	12	5	4	13	6	·9	7	2	5

Goitre, leprosy, and stone are common amongst the inhabitants of the hills about Simla.

Between Simla and the plains are situated the stations of Subathoo, Dugshaie, and Kussowlie, the two former of which are elevation of 6,400 feet on the ridge and northern slope of the hill, purely military stations for European troops, while the latter is a

convalescent dépôt for European troops, and also a small civil station and sanitarium.

Dugshaie, on the new road between Kalka and Simla, is situated on a rocky and almost treeless hill, which rises abruptly to a height of about 6,100 feet above the sea-level. Geologically, the hill is entirely made up of the red clays and hard purplish sandstones of the Middle Sirmoor group of tertiaries. The station is freely exposed all round to the winds, and the climate is on the whole an excellent one for British troops, though the heat in summer is sometimes oppressive, the atmosphere during the rains steamy and relaxing, and the cold of winter somewhat piercing. The mean temperature for each month of the year is given as follows by Messrs. Schlagintweit:—

January	39°	August	68
February	54	September	67
March	58	October	64
April	63	November	57
May	69	December	47
June	74	The year	61
July	69		

In 1874 the mean temperature of the months (December not noted) ran as follows,¹ 43°, 47, 53, 68, 76, 73, 67, 69, 68, 65, 66. The lowest temperature recorded in 1874 was 20° in January; the highest 88° in May.

The water-supply is derived from an excellent and abundant spring, which emerges from the hill at some distance below the station; but owing to the labour and expense of carrying the water thence to the barracks the supply is limited to four gallons per man per diem for all purposes. (For an analysis of the water, see p. 38).

Hill diarrhœa is very prevalent during the rains amongst the troops stationed at Dugshaie. It most commonly attacks, and assumes the most severe shape, amongst those of the men whose health has been impaired by the malaria of the plains. Diseases of the respiratory organs also are prevalent in the cold season.

Kussowlie is a little under twenty miles in a direct line from Simla, and about five miles west of Dugshaie, the new road to Simla winding upwards through the depression between the hills on which these two stations are respectively situated. The old road to Simla passes through the station, rising sharply up to it from the starting point at Kalka. The station is situated at an elevation of 6,400 feet on the ridge and northern slope of the hill,

¹ *Army Medical Report.*

and as this is isolated and overtops the others between it and the plains, the view in that direction is a very extensive one. To the north the slope is more gradual, and the face of the hill on this side is covered with an open forest of fir trees. On the Kussowlie ridge the red clays of the Dugshaie hill are wanting, and we here find some 600 to 800 feet of sandstone, with only occasional partings of grey sandy shale in which the leaves of plants are locally abundant.¹ The surface soil is open and porous. The climate of Kussowlie is in the main a temperate and agreeable one; fogs and clouds are not so common as at Simla. January, February, and March are cold months, with a good deal of wind and occasional falls of snow; April, May, and June are warm; and October, November, and December are cold, fine, and bracing. The rainfall averages 72 inches annually, the mean temperature is given as follows by Messrs. Schlagintweit:—

January	39·6°	August	65·9
February	39·6	September	66·1
March	54·8	October	61·1
April	54·2	November	53·8
May	64·2	December	45·6
June	69·3	The year	56·8
July	67·2		

The water supply is excellent in quality, and the yield of the springs is abundant, but unfortunately the main spring is 1,000 feet below the station on the north side of the hill, while the ‘Sappers and Miners’ spring’ is some way down the Kalka road.²

Kussowlie is a dépôt for convalescents from the European regiments stationed in the plains. Hill diarrhœa is very prevalent amongst them and the other residents during the rains; rheumatic affections are also very common.

The climate of both Kussowlie and Dugshaie is very beneficial to patients suffering from the malaria of the plains, but it does not suit patients suffering from liver or bowel complaints, or from respiratory diseases.

The Sanitary Report of the Army Medical Department for 1871 includes an excellent paper by Dr. Corban on Indian hill climates, their uses and abuses. This paper seems to have been written with special reference to the Kussowlie climate, and the conclusions arrived at by Dr. Corban are summed up as follows.

1. Indian hill climates are eminently curative in nearly all Indian diseases: they are by far more genial and equable than any English military station.

¹ *Manual of Indian Geology*, p. 532.

² Analyses at p. 38.

2. Invalids who die at our Indian sanitarium are generally men who could not recover in any climate.

3. It is not desirable to prohibit the practice of sending to the hills men who require change to England, as another hot season in the plains may be too much for them.

4. Hill climates must have time to act. The longer a soldier has been in the plains, the greater time he should remain in the hills. We never think of sending a broken-down man to England for six months only; and putting the reviving influence of 'going home' out of the question, a well-selected hill climate will bring round the enfeebled soldier as soon, if not sooner, than any to be found in the United Kingdom. Finally, we have in the Himalayas, Aravallis, and Neilgherries, climates that would be highly prized if they existed in or near England; why then should so many lives be yearly wasted in India by delaying to avail ourselves of them?

Subathoo. The station is situated in the valley to the north of, and beneath the Kussowlie hill, about five miles in a straight line from that station, the Ghumber river flowing in the hollow between them. The site of the cantonments is the crest of a low ridge (4,200 feet) which runs down into the valley from the Dugshaie hill. There is a good deal of rice and other cultivation in the valley, but the site of the station is almost destitute of trees, and the surrounding hills are mostly bare and uninteresting. The water supply is derived partly from springs and partly from wells. The drinking water for the troops was formerly taken from open cisterns fed by springs, and both in the cisterns and at the source was very open to pollution; cisterns, aqueducts, and springs are now carefully covered, and there seems no reason to think that the water from these sources is otherwise than wholesome. Unfortunately so satisfactory an account cannot be given of the wells, the water from which is also used.

Geologically the site of the station is made up of the soft calcareous clay characteristic of the nummulitic group (Subathoo) of tertiaries, together with the red clays of a more recent (Dugshaie) group, and slaty flags of pre-tertiary times.

Climate. Sunk as Subathoo is in a deep valley, the climate is both milder and more equable than that of the neighbouring hill stations. The heat in May and June is often considerable, the thermometer for weeks together registering upwards of 90° during the day in private houses; and the high temperature, with a still atmosphere, often renders the heat, especially in the evening, very

oppressive. The following table is compiled from the MS. reports for 1872, 1873, 1874 of the Army Medical Department.

Average of three years.

	Mean temperature	Mean of maxima	Mean of minima
January	52·3°	57°	48°
February	54·3	59	50
March	61	66	57
April	72·	76	68
May	75	80	71
June	82	86	78
July	75	77	76
August	75	77	72
September	74	75	69
October	67	71	64
November	60	64	57
December	48	59	49
The year	67	71	63

Highest temperature registered 97° in June. Lowest 31° in January.

Bowel complaints, rheumatism, and respiratory diseases are decidedly less prevalent at Subathoo than at Kussowlie or Dugshaie, and the climate favours the recovery of patients coming from the plains with disease of those classes.

The troops stationed at Subathoo have at times suffered fearfully from cholera, and the station has the character of being the least healthy of the Himalayan hill stations. During the year 1877, 17 cases of enteric fever occurred amongst the European troops stationed there,¹ and the men generally were described as pale and anæmic, with an appearance very unlike what British soldiers should present after eighteen months' residence in a hill station on the Himalayas.

Goitre is very common in the villages amongst the Simla hills, but it is not associated with cretinism; indeed the people are a hardy, muscular race, and very enduring, though they live upon food of the poorest and coarsest kind, and are very dirty in their habits. At Simla during the five years ending 1873, 4·4 per cent. of the cases treated at the dispensary were for this disease. During the same period 5·2 per cent. of the cases treated at the Kussowlie dispensary were for goitre. Dr. Mackinnon, who was officiating as Civil Surgeon during 1872, states that the disease is endemic in all the villages about Kussowlie, especially in those situated at low elevations, and that the people suffer much from

¹ *Report*, p. 23, of Sanitary Commissioner with the Government of India.

remittent and intermittent fevers, and from venereal disease. At the foot of the Kussowlie hills, between them and the parallel range of Sub-Himalayas, is the Pinjore Doon, which belongs to the Nalaghur state. This is a well-cultivated valley, watered by many streams, which run in one direction into the Ghuggur and in the other into the Sutlej. Malarious disorders and goitre are common in the valley. The natives believe that goitre is caused by the water they drink. They say,¹ 'if you take water from a spring coming out of the surface of the ground you will certainly get goitre, but if you drink water from a deep well you will avoid it.' The rainy season is the time of year when the people chiefly suffer from the disease.

Bussahir. This, the largest of the group of native states which adjoin Simla, has an area of about 3,000 square miles; it lies to the north-east of Simla, and stretches away in an easterly direction to the confines of Chinese Tartary. On the south it is bounded by Gurhwal, and on the north by the British district of Spiti. The country is chiefly a maze of mountains, separated by deep glens which hardly deserve the name of valleys, and only here and there an inconsiderable spot of level ground can be discovered. Through the centre of the country flows the Sutlej, receiving in its course many tributaries large and small. The climate varies from the tropical character and heat of the deep Sutlej valley, where the bamboo and tropical fruits thrive, to that of the regions of perpetual snow. The southern portion of the district comes within the influence of the periodical rains of Hindustan, and the rainfall is in some places very heavy. Vegetation flourishes at an elevation which appears to be without parallel elsewhere; thus we find one of the bamboo tribe growing at a height of 10,000 feet; grapes ripening at 9,000; the mountain ash and sweetbriar flourish at heights between ten and twelve thousand feet, and wheat and barley are cultivated up to a height of 13,000 feet.

The inhabitants, a hardy race of mountaineers, are for the most part Hindoos, yet they form a transition step between the Hindoos of the plains and the Mongolian inhabitants of central Asia. As to their diseases, the only account on record is that they, like their neighbours of Gurhwal, suffer much from goitre. The late Dr. Stoliczka, writing in 1872 of these regions, says, 'goitre is prevalent in all the valleys leading into the Sutlej, but as soon as you cross the Bhabar Pass into the Spiti valley there is not one case to be observed. Now the whole of the rocks in the Sutlej

¹ *Special Report* by Dr. Dickson, Civil Surgeon of Nalaghur, 1872.

valley, as far as the frontier at Shipki, consist of gneissous and other metamorphic rocks, while all the rocks in the Spiti valley are limestone or calcareous shales.' This observation of Dr. Stoliczka is of importance because it decides against the necessary connection of goitre with a limestone region; and we shall presently see what is the probable explanation of the contrast which Dr. Stoliczka draws.

To the north of Bussahir lies the district of *Kooloo*, embracing the sub-districts of *Lahoul*, *Spiti*, and *Kooloo* proper.¹ The whole forms a tract of country some 6,000 miles in area, which stretches away from the right bank of the Sutlej, where that river bounds the Simla states, to the southern boundary of Ladakh, which is here formed by the Bara Lacha chain of the Himalayas. Ranges of mountains of vast height separate Lahoul, Spiti, and Kooloo from one another and from the neighbouring countries; only to the south-west does a diminution in the height of the mountain ranges leave the country comparatively open towards the plains of the Punjab. Kooloo, the south-western of the three districts, is drained by the Beas; Lahool, the most northern of the three, by the Chundra Bagha (or Chenaub); and Spiti, which lies to the east, by a river of the same name, a feeder of the Sutlej.

Kooloo has an area of nearly 2,000 square miles, but with the exception of small portions the whole of the country is waste and unculturable. The highest villages are some 9,000 feet above the sea, and the average level of the cultivated and inhabited part is probably not less than 5,000 feet. The country is a maze of mountains, the lower slopes of which are here and there dotted with villages. The garden of Kooloo is the valley of the Beas, for here the mountains stand back on either side a distance of one or two miles, and fine plateaus, carefully cultivated, run down with a gentle slope from their base to the banks of the river. Extensive forests cover a large portion of the hill sides; the trees which most commonly occur are pines, oaks, horse-chestnuts, rhododendrons, birches, and maple. Irrigation is carried on to a very considerable extent, and all the irrigated land is devoted to growing rice, which is the chief crop of the district; the other crops consist of wheat, barley, maize, millets, poppy, and tobacco. Almost every description of grain, however, grows to perfection where circumstances permit of its cultivation. The aspect of the country when all the rice has

¹ *Settlement Report* by J. B. Lyall, Esq., C.S., Settlement Officer, Lahore, 1876. *Kooloo, Lahoul, and Spiti*, by Captain Harcourt, late Deputy Commissioner of the District. W. H. Allen & Co., London, 1871.

been planted out is said to be very striking; the enormous extent of vivid green being peculiarly beautiful (Harcourt).

The inhabitants are a strong active race of mixed Mongolian and Hindoo origin. The climate, in the inhabited parts, is equable and agreeable; the spring and summer seasons are genial and pleasant, and hot winds are unknown, but in July and August the weather is often for days together sultry and oppressive. The rainfall over the whole district averages about 40 inches, but it varies much in different parts; in some valleys the fall being exceptionally heavy. In winter snow falls heavily over a great part of the district, but it has all melted away, except at the greater elevations, by the beginning of March. The mean temperature of Sultanpore, the capital, in the Beas valley, 4,000 feet above sea-level, and one of the hottest places in the country, is given as follows by Messrs. Schlagintweit:—

May	70·3°	September	70·8
June	72·7	October	58·9
July	75·2	November	55·6
August	78·1		

Kooloo, says Mr. Lyall, does not appear to have a healthy climate. Intermittent fevers and bowel complaints are very prevalent, and every now and then contagious fevers of a very bad type, together with cholera, are rife and cause considerable havoc. Goitre is common in a few localities, and half-witted or deaf-and-dumb people are not uncommonly met with. Capt. Harcourt in his work mentions that bronchocele and scrofula are but too prevalent in this district. The men of the upper villages consider themselves safe from illness so long as they can stay there, and at certain times of the year they can scarcely be induced to go down into the lower valleys. 'A good deal of the sickness, however, might no doubt be avoided if more cleanly habits of living were adopted; but there is a rankness of vegetation and dampness of soil which, combined with a hot sun, will always prevent the country from being a healthy one.'

Lahoul has an area of about 2,000 square miles, and presents considerably less cultivation than even Kooloo; the forest land, too, is but of small area, the principal trees being pines, which here and there thinly cover the slopes above the villages, while higher up may be found patches of birchwood. The general elevation of the cultivated and inhabited part is about 10,000 feet. The scenery, writes Mr. Lyall, is almost oppressive from its wild and desolate grandeur, for the villages and cultivated lands are but mere specks

on the vast mountain slopes. Irrigation is practised wherever it is possible, and the crops, which are chiefly wheat, barley, and buckwheat, are wholly dependent on it, for without irrigation the land is almost barren. The people are chiefly Tibetans, a hardy race, but they are becoming Hindooised by contact with the inhabitants of Kooloo. The climate, as might be expected from the more northern latitude of the country and its greater elevation, is far more rigorous than that of Kooloo. Spring does not commence till the middle of April, and snow lies in the upper valleys till late in that month. Frost sets in towards the close of September, and from January till April the whole surface of the country is buried in snow. The influence of the monsoon is hardly felt; in July and August there are a good many showers of rain in the lower part of Lahoul; but generally speaking there is almost unbroken fine cloudless weather in the summer half of the year, and indeed up till January, when the heavy falls of snow commence. The temperature at Kardong, elevation 10,242 feet, is given as follows by Messrs. Schlagintweit:—

January	24°	July	63
February	36	August	60
March	44	September	52
April	47	October	46
May	49	November	37
June	54	December	27

‘No better place than Kardong,’ writes Mr. Lyall, ‘could have been selected to show the average temperature of the inhabited part of Lahoul, though the extremes registered are very great.’

‘The climate,’ writes Captain Harcourt, ‘is on the whole singularly dry and bracing. The winds, summer and winter, both here and in Spiti, are very bitter, so much so that if the hands and face are left exposed they become chapped and abraded by the fury of the gale as if they were cut by a penknife. The air is very dry and pure, and dried meat will keep for any number of years.’ There is very little sickness of any kind, and Mr. Lyall reports that he has not observed any cases of goitre.

Spiti has an area of over two thousand square miles. Its elevation is even greater than that of Lahoul; that of villages averaging 12,000 feet. There is very little natural vegetation; the hill sides look bare and brown, and with the exception of a few poplar and willow trees in some of the valleys, and a sparse growth of dwarf birch, furze, broom, wild rose, and currant bushes in a few places, there are neither trees nor shrubs in the country. Owing

to the depth of the channels which the rivers have cut in the soft lime and sandstone soil, irrigation can be carried on only from the small streamlets of the upper valleys; hence the cultivation of the country is excessively limited. The people are of almost pure Tibetan race, and are short, well-built mountaineers. As regards climate, the seasons assimilate very much to those of Lahoul, but the rainfall throughout the year is lighter. Messrs. Schlagintweit, quoting Cunningham, give the following as the mean temperature of the Spiti valley, at an elevation of 13,000 feet:—

January	19·2°	July	63·6
February	18·7	August	58·6
March	24·5	September	55·5
April	40·9	October	40·1
May	49·	November	22·8
June	59·5	December	14·3

‘The climate,’ writes Captain Harcourt, ‘is even more bracing than that of Lahoul, and in other respects is also a remarkably healthy one; excepting, indeed, a few simple complaints such as colic or rheumatism, sickness appears to be almost unknown among the people.’ Mr. Lyall says that he saw no cases of goitre or cretinism.

We have seen that the late Dr. Stoliczka, a most observant traveller, contrasts the prevalence of bronchocele in Bussahir, in the valley of the Sutlej, with the absence of the disease in Spiti, and inclines to explain the fact in a manner which singularly differs from the theory of the disease generally prevalent in India, for he assumes that the prevalence of the disease in the Sutlej valley depends upon the presence there of metamorphic micaceous rocks, and that its absence in Spiti is due to the calcareous formation of the valley.

But we find a similar contrast drawn by Captain Harcourt and Mr. Lyall between Kooloo on the one hand, and Lahoul and Spiti on the other, and here we have a clue to the explanation of the distribution of bronchocele which Dr. Stoliczka has noted, for we find the disease prevalent in Kooloo and Bussahir, which in climate, productions, and the prevalency of malarious fever, assimilate very closely; while it is absent in Lahoul and Spiti, which boast a dry bracing climate and a singular immunity from most of the diseases which flesh is heir to.

CHAPTER XXV.

HOSHIARPORE.

Hoshiarpore and Kangra districts. Hoshiarpore, account of; goitre in the Juswunt Doon. Kangra, account of; extreme prevalency of goitre; Dr. Dickson's opinion that in the Kangra valley goitre takes the place of spleen in association with malarious fever. The *Joalla Doon* and salt spring. *Dhurmsala* sanitarium; description, climate, and diseases of; Dr. Wilson on goitre in the neighbourhood. *Dalhousie*, sanitarium. *Bukloh*.

WE have seen that the Umballa district extends along the base of the hills as far as the left bank of the Sutlej. On the other side the river is the Hoshiarpore district, a long narrow district which stretches from south-east to north-west between the Sutlej and the river Beas, a distance of about ninety-five miles.

Along the centre runs a low range of hills, a continuation of the outer Siwaliks, around which at either end the Sutlej and the Beas respectively sweep. To the north-east of Hoshiarpore, between it and the Himalayas, lies the Kangra district, the natural boundary between the two being for some distance a second range of hills which runs parallel to the Hoshiarpore hills, and belongs to the same geological formation. The valley between the two ranges is known as the Juswunt Doon, and is drained by the Sohan river, a tributary of the Sutlej.

The Hoshiarpore hills are about eight miles in breadth, and attain an elevation of about 1,500 feet above the level of the plain. Towards the plains they present steep precipitous banks, but in the opposite direction easy slopes. Their surface is very bare of trees, and for the most part of the year is almost destitute of vegetation excepting some scanty jungle in the glens where a little moisture may be retained.

The town of Hoshiarpore is situated in a fertile, well-cultivated, and wooded plain, which rises by gentle slopes to the foot of the hills distant some seven or eight miles. The soil is light, porous, and sandy, and is scored at intervals by wide and tortuous channels which bring down the drainage from the hills; the banks of these

channels are low, and in places give way to marshes of greater or less extent.¹ The subsoil water level is generally near the surface, varying from a few inches to eight or ten feet in depth, but in the town of Hoshiarpore the depth is somewhat greater, about seventeen feet, and in the fields around about fourteen feet. The climate is reckoned a very healthy one, and the summer heat, though great, is moderate as compared with that of many stations in the Punjab, while the cold season is long and very invigorating. The annual rainfall at the station averages 33 inches. Statistics of the mortality of the Hoshiarpore district are given in the tables at pp. 61 and 344. Under exceptional circumstances such as those described in Chap. v. the mortality from fever amongst the civil population has been very high.

The Juswunt Doon is sandy, and not nearly so well cultivated as the inner valleys, which enjoy a heavier rainfall, and are moreover watered by perennial streams, the Beas and its tributaries. The Sohan, which traverses this Doon, contains in the hot season but very little water, and that little can only with difficulty be used for irrigation, as the river flows along the lowest level of the valley.

In those places where water can be obtained by means of 'kools,' which sometimes run for miles along the slopes, irrigation is very successfully practised, and vegetation becomes most luxuriant. Such is the case at Umb, in the northern part of the valley, a place celebrated for its gardens.

From special reports on the subject, it appears that goitre is not endemic outside the hills, though owing to proximity to goitrous regions, the roads from which pass through Hoshiarpore, many cases are treated in the dispensary there. The disease exists along the valley of the Sohan, though not to the same extent as we shall find it in the Kangra valley, and is most prevalent about Umb, where 20 per cent. of the people suffer, owing as they say to the use of the water of a stream running close to the town. This they drink, though they consider it unwholesome, in preference to well water, because the depth of the well makes the labour of drawing water very great. These waters were compared as regards the amount of lime and magnesia, and the well water (see table at p. 38) was found to contain the largest quantity of both bases. There are a few cretins in the town and neighbourhood.

The reports state that fever is very prevalent in the goitrous localities.

¹ *Sanitary Report for 1877*, p. 145.

Kangra. That portion of the district of Kangra with which the present enquiry is concerned lies between the Hoshiarpore district and the Himalayas. On the west it is bounded by the district just mentioned, the line of separation between the two coinciding towards the north with the river Beas, and south of this with the low Juswunt range of Siwalik hills. To the north-east the district is bounded by the great Dhaoladhar chain of Himalayas, and on the south-east by the mountainous district which is included in the native state of Mundi. The district is indeed a 'Doon,' but unlike the Dehra and other Doons hitherto noticed, it is triangular in shape; moreover it differs in being divided by many hills of the Sub-Himalayan formation into subordinate valleys. One such has already been noticed, the Juswunt Doon which lies between the Hoshiarpore and Juswunt hills; another and parallel valley is the Joalla, which lies between the latter and another more broken range to the east; and still further to the east are other valleys, irregular in shape. One of these is the Kangra valley proper, lying at the foot of the Dhaoladhar range, beneath the sanitarium of Dhurmsala. On the same range, but thirty miles to the north-west of Dhurmsala, is another hill station, Dalhousie.

Geologically the Kangra district is composed of the sandstones and clays of the newer tertiaries (Nahun), a narrow zone of older tertiaries (Upper Sirmoor) running along the northern inner boundary of the newer formation. On this zone the station of Dhurmsala is situated. As has been already pointed out,¹ the tertiaries in this region occupy the area of the Lower Himalayas, and come very close to the central gneiss of the Dhaoladhar range.

The Kangra valley proper, irregular in shape, lies between the Dhaoladhar range on the north and the Beas river on the south; it is about thirty or forty miles both in length and breadth, with a surface broken here and there by low hills; a good deal of it is terraced by the cultivators in order to retain the water. The valley is profusely watered by a heavy rainfall, and by tributaries of the Beas; it is well wooded and richly cultivated, presenting in the autumn a wide sea of rice; the soil is for the most part a rich loam, only here and there are bits of stony, sterile ground. The general altitude varies from two thousand to four or five thousand feet. The valley is strewn with forts, which were built by the Seikhs, who held it from 1804 to 1850, until the British took possession. During that period Kangra was thinly populated and poorly cultivated, but now, in addition to large crops of rice, wheat, Indian corn, and barley, the valley produces a good deal of tea,

¹ See Chap. i.

the cultivation of which is extending under European management. The people are chiefly Hindoos, amongst whom is a migratory class, the Gudhees, who are mostly shepherds, inhabiting the slopes of the hills above the valley. Living in a warm, freely watered valley, much given up to rice cultivation, the inhabitants suffer a great deal from malarious diseases—fever, dysentery, diarrhœa, a low form of pleuro-pneumonia, and goitre; very frequently too they are tainted with scurvy.¹

The town of Kangra, about eight miles from the foot of the Dhaoladhar range, is situated on a low hill which occupies the angle at the point of junction of two tributaries of the Beas; the extremity of the hill is occupied by the fort, now in ruins. The town is about 150 feet above the level of the valley, and about 2,500 above sea-level. The rainfall is very heavy, averaging 150 inches; the mean temperature, as given by Messrs. Schlagintweit, is as follows:—

General mean 1852–54.

January	49·7°	August	76·
February	55·4	September	75
March	62·6	October	67·6
April	68·4	November	60·6
May	79·	December	53·7
June	85·7	The year	67·6
July	78·2		

In the 'Indian Annals of Medicine' (No. 26 of 1870), is a paper on the Sanitarium of Dhurmsala, by Dr. Dickson, Civil Surgeon of the district, in which is some account of the diseases of the Kangra valley. Miasmatic fever is, writes Dr. Dickson, universal there. Yearly the valley is ravaged by dreadful visitations of intermittent fever; scurvy also is very prevalent, outbreaks of cholera have frequently occurred, and the mortality from diarrhœa is very heavy. Small-pox prevails each spring. Leprosy is common. Goitre also is very common, and many cretins may be seen, and the peculiar small-limbed, prematurely aged, coarse-featured, dwarfish individuals to be met with on every side strike a new comer painfully. As regards the prevalency of goitre, Dr. Carter, in a special report dated February 1874, writes, 'My observation leads me to believe that in the Kangra valley there is scarcely an individual over twenty years of age who is not affected with

¹ See on Valley of Kangra an interesting paper by Surgeon-Major Carter, of the 1st Goorkha regiment, in the *Annual Report* for 1870 on the Sanitary State of the Native Army of Bengal.

bronchocele. Of some 600 recruits for different regiments examined by me during the last two years, very few were entirely free from the disease. I think the people who live in the lower part of the valley are more subject to the disease than those who live in the higher parts. The people living in the valley take their drinking water from the streams, the water of which is pure and delightful to look at, and to the taste.¹

Dr. Dickson remarks that though miasmatic fever is so prevalent in the valley, splenitis is very rare. He states that in the many post-mortem cases he has had to make, he had met with a very large spleen only in one instance—not that the organ may not become enlarged in cases of fever; that must always be the case when the fever lasts any length of time—but enormously large spleens are seldom met with, nor indeed are spleens which can be determined by palpation.

Dr. Dickson adds the following table, which he truly remarks would greatly contrast with a similar table showing the results of the cases of fever treated at a dispensary of one of the fever districts neighbouring on the canals in the plains.

Dispensary	Cases of fever	Enlarged spleen
Dhurmsala	591	—
Kangra	2395	1
Noorpore	1583	16
Palumpore	1401	2
Kooloo	330	7
Total	5300	26

Here we have only .5 per cent. of the cases of fever treated at the dispensary, suffering from enlarged spleen, while in the villages along the Western Jumna Canal, Dr. Adam Taylor found 30, 40, often 60 or 70 per cent. of the inhabitants affected with enlargement of that organ. But while along the Jumna Canal goitre is rare, in the Kangra valley the disease is universal.

To the west of the Kangra valley is another subordinate Doon or valley, that of Joalla, through which the river Beas takes a southerly course for a considerable distance. The valley is richly cultivated, and is famous as containing the holy city of Joalla Mukhi. The city is fifteen miles south of the town of Kangra, at the foot of the Chungur hills, about five miles from the right bank of the Beas. At the principal shrine a stream of inflammable gas issues from the rock, and outside the temple is a saline spring, the water of which, evaporated down, yields salt which is used for

¹ Analysis in table at p. 34.

domestic purposes, and is moreover said to be a cure for incipient goitres. Besides this spring there are four others, yielding a residue of a similar nature, along the foot of the same hills in the Joalla valley. The water of all was analysed in 1855 by M. Marcadieu, who was then officiating as geological surveyor to the Punjaub Government. His analysis gave the following results:—

Name of spring	Total solids per 1,000 parts of water	Iodine
Joalla	26·3	·094
Kooperah	22·	·08
Joalla, a second spring	24·	·08
Naguah	22·2	·094
Chunga Bassa	23·	·094

The Joalla-mukhi spring is situated on the line of a great fault, some 200 miles in length, which commences a little to the south-west of Subathoo, crosses the Sutlej, and takes a straight course through the Kangra district to a point on the Ravee a few miles below Dalhousie—where is another mineral spring on the same line of dislocation¹—the fault crosses that river and finally terminates at the Chenaub river about twenty miles north of the town of Jumoo.

Dhurmsala. Dhurmsala² was first occupied in 1852 by a native regiment, and was probably chosen as a cantonment for the simple reason that it presented the only tolerably flat piece of ground, free from jungle, plentifully supplied with water, and at the same time somewhat raised above the Kangra valley. Behind the cantonment rises gradually the hill on the spurs and slopes of which is situated the sanitarium of Dhurmsala, and again almost immediately behind these is a towering snow-clad range of the Himalayas, with peaks rising to heights varying from 12,000 to 19,000 feet, attracting every passing cloud, and throwing them back in the shape of water on the rain-tired inhabitants of Dhurmsala. Snow begins to tip the peaks early in November, and gradually increases in quantity, covering the upper portions of the mountains, till the middle of March, when it begins to disappear, and about the middle of July only a little is left upon the highest peaks.

Above 12,000 feet in height the hills are almost barren; their

¹ See *Manual of Indian Geology*, p. 548.

² Surgeon-Major Carter, in *Medical and Sanitary Report, Native Army of Bengal*, for 1870.

geological structure has already been noticed.¹ The station of Dhurmsala is chiefly built upon clays and sandstones of the upper beds of the Sirmoor series of tertiaries. According to the account of Surgeon-Major Whitwell,² under the name of Dhurmsala are really included three different places: the cantonment of the Goorkha regiment, to which the name of Dhurmsala is alone properly applicable; the civil station, officially known as McLeodgunge; and the European cantonment of Bagshoo. The station itself is situated in $32^{\circ} 14'$ north lat. and $76^{\circ} 19'$ east long., and its height above sea-level varies in different parts; thus at the highest part of McLeodgunge it is 6,150 feet, while the ridge on which the barracks of the European troops are situated is some 250 feet lower, and the lines of the Goorkha regiment have an elevation of only 4,050 feet.

To the north of the station, running from east to west and completely bounding the view in that direction, is a range of lofty mountains, whence spurs run out into the valley almost invariably in a direction from north-east to south-west; these vary both in height and in the distance which they run from the parent range, and they are separated from each other by deep ravines down which rush mountain torrents to join the many tributaries of the Beas river which water the Kangra valley.

On two of these spurs, running nearly parallel to each other, the station of Dhurmsala is built; the eastern spur, known as 'Dhurmcote,' breaks up into two smaller spurs, on the western of which are situated the European barracks, the hospital, and their subsidiary buildings, and on the other are a few houses occupied by the European residents. On the other main spur the larger portion of the houses of the civil community and the McLeodgunge bazaar are situated, while lower down is the jail, and still nearer the plain lie the Goorkha lines. To the north-east of the station a third spur projects for a short distance into the valley; it is known as Bagshoonauth, and its western slopes are here and there dotted with a few houses.

The whole of the ridges are fairly covered with forest, which is chiefly composed of pines, Himalayan oak, and rhododendron. The horse-chestnut, maple, walnut, and elm also grow freely. Deodar is now being planted to replace the loss which has been occasioned by the wholesale destruction of the oak for fuel. Formerly rice was cultivated in the immediate neighbour-

¹ See Chap. i.

² *Report on Water Supply of Dhurmsala*, October, 1870.

hood of the Goorkha lines, but though this is now prohibited the crops in the valley are only about one hundred feet below. To the north of the Dhurmcote hill the rocks are of limestone, and outside the station there is plenty of shale, but neither are to be found in the station itself; there all is sandstone, and red and grey clay, covered with a sandy soil in most places, and a black vegetable mould in others.

The water supply of the station is abundant and is naturally of excellent quality. It is obtained either from 'baolies' or 'kools;' the former being cisterns, generally of masonry, into which the water of a spring is received either immediately or shortly after its issue from the ground, while the 'kools' are open channels of earth through which the water is brought from a distance. The supply for the greater part of the civil station has its origin in a spring which issues from granitoid rock at the foot of a glacier eight or nine miles distant; there it is exceedingly pure, but unfortunately it is liable to serious contamination in its passage through the kool. The water for the European troops is taken from a well-constructed and carefully kept 'baolie' on the side of the hill below the barracks. That for the native troops at Dhurmsala is from a baolie supplied by a spring which issues from the side of the hill near the lines. (For analyses, see table at p. 34.)¹

Climate. The most unpleasant, and the only unhealthy season of the year, is during the rains which last from early in June till the middle of September. At this time the weather is damp, foggy, and depressing. The station is sometimes for long together veiled in clouds, which lift for a time, only to display the mass of cloud with which the valley beneath is covered. Before and after the rains the climate is dry and bracing. Snow falls in January and February, but seldom more than three or four days together, and quickly melts away. Owing to the nature of the soil and the considerable slope of the surface, water quickly runs off, so that

¹ In the *Indian Annals of Medicine* (1874) is a paper by Dr. Wilson, of H.M.'s British Forces, on the causes of goitre and the circumstances under which it is developed. Dr. Wilson analysed the waters of several sources from villages in the neighbourhood of Dhurmsala where goitre is prevalent, and satisfied himself that the remarkably small quantity of mineral matter which the water contained could not possibly account for the prevalence of the disease amongst people who from their birth had used no other water. Dr. Wilson inclines to think this goitre a circulatory disease resembling the exophthalmic variety, and that the tendency to the disease is encouraged by circumstances such as active exertion at high elevations, especially at times when the system is enfeebled by disease.

there is seldom much permanent dampness in the soil. The table No. 31 in the Appendix gives the meteorological elements of the station.

Dr. Carter, in the paper already quoted, writing more particularly of the Goorkha cantonments, which it will be remembered is the lowest section of the station, says that he is not disposed to think highly of the climate; it of course compares favourably with that of the plains, free as it is from their scorching heat, though the heat of the station is not unfrequently considerable. But the air is often in a very stagnant state, owing to the wind protecting power of the great mountain barrier to the north, and as the site is not much raised above the level of the valley, the climate is apt to be relaxing. As a sanitarium Dr. Carter considers that Dhurmsala is inferior to Murree and Mussourie for individuals wishing to recover health and strength; even the highest parts of the station partaking of the climatic peculiarities of the lower sites.

Diseases of Dhurmsala. Dysentery and hill diarrhœa are, says Dr. Dickson, the diseases of the station, especially during the rains, but not equally over the whole of it; for he notes that their prevalency is limited to the western side, low down the station. He ascribes the prevalency of bowel complaints there and in the jail to a water supply contaminated by exposure in open channels. The mortality from diarrhœa in the jail is very great, and cholera has frequently visited it. Fever seldom originates amongst people living on higher sites, and fever patients coming from the plains as a rule quickly recover. But lower down, especially in the Goorkha lines, fever and ague are exceedingly common. Dr. Oldham¹ thinks that a large proportion of the sickness of the regiment should be ascribed to a piercingly cold wind which blows at night, for a great part of the year, down a gorge in the hills which opens directly from the Snowy range.

Dr. Dickson, as a result of his observation at Dhurmsala, believes that there is a strong bond of connection between the three diseases, intermittent fever, dysentery, and diarrhœa, as they show themselves at the station. 'Last year,' he writes, 'in the autumn intermittent fever prevailed most extensively in the valley, so that in towns no single individual was unaffected, and also in the Goorkha lines): while in the bazaar and jail there were fewer cases of fever, but more of bowel complaint; and in the upper station most troublesome ulcers and boils occurred amongst the inhabitants. The

¹ *Medical Report of Native Army of Bengal, 1874.*

conclusion to be drawn is, I think, that these three diseases prevail about the same time, and are probably due to the same ultimate cause.' Statistics of disease amongst the native troops at the station will be found in the table at p. 84.

*Dalhousie.*¹ About thirty miles to the north-west of Dhurm-sala the Dhaoladhar range breaks up into spurs, which run down to the left bank of the Ravee. On the summit and slopes of the three last peaks of the range is situated the sanitarium of Dalhousie, in a direct line twenty-five miles, and by bridle road fifty-six miles, distant from Puthankote at the foot of the hills. At Puthankote the carriage road ceases, and visitors to the sanitarium must be carried in a dooly, or ride the remainder of the journey. The three peaks on which the station is built are named respectively, Bukrota, Teyra, and Putrain. Bukrota is the most eastern and the loftiest of the three, attaining an elevation of 7,700 feet. Teyra, the central peak, has an elevation of 6,840 feet, and Putrain 5,750 feet. To the north-west of the civil station is the military station, situated on another spur or hill known as Baloon, at an elevation of from 5,500 to 6,000 feet. The granite peak of Dyun Koond, upwards of 9,000 feet in height, clothed with pine forests, and capped with snow far into the summer, rises immediately above the station to the east; and beyond this are the great peaks of the range covered with perpetual snow. Bukrota and Teyra are of gneissic formation, while in Putrain the gneiss is intermixed with slaty shale and schist, and this is a difference which characterises the other hills in the neighbourhood, those of the higher ranges being gneissic, while the more southern elevations are slaty, and lower still the hills are conglomerate. Baloon is chiefly composed of clay slate. The Dalhousie hills are as a rule scantily covered with soil, but here and there in patches it is deep and rich, and in some places almost peaty. Vegetation flourishes luxuriantly, and heavy crops are obtained wherever the slopes can be terraced, while elsewhere the hill sides are finely wooded with oak, rhododendron, fir, chestnut, and poplar. On the higher elevations the deodar flourishes. Owing to the steepness of the slopes, the drainage is excellent, and the soil is so porous that the roads quickly dry after the heaviest rain. The scenery is thus described by Dr. Davie:² 'On the east are steep hills, whose slopes are clothed with pines, oaks, and rhododendrons. On the west are

¹ Surgeon-Major Whitwell, in *8th Report on Water Supply of Cantonments of Northern India*, 1871.

² *Report on Sanitary Establishments for European Troops in India*. Calcutta, 1862, page 25.

lofty hills, whose rough and rugged sides form a pleasing contrast to the sylvan beauty of the slopes on the east. On the north is the Snowy range—whose snow-clad peaks excite a feeling of coolness even in the hottest weather—now near at hand, now far distant, according to the state of the atmosphere. On the south is the glistening Ravee, winding its course to the plains, and finally with them disappearing in the distance like a dissolving view. Thousands of feet below are fertile valleys, with here and there a murmuring stream threading its way to the Ravee or the Chuckhee.’

Climate. Excepting during the rainy season, the climate of Dalhousie is a delightful and healthy one. The winter is not severe, and the air at that season is dry and very bracing, and, unless when snow falls, the days are bright and clear. The spring and autumn are very pleasant. The rainfall is heavy, averaging sixty-five inches, but this may be greatly exceeded, as much as 119 inches of rain having been collected during the year. The rains commence about the end of June and last into September. During this season the weather is apt to be hot, close, and relaxing, and mists and clouds frequently obscure the station, but do not envelop it for long, as is the case at some of the Himalayan stations. At this season sudden and great changes of temperature are common. The following table is compiled from observations taken in an open verandah at Lower Baloon, 5,400 feet. Snow is calculated as rain.¹

	1875							
	Highest in month	Lowest in month	Range in month	Mean of all highest	Mean of all lowest	Mean daily range	Mean of month	Rainfall
January .	57°	29	28	45·8	38	7·8	41·9	3·6
February .	54	31	23	44·2	36·9	7·2	40·5	10·8
March .	69	41	28	57·6	50·5	7·1	54·	1·9
April .	77	51	26	68·7	61·6	7·1	65	·6
May .	78	53	25	72·5	63·8	8·7	68·2	1·1
June .	85	57	28	76·9	68·2	8·7	72·6	7·3
July .	76	60	16	71·	64·7	6·4	67·8	35·5
August .	73	57	16	68·2	62·7	5·5	65·5	27·5
September .	72	52	20	66·4	60·5	5·9	63·5	22·1
October .	66	38	28	58·5	50·8	4·7	54·7	4·3
November .	55	41	14	50·8	44·9	5·9	47·9	1·9
December .	50	36	14	47·2	39	8·3	43·1	1·9
The year .	67·7	45·5	22·2	59·8	53·5	6·9	57·1	118·5

Water supply. The supply is derived mainly from a magnificent spring which issues from the side of the Dyun Khoond hill,

¹ MS. Report of Army Medical Department.

about two and a half miles from the station, and about 1,000 feet above it. Thence the water is brought for some distance in an open channel, and subsequently, past the station, in an iron pipe to Baloon; supplying on its way to that place a covered reservoir for the use of the civil station. The water, as will be seen from the analysis, is very pure and for the greater part of the year is beautifully clear, but during the rains is liable to become clouded, owing to the access of the surface drainage from the hill side. The supply from the main spring is supplemented by two other springs, one on the north side of the Bukrota hill, and another low down on the Baloon hill. (For analysis, see table at p. 36.)

The principal diseases which affect residents at the station are slight malarious fevers, rheumatism, hill diarrhœa and dysentery, all prevailing chiefly during the rains. At that season, the invalids who have suffered from ague and diarrhœa in the plains are very liable to a return of their complaint, but they improve in health remarkably so soon as the cold weather sets in. The natives of the hills are a very sturdy, healthy race.

Goitre is very rare in Dalhousie and the immediate neighbourhood. Dr. Fairweather, late officiating Sanitary Commissioner for the Punjaub, states, that from inquiries which he personally made, he learnt that the disease is rare amongst the Gudhees, a shepherd people who wander with their flocks over the hills at considerable elevations, but that it is common in the neighbouring Chumba valley, and is also very common amongst the people of the low hills under the Dalhousie range, where there is a good deal of rice cultivation, with a climate liable to sudden and great alterations of temperature.

Bukloh. The cantonment of Bukloh, where a Goorkha regiment is stationed, is about seventeen miles from Dalhousie, on the road from that station to the plains. The barracks and residences of the officers are scattered over a semi-circular ridge having an elevation of 4,300 feet, one of a series of ranges which gradually increase in height till they merge into the spurs of the great Himalayan range beyond. Sites for the buildings have been obtained by cutting away the crest of the hill. The ridge has been under cultivation as is proved by the marks of terracing which are still visible. All the trees upon the site have been cut down, but the neighbouring hills are well wooded, chiefly with fir.

The water supply is obtained entirely from springs. Of these there are three principal ones, but, writes Dr. Whitwell, 'during the rains, and for some time after their termination, they are to be

numbered by hundreds, every fissure in the rock giving exit to a little stream. An iron conduit carries the water from the principal spring to a masonry reservoir which is well built and kept scrupulously clean. From this reservoir the regiment is mainly supplied. Other springs supply the regimental hospital and the civil station.¹

In addition to these two principal sources, Dr. Whitwell notices two or three springs in the vicinity of the barracks, 'mere excavations in the ground, in which the water of the springs collects. No care whatever is taken of them; their edges are surrounded by rank vegetation and filthy slush.' Strict orders existed against the use of these springs, yet some portion of the water supply was evidently taken thence.

Surgeon-Major Chesnaye, in his report, for 1873, on the health of the regiment at Bukloh, notices that although the men were supplied from the reservoir, the women, to save trouble, almost invariably drew water from a most impure source nearer the barracks, under the station garden. The result was a good many cases of typhoid fever amongst them during August and September.

The principal diseases of the station are fever, rheumatism, and in the cold weather, bronchial affections. Ophthalmia, caused by the intense glare in the hot season, is a common disease at Bukloh. Fever is most prevalent from July to September: it is of the intermittent type, and mild in its character. Goitre is prevalent amongst the women and children of the regiment, and is also commonly met with amongst the villagers in the neighbourhood. Statistics of disease amongst the troops of the station will be found in the table at page 84.

¹ See analyses at page 36.

CHAPTER XXVI.

GOORDASPORE.

Districts of *Goordaspore, Sealkote, Gujrat, Jhelum*. Goordaspore, the Baree Doab; malaria and goitre in the upper part of the Baree Doab. Dr. Fergusson's *Report* on the villages of the Upper Doab. *Sealkote* district and cantonments, description, climate, diseases. Goitre in the district, evidence the circumstances bear to the malarial origin of the disease. The Cashmere valley, goitre in Cashmere. Thelum district and cantonment.

THE Goordaspore district lies to the west of Kangra and Hoshiarpore, occupying the upper part of the Baree Doab, the tract of country between the rivers Beas and Ravee. From Kangra, Goordaspore is separated by the Chukhee river, a tributary of the Beas, and from Hoshiarpore by the Beas itself. Near the point where the Beas first touches Goordaspore it makes a great bend or elbow, changing its direction from north-west to south, and in this portion of its course is very close to the Ravee. The Ravee leaves the hills near the town of Shahpore some twenty miles north of the bend of the Beas; at the bend it is eight or ten miles nearer, but then the rivers again diverge, the Beas flowing south and the Ravee south-west.

At the bend the Beas receives the Chukhee, a hill-stream which has a source very nearly parallel to that of the Ravee, the rivers enclosing a narrow strip of Goordaspore, which stretches up into the hills to the great Dhaoladhar range of Himalayas, where the sanitarium of Dalhousie forms the most northern and the highest point of the district. This portion of the district is crossed by two ranges of Sub-Himalayan hills, which are geologically a continuation of those of the Kangra valley, and of these the innermost terminates in this district near the small town of Puthankote. Outside these hills Goordaspore stretches away some fifty or sixty miles along the Baree Doab; and moreover extends on the other side of the Ravee into the Doab, between that river and the Chenab, but it does not there touch the foot of the hills, as the territory of Jumoo intervenes. The sub-montane portion

of the Baree Doab is the scene of the very interesting history of goitre which is given by Dr. Fergusson¹ in his report on the sanitary state of the Baree Doab villages in connection with canal irrigation, and to this part of Goordaspore we may confine our attention.² Landmarks in this tract of country are Deenanuggur, a town on the road from Goordaspore to Dalhousie, about midway between the bend of the Beas and the Ravee; Goordaspore, the civil station of the district, on the same road and about ten miles south of Deenanuggur; and Puthankote, a town which is also on the Dalhousie road, about fifteen miles north-east of Deenanuggur, due north of the bend of the Beas, and midway between it and the debouch of the Ravee, near Shahpore. Madhopore is a large village on the Ravee, about four miles south-west of Shahpore, where are the head works of the Baree Doab canal. The general slope of this part of the district is to the south-west, with a subordinate slope to the west, from the high right bank of the Beas towards the Ravee.

The Baree Doab canal leaves the Ravee through a cutting sixty feet deep in the high bank of the river, and runs for eighteen miles almost due south, between high banks, below the level of the plain, to a point about four miles east of Deenanuggur, where it emerges upon the plain and becomes available for irrigation—its course is still southerly to a point about seven miles east of Goordaspore, where it divides into two main channels. The aggregate length of the main canal is 212 miles, with 692 miles of tributary channels, and in 1872-3 it watered 228,796 acres of land. Profiting by the experience gained in the construction of the Ganges and Jumna canals, care has been taken in the case of this canal to lay down its course along the watershed, so that the natural drainage of the country is not interfered with, no percolation takes place, and no swamp is produced along its banks. The evils therefore we have to look for are not, says Dr. Fergusson, in the case of this canal those produced by the presence of the canal itself, but rather those produced by the spreading out of a large sheet of its waters over an expanse of country, thereby saturating the soil and subsoil with moisture; and this state of things is found more frequently at some distance from its banks than close to them, for there the land is often too elevated to admit even of any irrigation at all. (Report, para. 16.)

The Chukhee river rises in the hills near Dalhousie and shortly after its escape into the plains, at a point about three miles south

¹ Appendix to *Report of Sanitary Commissioner for the Punjab*, 1871.

² For some statistics of the Goordaspore district, see the table at p. 344.

of Puthankote, divides into two streams, one of which flowing south enters the bend of the Beas, the other, taking a south-westerly course, formerly crossed the Doab and reached the Ravee; but this branch has been dammed back in order to keep it clear of the canal, and the whole of the water now flows through the other branch into the Beas. The old channel, however, in the southerly part of its course, still receives a good deal of drainage from the low land on either side, which it empties into the Ravee in about the latitude of Goordaspore. Other streams have, like the Chukhee, been dammed back, so that the whole of the drainage of this sub-montane portion of the Doab is diverted into the Beas.

The west bank of the Beas in this part of its course is high, and is named by Dr. Fergusson the Dhangoo ridge, as he considers it a continuation of the spur of low hills, known as the Dhangoo range, which terminates as a hill a little to the east of Puthankote. Between the ridge and the present course of the river-bed is an extent of low land from a mile to six miles in breadth. The widest part lies to the south-west of the town of Goordaspore, and there is here an extensive tract of swamp known as the Kanowan jheel; its surface is covered with rank vegetation, and its margins form extensive rice-fields. Another great swamp in this part of the district exists about three miles north-west of Goordaspore, and very extensive swamps exist in the neighbourhood of Deenanuggur.

Soil. The water-bearing stratum of the Doab about Goordaspore is sand, and above this clay, and between the two is often a stratum of kunkur clay. Above the clay is the soil, which, says Dr. Fergusson, may be roughly stated to be of three varieties: the first is almost pure sand, which generally occupies the highest ground, and forms low hills along the Beas; another soil is a mixture of sand and clay, and this is the predominating soil; and the third variety, pure clay, is confined to low parts near the water-level, and forms the rice land. Overlying these strata, in the Bhangur or upland tract neighbouring on the hills, is a layer of boulder gravel. At first the boulders are found scattered on the surface, but they presently disappear below it, and south of Puthankote are found at a depth of from ten to fifteen feet, while further south shingle takes their place, and this also soon disappears.

The soil is very fertile, and, watered as it is by a plentiful rainfall, by rivers, and by the canal, yields rich crops of wheat, barley, rice, sugarcane, Indian corn, cotton, &c. &c. The district is well wooded, but contains no forest.

Climate. The climate of the upper part of the Baree Doab is

cool and pleasant, the temperature at Goordaspore is approximately as follows :—

May		July		December	
Maximum	. 113·3°	Maximum	. 103°	Maximum	. 75°
Mean	. 86·9	Mean	. 85	Mean	. 54
Minimum	. 60	Minimum	. 71	Minimum	. 32

The rainfall at the station averages 28·5 inches, the rains commencing at the end of June and ending in September. The rainfall increases considerably above Goordaspore, and within sixteen or seventeen miles of the foot of the hills averages about fifty inches.

Dr. Fergusson in his report discusses the sanitary and other conditions of the canal villages in twenty-three groups, but with only six of these is the present inquiry concerned; these are the five groups situated on the boulder area near the hills, and on the low land bordering on the old bed of the Chukhee, and a sixth which comprises the villages situated on the Dhangoo ridge.¹

The first five groups (Report, para. 44) consist of irrigating and non-irrigating villages, and present many features in common with each other, yet different from those of any other part of the Baree Doab. The soil is a fine alluvial deposit with a subsoil of coarse gravel and boulders, and beyond this a thinnish layer of clay, overlying sand; it is therefore a soil easily permeable to moisture with a water-level near the surface. The villages, and indeed the individual houses, are enclosed in a thick growth of trees, and rank vegetation rendered more compact by bamboo clumps and creepers. Thus a humid, stagnant atmosphere, loaded with products of decaying vegetation, is made to pervade the homesteads, and the result is a very low degree of health amongst the inhabitants. The water supply is mainly from wells, but in some instances from the Ravee or canal; the wells are generally masonry in the towns, unlined shafts in the villages; as a rule the mouth of the well is unprotected from the entrance of dirty water, which is too commonly allowed to collect around. Still the water appears to be good, excepting in the case of Puthankote, and a town, Sujanpore, not far from it. At both those places Dr. Fergusson found the wells in a filthy state, and the water very impure; liquid filth finding entrance in no small amount. Of the five groups, the five villages included in group No. 3 call for special notice, owing to their high spleen percentage combined with a low spring level. These villages are on an elevated tract

¹ See table at p. 414.

of land to the south of, and within five miles of, Puthankote; they are along the course of the Chukhee and are freely irrigated by it; 'they are inhabited by Rajpoots and are in fair sanitary condition, with sufficient slope for surface drainage; and, in short, afford no tangible reason for their extreme unhealthiness beyond the fact that their inhabitants are terribly affected with goitre and cretinism. Goitre is not confined to these villages only, but is found in almost every village in this district. It is, however, most abundant here, and combined with cretinism. That the causes which produce such a malady should have a deleterious effect on health generally is, I think, what we might expect, and this appears to me the most satisfactory reason for the extreme unhealthiness of these villages. Many of them are miserable specimens of humanity, being low in stature, pale and exsanguine in countenance, and the entire population struck me as being remarkably void of intellect' (para. 49). These characteristics, says Dr. Fergusson, belong also to a few other villages in this locality, but on less favoured sites, as Mallakpore, Sarna, Jeswal Lahari, &c. irrigated villages belonging to group 4, situated to the south of group 5 on the low ground along the old bed of the Chukhee. 'The population here is certainly both mentally and physically the lowest I have met with in the whole Doab, and contrasts strongly with their immediate neighbours and caste-brethren at Madhopore and beyond it in one direction, or the dwellers to the south of the old Chukhee bed in the other.'

From Dr. Fergusson's chart it appears that there is more spleen and fever amongst the villages of the five groups so far considered than in any other part of the Doab, and he considers that they must have been always unhealthy, though canal irrigation may have increased the sickness amongst the people, as is indeed their own opinion. The tract of country which they cover extends southward, a few miles beyond the boulder area to the latitude of Deenanuggur. The next group, Dr. Fergusson's No. 6, extends some fifteen miles further south upon the Dhangoo ridge, the position and soil of which has already been referred to. The villages, though built on the ridge, have land in the swampy khadir below, while some of them are situated on the slope immediately above it, and the villagers are thus exposed day and night alike, to the malaria of the khadir. No irrigation is practised or needed; the villages are extremely dirty, and trees and vegetation which might protect the inhabitants from malaria are wanting. The water supply is from wells into which a good deal of surface drainage of a very

dirty sort must find ready access. The percentage of spleen disease and fever in the villages is very high. The villages offer an illustration of the well-recognised fact that slight elevations in malarious localities are commonly very dangerous as a site for habitations.

The town of Deenanuggur is on the low ground to the west of the ridge, receiving the drainage thence, and with a water-level near the surface. The fields around the town are profusely irrigated, and dense vegetation comes up to the very walls. The larger streets are cleanly, but the small streets are uneven, unpaved, and without drainage; the spaces between the houses are abominably dirty ('Report of Sanitary Commissioner of Punjab for 1870,' para. 172). The wells are described as dilapidated, with disgusting puddles around them. 'Into these I observed,' writes the Sanitary Commissioner, 'the sewage from the neighbouring privies frequently flowed, and in an extensive pool I measured with my stick half a foot of black seething fluid.' 'The death rate of Deenanuggur has averaged 41 per mille for the past three years, and this high mortality is attributed chiefly to the proximity of the canal: but until the sanitary defects of the town are removed, it is impossible to say how much of the unhealthiness may be attributable to that cause.'

As regards goitre in the district, Dr. Fergusson states that the disease shows itself at Shahpore at the foot of the hills; and for a few miles south of that place is met with in all the villages along the Ravee and inland from it. It is, however, most prevalent immediately south and east of Puthankote, where as many as sixty per cent. of the population are affected. Some seven or eight miles south of that place the disease becomes less common, and a little further south is rarely met with. Dr. Fergusson's examinations in the villages were necessarily confined to males, but he is satisfied that goitre is still more frequent amongst females; for when residing at Madhopore in 1869, he was able to examine two batches of people, and he found that of fifty men in one batch 28 per cent. were goitrous, and of twenty-four women 37·5 per cent. were goitrous; in the second batch, in which were forty-four men and twenty-two women, 15·9 per cent. of the former, and 40·9 per cent. of the latter, were affected.

In the majority of cases Dr. Fergusson found both lobes of the gland affected, but where only one was involved, the right was most commonly so. In some cases the isthmus only was enlarged. 'The subjects of the disease were pale and anæmic, more especially

if the tumour were a large one; in short, they presented the appearance of bloodlessness, very similar to that observed with enlargement of the spleen. Both the thyroid and the spleen are blood-forming glands, and it is even probable that enlargement of the former may produce the same leucocythæmic conditions observed in enlargements of the latter. The cretinism found along with goitre in the neighbourhood appears to prevail only where the goitre is worst.'

Dr. Fergusson was very much struck by the anomalous distribution of the disease within the limits just mentioned. Thus, there was but a mere trace of it at Puthankote, and in a few villages between that place and Sujanpore, a town half-way between Puthankote and Madhopore, while at Sujanpore the percentage rises suddenly to 32.5, and in some villages along the Ravee and near the southern limit of the goitrous area, the difference in this respect between villages quite close together was very remarkable. These facts, says Dr. Fergusson, puzzled me, till I found that the limits of the goitrous area corresponded exactly with the limits of the boulder subsoil layer, and afforded an explanation of the distribution, and of the cause of the disease, namely, the subsoil water charged with salts dissolved from the limestone boulders. But though Dr. Fergusson's view of the cause of the disease does appear to derive support from the coincidence of the boulder and goitrous area, the explanation fails when we extend the inquiry to the corresponding strip of country along the Hoshiarpore and Umballa Siwaliks, and find that the disease is absent there, excepting in one locality, that of Munee Majra, where other conditions come into operation, and have reduced the people to the same state of suffering from fever, spleen, and goitre, which is so painfully illustrated in many of the villages situated on the boulder area of Goordaspore. Moreover, when considering the probability of this view of the cause of goitre in Goordaspore, we have to remember the prevalency of the disease in a locality not very far distant, namely, the villages in the neighbourhood of Dhurmsala, where the water is very free from lime, and indeed in many other localities, as throughout Assam, where also lime is wanting.

Further, on examining the tables appended to Dr. Fergusson's report, we find that goitre is very prevalent at Madhopore, where river water is drunk, and at Beheri, a village not far distant from Madhopore, where canal, that is Ravee water is drunk. Again, at a village named Attipore, not far from Beheri, where there is much

goitre, the people drink well and canal water, but ascribe the disease to the latter, and at Dherewala, a village irrigated from the Chukhee, where the disease is excessively common, the 'Chamars,' who drink nothing but canal water, suffer equally with the rest of the inhabitants who use well water.

Some samples of water which were sent to Calcutta for analysis gave the following results, from which it will be seen that lime is present in large quantity only in the case of the Puthankote well, a place where goitre is a comparatively rare disease.

	Lime in parts per 1,000	Magnesia in parts per 1,000	Remarks
River Ravee at Madhopore . . .	·039	·002	
„ Chukhee	·045	·005	
Well at Dherewalla	·064	·01	Much goitre
„ Puthankote	·249	·123	} Little goitre
„ Narot	·089	·034	
„ Bheempore	·086	·029	

The disease is not limited to the sub-montane portion of Goordaspore, for it is very common amongst the natives of the Sub-Himalayan hills which here skirt the Dhaoladhar range.

For the cause of the disease we must look to conditions which exist alike in the Kangra valley, in the adjoining sub-montane portion of Goordaspore, both of which are on the same geological area, and in the hills just mentioned, and the conditions are no doubt those which foster the development of malarious diseases. Hence goitre is at its maximum in the villages of group No. 3, on the unhealthiness of which Dr. Fergusson lays so much emphasis. There the whole population is afflicted with fever, spleen, and goitre, and, as Dr. Fergusson suggests, the spleen and goitre both aid in producing the leucocythæmic condition which is very common amongst the people. Generation after generation has suffered in this way, and things have been made worse by constant intermarriage amongst the sufferers: hence the deplorable physical state of the population, and the cretinism which Dr. Fergusson describes.

As regards the general result of Dr. Fergusson's investigations into the influence of canal irrigation on the health of the Baree Doab, a careful perusal of the report seems to justify the Lieutenant-Governor's opinion¹ 'that it does not record sufficient evidence to establish the conclusion that fever is generally more prevalent, or

¹ *Minute* of the Lieutenant-Governor at page 2 of the *Punjab Sanitary Report* for the year 1871.

Baree Doab Canal Villages.

Name of the town or village	Group	Position and peculiarities of village	Spring level in feet	Soil	Water supply	Average annual percentage of fever	Percentage of spleen	Percentage of goitre
Shahpore . . . (Group, 1 non-irrigating villages on Ravee alluvium)	1	On the side of the hill just as it subsides into the plains above which the village is elevated several hundred feet. Choked with jungle and vegetation. Non-irrigating	48	Clay and gravel	Scarce,—from wells, but in dry weather from the Ravee	60	32.5	Not much
Rajpoora . . .	1	Village on bank of Ravee, a mile below Shahpore; very clean; non-irrigating	50	Boulder, on the Ravee alluvium	From Ravee	45	32.5	Not stated
Madhopore . . .	1	Town at canal head; population very mixed, artisans and labourers on canal	50	"	From Ravee	46.6	30	Very prevalent
Tarhal . . .	1	Non-irrigating village on high land near Madhopore; much vegetation	80	"	From wells, deficient	55	15	Not stated
Beheri . . .	1	Village, close to canal on the Ravee; village fairly clean; surface drainage good; non-irrigating	32	"	The canal, supply good	70	22.5	Much goitre
Mirzapore . . .	1	On Ravee; water level in places so near the surface as to admit of rice cultivation without irrigation	22	"	Water from wells	71.6	37.5	Common
Soojanpore . . .	2	Large town close to canal. Town in a hollow, much choked with jungle. Rice grown near on irrigated lands	20	Alluvial and gravel	Well water, water very impure	60	30	32.5
Puthankote . . .	1	Large village, at base of spur of low hills; non-irrigating	18	Clayey	From wells, very impure	60	17.5	Not much
Attipore . . . (Group 2, irrigating villages on Ravee alluvium)	2	Village, close to Ravee near Beheri; an irrigating village	30	Alluvial, over sand, gravel boulders	Wells and canal. People ascribe goitre to use of canal water while at work in fields	61.6	10	32.5

Ferozepore . . .	2	An irrigating village near the last	32	"	"	63.3	17.5	15
Phoolpiara . . .	2	An irrigating village between canal and Ravee, about 2 miles from each; very dirty; much rank vegetation	16	"	"	60	27.5	Much goitre
Jakean Lahri . . .	2	East of Phoolpiara, about 3 miles west of Puthankote; low-lying; much irrigation	12	Black clay .	.	50	30	Little, if any
Salampore . . .	2	Low-lying, irrigating; on the canal; bad drainage	10	Boulder .	.	75	27.5	17.5
Pajura . . .	2	3 miles west of Salampore, near the Ravee; an irrigating village	14	"	.	61.6	25.	17.5
Eti . . .	2	Near the above . . .	9	"	.	68.3	27.5	17.5
Bahadur Lahri . . .	2	An irrigating village . . .	20	"	.	33.3	37.5	But little
Butrali . . .	2	An irrigating village near the Ravee .	18	"	.	70	30.	"
Gurota . . .	2	Much irrigation, watercourses cut in all directions through dense undergrowth round village	8	"	.	30.9	35.7	60.
Narot . . .	2	Irrigating village east of Gurota; very dirty, choked with jungle; children wretched and dirty; men pale and unhealthy	14	Clay and alluvial	.	69.1	33.3	Very little
Barowli . . .	3	On elevated ground, irrigated from the Chukhee; much land under rice, about 2 miles or less south of Puthankote	54	Boulder .	.	56.6	22.5	32.5
(Group 3, irrigated from Chukhee)		Irrigated by Chukhee; damp strong soil on which rank crops produced	55	"	.	53.3	32.5	20
Doultpore . . .	3	On elevated ground; good drainage, pretty clean, irrigated from Chukhee	50	"	.	68.3	35	57.5

Baree Doab Canal Villages.

Name of the town or village	Group	Position and peculiarities of village	Spring level in feet	Soil	Water supply	Average annual percentage of spleen fever	Percentage of goitre
Laduchuk .	3	South of Dherewala, on raised site, irrigated from Chukhee; men stunted and weak-looking	45	Boulder .	Wells .	66.6	47.5
Jumulpore .	3	South of Laduchuk, close to canal	33	" .	" .	78.3	65
Aima .	4	South of Jumulpore, on raised site destitute of trees, irrigated by canal	18	" .	" .	83.3	44.1
(Group 4, irrigating villages near old bed of Chukhee)							
Rajkarara .	4	Irrigated from canal, east of Aima	21	—	" .	83.3	60
Jeswallahri .	4	South of Aima. Low ground, much jungle	10	Gravelly subsoil	" .	86.6	42.5
Goolpore .	4	East of the above, on low ground	12	Boulder .	" .	66.6	40
Sakalgurh .	4	South of Goolpore; very dirty	9	" .	" .	65.0	40
Katarochuk .	4	Still further south	7	" .	" .	63.3	55
Fureednagar .	4	Same neighbourhood	13	" .	" .	80	45
Kotlinanglian .	4	East of Katarochuk	9	" .	" .	81.6	20
Jakrawar .	4	Outside the boulder area	9	" .	" .	80	Very little
Dhobera .	5	Like other villages of group; non-irrigating; is to the east of Katarochuk outside the boulder area; soil very moist, village very dirty	4	Clayey, wells	" .	70	None
				" .	" .		
Phangarian .	5	Soil very moist; irrigation not needed	8	Boulder	" .	53.3	20
Ghoroteh .	6	On Dhangoo ridge about 10 miles south of Puthankote	45	Clayey	" .	81.6	None

far more prevalent, in the Goordaspore district than it was before the opening of the canal.'

'The Lieutenant-Governor fully admits that overflowing and allowing canal water to remain stagnant on the surface of the ground has a most injurious effect, and is productive of malaria; but he is not inclined to allow that the necessary consequence of the construction of a canal and subsequent canal irrigation is injurious to the health of the general population. The reverse is indeed his belief; and it is possible to so manage the distribution of canal water as to prevent overflowing except in the case of certain crops requiring a very large quantity of water, which if villagers choose to cultivate, they do so at the risk of health, in the same way as artizans in Europe and elsewhere voluntarily adopt trades injurious to health and life.'

*Sealkote.*¹ Beyond the Ravee, and as far west as the debouch of the river Jhelum, a strip of land about one hundred and thirty miles in length which belongs to Jumoo extends between the base of the hills and British territory; it is crossed about midway between those rivers by the Chenaub, and elsewhere by numerous minor streams, which are however, with two or three exceptions, mere mountain torrents with little or no water in their beds during the greater part of the year.

The outer hills of this district belong to the Siwalik series, and shut in a succession of valleys or doons which, like those further to the east, are in places included within hills of the outer series, and in others are bounded on the north by the Himalayas proper. These valleys for the most part show a good deal of cultivation, and though their vegetation is not so luxuriant as that of the eastern doons, their surface contrasts pleasantly with that of the bare hills about them.

From the plains the outer hills rise with a gentle slope to an elevation of about 2,000 feet above the sea-level; their surface is intersected by many ravines, and is covered towards the plain with a thick growth of trees of the acacia species. Along their base the plain has an elevation of some nine hundred or one thousand feet; it is scantily wooded, but well cultivated, and the soil, which is a mixture of clay and loam becoming lighter and more pebbly towards the foot of the hills, is very productive when watered by seasonable rains.

Though the rainfall increases considerably towards the hills, the

¹ For a full description of this tract of country, see Mr. Drew's *Jummoo and Kashmir*, London, 1875.

zone of country lying at their base is very dry, owing to the rapid drainage through the porous soil into the many deep ravines which cut the land up into a series of elevated plateaus.

Outside the Jumoo border the British district of Sealkote extends between the western boundary of Goordaspore and the Chenaub, and the district of Gujrat between that river and the Jhelum.

The Sealkote district is bounded on the west, or rather north-west, by the Chenaub, excepting at the extreme north-western angle, where a detached bit of the district, the Bajwunt subdivision, occupies the narrow doab between the right bank of the river and its tributary the Tavi.

The Chenaub leaves the hills in Jumoo territory near the town of Akhnoor, fifteen miles below which close upon the border it receives a Tavi river from the east. Here the river bends, and after a short course to the west receives a stream from the north, also named the Tavi; it now makes another bend and assumes a course to the south-west which it pursues through the plains. Four or five branches of the Chenaub cross the small doab between the main river and the second Tavi, and from these are led numerous water-courses which intersect the land in all directions, so that not an acre of it is left unirrigated.

The Chenaub where it forms the boundary of the Sealkote district flows between abrupt banks in a broad sandy bed, in which the stream is constantly changing its course. One other perennial stream, the Degh, traverses the district, but the northern part is crossed by the beds of numerous hill streams which contain water only for a month or two during the rains, though their annual floods serve to fertilise a considerable extent of country. The surface of the district is generally very flat, rising however towards the north between the rivers Degh and Chenaub into a low plateau which scarcely breaks the general level, and on the edge of this, about twelve miles distant from the Chenaub and fifteen miles from the base of the hills, is the important military station of Sealkote.

The soil of the district consists chiefly of a mixture of sand and clay in varying proportions, with here and there an intermixture of loam. Kunkur is found in some places, especially near the high bank of the Chenaub; lime is prepared from it, and from boulders of limestone which are found in the Tavi and in the streams of the Bajwunt subdistrict. The soil, where well watered, is very fertile, and yields large crops of wheat, barley, and rice. Excepting in the Bajwunt district, the only irrigation that is practised is from wells,

or by means of Persian wheels fed from the streams of the Chenaub, the Ravee, and the Degh, or from the few small marshes which occupy sundry low places in the district and serve as reservoirs of no small local value. There are no forests in the district, and trees, where met with, are single or in small clumps.

The cantonment of Sealkote, which is spacious, open, and well drained, is situated on the edge of the low plateau already noticed, at an elevation of about eight hundred and fifty feet above the sea level. The soil consists of sand and clay, with kunkur at a depth varying from six to twelve feet. Water is found at a depth of about forty feet; the supply is abundant, and excepting that it is rather hard, is of excellent quality. (For analyses, see table at p. 36.)

Sealkote and the district generally are reckoned very healthy; 'no climate in the world can be finer,' says the Report of the Commission on the Sanitary State of the Army in India, 1863. The unhealthy time of the year is from the end of August to the beginning of October, but even this period is only unhealthy by comparison; June, July, and August are hot, but not inordinately so; the cold weather lasts till April, and is very delightful, the climate in November, December, and January being sharp and bracing. The Table XIX. in Appendix is from the official reports for 1875-76 of the Government Observatory at the station.

For statistics of mortality and disease amongst the civil population, see tables at pp. 61 and 344. The tables at pp. 60 and 84 give statistics of disease amongst the native troops at the station.

The people of the district are in general a strong, healthy race, suffering less than those of neighbouring districts from disease. The diseases chiefly prevalent are malarious fever, small-pox, dysentery, pneumonia, and rheumatism. Spleen disease is not common. The district has however its years of exceptional sickness, and of these a notable one was 1876. The deaths registered that year to fever were 32·8 per 1,000 of the population; the actual numbers during the fever months were, August 1,265, September 6,657, October 11,326, November 6,399. The troops (native) also suffered proportionately; the average number of admissions for fever per 1,000, for the year, was 563 against 377 of the previous year; the admissions during the fever months, out of a strength of 1,008, were, July 12, August 74, September 170, October 164, November 72. The cause of all this sickness was clear enough; the rainfall between the 10th and 31st July was

no less than 27·8 inches, against an average for the nine previous years of 12 inches for the whole month. In addition to this the Ack and Bheer nuddees overflowed and inundated the whole country, the inundations occurring on two occasions in July and August, 'and the country,' says Dr. McKellar,¹ 'may be described as having been throughout these two months in a thoroughly waterlogged condition.'

In August the fall of rain was under the average, viz. 6·3 inches as against 11 inches.

Beyond the Chenaub, between that river and the Jhelum, lies the district of *Goojrat*, with, as in the case of Sealkote, a strip of Jumoo territory intervening between it and the foot of the hills. The north-west angle of the district is crossed by the low Kharian hills which run down to the left bank of the Jhelum and are usually considered as the easternmost of the roots of the Salt range. In soil and climate this district resembles Sealkote, but the temperature is higher and the rainfall less; the latter, at the civil station, Goojrat, thirty miles west and a little north of Sealkote, averages 27·6 inches.²

As regards the existence of goitre amongst the inhabitants of the sub-mountain tract between the Ravee and the Jhelum, it may be said to be almost unknown excepting in the Bajwunt subdivision of Sealkote, which, as we have seen, occupies the irrigated doab between the Chenaub and the Tavi. Assistant-Surgeon Futteh Singh, in charge of the Government dispensary at Sealkote, writing in 1875, says: 'The number of goitre cases is increasing every year on account of large numbers of patients receiving benefit from the use of biniodide of mercury ointment. The disease has not, as far as I know, increased in the district, but the increase in the number of cases treated (195 cases in 1873, 419 cases in 1874), is attributable to more widely spread knowledge of the cure. The patients generally come from the Jumoo district, and partly from the Bajwunt subdivision across the Chenaub; they seldom come from other parts of this district.' If we consider that the Chenaub divides for about thirty miles the districts of Sealkote and Goojrat, the statements just quoted bear very strong evidence that the river water cannot be the cause of the disease, unless when, as in the Tavi doab, the people in one way get too much of it. And it will be important to remember this when

¹ Report at p. 147 of *Annual Report on Sanitary and Medical State of Native Army of Bengal* for 1876.

² Mr. Blandford's *Report* for 1875.

we find the disease developing itself in patches along its banks lower down in the course of the river.

The disease is not uncommon amongst the people of the outer hills; this is the statement in special reports of the Civil Surgeons of Sealkote and Goojrat; and so long ago as 1842 Mr. Vigne, in his travels in Ladak, Cashmere, and Iskando, noticed the disease, and stated that it was confined to those who breathed the malaria of the lower mountains that bordered on the plains.

Due north of the districts of Sealkote and Gujrat, but separated from them by the strip of plain just described, by the outer hills, and by a huge mass of lofty mountains sixty to eighty miles in breadth, is the valley of Cashmere, of which the capital, Sreenuggur, lies almost due north of Sealkote, and in a straight line about 110 miles distant. The valley is of an irregular oval shape, being about eighty miles in length and twenty in width, with its long diameter from south-east to north-west. On all sides it is surrounded by lofty mountains, excepting a gorge at the north-western extremity where the Jhelum escapes after traversing the valley. The floor of the valley is elevated about 6,000 feet above sea-level, and is in large part occupied by recent alluvial land of which much is swamp, while another not inconsiderable portion is covered by shallow lakes. The valley is well wooded and richly cultivated, yielding large crops, especially of rice. Though the rainfall is not large, the climate of the lower part of the valley is rendered very damp by the wide expanse of water and marsh upon its surface. The winter, though not severe, is characterised by damp cold; the spring is somewhat cold and showery; the summer, which sets in about the middle of May, is rather warmer than an average English summer, and in July and August is close and oppressive, the thermometer in the former month often rising to 95° in the shade. At this time too the climate, owing to the exhalations from the low grounds, becomes very malarious, and visitors are glad to escape from the now relaxing unwholesome valley to the beautiful, cool and healthy retreats which the slopes of the surrounding hills afford. In such a valley malarious diseases, as might be expected, are very rife amongst the inhabitants, especially during the autumn, and we have the evidence of Dr. Elmslie, who knew the valley and the people well, 'that the inhabitants of a good many of the villages suffer from goitre.'¹ The idea prevalent in the valley as to its cause is that the very impure water of the river and lakes which is drunk by the patients has

¹ *Vocabulary of Cashmere*, p. 119.

produced it.' Dr. Ross notices the same fact, and adds that the disease is almost confined to females. The goitres, he writes, grow to an enormous size, and some cretins are seen.¹

Jhelum. Beyond the Jhelum, the British frontier again includes some hilly country, namely the eastern portion of the Jhelum district which lies in the elbow of that river near its debouch. The boundary of this district extends for some distance along the right bank of the river, then runs to the north-west, cutting the Salt Range about its centre, and north of that range reaches very nearly to the Indus. The district is bounded on the north by Rawul Pindi. It includes the two military stations of Jhelum and Talagaon, the latter of which will be described in connection with the northern slopes of the Salt Range.²

Jhelum, a large cantonment for native troops, is situated on the high right bank of the river at the point where it is crossed by the grand trunk road, and about thirteen miles south of the spot where the river escapes from the hills. The country immediately around the cantonment is flat and well-cultivated, but low hills are near it on every side, while to the north the outer range of the Himalayas, some 12,000 or 13,000 feet in height, appears on a clear day as if close at hand. The cantonment stands high, with a good slope for surface drainage, and owing to the nature of the soil enjoys perfect subsoil drainage; but in the immediate vicinity there is a tract of low land covered with mud and rank vegetation, where the river once had its channel, and in this medical officers have found one of the causes of the autumnal fever which visits the station. The soil of the cantonment is sandy to the depth of a few feet, resting on a subsoil of coarse gravel and shingle thirty or forty feet in depth. Water in the dry season is found about twenty-five feet below the surface; the supply is abundant and of good quality. (For analyses, see table p. 32.)

The climate is for the greater part of the year very dry, and from the middle of April to the beginning of July the temperature is excessively high; the air even at night being hot, but the heat moderates rapidly when the rains set in. The annual rainfall averages 17 or 18 inches. The cold season begins in October and lasts till the middle or end of March; throughout this period the air is clear, cold, and bracing. The mean temperature for the years 1852-4 is stated as follows by Messrs. Schlagintweit:—

¹ For an account of the medical history of Cashmere, see Surgeon-Major G. C. Ross, in the *Indian Medical Gazette*, August, September, and October, 1878.

² For statistics of the district, see tables in Chapter xxii.

January	50·5°	July	87·3°
February	58·	August	85·2
March	65	September	85·
April	73·3	October	74·5
May	83·4	November	64·6
June	90·5	December	49·

Mean of observations.

January 1852, at S.R.	41·1°	June 1852, at S.R.	82·5°
„ at 4 P.M.	59·8	„ at 4 P.M.	102·2

Diseases. Intermittent fever is the principal disease amongst the troops. During the cold months bronchitis and pneumonia, brought on by chilling winds and cold nights, are common amongst both the civil population and the troops; but on the whole the climate of the district and station may be said to be a very healthy one.

Dr. Aitchison, who was for four years Civil Surgeon of the district, reports that goitre is very common amongst the people of the low hills near the debouch of the Jhelum. In the remainder of the district, excepting along the southern base of the Salt Range, the disease is almost unknown.

Statistics of mortality and disease amongst the civil population of the district and amongst the troops stationed at Jhelum will be found at pp. 82, 83, and 346.

The following table compares the rainfall and prevalence of fever amongst the troops for the eight years 1870-1877. The years most free from fever were 1871, 1874, and 1877; in 1871 and 1877 the rainfall in August and September was unusually light, in 1874 the fall was heavy. The most unhealthy years were 1872 and 1876; in the former year the autumn rainfall was below the average, in the latter it was considerable, but not nearly so heavy as in the preceding year, 1875, when the autumnal outbreak, though well marked, was in comparison with that of 1876 a slight one. This last year, 1876, was an exceptionally unhealthy year, being in fact a cholera year in the district. These figures support the view that in a thoroughly well-drained station like Jhelum the severity of the autumnal outbreak of fever is not proportional to the rainfall, and that there is some factor more powerful than rainfall concerned in influencing the degree of the production of malaria.

Melum.

RAINFALL, AND ADMISSIONS FOR FEVER AMONGST THE TROOPS, EACH MONTH OF THE EIGHT YEARS 1870-77.

	1870		1871		1872		1873		1874		1875		1876		1877	
	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever	Rain-fall	Ad-missions for fever
January	.	51	—	45	1.7	23	.2	21	1.9	12	.8	37	.7	33	9.2	10
February	.	35	2.4	33	2.2	13	.1	19	.1	10	.6	26	1.3	24	5.3	10
March	.	46	—	20	1.5	5	.5	20	2.2	35	.5	31	1.6	24	.6	9
April	.	28	—	20	1.8	23	—	19	.1	26	—	32	1.6	31	2.0	8
May	.	57	—	29	.9	51	1.4	15	.2	22	.7	29	1.7	50	.5	38
June	.	48	3.3	25	.9	24	—	16	2.3	32	.2	15	1.8	35	1.3	35
July	.	71	5.1	26	5.9	68	3.1	21	5.5	40	6.7	25	6.7	31	2.8	29
August	.	106	1.1	40	1.2	68	5.4	71	4.2	17	11.1	52	3.9	129	.8	12
September	.	139	.7	27	1.2	179	1.6	105	3.2	52	5.8	139	.8	408	.9	12
October	.	230	—	30	—	421	.2	79	—	71	.7	192	1.6	437	3.8	43
November	.	235	—	18	—	235	—	49	—	36	.5	178	.6	103	2.9	11
December	.	52	.7	37	1.	89	.7	23	—	72	.7	55	.7	68	6.1	4
The year	. . .	19.8	13.3	—	17.8	—	13.2	—	19.7	—	28.3	—	22.3	—	36.2	—
Strength	. . .	1633	1235	—	1304	—	1457	—	1562	—	1606	—	1440	—	870	—
Admissions per 1,000 for fever	.	672	283	—	920	—	314	—	272	—	505	—	960	—	254	—
Admissions per 1,000 for all diseases	.	1154	715	—	1755	—	724	—	649	—	950	—	1340	—	679	—

1870.—Plentiful rains; a healthy year. 1871.—A very healthy year. 1872.—Fever very prevalent in station and throughout the district; a cholera year amongst the troops (July and August) and civil population. 1873.—A very healthy year; autumnal rainfall heavy, but no exceptional circumstance occurred. 1874.—Rain plentiful, a healthy year. 1875.—A healthy year, excepting the large number of fever cases in September, October, and November; rains very heavy. A cholera year in the province, but no cases amongst the troops or civil population of the station or city. 1876.—Heavy rains in July and August; fever very prevalent from second week of August amongst the troops and civil population. A cholera year amongst the troops and civil population. (Between July 11 and September 26 in cantonments). 1877.—Monsoon set in late and rainfall so slight as to cause no reduction in temperature of the season; a very healthy year.

CHAPTER XXVII.

SALT RANGE. TALAGAON.

Salt Range of hills; *Talagaon*. Description of Salt Range; *Pind Dadun Khan*; Keora mines; goitre in the district; Kalabagh mine; geological formation of the Salt range. *Talagaon* cantonment.

THE Salt Range,¹ as we have already seen, forms the southern raised edge or scarp of the Rawul Pindi plateau, and extends across the Sindh-Sagur Doab from Jelalpore on the Jhelum to Kalabagh on the Indus. Beyond the Indus the range is continued, geologically, by the Chichali hills, which follow the direction of the western bank of that river, and by the Sheikh Budeen hills, the terminals of the Chichali hills. The hills about Bahadoor Kheyl to the north-east of Bunnoo belong apparently to the same geological series.

The Salt Range proper presents a convexity, or rather a salient angle, to the southern plains. About one hundred and twenty miles long, for two-thirds of its length the range follows the northern bank of the Jhelum, but at Shahpore the mountains and the river widely diverge; the latter changing the direction of its course from west to south, and the former bending sharply to the north-west. At its widest point, nearly opposite Shahpore, the breadth of the range is about twenty miles, but it rapidly narrows towards the east and west. The summit presents a plateau on which three zones can be recognised; a southern formed of the ancient salt rocks from which the range takes its name, a central one of limestone rocks, and a northern of sandstone which is geologically continuous with the tertiaries of the Rawul Pindi plateau. The watershed of the range is much nearer the southern than the northern edge, and while in the former direction the

¹ *Settlement Report on Shahpore District*, by Major Davies; 'The Salt Range,' by Mr. W. T. Blandford, *Manual of the Geology of India*, Chap. xx.; Dr. Fleming's 'Report on the Salt Range,' *Journal of Asiatic Society of Bengal* for 1853.

drainage finds ready outlet; towards the latter it is otherwise, for much of the water collects in depressions or blocked ravines forming many lakes, the larger of which are with one exception either salt or brackish. Finally, the northern drainage finds its way to the Sohan river.

The scenery of the Salt Range is described as being throughout of a pleasing, and in some parts of a grand character, and its valleys and hills, the latter varying from 2,500 to nearly 5,000 feet in height, watered by a considerable rainfall, enjoy a climate many degrees cooler than that of the plains at their southern base. The loftiest peak is the Sukesur hill, which is in the neighbourhood of the salient angle of the range. On this hill is a small sanitarium. The hill is well wooded, has a plentiful supply of good water, and is surrounded by charming scenery.

On the summit of the limestone district there is a good deal of table land, the soil of which is very fertile and is richly cultivated. The northern sandstone district is formed by a succession of ridges separated by deep ravines which are but little cultivated, but it shares with the central portion a tolerably abundant natural vegetation. On the north the slope towards the plains is a gradual one; the southern edge on the contrary presents a jagged outline, behind which is a high escarpment of limestone rocks broken up by deep gorges through which the drainage escapes to the plains below.

The strip of land which extends along the southern foot is known as the 'Mohar;' it consists of a fertile belt of alluvial soil from three to four miles in width, which slopes rapidly away from the hills and is frequently intersected by the beds of torrents, and reaches out into a level plain the soil of which is in some places impregnated with salt and barren, and in others good and cultivable. Tillage is almost confined to the upper portion, which yields more than sufficient for the wants of the inhabitants, who therefore use the land on the lower level chiefly as pasturage for their cattle. Good water is the crying want of a large portion of the Mohar, and at times the people are obliged to go some distance to get a supply for themselves and their cattle; for of the many streams which intersect these plains, only one or two can boast of a perennial supply of water.

About twenty miles west of the commencement of the range at Jelalpore is the large native town of Pind Dadun Khan. The town stands near the north bank of the Jhelum, and about four miles from the base of the hills. The country immediately

around has a stiff clay soil, is fully cultivated, and is freely, indeed excessively, watered by hill streams, by a canal which passes close to the town, and in addition, in their season, by the floods of the river. Wells also supply a good deal of water, and are the chief source of the domestic supply. They are very shallow, and the water which many of them yield, of those especially within and to the north of the town, is complained of as brackish. The sanitary condition of the town and of its surroundings is described as being most lamentable, and the death rate fearfully high, the chief cause of mortality being fever.¹ Goitre is very common amongst the inhabitants both of the town and the neighbourhood.

Four miles north of Pind Dadun Khan are the mines of Keora, which yield a large proportion of the salt consumed in Upper India. The health of the men, women, and children who work together in large numbers in the mines varies much according to the time of year. At the end of the hot season they exhibit a very sickly sallow appearance, but towards the close of the cold season they regain a healthy look and have pretty much the same aspect as the population of the Punjaub towns. They suffer a good deal from sickness, brought on partly by the close, damp, hot atmosphere of the mines, and partly by the position of their villages, which are situated in the unhealthy district neighbouring on Pind Dadun Khan. Fever is very prevalent amongst them, and the attacks are commonly associated with enlargement of the spleen. Goitre also is excessively common amongst the mining population.

The Indus leaves the Salt Range below the town of Kalabagh, running at first in a confined rocky channel some 200 yards in width; but on reaching the plains it rapidly spreads out into a broad shallow stream which in flood time inundates the low land on either side for a space twelve or fifteen miles in breadth. On the eastern side of the river the low land, or 'Cutchee,' is bounded by a high bank, beyond which the arid plain of the 'Thal' stretches far away to the south.

Early in May the river begins to rise, and by the middle of June the channels which intersect the Cutchee in every direction are full to overflowing, and the whole of the land becomes a vast inundation. The water deposits over the surface from six inches to a foot of mud on which the crops are subsequently grown. Towards the end of July the river begins to subside, and by October has returned to its winter bed, leaving the Cutchee for the two following months an unhealthy swamp.

¹ *Sanitary Report, 1870, of the Punjaub.*

At the northern extremity of the Cutchee, almost opposite Kalabagh, is the town of Maree, where salt is worked out of solid cliffs of that substance. Kalabagh is built immediately above the gorge of the Indus, against the side of a hill of rock salt. This hill deposit is however no longer worked for salt, but alum is manufactured in considerable quantities in the neighbourhood, being obtained from the pyritous shales and clays of the nummulitic series which are found there. The same series produces the so-called Kalabagh coal, a lignite of variable purity which is found in seams of two or three feet in thickness associated with gypseous shales. What has been already said as to the health of the mining population at Keora applies to that of Kalabagh, and here as there goitre is exceedingly prevalent; indeed, in the Kalabagh mines there is hardly a single person who is not more or less the victim of this disease. Nor is the infliction confined to the mining districts alone, for throughout the whole of this range it exists in the villages scattered amongst the gorges of the mountains.

The later tertiary beds of the range are conglomerates, clays, and sandstones of the same general character as those of the Siwaliks. The older tertiaries consist of nummulitic limestone and associated beds of sandstones, shales, and clays. Below the tertiaries are a series of rocks which together represent a geological period of prodigious extent. At their base throughout the range from east to west extends a bed of salt marl of early palæozoic date, which contains the beds of rock salt whence the range takes its name. The base of the marl is nowhere seen, so that the thickness of the bed is unknown, excepting so far that it exceeds 1,500 feet. Beds of salt, gypsum, and dolomite are irregularly distributed through the marl, which owing to its softness and the solubility of its contents in water, has become strangely dislocated and mixed up with the more recent rocks. At the Keora (Khewra) mines the bed of salt is 550 feet in thickness in places, the bands which make up the bed are almost pure salt; in others small quantities of sulphate of lime and chlorides of calcium and magnesium are present. At the same mines is found a band six feet thick of chloride of potassium and sulphate of magnesia.

The marl¹ is succeeded in ascending order by from 250 to 400 feet of deep purple sandstone, and then comes the lowest band containing recognisable fossils, a belt of black shale with calcareous layers. The fossils are such as probably indicate marine conditions, and an early palæozoic period. Above the shale comes

¹ *Manual of Indian Geology*, p. xxiv.

another unfossiliferous bed, the magnesian sandstone, which, at the eastern end of the range, is succeeded by upper mesozoic or tertiary rocks.

Various changes take place in the series further west, and it is by no means certain how far the formations at the two ends of the range represent each other; but to the west the various unfossiliferous sandstones die out, and the salt marl is immediately overlaid by carboniferous limestone, and then again by triassic and Jurassic sand and limestones which underlie the tertiary rocks.

Looking to its geological conformation, Dr. Waagen suggests¹ that the Salt Range marks a portion of the limit of the old land of peninsular India.

The northern slopes of the Salt Range are drained by the Sohan, a river which rises in the Murree hills, runs parallel with the range at a distance of about thirty miles, and eventually falls into the Indus twelve miles above Kalabagh. Midway between the range, at about its centre, and the river, is the cantonment of Talagaon, a brief description of which will serve to illustrate the nature of the country immediately to the north of the Salt Range. The cantonment is situated on a plateau about 1,600 feet above sea-level, between two nullahs which skirt it east and west. Between that on the west and the cantonment is a considerable tract of low-lying cultivated land, which has been supposed to exercise an unhealthy influence on the place. The plateau itself is rather bare, and not so well wooded as is much of the neighbourhood. Travelling in any direction from Talagaon (Surgeon-Major Carter, in 'Bengal Army Medical Report' for 1869) the country presents a succession of fine open high plateaux, intersected by deep ravines, nullahs, and sandy beds of rivers, which after rain upon the hills carry down torrents of great force and speed to the Sohan. Hence there are here two conditions of land; one the high plateaux between the torrent beds, and the other the cultivated low sites where water is close to the surface and the soil is very fertile. But cultivation is not confined to the latter, for the high ground also yields large crops of wheat and barley, mustard and millet. The subsoil, which is chiefly of sand, and lower down of sand and gravel, is very porous, so that even after the heaviest rain the surface rapidly dries. Water is found on the plateaux at a great depth, varying from 100 to 150 feet. In the cantonments the wells are 136 feet deep, and yield an abundant supply of excellent water.

¹ *Manual of Indian Geology*, p. xxiv.

An analysis made in May 1871 by Surgeon Cookson gave the following results :—

Total solids, 28 grains per gallon.

Hardness, $25^{\circ}5 = 8.225$ grains per gallon, of carbonate of lime.

Permanent hardness, 11° .

Chlorine, .72 of a grain per gallon.

The climate of Talagaon is dry and healthy, and a pleasant one as compared with most of the stations north of the Jhelum ; it enjoys too a comparative immunity from chilling winds, and an equable cold season. The hot season does not begin till the middle of May, rain storms as a rule rendering the weather quite cool up to that date. The hot weather lasts till the middle of September. Though the thermometer ranges high in the hot season, the maximum temperature lasts only for an hour or two in the day, and does not produce the feeling of utter prostration which is complained of in many of the Punjaub stations. The nights are almost uniformly cool and pleasant. Autumn rains fall from July to October, sometimes in light showers, sometimes in torrents, and rain falls again in January and February, the yearly fall being from 20 to 30 inches.

Diseases. Autumnal fever, which extends from the middle of September to the middle of November, is the principal disease of the station, but it is of a very mild type. Bronchial affections are less prevalent here than at Jhelum. Goitre is almost unknown in the neighbourhood.

CHAPTER XXVIII.

RAWUL PINDI AND THE HAZARA.

Rawul Pindi, Attock, the Hazara country, Murree, Abbotabad. Rawul Pindi district, and cantonment. Attock. Rock series of the Northern Punjaub. Murree sanitarium, description, climate, diseases of; cholera at Murree. Abbotabad. Goitre in the Hazara country.

RAWUL PINDI. The district of Rawul Pindi occupies a considerable portion of the raised plain known as the Potwar or Rawul Pindi plateau, which extends northwards from the Salt Range to the hill country of the Hazara. On the south the district is bounded by the Jhelum district, on the north by the Hazara, and east and west respectively by the Jhelum and Indus rivers. The district is crossed diagonally by the Sohan river, which rises in the Murree hills and falls into the Indus at the south-west corner of the district, a little above Kalabagh.

The area of Rawul Pindi is 6,212 square miles, of which about 1,800 are cultivated or culturable. The crops are chiefly wheat, millets, barley, and maize; very little rice is grown. The population averages 114·5 to the square mile.

The plateau is raised about 1,000 feet above the general plain of the Punjaub. Geologically it is mainly composed of upper tertiary rocks, sandstones and clays, upon which rest extensive post-pliocene deposits of boulders, gravel, sand, and silt. North of the plateau, the Margalla and Chita Pahar hills, in which eocene (nummulitic limestone) rocks are largely developed, run across from the Murree hills to the Indus, and connect them geologically with the ranges which form the southern boundary of the Peshawur valley. About the centre of the plateau, twelve miles south-west of the station of Rawul Pindi, eocene deposits (upper nummulitic and hill nummulitic limestones) form another small range of hills, the Khairi Moorat hills (3,121 feet).¹

¹ *Manual of Indian Geology*, Chap. xx.

Along the south of the small ranges of hills just mentioned—the Chita Pahar and the Margalla—runs the line of division between the upper tertiaries (including the beds classed as upper nummulitics of the plateau) and the palæozoic and mesozoic beds, which will be mentioned presently, and the hill nummulitic limestone of the Hazara country.¹ This boundary line on the west runs first along the south of the Afridi hills, and after crossing the Rawul Pindi plateau to near the Jhelum, turns sharply to the north, runs up the valley of the river to Muzafirabad, about thirty miles north of Murree, and then turns sharply to the south-east along the flanks of the Kaijnag range in Kashmir.

As regards the tertiary rocks, the boundary is not an absolute one; for, as in the case of the Khairi Moorat hills, the older (hill) nummulitic limestone is in places found to the south of it, while newer tertiaries are in places found on the north of the line of general division.

To return to the plateau.² Its surface consists of an alluvial, rather light brown clay, often containing kunkur, and passing in places into fine silt. Beneath this alluvial deposit there is a mass of gravel and sand, sometimes enclosing boulders of large size.

The great military cantonment of Rawul Pindi is situated on the high road between the passage of the Jhelum at the station of that name, and that of the Indus at Attock, about sixty miles to the north-west of the former point. The cantonment is situated on a low ridge running east and west, and has an elevation of 1,737 feet above sea-level. The ridge drains on one side into the Leh, a tributary of the Sohan river, and on the other into a nullah which joins the Leh below the station. The native city, a populous and very dirty place, lies about a mile to the north of cantonments. The country about is well drained, for like the rest of the plateau it is cut up by deep ravines which carry off the surface water. Excepting in the immediate neighbourhood of the town, where the sides of the roads have been planted, it is sparsely wooded and poorly cultivated; the soil consists of a stratum of loam resting on red clay and sand, which overlies pebbles and conglomerate limestone boulders. Sandstone rocks crop up here and there about the station, and low hills, outliers of the Murree hills, run down into the neighbourhood. Water is found at a depth of from 60 to 100 feet, and the supply for cantonments is wholly from wells, as the water of the Leh is defiled

¹ *Manual of Indian Geology*, p. 483.

² *Ibid.* p. 515.

by the drainage of the native town. The water is rather hard, containing from 12 to 18 grains of carbonate of lime to the gallon (see table at p. 34), but is esteemed good, and is in ordinary seasons abundant in quantity.

Climate. The station is freely open to the winds, which are for the most part from the west or north-west, dry and healthy. From October to the middle of May the weather is very pleasant; then the hot winds begin to blow, and the weather is as a rule very hot till the rains set in in July. The rains continue, though often with long intervals between the falls, till the end of September, when the cold weather sets in. The cold is frequently very severe, especially about the time of the winter rains in January. (Meteorological tables in Appendix).

Diseases of the district. Malarious fever is the most prevalent disease amongst the troops and population generally, but the fever is usually of a mild type. Rheumatism is very common, and so also are respiratory diseases in the cold weather, especially amongst children. Dysentery may be brought on by exposure, but is not epidemic or endemic in the district or station. Small-pox appears almost every year in an epidemic form amongst the native population. Statistics of mortality and disease amongst the people, prisoners, and troops, will be found at pp. 84, 99, 101, 344.

Goitre is not a disease of the district generally, but is by no means uncommon in the northern part, about Hasan Abdal, which borders on the Hazara country.

Attock. About fifty miles west, and a little north of Rawul Pindi, commanding the point where the trunk road crosses the Indus to enter the Peshawur valley, is the fort of Attock. The fort was built by Akbar in 1581, and formerly included a considerable native city. The small hill on which it stands has an elevation of 1,210 feet above sea-level, and below it flows the rapid stream of the river, between precipitous banks, in a channel 540 feet in breadth. The rock is slate, which is traversed by veins containing a good deal of lime and magnesia, and iron-pyrites is scattered through it. The upper layers are full of cracks and fissures, and these and the intervening rock appear to have become charged, during centuries of native occupation of the site, with salts, the relics of sewage, and hence the water of the wells cut in the rock of the Upper Fort is exceedingly impure, containing a vast amount of chlorides, sulphates, and nitrates.¹ The best water is obtained from a well (No. 6), outside the fort, which is

¹ Dr. Center in *Fifth Report on Water Supply of Cantonments of Northern India*.

to a great extent divided by nullahs and reservoirs on both sides from the drainage of the fort. (For analyses, see table at p. 34.) The troops garrisoning the fort, European and native, suffer greatly from fever and bowel complaints, especially during the autumn months.

Cases of goitre are frequently treated at the dispensary attached to the fort, but they are for the most part travellers on their way to the Peshawur valley from the Hazara and that part of the Rawul Pindi district bordering on the Hazara where goitre is endemic.

About ten miles south-east of Attock, on the Campbellpore plain, is situated the cantonment of Campbellpore. It is occupied by European troops only.

The slates which form the Attock hill constitute the most prominent member of a group of rocks which is known to geologists as that of the Northern Punjaub. These rocks occupy the Hazara country, which lies to the east and north-east of Attock, on the north of the boundary line of the upper tertiaries which has been already mentioned. They form part of the Murree hills; the Margalla hills, which geographically are a continuation of the Murree hills; the Gandgarh hills lying to the north of the Margalla range; the Chita Pahar, Attock, and Cherat hills near the Indus; and the Afridi hills south of Peshawur. It is probable that the same group form the hills which bound the Peshawur valley on the north.¹ The rocks of the group, like those of the neighbouring Salt Range, comprehend a very extended series, eocene, mesozoic, and palæozoic; yet, and this is especially so in the case of the mesozoic rocks, they differ materially from those of the Salt Range, while they are connected in mineral character and fossils with the comparatively distant trans-Himalayan beds of Zaskar and Spiti.

The most extensively developed members of the group are the Attock slates and the hill type of nummulitic limestone. The former rest upon an immense thickness of rocks of the schistose series—quartzites, dolomites, and schistose beds passing down into gneiss of the crystalline series (probably a continuation of that of the Western Himalayas), on which in its turn the schistose series rests. These very ancient rocks occupy the north-western part of the Hazara, reach down to Torbela on the Indus, and are probably continued into the Yusufzaie hills—they are separated by a broad belt of Attock slates from the newer formations on the south-east.

¹ *Manual of Geology*, p. 483, and Chap. xxi.

The Attock slates consist of dark-coloured, irregularly cleaved slates, with limestones, some sandstones, and a few intrusions of basic trap. The slates are unfossiliferous; and the fossils that have been found in the associated beds have not been identified. The age therefore of these rocks remains unknown, excepting that they are certainly palæozoic, and possibly belong to the slate series of the Pir Panjal range. The Gandgarh hills are mainly composed of the Attock slates, while across the Indus they form the northern side of the Cherat hills south of Nowshera, and extend to the westward till they are lost near Julozai beneath the gravels of the Peshawur plain.¹ Upon the Attock slates, in the neighbourhood of Abbotabad, rest unfossiliferous sandstones, shales, and dolomites, probably infra-triassic; while in South-western Hazara the slates are overlaid by an immense thickness of unfossiliferous quartzites, slates, conglomerates, limestones, which together form a broad belt, in places eight miles broad from north to south, extending nearly east and west from the neighbourhood of Abbotabad to the Indus. The fossiliferous triassic beds which succeed—limestones, magnesian in part, shales and sandstones—are considered to be representatives of the triassic beds of Spiti. They are well developed between Murree and Abbotabad, and are probably represented by the massive contorted limestones of the Chita Pahar range, and of the detached ridges along the southern side of the ranges south of Attock and Nowshera.

Above the triassic beds, in the South Hazara country, are found jet black shales, and sandstones which by their mineral character, and the fossils they contain, have been identified with the upper jurassic deposits of the Spiti valley. These deposits, though not largely developed, are found in the Chumba hill, north of Murree, in the Margalla and Chita Pahar hills, and have been traced across the Indus into the Afridi country, where they are met with in the hills north of Kohat.

In Mount Sirbán near Abbotabad, the rocks of which,² according to the authors of the 'Manual of Indian Geology,' present an epitome of the geology of the Northern Punjab, a thin bed of sandstones, which fossils prove to be cretaceous, rests above the jurassic rocks, and is succeeded by an unfossiliferous bed of limestone which may belong to the cretaceous or to the succeeding nummulitic deposits. Cretaceous rocks have been hitherto recognised in only one other locality in the Northern Punjab, in the

¹ *Manual of Geology*, p. 500.

² *Ibid.* p. 498.

hills near Kohat, where a fossiliferous sandy limestone contains some fossils recognised by Dr. Waagen as of cretaceous age.¹

The hill nummulitic limestone which succeeds is described as 'a dark bluish grey or blackish limestone with olive-brown shales. The rock is generally foetid and massive, with nodular bands, but thick zones of pale grey splintery limestone also occur. Stratification is sometimes distinct but often obscure.' In colour and structure the rock differs from the eocene limestone of the Salt Range, but the distinction is one which may be due to physical changes experienced by the northern rocks. This limestone forms a broad belt throughout Hazara and the Murree hills, from the neighbourhood of Abbotabad through the Chita Pahar hills to the Nilabgarh and Afridi hills, ranges which are all chiefly composed of this formation.

Murree,² a hill station and convalescent dépôt for European troops, is situated near the western termination of the Himalayas, north lat. $33^{\circ} 40'$, east long. $73^{\circ} 8'$, about twelve miles from the right bank of the Jhelum river, which in this part of course flows nearly south, and forms the boundary between British territory and Cashmere. The station is gained by a road from the plains viâ Rawul Pindi, from which place it is distant in a direct line about twenty-eight miles, and by road forty miles. During the season the European population averages about 1,600, and the native about 9,000.

The Murree range commences as a somewhat detached ridge on the west bank of the Jhelum, takes a south-westerly direction, and terminates in low ridges which run down into the Rawul Pindi plain. From the river the range gradually rises, and attains its maximum elevation, 7,457 feet above sea-level, at the site of the station. The country around is altogether mountainous, but none of the adjacent peaks attain any very great elevation; the highest, about six miles north of the station, rises to 8,746 feet. The hills are for the most part richly wooded with forest trees such as pines, oaks, horse chestnut, walnut, and rhododendron. The valleys are well cultivated, and watered by numerous streams which feed a good deal of irrigation. The crops are chiefly wheat, maize, barley, and rice, but the cultivation of the latter grain is prohibited within a mile of the station.

¹ *Manual of Geology*, p. 504.

² 'Murree; its Topography and Medical History,' *Indian Annals of Medicine*, 1854; 'Murree Sanitarium,' by Dr. Ince, *Indian Medical Gazette*, February, 1871; Dr. Bellew, in vol. ii. of *Report of 1863 on Sanitary State of Army in India*; *Report on Water Supply of Murree*, by Dr. Center.

The geological formation of the station ridge belongs to the middle and older tertiaries (Nahun, Kussowlie, Dugshaie groups), and consists of alternate layers of hard grey and purplish sandstone, containing a good deal of lime and magnesia, and of an indurated red clay. The latter easily disintegrates, and forms the fine red clay which covers most of the surface of the ground. The general inclination of the strata is to the north-west; but many slips, faults, and curvatures exist amongst them. Immediately to the north-west of the station ridge, the sandstone comes into contact and mingles with nummulitic limestone which probably represents the Subathoo beds. The slope of the ridge on both sides is considerable; that to the south-east almost precipitous, that to the north-west more gentle. The drainage on the north is into a tributary of the Hurroo river, that of the southern valley into the Sohan river. The southern slope is bare, or at the most shrubby; the northern slope is finely wooded.

The station extends nearly west and east, at elevations varying from 7,000 to 7,500 feet, from the high peak called 'Pindi View,' to the end of the ridge about three miles distant, where there is another peak on the Cashmere road known as 'Cashmere Point.' The European houses are clustered round 'Pindi View,' and along the ridge, principally on the northern slope, to the Cashmere Peak, where the houses lie on both sides the ridge. The bazaar (native portion of the station) is on the southern slope, about midway between the peaks. The position is a confined one, screened from the wind on three sides by higher ground; many of the houses are built against the hill side and are much crowded; within too they are crowded to an almost incredible degree by the native occupants. Fortunately, owing to the precipitous character of the site, its natural drainage is very good, and since 1876, when the bazaar was destroyed by a fire, its conservancy has been greatly improved.

The barracks of the convalescent dépôt are placed just above and a little to the west of the bazaar. The Clifden Barracks are situated some way down the northern slope, below Pindi View. Other barracks are also on the northern slope about 1,000 feet below the centre of the crest of the ridge. The Lawrence Asylum is situated on the northern slope, below Pindi View and west of the Clifden Barracks.

The view from the station is on all sides very fine; to the east on a clear day may be seen the lofty ranges which north and south bound the Cashmere valley, to the west the hills and valleys of the Hazara, and beyond the distant mountains which bound the

Peshawur valley, while to the south-west extends the Rawul Pindi plain, in which the towns of Rawul Pindi and Rhotas can be distinguished.

Owing to the considerable slope of the ridge, drainage runs off very quickly, and there can be no stagnation of surface water in any part of the station. The numerous watercourses which seam the hill side serve as natural sewers, and are thoroughly scoured by the heavy rainfall. Only here and there, behind some big boulder, may foul puddles be discovered, but, writes Dr. de Renzy, 'though the air about the watercourses is not so foul as to be very distinctly perceptible to the sense of smell, its inhalation, as I have experienced more than once, has a very depressing effect upon the system.' However, Murree as regards surface cleanliness is in advance of other Punjaub sanitarium.

The subjoined analysis is from the sanitary report of the Civil Surgeon (Dr. Gray) for 1877. He remarks that the waters were taken for analysis when at their best, when rain had not fallen for a considerable time.

	Sources					
	Bhistis' Ghat No. 1	Peach-wood No. 2	Ellerslie No. 3	Frank-ville No. 4	Nutwood No. 5	Bazar No. 6
Total hardness . . .	15.1	7.5	12.8	11.	14.	12.9
Permanent hardness . .	5.5	3.7	3.	2.7	2.7	2.5
Total solid, grains per gallon	18.2	20.86	21.28	22.26	19.6	26.6
Free ammonia, grains per gallon	.0112	.0154	.0198	.0084	.007	.0056
Albuminoid ammonia, grains per gallon	.0098	.0112	.009	.0098	.0091	.007
Chlorides as NaCl, grains per gallon	2.7846	1.9656	1.9656	1.9656	1.9656	1.9656
Amount of oxygen for easily oxidisable matter, per gallon	.0119	.0028	.0098	.0098	.0028	.0028
Amount of oxygen, grains required for less easily oxidisable matter, per gallon	.0238	.0168	.0238	.0238	.0168	.0168
Nitric acid, grains per gallon	.38955	.20776	.5394	.57134	.18179	.2597

Remarks.—From the quantitative analysis the waters appear very uniform, with the singular exception of No. 2 having so much less hardness than the others; the total solids being the average.

The water supply, excepting during a prolonged hot season, is abundant, and the water, though somewhat hard, is in its natural state fairly good. The water for domestic purposes is taken from tanks fed by the numerous springs which emerge from the hill side.

Unfortunately many of the springs are situated in watercourses which serve both as sewers to the station and as latrines to the natives, and these are therefore exceedingly open to pollution. Dr. de Renzy, in the report already quoted, states that in his opinion the liability of the water supply to pollution is the cardinal defect in the sanitary arrangements of Murree. Many schemes, such as tunnelling the rock, forming impounding reservoirs, utilising the rainfall on the roofs of the houses, have been proposed for the improvement and increase of the supply.

Climate. The upper part of Murree is open and is freely exposed to the winds, but the lower part of the station is sheltered from the east and north-east winds of winter and spring, and from the damp east and south-east winds of summer, while it is open to the wholesome west and north-west winds. The yearly rainfall is heavy, averaging 65 inches, and owing to this circumstance, and to the presence of heavy forest and over-dense vegetation on the station and the neighbouring hills, Murree suffers from damp. The winter is not so severe as an ordinary English winter, yet it is so far rigorous as to oblige the discontinuance of the station as a convalescent dépôt during the winter months. Winter sets in about the middle of December, when snow begins to fall heavily, and the falls continue during the succeeding three months. Excepting during stormy weather with easterly winds, the air is at this time bracing and the climate is calculated to improve the health of visitors from the plains who are not suffering from organic disease or very great debility. Spring sets in during March with frequent storms of sleet, hail, and rain, followed by fine sunny weather. April is mild and balmy, in May the weather becomes rather warm, and in June it is decidedly hot during the middle-day; the sun's rays are then very powerful, the atmosphere is often very hazy. Towards the end of June the rains set in, and continue till the middle of September. At this season dense fogs are very common. Autumn follows, and is the most pleasant and the healthiest season of the year. The meteorological data of the station are given in Table No. XXIII. of the Appendix.

Diseases. The rainy season is the unhealthy time of the year at Murree, when bowel complaints, rheumatism, fevers, originate or exacerbate, and organic visceral affections which may have improved during the spring are very liable to become aggravated. On this account Dr. Bellew recommends that patients suffering from those complaints should be removed to Rawul Pindi before the rains set in. The Murree fevers are usually of a mild intermit-

tent kind, but fever of a very severe remittent type occasionally visits Europeans, and is by no means uncommon amongst the native cultivators of the surrounding valleys. Diarrhœa is perhaps the most frequent disease which originates at Murree amongst Europeans, but it is neither so common nor so virulent at Murree as at the Simla group of stations.

During the cold season, the natives suffer a good deal from chest affections.

Goitre is not a disease of the inhabitants of Murree itself, but it is very common amongst the natives of the surrounding country.

The good health of the children in the Lawrence Asylum at Murree says much for the general healthiness of the station and the natural excellence of its climate. 'During the five years ending with 1873 the average strength of the boys and girls in the Institution has been, boys sixty-eight, girls fifty-eight; the daily sick to strength per cent. has been, boys 2·76, girls 1·55; only two deaths occurred during that period, one from pneumonia, one from dysentery. The good health of the children is the more remarkable as they are mostly recruited from the unhealthy station of Peshawur.'¹

Of late years Murree has been scourged by visitations of cholera which have included both the civil populations and the troops. The first visitation occurred in July and August of 1858, another occurred in 1868 at the same season of the year, a third in August of 1872, and a fourth in July 1876. As regards the meteorology of the cholera seasons Dr. Bellew, in the Sanitary Report for 1876, remarks: 'On the last occasion (1876), as on the previous occasions of the appearance of cholera at Murree, the weather during the whole course of the epidemic has been characterised by an oppressive, close, and sultry condition of the atmosphere, which has been more or less densely obscured by frequent mists and fogs; whilst unusually heavy rains, with occasional storms of thunder and lightning, but little or no wind, have occurred to make up the sum of the most apparent meteorological phenomena of the season.'²

Dr. Bellew states that in his tour through Murree, Rawul Pindi, and the Hazara districts, he investigated altogether, exclusive of those which had occurred in Murree itself, 276 cases of cholera, and the result of his enquiry led to the following conclusions:—

¹ *Report of Sanitary Commissioner of Punjaub for 1873.*

² *Punjaub Sanitary Report for 1876, p. 39.*

‘First.—That the disease or its cause was not imported into Murree, but originated there independently.

‘Second.—That it became localised there as a centre of activity, and also subsequently in other places similarly conditioned as to density of population, such as Rawal Pindi, Harripur, &c.

‘Third.—That it was spread by means of atmospheric influences aided by the direct action of cholera dejecta from the human body, as well as by errors in diet, clothing, and bodily exertion.

‘In support of the first conclusion, no case of cholera is known to have occurred anywhere within the districts named until after the appearance of the disease at Murree.

‘The second conclusion is borne out by the fact that in a large number of cases the disease was conveyed to outlying villages by persons coming directly from the centres of its activity, and themselves being the first and very often the only ones to suffer an attack of it.

‘The third conclusion is supported by the facts of the different results of its known direct importation into different localities, showing that where the atmospheric conditions were unsuitable—whether the population was dense or scattered, well situated as to sanitary conditions or the reverse—the disease failed to spread, whereas where the atmospheric influences were favourable to its development, the disease rapidly spread.

‘But why the atmospheric influences of one locality should prove favourable to the development of cholera, and those of another and perhaps contiguous locality unfavourable, I am not prepared to explain, any more than I am to explain why the atmospheric moisture should collect into a cloud in one spot in the sky, and not in the spot contiguous to it, or why a thunder-storm should sweep along one line and not in the line parallel to or athwart it.

‘Whatever its causes, however, cholera owes its spread or its check to the defective or the sound bodily health respectively of the members of the community amongst which it appears. It is in fact the health-condition of the subject himself, and not the mere circumstances of his surroundings alone, which determines the activity of the disease. That is to say, the more perfect and sound the standard of individual health the more complete the immunity from this terrible disease. The mass of its victims is always from amongst the poor, ill-fed, scantily clothed, and hard-worked, with now and again the intemperate and careless.’¹

¹ *Report*, p. 40.

*Abbotabad.*¹ The huge Bára Lachá (Zanskar) chain of the Western Himalayas, starting from above the junction of the Spiti and Sutlej rivers, runs north-west to the Indus, forming the north eastern-boundary of Cashmere, and terminates in the great peak of Nunga Purbat. Thence spurs of comparatively low elevation take a south-westerly direction, and of these one follows the bearing of the right bank of the Jhelum, and another that of the left bank of the Indus. Between these two spurs or ranges is confined the narrow valley of Khagan, and subsequently the Hazara country into which that valley spreads. The Hazara, as a British district, is bounded on the south by the district of Rawul Pindi, and east and west by the Jhelum and Indus rivers respectively. The whole tract undulates with ridges, so that out of a total area of some 3,000 square miles, scarcely more than a tenth is level, and only about one-fifth is culturable. The valleys are but of very small extent, many of them, like that of Khagan, are indeed mere rocky glens traversed by a mountain stream.

About the centre of the district is the valley of Abbotabad, so called from the station of that name, where is maintained a large force of native troops with a view to overawing the turbulent and warlike tribes of the surrounding mountains. The area of the valley is about thirty square miles, and its height above sea-level about 4,000 feet. It is almost surrounded by hills, the chief breaks occurring north and south where the main roads enter the valley. East and north-east the hills have a very considerable elevation, rising to a height of 9,000 feet; to the south and south-west they are not nearly so lofty. West of the valley the hills are chiefly composed of slates and green sandstone (Attock slates), while those to the east are of hill nummulitic limestone.² The land at the base of the eastern hills is low and flat; springs rise to the surface here and there, and a marsh of some extent, which has been drained since British occupation, formerly occupied this part of the valley.

The valley is drained by a tributary of the Indus which intersects it from east to west. The soil of the valley is alluvial clay overlying a stratum of rounded pebbles; it is very fertile, and, well watered by a plentiful rainfall, yields fine crops of maize, wheat, barley, and rice. The inhabitants are a healthy, hardy race, albeit very filthy in their abodes and habits.

¹ 'Abbotabad,' by Dr. Tuson, in No. xix. of the *Indian Annals of Medicine*.

² *Manual of Indian Geology*, pp. 500 and 512.

The station of Abbotabad is situated on elevated sloping ground, intersected by numerous nullahs which render the natural drainage very perfect. Cultivation is carried on close up to the station, and the immediate neighbourhood is well wooded.

Climate. From the end of November to the end of March the weather is cold, and for a part of the time cloudy and wet, with a northerly wind, and occasionally a fall of snow. From April to the beginning of the rains the weather is hot, but moderated by a cool northerly breeze which generally sets in about ten A.M. and continues throughout the day. July, August, and September are the rainy months; the fall in that season averages 20 inches. The total fall of the year averages 46 inches, rain falling every month excepting in October and November, which are as a rule cloudless, cold, and bracing. The mean maximum temperature of January, the coldest month of the year, is 56·5; the mean minimum 27·2. The corresponding means of June, the hottest month of the year, are respectively 98 and 61·6. The summer temperature is, writes Dr. Skene, too high for patients who need a bracing climate, but affords great relief from the heat of the plains to patients suffering from chronic bowel and liver complaints, for whom the colder and more changeable climate of more elevated stations is ill adapted.

The water supply of the station is wholly from wells, and is good and abundant. (Analyses in table at p. 34.)

Abbotabad is considered on the whole a healthy station for the troops, though malarious fever, ordinarily of a mild type, is very prevalent, especially towards the end of the rains. Diseases of the respiratory organs are prevalent during the cold season, and the station in common with other frontier stations suffers from fatal outbursts of pneumonia or pleuro-pneumonia which are not confined to the cold season. Bowel complaints are not very common, and in the opinion of medical officers would be still less so if it were possible to keep the numerous ravines which intersect the neighbourhood of the station, and the surrounding fields, in a cleanly state.¹

Amongst the natives of the valley malarious fever is very prevalent, and is commonly associated with spleen disease.

Goitre is very common throughout the district, and especially amongst the inhabitants of the Khagan valley. There whole families, and even whole villages, suffer from it.

¹ For statistics of disease, see tables at pp. 84 and 346.

CHAPTER XXIX.

THE PESHAWUR VALLEY.

Peshawur valley. City and cantonments of Peshawur; climate of the valley. *Murdan*; *Nowshera*; *Cherat sanitarium*. Peshawur, diseases of; tables of sickness and mortality amongst the troops, with notes; Peshawur fever; the choleraic type of fever. Dr. Morton on the fever and its results. Causes of the fever, climatic, specific. Goitre in the Peshawur valley and in *Swat*.

PESHAWUR.¹ The Indus, between Torbela and its confluence with the Kabul river at Attock, a distance of about thirty-five miles, flows in a divided stream, and here forms the eastern boundary of the Peshawur valley, which extends westwards from the river some seventy miles to the base of the Khyber hills. The general elevation of the valley is about one thousand one hundred feet above the sea; its area is 2,400 square miles; on all sides but the east it is bounded by hills varying from 2,000 to 7,000 feet in height, the most lofty of which are those to the north and west. Those on the south, the Khuttuck hills, are an offshoot from the Safed Koh, and sweep round to the Indus at Attock, forming a deep pocket in the south-western corner of the valley, at the bottom of which is the entrance to the Kohat Pass. The north-eastern part of the valley is much broken up by spurs and outlying low hills from the mountain mass bounding it in that direction. About fifteen miles to the east of the entrance to the Khyber Pass, which traverses the hills of that name, is the city of Peshawur, almost under the shadow of the Tarturra mountain (6,862 feet). The Kabul river enters the valley twenty-five miles to the north-west of Peshawur, and has an easterly

¹ Dr. Lyell, 'On recent Epidemic Fever (1852-53) in the Yoosufzaie district,' in vol. ii. of *Indian Annals of Medicine*; Notes by Dr. Center on Medical Topography of parts of the Jhelum division, in Appendix to *Report on Sanitary State of Native Army of Bengal* for 1868; Report by Dr. Ince on Cholera in the Peshawur valley, in Appendix to *Report for 1869 of the Sanitary Commissioner of the Punjab*; Paper by Deputy Surgeon-General Morton, M.D., on the Peshawur Fever of 1870, in Appendix to *Report for that year on Sanitary State of Bengal Army*.

and somewhat southerly course to its confluence with the Indus at Attock. About thirty miles from the foot of the Khyber hills it receives the Swat and Bara rivers, the former from the north-west, the latter from the south-west. The triangular space included between the hills and the converging courses of those rivers is superabundantly watered by their branches, as well as by a perfect network of irrigation canals. Along the Kabul river, on both banks, are thousands of acres of reedy swamps, but the remainder of this tract is richly cultivated, and is densely populated.

The general aspect of the hills on the north and west of the valley is wild, barren, and uninviting; no trees of any kind are to be found upon their surface, and the scanty vegetation is almost imperceptible except upon a near approach; but at the base of the Khuttuck hills there is a strip of jungle, while evergreen plants such as wild olive and camel thorn flourish upon their slopes. The hills are of metamorphic rocks, slates, clay, and limestone schists. At their base are wide shingly slopes of the same material, cut across by the beds of numerous torrents, and here and there covered by a deep layer of culturable marshy soil. The soil of the valley is for the most part a very retentive clay; in some places sand predominates, and in others are tracts of saline soil which throws up an abundant saline efflorescence upon its surface. Through the greater portion of the valley the water level is at a considerable depth, so that irrigation from wells is impracticable.

The bottom of the valley is very flat, and probably at one time formed the bottom of a coextensive lake; there is a general slope to the east amounting on the whole to about two hundred feet, and there are subordinate slopes south and north towards the Kabul. The banks of that river in the upper part of its course are sandy, shallow, and shifting, edged by many broad marshes, but in the lower part of its course the banks are high and the channel well-defined.

Of the whole area, 1,270 square miles are cultivated, and of the rest, 588 miles are unculturable. The principal crops are wheat, barley, maize, millets, and, in the western districts, rice. The valley is almost barren of trees; only here and there are any found beside a well or watercourse, or where they have been planted by the British in and about the cantonments. The population averages 221 to the square mile, but while it is dense in the western portion of the valley, over the remainder and larger portion it is scattered and scanty. The people are almost all

Pathans, speaking Pushtoo—a strong healthy race, brave, fanatical, and warlike.

The valley is divided into four districts: the well-watered Doaba lying between the Swat and Kabul rivers; the Peshawur district, which occupies the valley south of the Kabul river, and is subdivided by the Bara river; the Hustnuggur, a narrow strip of fertile land which runs along the left bank of the Swat river, and is separated from the Yoosufzai district, which occupies the remainder of the valley, by a desert tract, 'the Myra.' The city of Peshawur is situated in that part of the district of the same name which lies between the Bara and Kabul rivers, in the most highly cultivated part of the valley; the remainder of this district, that between the Kabul river and the base of the Kuttuck hills, is for the most part stony and barren.

Other military cantonments in the valley are Nowshera on the south bank of the Kabul, twenty-four miles east of Peshawur; Murdan in the Yoosufzai district, fifteen miles north of Nowshera; and outposts, amongst which are Fort Mackeson at the entrance of the Kohat Pass, and the Doaba outposts, Fort Michni at the debouch of the Kabul; Fort Shubkudur in the plain eight miles east and a little north of Michni, and Fort Abazai near the debouch of the Swat river. The hill station of Cherat is on the Kuttuck hills in a direct line about twenty miles south-east of Peshawur.

The cantonment, fort, and city of Peshawur are situated in the angle between the Bara and Kabul rivers, about three miles distant from the former and twelve from the main stream of the latter. The cantonment, three miles in length and a mile in breadth, is situated on a ridge, at its highest point less than one hundred feet above the general level. The ridge runs from south-west to north-east, and slopes in the same direction. At the north-east end of the cantonment is the fort, and immediately on the east of this and the adjacent portion of the cantonment, is the native city.

The cantonment is spacious, and is divided along its length by a broad road which with the other roads is lined with trees; the drainage is naturally good, and sanitary arrangements are, with one important exception, carefully attended to. The soil is a stiff impervious clay, extending to a great depth, cold and damp; it supports, as in the gardens attached to the houses, a luxuriant vegetation fostered by the over-abundant supply of water which a channel from the Bara river supplies. The site was formerly in great part cultivated, and was renowned for its fertility; many

villages were included in it, and scattered amongst them numerous burial-grounds, one of which, of great size, belonged to the neighbouring city. The spring level varies in different parts of the station; thus to the north-east it is almost level with the surface, while in other places it is at a depth of above one hundred feet. The country around is very low, and is cultivated right up to the cantonment boundary. On the north were formerly two great marshes; one of them, the nearest, has been filled up, though the site still remains very moist; the other, known as the 'Artillery jheel,' about a mile from the station, still remains. But indeed the whole of the surrounding lands, when not naturally such, are artificially converted into a permanent swamp by the industry of the cultivators.

The water supply is partly from wells, but mainly from an open channel from the Bara river, eight miles in length. Beside this channel are situated three large villages, seven burial-grounds, and the stream works thirty-seven mills. The main channel gives off numerous distributories to various parts of the station—mere ditches scooped in the clay, open to, and receiving, pollutions of every conceivable description. In the station there are about fifty miles of these channels, alternately full and empty; in the latter state exposing beds saturated with filthy mud which is occasionally cleared out and laid along the margins. It is a matter of astonishment, says Deputy Surgeon-General Banister,¹ that the pernicious effects of water so notoriously unfit for drinking are not more distinctly striking and pronounced. Works are now (1877) in progress for the supply of the station with filtered water from the river through a covered aqueduct.

The water of the station wells is fairly good, indeed that of deep wells such as Mackeson's may be pronounced very good. (For analyses, see table at p. 38.)

The native city is a large, irregularly built place, the houses much huddled together, and the streets with few exceptions very narrow. It is surrounded by a mud wall, immediately without which are orchards of apple, peach, and plums, and cultivated land irrigated by many water channels. The site of the city is a very old one, for the place has from early antiquity held great military and commercial importance from its position on the high road between India and Affghanistan. The population is about 60,000, and is a very mixed one, of Pathans, Persians, Kashmeries, Hindkies, Punjaubies, Hindoos, and others. Formerly the town was

¹ *Report for 1873*, p. 183.

eminently filthy, but of late years a great deal has been done by the British authorities in the way of cleansing it and enforcing sanitary measures. Still the town remains exceedingly unhealthy—cholera is there frequently—small-pox, diarrhœa, and dysentery are very fatal, and most kinds of fever are endemic. Spleen disease is very common amongst the inhabitants. The water supply is partly from wells, most of which are fearfully open to pollution, but the chief water source is a channel from the Bara river which receives a good deal of drainage from the cantonment before it enters the city, and in the city itself a vast amount of sewage. The water to sight and smell is disgustingly foul, yet the people prefer it on account of its softness to the well water.

Climate. Until the year 1876 the Peshawur valley had no organised Government Observatory, but meteorological observations have from time to time been very carefully made and recorded by medical officers stationed in the valley. Such were those made by Dr. Hugh Clerk, of the Bengal Artillery, in 1861, and by Surgeon-Major Duke, of the Royal Artillery, in 1873. Dr. Hugh Clerk's observations were made four times daily. Major Duke states that the observations made during 1873 may be thoroughly depended on. The instruments were freely exposed in the verandah of the R.A. hospital, but were otherwise well shaded. The returns for 1876, the first year of the foundation of the Government Observatory, are incomplete; those for 1877 have been very kindly furnished by Mr. Blandford in anticipation of the publication of the annual report.

The cool season may be said to extend from the beginning of November to the end of April. Punkahs are usually left off in the first week of October, and are not again needed till the beginning of May. During this season the weather is cold and bracing, and very enjoyable to those who are sufficiently strong to bear its rigour. During December, January, and the early part of February the cold is very great; snow lies upon the neighbouring hills, but rarely if ever falls in the valley. Hailstorms frequently occur in the spring and in the autumn. The prevalent winds are from the west and north-west, and are bitterly cold, and very trying to all who are in weak health. The first quarter of the year is the season of the winter rains which are more constant than those of the summer; the mean humidity of the atmosphere is at this period considerable.

Spring begins early, and by the end of February the peach and pomegranate trees blossom luxuriantly. During April the day

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	The year	Authority
Mean temperature	1861 49.0 1873 49 1877 49.4	54.0 59 49	61.7° 65 60.8	75.5° 77 66.8	86.0 78 78.9	92.0 93 85.4	92.2° 93 89.7	89.8° 87 87.9	84.9° 84 82.	71.3° 70 69.2	59.6 60 60.5	53.3° — 50.9	72.5° — 69.	Dr. H. Clerk Surgeon-Maj. Duke Mr. Blandford
Highest maximum	1876 —	—	—	—	110	114	113	104.5	98	93	82	74.6	—	"
Lowest minimum	1876 —	—	—	—	58.5	64	71.	68.	58.	51	39.	34.5	—	"
Mean of maximum	1873 56	66	73	88	88	104	102	94	83	80	72	—	—	"
Mean of minimum	1876 —	—	—	—	91.5	89.7	91.5	95.6	93.5	90.	76.5	67.4	—	Surgeon-Maj. Duke Mr. Blandford
Mean daily range.	1877 61. 1873 41	62 47	75 55	78.6 66	93.3 70	102.5 83	105 85	105 80	97.3 75	83.7 58	73.3 49	62.3	—	"
Rainfall in inches.	1876 —	—	—	—	76.3	79.4	78.3	80.2	77.	70.	60.8	53.3	—	"
Average of 10 years	1877 40.7 1873 15	39. 19	49.4 18	58.2 22	67.4 18	72.8 21	77.3 17	75.5 14	69.8 18	58.6 22	52.6 23	44.2	—	"
Number of days rain fell	1876 —	—	—	—	29.5	29.6	21.2	18.3	26.	25.	26.	28	—	"
Mean humidity	1877 20 1873 2.74	23 .7	25.5 1.9	20.4 .4	26 1.64	29.7 .02	28 1.22	29.5 .67	27.5 .21	25 .48	20.7 .24	18	10.2	Dr. Hugh Clerk
Mean vapour ten- sion	1876 82 1873 80	62 71	50 64	40 57	36 54	53 35	61 65	66 77	60 90	82 89	44 83	68	—	From minima
Mean cloud .	1876 —	—	—	—	51	53	78	81	81	82	80	86	—	"
Mean wind resultant	1877 73 1873 .26	66 .23	62 .34	68 .45	49 .47	42 .5	40 .54	38 .49	45 .47	57 .4	79 .37	74 .28	—	Cloudless sky = 0.
General direction of wind	1877 5. 1873 20 S.	4.1 13 S.	3.2 21 S.	5.1 27 N.	2.8 30 N.	2. 46 S.	1.1 50 N.	2.3 38 N.	2.5 36 N.	2.7 47 S.	4.9 28 S.	6.6 21 S.	—	"
Mean wind velocity	1877 36 1873 29.024	89 28.945	92 .834	96 .793	97 .623	99 .472	114 .387	114 .449	91 .620	88 .853	70 .952	84 .968	—	"

temperature rises rapidly, but is not unpleasantly great; the night temperature continues low. May is a hot month, and from about its termination on to the end of September the heat is excessive—June is the hottest month, the temperature during the daytime often rising in the shade above 110° . The ground is dry and parched, and there is almost no rain or cloud, and often scarce any motion of the air to moderate the sufferings from a heat which is persistent day and night. An occasional dust storm or thunderstorm affords temporary relief. East and south-east winds are those which most generally prevail; but hot winds blow frequently for two or three days together during June and the early part of July, coming down sometimes from the Khyber like a blast from a furnace. As the heat increases, a blue haze, due to the condensation of the moisture in the upper regions of the atmosphere, forms and interferes with radiation. It is at the climax of this period, about the end of June or the beginning of July, that heat apoplexy takes its victims. Ardent or rather ephemeral fevers are common, but not malarious fever.¹

From about the middle of July to the end of September is the period of the rains; too often, however, the rain is *nil*, or so small in quantity that the day-heat continues almost unabated. As a rule, after the middle of September a reduction in the night temperature is marked; the diurnal range of temperature becomes great, while cold winds from the west and north-west begin, and a damp night air strikes raw and cold to the feelings.

So far as vegetation is concerned, autumn begins in August, when the leaves of the trees begin to fall, and during September the marshes are drying up. Malarious fevers begin to prevail in August, and are at their maximum in September and October.

Murdañ. This station is situated upon the left bank of the Culpani, a river which rises in the Swat mountains on the north of the valley, and empties itself into the Kabool river. The station occupies a very central position in the valley, and as we shall presently see, presents physical characters which differ considerably from those that characterise the Peshawur district. The district is high, freely open to the prevailing wind from the entrance of the valley, and though the surface is partially cultivated, it is as a whole bare and sandy, dependent almost entirely upon the rains for cultivation, for the rivers which traverse it are for the most part dry excepting during the rains, and all run in beds so far below the general surface that they cannot be used for irrigation. The

¹ *Center*, p. xi.

spring level too is deep, so that well irrigation can be but little resorted to. On the north and east of the station the country is much broken by spurs running down from the Swat range. The country immediately around Murdan is open; the soil is a dry sandy loam, free from stagnant water or swamp, and, fertilised by the winter rains, yields fine crops of wheat and barley, which in March and April cover the plain with a sheet of green.¹ The autumn crops, like the summer rains on which they depend, are uncertain. The annual rainfall is heavier than at Peshawur. In May and June the heat is very great, but by no means so oppressive as at Peshawur; the cold in winter is very severe, the thermometer some nights in January falling to 20°–25° Fahr.

Mean temperature	1873	1874	1875	1876	Mean of 4 years
January	47·01°	46·71°	46·90°	46·02°	46·66°
February	54·42	52·14	49·31	51·37	51·80
March	63·42	57·93	64·83	60·67	61·71
April	77·31	69·64	75·46	68·66	72·76
May	77·37	81·75	66·54	81·35	76·75
June	90·68	98·18	88·88	84·88	90·65
July	90·54	85·70	87·72	86·54	87·62
August	84·96	82·38	82·02	83·46	83·20
September	82·87	78·06	82·91	80·08	80·98
October	69·08	68·12	66·02	69·51	68·18
November	59·20	54·70	57·36	58·44	57·42
December	50·66	47·66	51·86	50·83	50·25
Total rainfall	23·95	21·60	42·30	30·54	29·59

The water supply of the station is from wells, and is abundant and good; for some purposes that of the Culpani is also used.²

The autumn fever at Murdan is usually of a mild kind, and uncomplicated by sequelæ of a serious nature. The district is healthy as compared with Peshawur, but, as in 1852–53 and 1869–70, is occasionally ravaged by epidemic fever of a severe type. In 1852–53 a low-lying marshy tract at a little distance to the west of Murdan was most severely visited, the fever carrying off upwards of 8,000 people out of a population of 55,000.³ The fever appears to have been the ordinary malarious fever of the country, aggravated by the peculiar, though undetermined conditions which give rise to a year of epidemic fever in Northern India, and by the dirt of the inhabitants and their dwellings.

¹ Surgeon-Major Johnson, *Medical and Sanitary Report of Native Army* for 1870.

² See table at p. 38.

³ See Dr. Lyall's admirable *Report* already referred to.

Though the cold weather is very severe, the native troops at Murdan are comparatively free from pneumonia, a circumstance which has been attributed to the care taken to see that the men are warmly clad when off duty and at night, but which must also depend upon the dry and bracing character of the climate as compared with that of Peshawur, and the mild character of the autumnal sickness.¹

Nowshera. This cantonment is situated on an open sandy plain, on the south bank of the Kabul river, about twenty-five miles to the east of Peshawur. South and west of the cantonment are low sandy hills, outliers of the Khuttuck range; to the east is an open plain, and on the north, about half a mile distant, is the river. The site is a new one. The neighbourhood is very sparsely inhabited, and vegetation both natural and artificial is very scanty. Trees have been planted along the cantonment roads. The soil is sand and clay to a depth of thirty or forty feet, when a stratum of sand and pebbles is reached from which the station wells draw their supply. The depth of water in them is not affected by the rise and fall of the river, considerable though it is. The water supply is ample, and the water is of good quality. (Analyses in table at p. 38.)

The natural drainage of the site is excellent, for the ground is intersected by deep nullahs which rapidly drain off the rainfall, and the artificial system is very complete. There are no marshes in the neighbourhood, but the expanse of sand and mud which the autumnal fall of the river leaves has been occasionally mentioned by medical officers in their reports as a source of malaria.

The climate is very extreme, the heat intense in summer and the winter bitterly cold, frost and cold winds making the latter season very trying, especially to those who are liable to affections of the respiratory system. The diurnal range of temperature is very great; winds are far more continuous and constant than at Peshawur. The rainfall, spring and autumn, is variable and uncertain.

The station is unquestionably a far healthier one than Peshawur, and the contrast would be even more marked if it were not that outpost duty very much adds to the sick rate of Nowshera. Fever is the cause of the greatest number of admissions to hospital, then dysentery, and, in the cold season, diseases of the respiratory organs. The Nowshera fever is rarely of the same severe type as

¹ Report by Surgeon Kelly, in *Medical and Sanitary Report of Native Army* for 1875.

that which is so common at Peshawur. In the Annual Report for 1877 Surgeon-Major R. Power writes: 'One would be led to suppose, from the great variation of temperature between the hot and cold weather, and the variation even in the single day, that malarious fevers would prevail here; but the other conditions, viz. water and vegetable decomposition, necessary to its generation are wanting, and Nowshera enjoys an immunity from fevers which unhappily does not exist in any other part of the valley. There are no marshes; there is generally some perceptible movement of the air; the water supply is abundant and good; the soil is sandy and porous, and without organic matter. There is no water in subterranean streams near the surface, very little evaporation, no over-crowding, and consequently there is very little malaria.'

The station enjoys a most happy immunity from the cholera which is so frequently localised in Peshawur.

*Cherat.*¹ About twenty miles south-east of Peshawur, on the Kbuttock range, at an elevation of 4,300 feet above sea-level, is the hill station of Cherat, a station which promises to be of great value as a sanitarium to the troops in the Peshawur valley. The range runs nearly due east and west, with spurs running north and south on either side. The southern face is comparatively abrupt, and is composed chiefly of limestone which has been almost denuded of soil, and is consequently very barren. The northern face slopes in spurs of clay slate intersected by limestone, and here the débris of the slate has formed a soil in which wild olive, camel thorn, and other plants flourish, while after rain it supports a luxuriant growth of grass and herbage.

In the ravines in the neighbourhood of the station are several villages inhabited by Pathans, a stalwart, healthy race, hard-working and peaceably disposed. Small patches of cultivation are found here and there where there is soil, and water for irrigation, but the hills yield little beyond wood for charcoal, and all supplies must be brought from a distance.

The station, situated on a narrow rocky ridge, extends east and west for a distance of about a mile and a half. The surface is very irregular, depressions filled with alluvial soil separating four rocky eminences. The natural drainage is excellent, and as all excreta and sewage are disposed of outside the hills, the inside presents a large area from which surface water might be collected and stored. It is hoped that eventually tanks will be provided which may be

¹ This sketch of Cherat is condensed from the *Medico-topographical Report on Cherat for the season of 1874*, by Surgeon-Major Knaggs, 1-17th Regiment.

replenished during the rains, and will materially supplement the present supply, the sources of which, though abundant, are inconveniently distant.

The water supply is from three tanks fed by springs which issue from the clay slate. They are from one to three miles distant from the station, and unfortunately the most abundant spring, the one which has to be relied on during the hot season, is the most distant. The water was analysed by Dr. Hunt in 1871 with the following results:—

Total solids	39.2	grains per gallon
Total hardness	32.2°	
Permanent	16.8°	
Lime	8.42	grains per gallon
Magnesia	3.5	„ „

Climate. The climate as compared with that of Peshawur is delightful; no stillness of the atmosphere, but generally a refreshing breeze from the north-west or south-east in the hottest day of summer, so that even in tents life is bearable, though the heat may be very great. The nights are always cool and refreshing, and sleep, undisturbed by heat or mosquitoes, is very grateful to the invalid, who is in a new world when he has left the punkahs and tatties, thermantidotes, mosquitoes, sandflies, and boils of Peshawur. 'The change,' writes Surgeon-Major Knaggs, 'effected even in a few days is marvellous; the exhaustion which is so apparent vanishes at once under the influence of the dry cool air, and the pale clammy countenance regains something of its tone and life almost at once; though the anæmia or cachexia of long-standing constitutional disease is not of course removed for a considerable time.'

Cherat	1873; in a tent							1874					
								Sunrise			4 P.M.		
	Mean temperature	Highest of the month	Lowest of the month	Absolute range	Mean of maxima	Mean of minima	Mean daily range	Mean maximum	Highest maximum	Lowest maximum	Mean maximum	Highest maximum	Lowest maximum
May	79	94	66	28	89	70	19	—	—	—	—	—	—
June	83	103	60	43	93	74	19	74	83	66	87	95	72
July	79	100	52	48	89	70	19	73	79	68	79	89	70
August	79	98	63	35	91	68	23	72	78	63	80	85	65
September	74	89	59	30	83	66	17	70	75	65	80	82	71
October	61	82	46	36	70	52	18	64	69	46	73	78	67
November	63	74	52	22	71	55	16	—	—	—	—	—	—

Thunder and wind storms were common. Rain fell on 23 days; amount collected 13 inches.

The table shows the temperature during the season, May to November, in 1873 and 1874. In 1874 north-west winds prevailed till towards the end of May; thence till the middle of September south-easterly winds, after which westerly and north-westerly winds predominated. The autumn rains are pretty regular.

About the middle of September the cold weather sets in, and from thence onwards till May the climate is too cold for sickly men.

Diseases. There are, writes the authority already quoted, no local sources of disease at Cherat. The station is above the malarial influences of the valley, and original admissions for ague and fever are very rare. There is not at Cherat the liability to the congestions or bowel disorders which are common in the higher ranges where the rainfall and variations of temperature and moisture are considerable, for patients are not here exposed to sudden or extreme ranges of temperature, and the air even at night is dry. Chronic cases of diarrhoea and dysentery sent up from the plains do not however do well. As a rule they relapse. Diseases of the lungs and liver usually improve. The recovery after acute diseases was, in the cases witnessed by Dr. Knaggs, 'simply astonishing.'

In the Annual Report for 1874, the Sanitary Commissioner with the Government of India writes: 'The occupation of Cherat in a sanitary point of view has been most successful,' 'and there can be no question that this hill has proved of great value to the health of the troops in the valley;' and Dr. Bryden writes, 'notwithstanding this special cause of mortality (enteric fever, an outbreak of which originated in the sanitarium), Cherat has hitherto admirably fulfilled the purposes on account of which its occupation was urged.'¹

Diseases of Peshawur. The tables at pp. 82, 83, and 457, compiled from the Annual Reports of the Sanitary Commissioner with the Government of India, and from Dr. Bryden's 'Vital Statistics of the Bengal Presidency,' exhibit the proportion in which the chief diseases contribute to the admission rate and mortality amongst the native troops in the Peshawur valley; and the following table gives statistics of the disease amongst the British troops at Peshawur for the period 1860-69.

As regards Peshawur, both in the case of Europeans and natives fevers far surpass all other diseases in sending patients to hospital; next follow bowel complaints, dysentery, and diarrhoea; then

¹ *Statistical Report, 1878.*

Peshawar. European troops. Number of admissions to hospital each month of the ten-year period 1860-69.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Admitted per 1,000 of strength	Total deaths during the 10 years
Cholera	—	—	—	—	163	107	78	14	321	78	6	—	40·6	467
Smallpox	5	—	2	1	—	1	2	—	—	—	3	4	1·	—
Fever, intermittent	955	505	427	588	1205	1073	1129	1351	1701	3736	3924	2420	1008·	22
„ Remittent and continued	62	69	96	327	2195	1559	1587	1441	1805	1243	283	93	570	68
Apoplexy	—	—	—	1	1	7	33	12	6	1	1	—	3·3	36
Dysentery	33	34	25	41	42	67	92	120	129	108	67	71	44·	42
Diarrhoea	77	66	87	125	192	227	468	449	306	233	131	155	133·	7
Hepatitis	68	71	106	92	74	89	90	81	85	81	47	72	51·	44
Spleen (6 years)	8	5	4	3	10	2	4	6	6	4	4	—	—	—
Respiratory diseases	157	160	164	101	75	96	90	92	71	88	137	204	76·	13
Rheumatism	111	107	139	113	82	78	69	66	70	75	75	117	58·4	—
All causes	2422	2023	2219	2552	5070	4219	4668	4586	5242	6295	5344	4036	—	785
„ per 1,000 of strength .	123	97	111	134·5	265·4	230·5	259·5	257·4	302	362	301	190	2580	41·6

Average of aggregate strength 18,870.

Peshawar and outposts. Fever prevalence among native troops.

	1867		1868		1869		1870		1871		1872		1873		1874		1875		1876		1877	
	Rainfall	Daily sick per 1,000 of strength	Rainfall	Daily sick per 1,000 of strength	Rainfall	Daily sick per 1,000 of strength	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever
January	—	4.02	.3	5.04	1.7	3.71	1.1	167	.1	197	1.5	141	2.74	87	4.8	137	—	354	—	213	3.2	243
February . . . . .	.5	3.67	.2	3.64	.9	2.58	.2	89	5.9	99	.7	110	.66	64	—	86	3.3	161	—	177	2.5	166
March . . . . .	.4	2.84	2.3	3.85	2.3	2.29	1.1	115	.4	73	2.1	80	1.89	69	1.4	115	1.4	142	—	101	1.1	128
April	2.7	2.12	3.6	3.12	.2	1.88	1.1	155	1.4	79	2.2	67	.4	98	.6	156	—	132	1.3	107	6.2	107
May . . . . .	.8	2.27	.4	2.98	—	2.89	—	268	—	156	1.7	71	1.64	124	—	187	.8	132	.01	191	—	231
June	—	2.76	—	3.25	.7	3.56	—	237	.7	92	.1	67	.02	158	—	188	—	121	—	174	—	239
July	—	3.36	.5	3.32	—	3.91	—	251	3.1	109	2.7	92	1.22	150	2.4	227	4.9	97	3.8	211	—	266
August	3.1	2.74	—	4.32	.9	7.66	3.6	520	—	153	5.1	251	.67	251	5.4	168	4.6	222	2.5	492	—	173
September	—	7.31	1.	4.82	7.	14.17	.8	1268	—	224	.4	860	.21	1139	.5	660	.4	717	.2	928	—	250
October	—	18.14	—	6.32	1.6	22.81	—	1366	—	581	—	1074	.48	1396	—	1247	1.	1102	.9	1533	.4	1085
November	—	22.48	—	8.43	—	16.59	—	1131	—	438	—	526	.24	752	—	1005	1.5	1266	.5	925	8.0	675
December . . . . .	.4	10.35	3.4	5.59	—	9.93	.4	323	.6	167	—	232	—	410	—	657	.7	411	.3	444	4.1	193
The year	7.9		11.7		15.3		8.3		11.3		16.5		10.17		15.1		18.6		9.51		25.5	
Admissions per 1,000 for fever	1691		863		1932		1608		671		1052		1389		1390		1430		1588		1111	
Admissions per 1,000 for all diseases	2301		1529		2680		2399		1319		1465		1947		1994		2008		2372		1682	
Strength	4393		4062		3380		3664		3530		3555		3382		3483		3397		3462		3381	
Rainfall, and admissions for fever of the autumn season July-November	—	—	—	—	—	—	4.4	4536	3.1	1505	8.2	2803	2.82	3688	7.8	3307	12.4	3304	7.9	4089	0.4	2449

NOTES UPON TABLE OF PREVIOUS PAGE.

1868. An unusually healthy year. Summer not so distressingly hot as is common, stifling heat and atmospheric stagnancy for which Peshawur is notorious, absent; atmosphere clearer and less muggy; autumn comparatively dry, and the cold season set in early.¹

1869. Excessive sickness this year amongst both European and native troops. Cholera was epidemic during September and October, and during those months and November fever and dysentery were unusually prevalent.² All classes suffered, nor did neighbouring stations, elevated and usually healthy, Campbellpore, Sydun Bowlie, Rawul Pindee, escape the fever epidemic. The weather was exceptionally hot at the time when the epidemic was at its height, and from the middle of September till the end of the year a mist was observed to settle over the lower parts of the station after sunset. The days were hot and close, the nights cold and damp, when cholera broke out about the middle of September in the 25th Regiment N.I. Heavy rain in September and October.³

1870. Another unhealthy year. Troops and people alike suffered from fever, dysentery, and asthenic pneumonia. Nothing peculiar in the climate this year. Rainfall in August heavy; light in September; none in October or November.

1871. A healthy year. Fever cases comparatively few, and of a mild type, as a rule uncomplicated by the splenic disease which was so common in 1869 and 1870. The hot season was an unusually mild one; rain fell frequently during the hot months June and July; no rain in August and the next three months.

1872. A good deal of fever, but that as a rule of a mild type. The Deputy Surgeon-General considers the year, barring an outbreak of cholera which affected the troops and city in October, rather above the average in salubrity. On the whole a cool year, excepting June, which was very hot. Rainfall of the year heavy. Much rain in July and August, little in September, none after that till end of year. The early part of October was calm, and as far as sky and temperature the weather would have been considered fine when cholera broke out on the 7th; the outbreak ceased in its severity after October 21 and 22, on both of which days violent westerly gales blew.

1873. A healthy year at Peshawur; no epidemic and less than the usual amount of sickness among the civil population. The fever cases among the troops were numerous, but as a rule of a mild type. Nothing very unusual in the climate; perhaps the heat from June to September less oppressive than some years. Rainfall of the year moderate. Moderate fall in July; light in August, September, October, and November.⁴

1874. Not an unhealthy year. No epidemic; fever cases as a rule of a mild type. Heat not excessive. Rainfall of July and August heavy; slight in September; none subsequently.

1875. Not an unhealthy year; autumnal fever of a mild type; no epidemic. July and August very damp, with much rain; little rain in September; slight rain in October, November, and December.

1876. A cholera and fever year; much rain in July and August.

1877. A healthy year; good health of the men attributed to the absence of rain and the moderate temperature of the autumnal season, and to the circumstance that a large proportion of them were away from the station on duty with various expeditionary forces.

¹ Report by Surgeon J. J. Clarke.

² Report by Surgeon G. A. Watson.

³ Surgeon J. Knox.

⁴ Report by Surgeon-Major W. E. Caird.

diseases of the respiratory organs; then amongst the European troops, rheumatism, hepatitis, cholera; and amongst the natives, rheumatism, spleen. Though not separated in the table, boils and ulcers are the cause of a considerable percentage of admissions.

Amongst the Europeans, the principal cause of mortality during the ten-year period, was, first cholera, then, in order, fevers, hepatitis, dysentery, apoplexy; amongst the natives during the five-year period the order runs, respiratory diseases, fevers, dysentery, cholera, diarrhœa.

The table p. 457 shows the number of admissions amongst the native troops, and the rainfall each month, of the years 1870-1877, and the rainfall, and admissions for all causes (fever not being at the time separated in the published returns) per 1,000 of strength, for the three preceding years.

Among European troops the fever season is from the middle of September to the middle of December; and during the hot months, May, June, and July, there is a marked rise in the daily admissions, owing to the prevalence of ardent fevers. Amongst the natives, who by birth and breeding are inured to the great heat, there is not this rise during the hot months; but their autumn fever begins earlier, late in August or early in September, is at its maximum in October, and terminates in November.

As regards the character of the fever,¹ the greater number of cases are of the intermittent type, but many cases of a remittent and continued character also present themselves, and in a bad fever year, both in their number and severity, become the feature of the outbreak. The fever is usually attended with great derangement of the spleen and liver; jaundice is a frequent concomitant. The patient is left very weak and anæmic, with much-impaired digestion and often with diarrhœa. Towards the latter part of the season dysentery is frequently associated with the fever, while pneumonia and bronchitis are too often fatal sequelæ towards the end of the year, such attacks ensuing amongst patients reduced by fever on the slightest exposure. From the end of December till the end of January is especially the pneumonia season.

Surgeon-Major Curran, A.M.D.,² describes as follows the more aggravated or choleraic type of Peshawur fever. 'A specific paroxysmal fever which begins with a feeling of superficial chilliness, or general rigor, and lasts from one to twenty-four hours or more.

¹ *Vide* Dr. Lyell's paper.

² *Indian Annals of Medicine*, vol. xviii. 1876.

Its onset induces great constitutional anxiety and depression, and its progress is characterised by much gastric irritability, frequent watery, bilious, or blood-stained stools, cold clammy surface, cramps of the extremities, and other symptoms that simulate cholera. Its termination is by resolution or collapse, and recovery from it is generally rapid, and almost always without febrile reaction. The cerebral sensibility, though often diminished, is rarely suppressed, and the most striking pathological features disclosed by death are congestion of the brain and lungs, and, to a lesser degree, of the liver and other abdominal viscera.'

Mr. Curran's experience as to the rapidity of recovery in these cases agrees with that of the late Dr. Purefoy Colles,¹ who, after considerable experience of frontier fever, writes: 'In my experience, those cases which commence with choleroïd symptoms are, in their subsequent course, if not unusually mild, certainly not severe.'

Amongst the natives of the valley the autumnal fever is far more prevalent where there is much irrigation than amongst those living in higher and drier parts. But the residents do not suffer so severely as do strangers coming amongst them; and so it is with the native troops, the regiments suffer less the second and third years of their stay in the valley than the first, when invariably half or two-thirds of the men are placed upon the ineffective list by fever. Yet it is not clear in the case of the troops whether this comparative exemption from fever is due to the men having become accustomed to the climate, or to the weakly members having been removed by death or invaliding during the first year.

However, though the attacks of fever are as a rule less severe amongst the natives of the valley than amongst the troops, they suffer greatly from the sequelæ of the disease, especially from spleen, which seems to be as common amongst them as it is amongst the inhabitants of the worst portions of the irrigated tracts of the Doab. Thus, Dr. Morton says:—² 'It is the low-lying portion which gives to the Peshawur valley its unhealthy name. Here the Peshawur fever may truly be said to be endemic. The higher tracts by no means partake of the same unhealthy characteristics. The inhabitants of each present such marked contrasts that the most inexperienced eye can distinguish them at a glance. The Civil Surgeon of Peshawur

¹ *Medical and Sanitary Report of Native Army of Bengal* for 1871, p. 280.

² Deputy Surgeon-General Morton, *Report on Peshawur fever*, in Appendix to *Medical and Sanitary Report of the Native Army of Bengal* for 1870.

informs me that as the result of many measurements, he puts down the inhabitants of the low-lying districts, the Daoodzye, as averaging 5 feet 3½ inches in height, whilst in the Yoosufzye and other high level tracts, the average height is at least 5 feet 7 inches, and in either case there is a corresponding physique. In the fever-stricken portion of the valley, again, nearly every case of post-mortem examination shows a diseased and enlarged liver and spleen. It is very rare indeed to find a single individual perfectly sound in these viscera. The Surgeon at Peshawur has kept a record of the weight of a great number of these spleens, as shown in their post-mortem examinations. Looking over this record a few days ago, I was struck by the circumstance that, from long being accustomed to witness enlargements of the spleen from five to ten times the natural size, the Civil Surgeon notes all which are only double or triple the normal weight as "slightly enlarged."

A feature in the history of the Peshawur fever is that it prevails every year; 'one year,' says Dr. Morton, in the report just quoted, 'is perhaps a little more, another a little less unhealthy, but all years undeniably bad.' 'Peshawur is essentially a fever-stricken, cholera-infected locality,¹ in which any length of residence involves so much damage to health that its continued occupation can be justified only on the grounds of political and military considerations of the highest importance. The same sad story repeats itself from year to year, and becomes the dismal heritage of every native regiment of the garrison. Arriving in fair average, or haply robust health, one after another successively departs, after three years' residence, a wreck and shadow of its former strength and efficiency. Death has hurried many away, numbers have been admitted to pension; some have retired, and others have gone to their homes for change of air. Striplings take the place of old familiar faces, and all are enfeebled by nervous exhaustion or some other form of bodily suffering, such as gravid spleens, diseased livers, or lungs impaired in resiliency and function.'

Of no other station in Northern India is the evil report so strong and so persistent as of Peshawur, and the question arises on what circumstances does its extreme unhealthiness depend? Are they to be found in defects of local sanitation, or in the meteorological conditions of the locality, or in conditions pre-eminently developed around Peshawur, which the malarial theory teaches foster the production of marsh miasm?

¹ Deputy Surgeon-General Banister, in *Medical and Sanitary Report on Native Army of Bengal* for 1873, p. 183.

The sanitation of the station, water supply excepted, is not at fault. The water of the canal is very bad, and its foul and often infected water must be reckoned one of the causes of disease amongst those who use it; but inasmuch as the Europeans, and some of the native troops, use the uncontaminated water of certain wells, this condition can be counted but as a partial factor in the unhealthiness of the station.

As to the influence of meteorological conditions, neither the extreme and persistent heat of Peshawur nor the extent of the diurnal range of temperature are sufficient to account for the trying nature of the climate, for these are surpassed in other and comparatively speaking healthy stations of the Punjaub. Nor does the rainfall exert any uniform influence on the health of particular years; this is clear from Table III. and the appended notes. Indeed the rainfall at its maximum at Peshawur is but a drop in the bucket when compared with the flood of water which the irrigation canals pour upon the land. The stillness, almost stagnation, of the atmosphere is a peculiar feature in the climate of Peshawur, and one which is most trying to the system, and it is curious to find at the very opposite extremity of India, at the end of the Assam valley, a medical officer commenting upon the existence of this feature there, and insisting on its trying character: 'In a climate like this, where humidity is at its maximum, and where for hours there is scarcely a perceptible movement of the air, the temperature at 91° is almost unbearable. We are fortunate in not having it for many days together above 90° Fahr.'¹

But at Peshawur we find the stagnant, humid atmosphere of Assam, and with this persists a temperature which is for days, weeks, even months together, far higher than that complained of in Assam, and beyond doubt this hot, stagnant atmosphere must have a very depressing effect upon the system, putting it at the mercy of any, even the slightest extrinsic influence, such as a chill, an injury, a drink of foul water, the effects of which a well-braced system would repel.

Another feature in the climate of Peshawur is the dampness of the atmosphere during the autumn, which possibly causes confinement of surface heat during the day, and certainly renders any sudden fall of temperature after sunset far more chilling than thermometrical changes can indicate. Constantly do we find medical

¹ Dr. Curran, in *Medical and Sanitary Report of Native Army of Bengal*, 1873, p. 35.

officers ascribing attacks of fever to chill caused by the raw cold of the night air, or by chilling blasts from the hills.

Therefore, in the meteorological conditions of Peshawur, especially in the damp cold nights of autumn, following days still very hot, and acting upon systems enervated by the preceding summer, we find some explanation of the unhealthiness of the autumn. Yet conditions of climate do not alone appear to constitute a cause sufficient to account for the almost universal prevalence of autumn sickness amongst men and officers, natives and Europeans, who are well clothed and fed and housed, and provided in every way that experience teaches is beneficial to enable the system to withstand climatic influences: for the contrast as regards the fever returns between Peshawur and Nowshera: nor for the frequency with which apparently healthy individuals are suddenly struck with fever under circumstances which render the seizure far more like the effect of a dose of poison than the result of the influence of meteorological changes.

But the autumnal sickness of Peshawur is quite explained if we connect the enervating influences of the summer climate, and the liability to checked elimination from the cold night air and chilling blasts of autumn, with the presence of marsh miasm in air and water, miasm generated in the marshy land around the station throughout the hot season, but with especial virulence during the drying-up season of August and September.

Under the malefic influences of malaria and climate, acting together through the long summer, the health of a vast number of the men is slowly sapped; of these some fail early, others a slender store of vitality carries on till a virulent autumn miasm or the chilling winds cut them down. Fortunate are those who survive, and maintain sufficient strength to be benefited by the fine climate of the cold season.

Goitre in the Peshawur valley. The Peshawur valley presents us with another remarkable instance of a locality in which some forms of malarious disease are eminently rife, while goitre is practically unknown. Dr. Ince mentions in his report that he had made careful inquiry regarding the existence of goitre in the valley, and that he had satisfied himself that the disease is very rarely met with. He could hear of only thirteen cases, and these were all in the eastern portion of the valley, and consequently not far distant from the Hazara country where the disease is very prevalent. Later, special reports confirm Dr. Ince's statement. Two of them mention the prevalency of goitre in the Swat valley.

This is a long narrow valley which lies to the north of Peshawur and is traversed by the Swat river. The river fertilises the land on either side, enabling the inhabitants to grow immense quantities of rice along the banks where they have been cleared of the forest which elsewhere clothes the sides of the valley. Dr. Lyall describes Swat as a very fertile district, producing most abundant crops of rice ; but fever, he says, is remarkably prevalent amongst the inhabitants, and those of them whom he had seen showed the characters of a sallow sickly race. That it is no peculiarity in the water of the Swat river which causes goitre in the valley is clear from the fact that of the many dwellers by that river after it has entered the Peshawur valley, none suffer from the disease.

CHAPTER XXX.

KOHAT, BUNNOO, DERA ISMAEL KHAN, DERA GHAZEE KHAN.

Trans-Indus districts of *Kohat, Bunnoo, Dera Ismael Khan, Dera Ghazee Khan*; description of the districts; their climate and diseases. *Sheikh Budeen* sanitarium. Goitre in *Tank*.

KOHAT. The Kohat district lies between the Indus on the east and the northern termination of the Suleiman range on the west. On the north it is separated from the Peshawur valley by hills belonging to the Sufed Koh range. The whole district is occupied by the broken ridges and intervening valleys which, on the north of the Bunnoo plain, run east and west between the Indus and the Affghan frontier. The area of the district is 2,838 square miles, of which only 251 are cultivated, and of the remainder by far the larger portion is a barren unculturable waste.

Kohat, a military cantonment and native town, is situated about thirty miles south of Peshawur, on a stony outlier of the ridge which on the north bounds the long narrow valley through which the Tovey river flows on its way to join the Indus. The hills around are very barren, and are for the most part of nummulitic and upper tertiary formation; the upper tertiaries covering a very large portion of the district. In the hills immediately to the north of Kohat, Jurassic and cretaceous rocks have been identified, but the rocks are mainly tertiary, upper middle and lower. In the hills south of Kohat, between that district and Bunnoo, huge beds of rock salt, covered by gypsum and associated clays and shales, are found at the base¹ of the eocene deposits. At Bahadoor Keyl, forty miles south-west of the town of Kohat, where there is a fort garrisoned by detachments from the Kohat cantonments, rock salt is seen for a distance of eight miles, and the thickness exposed exceeds 1,000 feet, the width of the outcrop being sometimes more than a quarter of a mile; its base is not seen. These beds

¹ *Manual of Geology*, pp. 503 and 508.

of salt are distant only about twenty miles from those of the Salt range, yet there is good reason to believe that they belong to a different and much later (probably eocene) geological series, for not only do they differ in appearance, and in the absence of potassium and magnesium salts, from the beds of the Salt range, but moreover the eocene beds rest conformably upon them, while in the Salt range a great series of mesozoic and palæozoic beds intervenes.

The station is situated about three miles north of the Tovey, and is mainly on some high ground formerly used as a graveyard to the town; a portion of it is however in low ground, swampy and with bad drainage. The native town, with a population of about 6,000, is situated close to cantonments, on the western side.

The natural vegetation in the neighbourhood is very meagre, but owing to a plentiful water supply, derived partly from the river, and partly from fine springs which burst from the high ground on the north of the station, artificial cultivation is abundant, and the soil, which in the lower grounds is alluvial and very retentive of moisture, yields good crops of maize, bajra, wheat, barley, cotton, and sugarcane. The station is beautifully wooded, and when approached from the Peshawur road ¹ presents a most picturesque appearance, being embowered in a rich mass of vegetation which contrasts strongly with the arid stony country around.

The water supply of the station and city is mainly derived from 'the springs' which flow from the base of a slight elevation of stony conglomerate, upon which stand the ruins of some ancient building, about half a mile distant from the cantonments. The supply is very abundant, and runs through the station and the neighbourhood in canals which provide a good deal of irrigation in their vicinity. The water at the source is very pure, and that required for drinking purposes is now carried to its destination through a well-protected covered aqueduct. Other sources of supply are the wells, two of which, in the fort and jail respectively, yield fairly good water,² and a canal from the Tovey river—one of the many which supply the town and its outskirts; this water is however very much polluted, and its use for drinking purposes is forbidden by the authorities.

Climate. The mean temperature is given as follows by Messrs. Schlagintweit (mean of 1851, 1855, and 1856).

¹ Dr. Whitwell, in *Eighth Report on Water Supply of Cantonments*.

² Analyses in table at p. 40.

	Mean temperature	Rainfall, mean of 9 years
January	51·8°	1·2
February	59·4	1·9
March	68·7	2·3
April	76	1·3
May	86·7	1·3
June	91·3	·8
July	90	4·2
August	87·6	3·5
September	86·7	2·4
October	78·	·4
November	62·	·2
December	57·6	·5
The year	74·7	20

The climate is an extreme one both in respect to the seasonal and diurnal range of temperature, and is at the same time very changeable. In winter, from November to March, a dry keen wind blows straight down from the Snowy range through the Hungoo, or more correctly Kuchai, valley, and is at times piercingly cold, especially in the early mornings, and very trying to weakly systems.

This 'Hungoo breeze,' as it is called, is felt so soon as the sun sets, and continues till eight or nine o'clock the following morning ; but it is hardly noticed during the height of the hot season or during the rains.

From March to June the dry heat is exhilarating ; showers fall pretty regularly every twenty days in May, June, and July, and then the rains, if they merit such a designation, set in. From August to October the valley is damp and unhealthy, owing to an occasional damp south-east wind, intermitting rain, and retentive subsoil. In October and November the contrast between the heat of the day and the cold of the night is very great, but the cold season, to those who are sufficiently strong to withstand the effects of the cold wind, is pleasant and invigorating.¹

Diseases. The principal diseases of Kohat are malarious fevers, bowel complaints, and diseases of the chest ; the latter class of affections is common in the winter, especially amongst those who have been weakened by the fevers of the previous autumn. The fever is chiefly intermittent quotidian, and the attacks are as a rule very persistent, recurring again and again in the autumn, and often through the winter months. As at Peshawur, the attack of fever is not unfrequently ushered in by choleraic symp-

¹ Dr. Johnston, in *Report* already quoted.

toms; and enlargement of the spleen, and other sequelæ, commonly follow the attacks.

The cases of fever¹ begin to multiply towards the end of August, increase rapidly in September, and reach their maximum in October. The admissions per 1,000 of strength are almost as numerous as at Peshawur, but the fever is not so severe either directly or in its after effects. The field for the development of malaria is not so widespread as is that of Peshawur, but on the other hand the Hungoo breeze is a more persistent extrinsic cause of attacks than the cold blasts of irregular frequency which visit Peshawur during the autumn nights. Happily however for the inhabitants of Kohat, the weather which immediately precedes the fever season is not of that depressing character which marks the corresponding period at Peshawur.

Cholera has at times visited the station, causing heavy mortality in the town and cantonments.

Goitre is almost unknown amongst the inhabitants of the valley and the neighbouring hills.

The Civil Surgeon,² in his Sanitary Report for 1877, gives a woeful account of the insanitary state of the town of Kohat, where among the abuses enumerated are wells open to pollution, drains in some cases mere elongated cesspools, swamps of green foetid stagnant water, dirty ponds and ditches full of green and stagnant water, human excrement and offal in a decomposing state lying about in the streets; and he continues, 'it is scarcely wonderful that with the sanitary defects above described, Kohat should enjoy such an evil sanitary reputation.' Typhoid fever seems to be on the increase in the town, and is becoming common even amongst European officers and their families.³

*Bunnoo.*⁴ The district of Bunnoo lies to the south of Kohat, and stretches eastwards from the frontier of Affghanistan across the Indus into the Sind Saugor Doab. The area of the district is 3,150 square miles, of which about one-fourth is cultivated, and of the remainder the greater portion is an unculturable waste.

That part of the district which lies across the Indus, together with the districts to the south, Dera Ismael Khan and Dera Ghazee Khan, constitute the Derajat, the long narrow strip of

¹ See statistics in table at pp. 82 and 83.

² *Punjab Sanitary Report* for 1877, p. 80.

³ *Ibid.* p. 80.

⁴ For this account of Bunnoo I am mainly indebted to the very full and able report of the late Dr. Purefoy Colles, published in the *Report for 1871 on the Medical and Sanitary State of the Native Army of Bengal*.

country which intervenes between the Indus and the Suleiman range of hills.

The valley of Bunnoo, including Bunnoo proper and Marwat, is of an irregularly oval shape, and measures about sixty miles from north to south and thirty-five from east to west. The valley is completely hill-girt, excepting where the rivers enter or leave through narrow passes; of these passes the principal are those near the north-west angle, which admit the Koorum, Gumbeyla or Tochi, and Wach Baran rivers; and one which gives exit to the combined stream of the rivers just named near the south-eastern angle of the valley. The rivers just mentioned are the only permanent streams which the valley possesses, but their course is joined by innumerable nullahs, the beds of streams which are for a few hours at a time during the season of the rains roaring torrents, and for the rest of the year dry beds of sand and gravel. Before entering Bunnoo the Koorum drains the valley of the same name, and thence its waters bring down a rich deposit which is most valuable to the cultivators of Bunnoo.

The most lofty of the surrounding hills are those to the west and north-west. The former belong to the Suleiman range, and reach an elevation of 6,000 feet; the latter are the hills of the Waziri country which stretch east and west between Bunnoo and Kohat. On the east of the valley, north of the break made by the Koorum river, are the Chichali or Shingarh hills; south of the break the range is double in a direction parallel to the course of the Indus. The outer range is known as the Kafirkot or Rota Roh; the inner is the Sheikh Budeen range. The Sheikh Budeen range, to the west of the peak of that name, completes the southern boundary of the valley, running up into the Suleiman range under the name of the Bhuttanee hills. The hills on the south of the valley are, with the exception of the peak of Sheikh Budeen, of low elevation, not exceeding 2,500 feet.

The whole of the southern hills, with the exception of Sheikh Budeen itself,¹ are believed to consist of later tertiary strata,¹ as are also the north-western slopes of the Rota Roh. A broad tract to the west of the Bunnoo plain, the Waziree country north of Bunnoo, and the western slopes of the Chichali hills are similarly composed, so that the newer Siwalik beds entirely surround and probably underlie the Bunnoo plain. The soil of the valley is composed of beds of gravel, covered in most places by a layer of clay of varying thickness.

¹ *Manual of Geology*, p. 514.

It abounds in salts, such as chloride of sodium and carbonate and sulphate of soda; hence nearly all the well water is brackish, and its use tends to produce a scorbutic condition of the blood. East and west of the valley stony table-lands called the 'Thalls' skirt the base of the mountain ranges. Excepting in Bunnoo proper, which constitutes the north-western part of the valley, vegetation is scanty, and the natural surface affords nothing but pasture for cattle.

Bunnoo proper, in all its characteristics, presents a marked contrast to the rest of the valley. The soil consists of a tenacious clay, remarkably fertile, and with resources which are well developed by the aid of an abundant water supply which a perfect network of irrigation channels dispenses from the Koorum and the Tochi rivers. Instead of a rolling prairie or stony plateau, Bunnoo proper is a well-wooded verdant country, covered with large and prosperous villages.

The most fertile part is a strip of land about seven miles long and two broad, which lies between the hills and the north bank of the Koorum, and an island about a mile long and half a mile broad, situated in the bed of the river shortly after its escape from the hills.

Bunnoo, or Edwardesabad, a native town and military cantonment, is situated in a *cul de sac* of the north-western angle of the district, on the south bank of the Koorum, some three miles from the base of the hills, and about 1,276 feet above sea-level. The bank is high, and the natural drainage of the fort, the lines, and the native city, is for the most part good; but no drainage can entirely prevent the dampness of the clay soil which results from the superabundant irrigation of the neighbourhood. The fields come up close to the cantonments, and as the cultivation requires and receives a lavish supply of water, the land is for much of the year converted into one huge swamp, while the tall crops in places afford a shelter which is used as a common necessary both by the troops and civil population. The station, in common with the neighbourhood, is well wooded; beautiful avenues of trees lining the roads of the cantonment.

The drinking water for the troops is supplied by wells which are of great depth. The water is fairly good,¹ and in summer deliciously cool; but the labour of drawing it is so great that the men are very apt to use instead the water of the irrigation channels which are everywhere at hand. Indeed, the great sanitary defect of the station is, writes the Sanitary Commissioner, in his

¹ See analyses in table at p. 40.

Report for 1874, the state of the water supply. 'Drinking water,' he says, 'is taken from open gutters, or from tanks fed by the gutters, which are exposed to every form of pollution. The drain of a native officer's privy was found to drain into one of the gutters. The gutters themselves are originally supplied with water which is no better than the drainage of the polluted rice-fields. Such being the state of the water supply, it is no wonder that the men suffer terribly from fever, enlarged spleen, and diarrhoea. There is a fine well in the fort, but as the water is at a depth of 130 feet below the surface, and there are none but the usual rude contrivances for raising it, people prefer the foul gutter water to the labour of lifting the pure well water. The sepoys' children were in a lamentable state of ill health from fever and spleen. It is worthy of note that although the station is so extremely unhealthy for native troops, the officers who use only well water enjoy fair health. There are no regimental latrines; the men resort to the fields, which, as at Kohat, become at times extremely offensive.'

The troops stationed at Edwardesabad furnish garrisons to many small frontier outposts. Several of these are from a sanitary point of view very badly situated, and have a water supply which is brackish and very liable to artificial pollution. Outpost duty is not however considered unhealthy, and is rather popular with the men.

Climate. The following table of the temperature of Bunnoo is taken from Messrs. Schlagintweit's work; it represents the mean of the years 1853-4. The rainfall table is from Mr. Blandford's Report for 1876, and shows the average of ten years.

	Mean temperature	Rainfall
January	50°	·75
February	55	1·13
March	64	1·63
April	74	1·2
May	82	·53
June	93	·82
July	91	1·95
August	89	3·05
September	86	·65
October	75	·07
November	65	·07
December	55	·29
The year	73	12·14

'There are,' writes Dr. Colles, 'no steady periodical winds at

Bunnoo, and indeed the atmosphere is as a rule still. Towards morning however a cool breeze usually blows for two or three hours from the direction of the Koorum Pass. In winter this breeze, though not very strong, is often extremely cold, and may be considered as the analogue of the "Hungoo" breeze of Kohat. The atmosphere contains much moisture, and during the later months of the year is damp and cold.

*Diseases.*¹ The greatest number of admissions amongst the troops are for fever,² the season for which commences with a mild quotidian type of disease about the middle of September, and lasts until the end of December. During the latter months the remittent type with pneumonia as a complication becomes very frequent, and causes the greater part of the mortality. But although fresh admissions for fever become more rare at the latter part of December, the hospital remains crowded with patients whose constitutions have become debilitated by frequent attacks, and who remain on the convalescent list or in hospital till the returning warmth of spring infuses fresh vigour into their systems. Towards the end of the fever season the tertian and quartan types become prevalent, and are exceedingly obstinate in yielding to treatment. Neither quinine nor arsenic seems to be of much good, and change of air is the only efficient remedy. Most of these cases have enlarged spleens. Next to fever, bowel complaints give the highest number of admissions, but as a rule are very amenable to treatment. As might be expected from the nature of the climate, diseases of the lungs, bronchitis, and pneumonia are frequent. Abscesses and boils, 'Delhi boils,' as they are called, are very common amongst the men.

Dr. Colles lays stress on the circumstance that at Bunnoo, as elsewhere along the western frontier, cases of fever not uncommonly commence with rice-water purging, vomiting, and collapse, rendering the case very like one of cholera. In his experience, such cases in their subsequent course are not unusually of a mild, certainly not of a severe character.

Fevers and spleen disease are very common amongst the natives of Bunnoo, as are also bowel complaints. Cholera is not endemic, but occasionally visits the district; vaccination is making progress. The natives consider the valley unhealthy, and ascribe

¹ Statistics of disease and mortality amongst the troops and civil population are given in the tables at pp. 84 and 346.

² Surgeon-Major Holmes in *Report for 1874 on Medical and Sanitary State of Army of Bengal*.

the unhealthiness to the Koorum water; not however to their superabundant employment of it, but to its foulness, the result of its employment in irrigating and draining the rice fields of the Koorum valley.

The Sanitary Commissioner of the Punjaub, in his Report for 1868, mentions 'goitre' as one of the endemic diseases, but confirmatory evidence of this statement is not forthcoming from the reports of medical officers who have served at the station.

Dera Ismael Khan. The D. I. Khan district lies between the Suleiman range and the Indus, and stretches across the river, embracing a large tract of the desert 'Thal' of the Sind Saugor Doab. To the south, trans-Indus, it has the district of Dera Ghazee Khan, from which it is separated by an artificial boundary which is ethnologically important as it corresponds with the line of division between the Pathan and Belooch frontier tribes.¹ Along its northern boundary the district is divided from that of Bunnoo by a range of hills which from the name of the highest peak is known as the 'Sheikh Budeen range.' The area of the district is 7,096 square miles, of which only 846 are cultivated, and of the remainder 4,172 square miles are unculturable.

Sheikh Budeen, elevation above sea-level 4,604 feet, stands about midway between the Indus and the Suleiman range; the hills on the east are known by the same name, and are continuous with the Chichali range, which we have seen is geologically a terminal of the Salt range; those to the west are the Bhuttanee hills, which may be considered outliers of the Suleiman range. The Sheikh Budeen range, according to Dr. Verchere,² is mostly composed of miocene sandstone, clay, and conglomerates, through which the deeper rocks have endeavoured to push their way, but have failed except at one point, the Sheikh Budeen summit in the centre of the range.³ At one time the miocene rocks reached to near the summit, but the friable sandstone and lime conglomerate have crumbled away, leaving the Sheikh Budeen hill of Jurassic limestone towering above, and probably still at very nearly its original height. On the very summit of the hill are thin beds of coral rag, while below the Jurassic, are triassic beds of shales, gypsum, and limestone. The marl of the Salt range extends, too, thus far, and even round and a little beyond the southern base of

¹ T. W. H. Tolbort, C.S., 'On the district of D. I. Khan,' in the *Journal of the Bengal Asiatic Society* for 1871.

² *Journal of Asiatic Society of Bengal*, vol. xxxvi.

³ See also Dr. Costello's *Report*, at p. 214 of the *Medical and Sanitary Report of Native Army of Bengal* for 1873.

the hill. The other hills of the range nowhere attain an elevation of above 2,500 feet, and are generally very much lower.

On the summit of Sheikh Budeen is a small sanitarium, which during the hot season is resorted to by Europeans from the neighbouring stations. Much of the southern aspect of the hill is scarped perpendicularly for some 3,000 feet; on the northern aspect are ravines which are covered by olives and *Acacia modesta*, but the exposed parts are almost destitute of vegetation. The water of the sanitarium is obtained from tanks in which the rain is collected, supplemented by a supply brought from a village about eight miles distant.

The weather at the sanitarium is pleasant even during the hottest part of the year, and the daily range of temperature is slight. The prevailing wind, which is southerly, rises at eleven A.M., blows gently till three P.M., stronger till sunset, when it often increases to half a gale, blows till midnight, and then gradually dies away. In September the wind becomes less steady, and has a westerly direction. Heavy rains fall after the middle of July, and last till the middle or end of August. About the end of the year there is another rainy period. During the winter, snow lodges in the hollows and sheltered places.¹

To return to the trans-Indus plains. Along the side of the Indus lies a fertile belt of alluvial land, the 'Cutchee.' Close to the hills the soil is gravel overlying conglomerate. The remainder of the district has a clayey soil, with a surface hard and level in dry weather, but readily cut into ravines by rain or by mountain torrents. The almost unbroken surface extending for miles, a dead level uninterrupted even by a tree, is known as the 'Pat.' The vegetation is a free growth of salsolaceæ, which serves as food for camels and as a source of barilla. The crops of the district, where water for irrigation can be obtained, are chiefly wheat, barley, and millets. Rice is grown in a few isolated localities. Abundance of fruits—dates, mangoes, oranges, pomegranates, and melons—are grown in the cultivated parts. The irrigation of that part of the district which lies along the foot of the hills is managed by placing across the beds of the mountain torrents embankments which arrest the water and spread it over the fields. The irrigated area however, as compared with the rest of the district, is very limited, and is chiefly confined to the districts of Tank and Zam near the frontier, and to the neighbourhood of the town of Dera Ismael Khan. The rivers, excepting the Indus, are mere

¹ Notes by Surgeon E. Sanders.

mountain torrents, the waters of which are used up by the cultivators shortly after their escape from the hills. Two only, the Vehawa coming through the Vehawa Pass, and the Luni which flows through the Goomal Pass, can be said to be perennial; the latter supplies a large proportion of the irrigation around the suburbs of Dera Ismael Khan.

Dera Ismael Khan, a large native town, with close upon 20,000 inhabitants, is situated 570 feet above sea-level, on the right bank of the Indus, some eighty-five miles south of Edwardesabad, and fifty miles from the base of the Suleiman range, the highest point of which, 11,300 feet, is almost opposite the station. The town was rebuilt in 1825, to take the place of one which was carried away by the river. It is surrounded by a mud wall, the eastern face of which extends for about 1,400 yards north and south, at a distance of five or six miles from the main stream of the Indus. The intervening space is under cultivation during the cold weather, but in August the river overflows its banks and spreads to within a mile or so of the town. The country in the neighbourhood of the town has a slight slope to the east, yet so slight that the natural drainage is very imperfect, and consequently numerous pools of water remain after rain about the suburbs. Within the town are numerous trees and gardens, while outside the walls considerable irrigation is maintained by utilisation of the Luni water. The streets are well laid out, but the drainage is imperfect. The water supply is from wells, in which the water stands at a depth of about twenty feet.

The cantonments are situated between the city and the river, on a site which was for some years in considerable peril, owing to the encroachments of the Indus, from which however it has lately (1876) been relieved by the diversion of the main stream to its old channel five miles distant. Deputy Surgeon-General Allen, writing in 1876,¹ reports the lines the best he had seen on the frontier; scrupulously clean, well wooded, with an ample supply of excellent water. Analyses of the water of some of the wells which supply cantonments will be found at p. 40. When freshly drawn the water is tasteless, but is liable to become disagreeable after standing, owing to the decomposition of the sulphates which it contains.

Climate. Dera Ismael Khan is reckoned the most healthy of the frontier stations, and though serious sickness occurs amongst the troops stationed there, it may be almost always traced to the

¹ *Annual Report on Sanitary State of the Native Army of Bengal.*

bad effects of duty at the frontier posts, which are garrisoned by detachments from D. I. Khan. Many of the men who leave head quarters for outpost duty in excellent health, return suffering from obstinate fever, spleen, dysentery, frontier sore, general anæmia, and often from guinea worm; the latter is very troublesome in the case of patients debilitated by fever. Many of the outposts are situated in marshy places near the foot of the hills, irrigated by hill streams, are badly supplied with water, and are small and overcrowded.

The climate of the district is a very dry one, and very extreme both as regards diurnal and seasonal variations of temperature. Four or five months of the year the heat is intense, while during the winter the weather is often bitterly cold, with sharp cutting winds from the then snow-clad Suleiman hills. In May and June the heat is often so intense as to give rise to attacks of heat apoplexy, yet the nights are as a rule cool, and the custom is to sleep out of doors till August, when heavy night dews forbid the practice. There are no regular rains, only showers preceded by dust storms, and the total rainfall of the year averages but 8 inches. It is said that the average is increasing. (Table of meteorological data will be found in the Appendix, No. XXIV.)

Diseases. Amongst the troops fever is the principal cause of admission to hospital. The sickly months are from July to October inclusive. The table at p. 84 shows that the number of admissions increases rapidly in August, and is at its maximum in October. The fever is usually of intermittent type, and of a mild character; remittent fever is comparatively rare. Next to fevers, bowel complaints are the most common causes of sickness. Chest affections are very common, and are the chief cause of mortality amongst the troops. Ulcers and boils are very common, but for the most part cause merely temporary inconvenience. There is however a form of ulcer known as 'frontier sore' which occurs generally in the hot weather, and is apt to be exceedingly troublesome.

The troops at Dera Ismael Khan have been very free from cholera visitations, a happy feature in their history which is probably due to the isolated situation of the station, and its dry climate.

Goitre is scarcely known in the district excepting in the subdivision of Tank. A few cases are however treated annually at the station dispensary, and at the Bakhar branch dispensary on the other side of the river. The valley of Tank occupies the north-west angle of Dera Ismael Khan, separated from the district of

Bunnoo by the Bhuttanee hills. In position Tank somewhat resembles Bunnoo proper, lying in a corner, with hills to the north and west, but open to the south and east. Like Bunnoo too it is freely watered by streams coming down from the hills, and the two valleys are described as equalling one another in beauty and richness. Plentiful irrigation has turned a barren plain, or camel pasture, into a fertile highly cultivated tract which yields abundance of grain and fruits. Many cases of goitre may be seen in Tank itself, a town near the hills, and in a village in a marshy valley four miles distant; both places take their water supply from the same stream. The native Assistant-Surgeon, who reports on the subject, states that goitre is not known in other villages using the water of the same stream. He was informed by the inhabitants that 'forty years ago goitre was much more common than now, as they say owing to the vegetable growths, or to the decomposition of dead leaves in the water; the leaves are removed from the water nowadays.' The disease affects both sexes alike, and developes most quickly at the commencement of the cold weather.

Dera Ghazee Khan. This district occupies the long narrow strip of country which extends between the Indus and the Suleiman range from Dera Ismael Khan on the north to the confines of Sindh on the south. In its physical characters the district resembles Dera Ismael Khan, but is an even more rainless tract. It enjoys however the advantage of considerable canal irrigation, and consequently boasts a comparatively large proportion of cultivated land. The canals have been of late years reconstructed, enlarged, and lengthened, and on their operation depends nearly half the produce of the district.

Along the low banks of the river there is a dense tree jungle, growing to a height of twelve or fifteen feet, and outside this is a considerable tract which is inundated by the yearly floods. The benefit to the cultivator from these floods is however a precarious one, for the waters not unfrequently deposit sterile sand instead of loam. Along the base of the hills is another tract of cultivated land, which possesses a rich clay soil, and is very fertile wherever water can be supplied. The hill streams afford a precarious supply, and on this the cultivator depends, for water in the wells is at a depth of 300 feet from the surface. Between the tracts just mentioned is another in which water is at no great depth from the surface, and well irrigation is largely resorted to.

The principal town of the district is Dera Ghazee Khan, a

large place, with some 17,000 inhabitants, situated on the west bank of the Indus, about three miles distant from the main channel. The town is in north lat. $30^{\circ} 3'$, east long. $70^{\circ} 50'$, 112 miles south of Dera Ismael Khan, and forty miles west of Mooltan. The elevation of the site above sea-level is 430 feet, and thence the surface rises very gradually to the low Belooch hills distant about thirty miles to the west. The slope is however so slight that the land about the town may for all practical purposes be said to be level, while the situation with reference to the river is so low that embankments are needed to protect the cantonments from the yearly inundations. The soil is clayey, and when watered very fertile. In places it yields a saline efflorescence of sulphate of soda and nitrate of the alkalies. Water is found at a depth of from twelve to fifteen feet, and is, when freshly drawn,¹ of good quality,¹ but on standing develops a smell of sulphuretted hydrogen, owing to the decomposition of the alkaline sulphate which it contains. At a considerable depth below the surface, beds of conglomerate and sandstone are struck.

For some distance around Dera Ghazee Khan the country is freely watered by means of irrigation canals, which have converted the once barren plain 'into a garden the most lovely and the richest part of the Punjaub' (Edwardes). Date trees stud the fields and skirt the numerous water channels, forming a delightful shade from the fierce sun. The crops are chiefly wheat and millet; a good deal of barley, rice, cotton, and indigo are also grown.

The cantonments are in an open plain, about one mile west of the city. The land about is fully cultivated, but such crops as rice and sugarcane, which need very free irrigation, are not allowed in close proximity to the lines.

The Sanitary Commissioner, Dr. de Renzy,² writing in 1874, says: 'The low site of this badly selected station presents great difficulties to effective drainage, in consequence of which in the rains the ground is largely covered with sheets of stagnant water, and the natural disadvantages of the place have been increased by the numerous deep excavations made in making bricks for station purposes. There is hardly a building in the station which has not in its vicinity a large excavation in which water stagnates and filth collects. He describes the barracks as being very bad; the floors of some low and damp, many of the huts crowded, and from

¹ For analyses, see table at p. 40.

² *Punjaub Sanitary Report* for 1874.

want of doors ill protected from the cold night wind. Latrines were wanting, the men making use of the surrounding fields.

Since Dr. de Renzy's visit, the barrack, and sanitation generally of the cantonments, has been improved, so that in 1876 the Deputy Surgeon-General reports¹ the lines clean, well wooded, and water excellent; still there is complaint of ineffective drainage, and during the cold weather, when the canals are empty, the drainage is simply absorbed by the soil.² It is however so small in quantity, and the conservancy in other points is so well carried out, that it does not seem to be injurious. The dry earth system is in use in the latrines, which are at a convenient distance from the lines, and the excreta are removed periodically, to be used as manure by the cultivators in the neighbourhood.

Climate. The following table of temperature is from the Messrs. Schlagintweit's work; that of rainfall from the Meteorological Report 1876.

	Mean of 1852-54	Rainfall, mean of 8-10 years
January	51·4°	·45
February	59·7	·16
March	68·9	·68
April	78·6	·26
May	85·2	·39
June	93·8	·50
July	91·3	2·03
August	88·3	1·61
September	86·2	·51
October	71·7	·07
November	64·5	·14
December	55·5	·35
The year	74·6	7·15

May, June, July, and August are intensely hot, the temperature in the shade during the day rising to from 100 to 110, or even higher. June is the hottest month, for the rains which fall in the two succeeding months, though slight, to some extent mitigate the heat. In September the weather begins to get cool. During the cold weather, from November to February, the range of temperature is very considerable; the middle of the day is often very hot, while a hoar frost covers the ground in the early morning. Ice is made abundantly at the station every

¹ *Sanitary Report of Native Army of Bengal* for 1876.

² Surgeon C. McCartie, in the *Annual Report of the Medical and Sanitary State of the Army* for 1877.

night during this season. Owing to the neighbourhood of the river, the numerous canals, and the wide area of irrigated land, there is always a good deal of moisture in the atmosphere, though the relative humidity may be very low. And from the same cause, the low site and the defective drainage, the subsoil is always damp. During seven months of the year which constitute the cold and cool season, the wind is pretty constantly from the north, and as constantly from the south during the hot season.

Diseases. Statistics of disease and mortality amongst the troops and people will be found in the tables at pp. 82, 83, and 346. The chief sickness of the station is from intermittent fever of a mild type. Remittent fever is rare amongst the troops at head quarters, but is not uncommon amongst the men while on outpost duty, especially when stationed at Hurrund, an outpost within a few miles of the hills, on a site which is below the level of the surrounding country, and receives a part of the drainage from the hills. Here fever of a bad type is very common, and enlargement of the spleen, and dysentery, are of frequent occurrence.

Next to fever, dysentery and diarrhoea are the most common causes of sickness at D. G. Khan. During the cold season severe cases of pneumonia and bronchitis are not infrequent, and are attributed in part to the cold nights following hot days, and in part to the habit the men have of half stripping themselves to cook their food immediately after return from parade.

The year 1874 was a particularly unhealthy year at the station; the number of admissions for fever rose from 46 in July to 350 in August, and in September to 772, after which the numbers declined. The autumn rainfall of the year was unusually large, 5·2 inches falling in July, and 3·1 in August. The floods too were excessive, those of the Indus more or less covering the country for a space of some fourteen miles to the east of cantonments, while on the west the mountain torrents overflowed the country. The irrigation canals were full, and in some places burst their banks. The troops¹ and civil population suffered equally, but the prisoners in the jail, living on a well-drained, airy site, well fed and clothed, were very little affected. The greatest prevalence of fever corresponded with the drying up of the surface water and the commencement of fairly cool weather.

¹ Report by Surgeon O. T. Duke, in *Sanitary Report of Native Army* for 1874.

CHAPTER XXXI.

SOUTH-WESTERN DISTRICTS OF PUNJAUB.

Districts of *Mooltan*, *Jhung*, *Montgomery*, *Shahpore*. Mooltan city and cantonments. Mooltan fever; fever and rainfall. Goitre in the Mooltan district. *Montgomery* district; history of goitre at Dipalpore. *Jhung* district; goitre along the Chenaub. *Shahpore* district; goitre at Midh and along the Jhelum.

MOOLTAN.¹ This district, triangular in shape, occupies the lower end of the Baree doab, with its apex at the meeting of the Sutlej and Chenaub. The area of the district is 5,832 square miles, of which 976 are cultivated, and 3,783 are unculturable. Mooltan, the civil station, and a large military cantonment, is situated four miles from the left bank of the Chenaub, about fifty miles distant from the Sutlej, and about seventy miles north-east of the junction of the rivers. All around the station is an almost level plain, for the raised land which higher up occupies the centre of the doab, has here disappeared, and the low 'khadir' land extends across from river to river. The nearest hills are the Suleiman range, seventy miles away across the Indus, but in clear weather distinctly visible along the western horizon.

In this, an almost rainless district, but with abundance of water flowing in the great rivers, the inhabitants have, from a very early period, not only taken advantage of the yearly inundations, but have spread their influence beyond the neighbourhood of the rivers by means of a network of canals. This, of late years, has been considerably extended, and now covers the angle between the Sutlej and the Chenaub to a distance of some twenty or thirty miles above Mooltan. From May to October, when under a scorching sun and almost cloudless sky, all natural vegetation is stunted or shrivelled up, the canals are full, and the land along their banks and in their vicinity is clothed with luxuriant crops.

¹ Paper by Surgeon-Major Lyons on the Climate, &c. of Mooltan, in *Indian Annals of Medicine*, 1865. Reports by Surgeon-Majors G. A. Watson and G. H. Daly, in *Annual Reports of Medical and Sanitary State of Native Army of Bengal* for 1870-71 and 74.

The principal crop is wheat, which is twice mown down as fodder for cattle before it ears; other crops are barley, millets, maize, cotton, and rice, while oranges, pomegranates, and other fruits flourish in a succession of beautiful gardens, which are shaded by date palms. The date palm is indeed the characteristic feature in the landscape; the whole country around Mooltan is covered with it, and at the time of ripening of the fruit in August, presents a beautiful appearance, the long bunches of golden fruit hanging in profusion from amongst the panoply of leaves which crowns the palm stems.

The soil is a stiff tenacious clay, here and there mixed with sand, extending to a depth of six or eight feet, beneath which is a subsoil of almost pure sand. The clay is very impermeable, so that the heaviest fall of rain penetrates but a few inches, converting the surface into a thin tenacious sheet which rises as it were in blisters from the soil beneath. During the dry weather the soil crumbles into an impalpable dust, the feeder of the dust storms for which the district is so notorious. Water is found at a depth of about twenty-five feet from the surface, the depth varying little at the different seasons of the year, and even in the neighbourhood of the rivers is apparently little affected by their rise and fall. During the cold weather, when the inundation canals are dry, the wells are largely used by the cultivators, and so long as they are steadily worked the water is fairly good, but it soon becomes brackish if the wells are disused; indeed the water of many wells contains at all seasons so much saline matter as to be undrinkable. This saline matter is found as an efflorescence on the surface of many parts of the district, and though by flooding the land with river water it can be got rid of, much of the land is practically spoiled by its presence.

The native city of Mooltan, population about 45,000, is enclosed on three sides by a wall and ditch, which latter does service as a receptacle for part of the drainage of the town; on the north side are the ruins of the once great fort of Mooltan. The surface on which the town is built is irregular, not so much from natural causes, as because beneath is the débris of older towns which have preceded the existing one. The streets, excepting one which was cut through the city by the British, are narrow and tortuous. The main streets are well paved but have no drainage, while the liquid sewage is left to sink into the soil or to be carried off by evaporation, and the place is saved from the perpetual pestilence which its insanitary state threatens only by the exceeding dryness

and heat of the climate. As it is, the city is very unhealthy, and Dr. de Renzy describes the population as a feeble, narrow-chested, anæmic race, ill comparing with that of the surrounding villages.

The city is surrounded with groves and gardens which flourish luxuriantly along the numerous cuts which lead the water from the neighbouring river. 'Proceeding to Mooltan,' says Dr. Lyons, 'the traveller passes through vast tracts of arid uncultivated land, relieved at distant intervals, few and far between, by small mud villages surrounded by scanty and meagre fields. The wildness and solitude of the country increases as he progresses, the small fields dwindle gradually into smaller until he approaches Mooltan, when vegetation reappears with a luxuriance and profuseness which falsify his anticipations. While hitherto he has beheld nothing but meagre crops, stunted trees, parched grass, and the wild thorn, he now views stretching before him groves of tall date trees and sissoo, magnificent peepuls and other lords of the vegetable world, and far-spreading fields, strangely contrasting with the hoary city in their midst.'

The cantonment is about two miles west of the city, and is connected with it by a broad well-raised carriage road lined by fine trees. The plain in which the cantonment is situated is somewhat higher than the level of the city; its ample area is unconfined by trees or jungle, and is therefore freely exposed to the purifying influence of the winds. The eastern or European section is somewhat higher, and is more destitute of trees and vegetation than that allotted to the native troops; it is however considered more healthy. The whole has a dreary, uninviting look which contrasts with the rich luxuriance of the surrounding tract. A branch of the canal runs through the station, supplying it with water, inundating the land in the immediate neighbourhood of the native lines, and also acting as the main drain. Owing to deficient slope of the general surface, the natural surface and subsoil drainage of the cantonment are defective, a defect which is frequently dwelt on by medical officers in their reports as constituting a cause of disease. After heavy rains the cantonments may be under water for days or weeks together. All, however, that cleanliness and neatness can do to compensate for natural defects is done, and the station in this respect contrasts notably with the neighbouring city. Dust is a great nuisance, and one which can be only palliated by grassing where possible the cantonment area.

The drinking water of the cantonment is entirely from wells, and is of very fair quality. (For analyses, see table at p. 40.)

Climate. The characteristics of the Mooltan climate are dryness, and intense and prolonged summer heat. The hot season extends from the beginning of April to the end of September. June and July are intensely hot, and May and August would be considered so anywhere else but at Mooltan; even September is usually very hot, though the heat has then sensibly declined. During the height of summer the night temperature is within a few degrees of that of the day, and for the major portion of the hot weather the temperature of the interior of the houses differs little through the twenty-four hours. Towards the decline of summer the difference is more marked, the day retains a steady temperature, but the night air cools with some quickness, and towards the early morning there is a considerable fall in the temperature; indeed, during August and September, the nights are occasionally cool and even chilly. In October and November the heat of the sun is moderate while the nights are cold, and at sunset a cold cutting wind from the north frequently springs up. Ice is manufactured during the cold season by exposure of water at nights in shallow basins. With a clear, dry, mellow atmosphere, an unclouded sky, a pleasant temperature by day, and sufficient cold at night to render fires needful, the cold weather at Mooltan is delightful, and for the time it lasts very invigorating.

The air during the greater part of the year is very dry, yet looking to the volume of the river, to the extensive surface exposed by the canals, and to the large area of inundation, there must be absolutely a large quantity of vapour in it, but it is very seldom precipitated as dew or cloud; throughout the year the sky is almost cloudless. The rainfall is very slight, averaging only 7·19 inches per year, while some years the fall does not reach 2 inches, and the rain never continues a sufficient number of days to constitute a season. The prevalent wind is from the south-west, but in the hot season light winds blow constantly and irregularly from all quarters, and these somewhat alleviate the distressing heat. In April, May, and June the wind often blows with considerable violence, and frequent dust-storms, though disagreeable in other ways, cool the temperature of the atmosphere. Northerly winds are frequent during the cold season.

The Table XXV. in Appendix is compiled from Mr. Blandford's reports for the years 1875-6. Averages are given in Tables XXVI., XXVII., and XXVIII.

Diseases. The disease which brings by far the largest number

TABLE A.

	1867 ¹		1868 ¹		1869 ¹		1870		1871		1872		1873		1874		1875		1876		1877	
	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever	Rainfall	Admissions for fever
January	—	1.93	.8	2.06	1.1	4.46	—	29	—	17	.1	13	.6	58	.75	35	—	25	.23	10	.2	75
February	—	2.29	.5	2.83	.1	3.36	—	11	.2	11	—	5	.04	32	.1	20	—	18	.35	22	.5	79
March . . . . .	.3	2.52	.5	2.53	4.	3.04	.8	14	—	9	—	7	.85	18	.88	29	—	20	.14	18	.7	41
April	1.0	1.62	2.9	2.29	.3	2.68	—	20	.1	1	.2	12	.01	31	.1	20	—	27	—	12	.4	31
May . . . . .	.8	1.74	.1	2.05	—	1.2	—	28	—	15	—	10	2.55	43	—	51	.6	22	—	18	1.0	111
June	—	1.34	—	2.52	.6	1.75	.2	15	1.2	11	—	47	.01	64	.46	82	—	15	1.2	37	—	164
July	2.1	2.9	.1	2.35	2.7	2.18	—	11	—	14	3.	62	2.32	35	7.4	26	1.1	7	3.3	27	1.5	93
August . . . . .	.5	3.37	—	3.01	2.8	4.27	1.	28	—	32	1.5	103	1.4	117	1.67	227	1.1	42	1.83	182	—	30
September . . . . .	.6	6.19	—	3.38	1.9	5.3	—	93	—	23	.7	226	—	488	.7	578	.5	163	—	517	8.2	26
October . . . . .	.1	4.27	—	3.01	—	11.26	—	77	—	29	—	422	—	235	—	315	—	152	—	691	—	202
November	—	2.82	—	1.75	—	13.53	—	66	—	24	—	277	—	81	—	113	.3	224	.39	382	—	152
December	1.1	2.79	.2	1.76	—	9.05	—	19	.4	30	—	97	.62	55	—	43	.01	57	—	121	1.1	105
The year	6.5	—	5.1	—	13.5	—	2.	—	1.9	—	5.5	—	8.4	—	12.06	—	3.7	—	7.44	—	13.6	—
Average strength of troops (native)	1040	—	1137	—	946	—	936	—	999	—	957	—	1023	—	1002	—	1026	—	909	—	1029	—
Admissions for fever per 1,000 of strength	478	—	396	—	1005	—	439	—	216	—	1338	—	1228	—	1535	—	752	—	2241	—	1078	—
Admissions for all causes per 1,000 of strength	1036	—	892	—	1301	—	931	—	622	—	1858	—	1834	—	2175	—	1498	—	2722	—	1491	—
Autumn rainfall and fever admissions	—	—	—	—	—	—	.1	275	—	122	5.2	1090	3.72	976	9.77	1259	2.7	591	5.33	1799	9.7	503

¹ 1867, 1868, 1869, 2nd column, gives daily sick per 1,000 of strength. Till 1870 the admission rates for fever were not separated.

TABLE B.—Mooltan. *European troops. Admissions to hospital, ten-year period 1860-69.*

Diseases	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Admitted per 1,000 of strength	Deaths of the 10 years
Cholera	—	—	—	—	1	1	—	—	—	—	—	—	.2	—
Small-pox	3	—	2	—	—	—	—	—	—	—	—	—	.6	—
Fever, intermittent.	125	104	168	437	474	457	573	739	1150	1266	1083	837	847.	13
„ Remittent and continued	14	24	28	98	116	144	190	146	81	44	28	12	106	23
Apoplexy.	—	1	1	—	7	20	35	10	3	—	1	—	9	38
Dysentery	22	22	24	27	17	12	23	37	59	49	32	28	40	17
Diarrhoea	29	33	36	53	51	43	55	106	80	62	48	35	72	1
Hepatitis.	30	45	35	33	32	53	41	55	44	35	41	36	55	19
Spleen (1864-69)	—	2	3	2	5	9	6	2	3	2	4	—	—	—
Respiratory diseases	113	132	69	40	60	57	45	48	35	51	39	62	86	6
Rheumatism	74	70	58	60	48	25	51	49	36	42	34	39	67	—
All causes	1000	955	947	1265	1302	1290	1605	1699	1938	2011	1693	1504		162
„ per 1,000 of strength	108	104	108	145	149	148	185	197	225	237	197	175	1965	18.5

Average of aggregate strength 8756.

of patients to hospital amongst the troops, both European and native, is intermittent fever, generally quotidian of a mild character and uncomplicated. This also is the form of disease which is most common amongst the natives of the district.¹

The table at p. 84 shows the relative frequency of the chief diseases amongst the native troops at the station. Table A., page 485, bears upon the question of rainfall and fever prevalency, and places side by side the admissions for fever amongst the native troops, and the rainfall for each month of the years 1867-1877. Table B. gives statistics of disease and mortality amongst the European troops at Mooltan for the ten-year period 1860-69.

The tables at pp. 84 and 485 show that the rise in the number of admissions for fever occurs periodically in August, and as a rule culminates in September. Yet though the autumnal exacerbation is a constant one, the circumstances vary remarkably. Thus, in 1871 the number of admissions rose from 14 in July to a maximum of 32 in August, in 1877 it fell from 93 in July to 30 in August, while in 1874 the rise was from 26 admissions in July to 578 in September, and the numbers for 1873 are almost as striking. Evidently the cause, whatever it may be, of the disease is one which varies in intensity from year to year, and is not to be found in meteorological conditions, such as great heat and great diurnal variation of temperature, which are recurrent features of the climate. Moreover, the variations in the intensity of the cause depend upon local circumstances, which may act quite independently of the conditions, whatever they are, which occasionally send a fever wave through the whole or a part of the province. The difference between two fever seasons at Mooltan is strikingly exhibited by the following passages from the reports of medical officers, written, the one after a healthy, the other after an unhealthy year.² Surgeon G. A. Watson, writing in 1871, says: 'The past year (1871) has been an exceedingly dry one, even for Mooltan; scarcely more than 2 inches of rain have fallen. The rainfall in 1870 was only 2 inches, so that there have been two very dry years in succession, and it is doubtless to this that the unusual healthiness of the season, and almost entire absence of autumnal intermittent fever, are to be mainly attributed.' 'Generally speaking, the past year has been one of plenty, cheapness, and freedom from sickness and epidemic disease. It may appear strange to speak of Mooltan as a sanitarium, and yet there can be no doubt that it is a remarkably healthy place, and that many

¹ See table at p. 346 for death rate of the district from the chief diseases.

² *Medical and Sanitary Report of Native Army* for 1871.

persons, especially those suffering from the effects of a damp climate, might derive benefit from a temporary sojourn in it. In particular, those suffering from hill diarrhoea and asthma would find here conditions favourable to their recovery. In some parts of the dry rainless country between this and Montgomery would be found most suitable sites for encamping grounds for troops suffering from epidemic cholera, not only from the climate being apparently unfavourable to the development of that disease, but from the country being so thinly populated that possible risk of disease spreading by human intercourse would be very small.'

Surgeon-Major G. H. Daly, M.D., writing in 1874,¹ gives a very different account of the climate of Mooltan. In his regiment, the 13th Bengal Cavalry, fever, as in the preceding year, showed itself in force in August. Up to the 16th of that month there had been only 13 admissions, but by the 31st the admissions amounted to 122. September was the most sickly month, but the greatest number of admissions on any one day was on August 31st. About the third week of October the outbreak began to abate. 'The disease, as observed in August and during the subsequent months, was of a truly malarious character, and distinguished by the sequelæ of that type of fever. Enlargement of the spleen was the predominant complication; indeed freedom from it was the exception, and the extent to which this organ was affected I have only seen exceeded in Bengal. Young and old, men women and children, Europeans, Eurasians and natives, strong and weak, were attacked; sleeping in or out of doors seemed to make no difference. All suffered alike from great depression during and after the attack. There was no apparent cause in the station. As a result of my observations, I have no hesitation in ascribing to this fever a malarious origin, and for the source of the poison we have to look outside the station, but not far. From the north to the south-west, the river Chenaub runs in varying proximity to the station—at one point to the west it is within four miles. This river, in common with the rivers of all this part of the Punjaub and Sindh, has low banks, more or less overgrown with thick scrub jungle, which, during two or three months of the year, are submerged for many miles. On the subsidence of the inundation, at about the same period every year, an immense surface of rotting vegetation is exposed to the direct rays of a powerful sun. Of the effect of this there can be no doubt. It is very appreciable to the men, even when travelling by train through the district conti-

¹ *Report for 1874.*

guous to the river. And the residents of this district, Europeans as well as natives, exhibit marked symptoms of marsh ague.

‘The European as well as the Eurasian and native employes of the Indus Valley Railway, which runs contiguous to the Indus and Chenaub rivers, and crosses the Sutlej about fifty miles south of Mooltan, suffer severely from ague, accompanied by splenic enlargements and followed by a cachectic condition of the system. These sequelæ in many instances are of so obstinate a character as to require the removal of the sufferers from the locality.

‘The system of irrigation canals of this district I look upon as another factor in the production of the fever at Mooltan, though in a minor degree. The canals form a perfect network throughout the whole district and around the immediate neighbourhood of the station, and without doubt contribute a share in the causation of the disease. It is true they contain running water, but in many of them the stream is sluggish, and in all there is more or less a growth of vegetation. They are fed by the inundations of the rivers, and dry up as these subside. An immense surface of water, pretty freely contaminated with vegetable as well as animal decay, is thus exposed to a drying process which cannot fail to assist in the production of materials prejudicial to health.

‘My observations of the fever and its causes during the last outbreak do not bear out the conclusions which Dr. Gunn, my predecessor, has arrived at. Although I cannot but admit that great diurnal and nocturnal changes of temperature do take a considerable part in the causation of disease, yet I cannot admit that such changes are, or can be, the chief cause of so extensive an outbreak of a fever of so characteristic a malarious type as we have in Mooltan every year during the autumn. In August the last stage characterised the fever; it was of long duration, occasionally it had a tendency to a continued character, and was accompanied by severe headache and bilious vomiting. In September splenic enlargements were the rule, and there was an occasional tendency to intestinal irritation, and to collapse after excessive sudoresis.

‘Some of the spleens were of such enormous size, that I doubt if they were only of one year’s growth. In October there was a marked tendency to critical discharges and resulting collapse. Towards the end of the month, and during the two subsequent ones, scurvy began to show itself. In November and December the cold fit was the characteristic symptom—in some cases the only symptom of the fever. Catarrhal complications were superadded,

and pneumonia made its appearance. Anæmia was also a result of repeated attacks of fever.'

Surgeon-Major T. G. Skardon, in medical charge of the 31st Regiment Native Infantry at Mooltan during 1874, states 'that the meteorological peculiarities of the year were a somewhat lower temperature than is usual at Mooltan, and an unusually high rainfall. It was during the months in which the range of temperature was least that the most fever cases were admitted; when the range increased dysenteric complications and internal congestions appeared.'

Perusing the very numerous reports of medical officers in charge of regiments at Mooltan, we find all, almost without exception, agreeing to connect the intensity of the fever season at Mooltan with the amount of rainfall, and an examination of the table at p. 485, and the circumstances of the individual years, so far as they can be gathered from published documents, give very strong support to the substantial truth of this opinion, more especially if we compare the rainfall of the autumn months, July to November, with the fever admissions of the same period. 1869 (see table) was a fever year throughout the Punjaub, and at Mooltan fever was prevalent throughout the hot weather, but it was only after the heavy rains of August and September that the number of cases became unusually great, and the type of fever serious. 1870; this year malarious fever was even more rife in most of the Punjaub stations than during 1869, but Mooltan¹ was amongst the few stations which escaped the epidemic. There, though the unhealthy influence of 1869 affected the first quarter of the year, the other months were unusually healthy. The rains of the five months were very light, only an inch in August; the fever cases of the period numbered 275. 1871; in respect to fever a healthy year throughout the province, and remarkably so at Mooltan. The year was a very dry one; the cold weather set in early and was unusually severe, no rain fell during the five months; number of fever cases 122. 1872; a fever year at Mooltan, and at many other stations of the province. Fever began to prevail at the end of August; the number of cases of the five months was 1,090. In July the weather became muggy; the rains were heavy that month and in September. Rainfall of the five months 5·2 inches. 1873; sickness rather above the average in the province. During the fourth week of August fever broke out almost like an epidemic, affecting alike the troops and the civil population of the city and

¹ *Report for 1870 of Sanitary Commissioner with Government of India.*

neighbourhood. The admissions of the five months, 976. The epidemic was at its height in September; the admissions during October were not much more than half those of September, and in November were very few in number. In July, August, and September there was a good deal of rain, 3.72 inches. 1874 was an unusually healthy year for the province generally, but Mooltan and the neighbouring districts suffered severely from fever, owing to heavy rainfall and high inundations of the Indus and Chenaub. At Mooltan the fever became rife towards the end of August; the admissions of the five months numbered 1,259. Rainfall was very heavy, 9.77 inches during the five months; 7.4 inches fell in July alone; the cantonments were at times completely flooded. 1875; this year felt the effect of the malaria of 1874, many of those who had suffered during 1874 sickening under the influence of the malaria of 1875; moreover the inundations this year were very great, and to these two causes the Civil Surgeon¹ attributes the prevalency of fever in the district. The troops suffered much less than during 1874; the admissions were 591, the rainfall of the five months 2.7 inches. 1876; a fever year almost throughout the Punjaub. Fever very prevalent at Mooltan amongst all classes, civil and military. Rainfall heavy in June, July, and August. Fever attributed to heavy rainfall, and, in the absence of effective drainage, to the inundations of the Walli Mahomed Canal in the immediate neighbourhood of the regimental lines.² 1877 was on the whole a healthy year; an exceptional outbreak of fever happened during May, June, and July, and were it not that one of the regimental medical officers³ states that the outbreak was one of ordinary intermittent fever, the period suggests fever of a contagious type. And it is noticeable that this outbreak followed one of remittent fever which occurred in the same regiment during February, March, and April, and reminded the medical officer in charge of an epidemic of relapsing fever which he witnessed at Ferozepore in 1864.

But the most remarkable feature in the medical history of the year was the little sickness which occurred during August and September, followed by a sharp outbreak of malarious fever in October. There was this year practically no overflow from the rivers and canals, a circumstance to which Dr. Veale⁴ attributes the healthiness of the year. But a most unusual rainfall occurred

¹ *Report of Sanitary Commissioner of Punjaub*, 1875.

² Report of Surgeon-Major T. S. Veale, M.D., *Medical and Sanitary Report of Native Army* for 1876.

³ Report of Surgeon-Major Veale, *ibid.* 1877, p. 123.

⁴ *Ibid.*

on September 6th and 7th, which inundated the lines for some days till the water was removed by percolation and evaporation.¹

The results of 1868, 1870, and 1871 show that the troops at Mooltan may remain free from an autumnal outbreak of fever. But then, those were dry years; no rain or exceedingly little fell from the end of June to the end of November. In 1877, August and September showed very little fever, and this notwithstanding the heavy fall of rain early in September; a circumstance which militates against the chill theory of fever, for the fever did not occur at the time of, or shortly after, the rainfall. But it is difficult to avoid finding a connection as cause and effect between the rainfall of September and the fever of October, a connection which if assumed may be explained by the supposition that the rainfall gave rise to the development of malaria which in due course showed itself in the fever outbreak.

Table A. shows that not only in 1877, but that as a rule the fever outbreak does not occur during the same month as the rainfall, but in the following one. And another circumstance, with a similar bearing, to be learnt from the table is that the fever is most rife at a time when the temperature is still high and the diurnal range comparatively slight, while the number of admissions diminishes rapidly just as the cold weather is setting in and diurnal range of temperature is at its maximum. We can then scarcely avoid accepting the view that the intensity of the autumnal outbreak of fever at Mooltan is very much governed by the rainfall of the season, and to some extent by the diffusion of the inundations over a badly drained site, and that these influences exert themselves by giving rise to the development of malarial poison. No doubt the long and intense summer heats are necessary to dispose the systems of numerous individuals to suffer from the effects of an often light malaria, and hence spring rainfall when it occurs, does not as a rule develop fever unless amongst patients who have suffered during the previous year, for at that time of the year the system is braced up by a long invigorating cold season, and is able to resist malaria. Moreover at that time one powerful factor in the generation of the fever poison, namely decaying vegetation, is not present in the same abundance as it is during the autumn.

Doubtless too chills may dispose individuals to attacks of fever, and may occasionally be the immediately exciting cause of an

¹ Surgeon-Major Tandy, in *Medical and Sanitary Report of Native Army for 1877*, p. 120.

attack, but it is difficult to believe that the chills of an almost rainless and dewless Mooltan August can account for the outbreaks of fever which often mark that month, or that a slight rainfall can account, in the way of chill, for an outbreak of fever occurring a month or six weeks subsequently. And indeed, that such is the opinion which forces itself upon the minds of medical officers at the station is very clear, for they rarely allude to chill as the cause of the fever. In this respect the reports, doubtless with good foundation in fact, contrast remarkably with those which are received from medical officers at Peshawur, where, as we have strong reason to believe, chill is very often the exciting cause of fever.

Other diseases. Diseases of the respiratory organs—bronchitis, pleurisy, pneumonia—are during the cold season common amongst the troops at Mooltan and amongst the inhabitants of the city and district; indeed this class of diseases is the chief cause of mortality amongst the troops, and, as might be expected, is especially fatal amongst those who have been enfeebled by malarious fever.

Cholera seldom visits the district. Small-pox is in some years very fatal in the city.

Boils and ulcers are very prevalent amongst all classes, and a very intractable sore which is common enough, is well known under the name of 'Mooltan sore.' That these sores are not a mere local disease of the skin appears from the fact that their eruption is generally preceded and accompanied by malaria and dyspepsia; moreover, the boils to which intemperate people are liable are much more intractable than those from which temperate people suffer.

Goitre is very prevalent in many villages in the neighbourhood of Mooltan,¹ and cases are commonly met with amongst the inhabitants of the city. Of 35,741 cases treated at the city dispensary during five years, 1,630 were for goitre. Not very far from Mooltan are two Government dispensaries, one at Shoojabad twenty-six miles south, and another at Kuhror fifty miles south-east of the city. Cases of goitre are very rarely treated at either of these dispensaries, and enquiries made by the Civil Surgeon of the district show that goitre is very uncommon there or in the neighbouring villages, yet both places are fever localities, as much so as Mooltan, and the lands about are watered by canals. The canals about Shoojabad are fed by the Sutlej, but about Kuhror

¹ For these particulars I am indebted to the kindness of Dr. Gray, the Civil Surgeon of Mooltan.

by the Chenaub, and this circumstance is of importance because it shows that the specific cause of the disease is not in the water of that river, common though the disease is in places along its banks.

Goitre is met with in some villages of the Mozufferghur district which lies along the right bank of the Chenaub, opposite to Mooltan, but in none of them, so far as we have been able to discover, is it nearly so common as in the neighbourhood of Mooltan.

Montgomery district. To the north-east of the Mooltan district lies the Montgomery district, stretching from the west bank of the Sutlej river across the Baree Doab and the Ravee river into the Rechna Doab. On the east it is bounded by the district of Lahore.

That portion of the district which lies between the Sutlej and Ravee rivers is traversed at a distance of about twenty miles from the former by the old bed of the Beas, now marked by a succession of pools or swamps, distant some three or four miles from each other. These are fed by the drainage of the surrounding lands, and, as many of them contain water throughout the year, they are of much value to the pastoral people in the neighbourhood. By far the larger portion of the district, all indeed outside the strip of inundated land along the rivers, and that portion of the Dipalpore subdivision which is watered by canals, is a mere wilderness, occupied as grazing ground by vast herds of cattle; yet it possesses a good soil, and only needs water to render it culturable. The soil is a mixture in varying proportions of sand and clay. For most of the crops of the district a light sandy soil is considered best, but for rice a heavier clayey soil, such as that which prevails about Dipalpore, is preferred.

The tract of country between the old bed of the Beas and the Sutlej lies low, and is watered in part by the wide-spreading inundations of the river, and in part by three inundation canals, the Khanwah, and the old and new Sohag canals. These canals draw their supply from the Sutlej, and distribute over that portion of this tract which is occupied by the Dipalpore subdivision.

These, and indeed all inundation canals, differ in their operation from irrigation canals, for while the latter, which are always full, supply the crops till they reach maturity, the former overflow the land before it is prepared by the plough, fertilising the soil by saturating it with water and by depositing the rich mud which the water holds in suspension. Perhaps not till a month or more after the waters have receded is the land ploughed and the

grain sown. As a rule the land needs no further artificial moisture, the cultivator depending upon rain to bring his crops to maturity; but not unfrequently he is obliged by the occurrence of a dry season to superadd irrigation from wells. The average rainfall in the Montgomery district is 10 or 12 inches, varying from 4 to 24 inches; the rain falling chiefly in July and August.¹ The district is considered a healthy one. Intermittent fever, small-pox, bowel complaints, and in the winter respiratory diseases, are the chief diseases. Fever is far more prevalent in the inundated tracts than elsewhere.

In the north-eastern portion of Montgomery is the ancient native town of Dipalpore, on a somewhat raised site on the old bank of the Beas, but surrounded by low rice lands. Two canals, the Khanwah and the Sohag, run close to the town, and from May to August are the chief sources of water to the inhabitants. The soil of the neighbourhood is a hard black clay which is remarkably well suited for the growth of rice. The town is a very old one, and its decaying brickwork is saturated with noxious matters. Unlike the rest of the district, it is notoriously unhealthy, so much so that people are unwilling to settle there permanently. The inhabitants are chiefly agriculturists; they attribute the sickness which prevails amongst them to bad water and to the surrounding rice cultivation. Intermittent fever, bowel complaints, small-pox, and in the cold weather pulmonary complaints, are the diseases of the town. Moreover, the inhabitants are almost universally afflicted with goitre, while cretins and dwarfs are numerous. More women than men are goitred; many children after their fourth year become affected. Strangers are frequently attacked after about a year's residence in the town. Animals, especially dogs and goats, very commonly suffer. The people attribute the disease to the use of the well water, which they are obliged to drink when they are unable to obtain canal water; they do not consider the disease hereditary, but they notice that individuals of a weak habit of body are the most liable to be attacked, and they consider that a poor diet tends greatly to the development and growth of the disease.

Goitre is also present amongst the inhabitants of Hujra, a town on the Khanwah canal about twelve miles from Dipalpore, and at Pākputtan, a very filthy town some thirty miles south-west of Dipalpore, on the high bank overlooking the lands inundated by the Sutlej, but at neither of these places is the disease any-

¹ See table at p. 346 for statistics of the district.

thing like so prevalent as at Divalpore. The circumstances of the disease as it exists at Divalpore are very similar to those of Munee Majra (see p. 365). We find an unhealthy patch in a healthy district; the unhealthiness depending on excessive inundation in a low-lying tract, which cannot be, or is not drained, and showing itself in the development of malarious diseases, especially fever and goitre.

Jhung. This district lies along the northern border of the districts of Mooltan and Montgomery. Its western portion is traversed, first by the Jhelum and Chenaub, and subsequently by the combined stream of those rivers. The Ravee touches the district at its south-western angle.

Excepting a narrow fringe of cultivation along the banks of the river, the district is a wide extent of desert or jungle, sparsely inhabited by pastoral tribes.

Of the two rivers which traverse the district, the Chenaub has the greatest volume; but it flows in a broader channel than the Jhelum, and is therefore a more sluggish stream, and its floods are not so violent. As a fertilising agent it is not equal to the Jhelum, its deposits being less in quantity and inferior in quality, often a mere unculturable sand; and the soil of its banks is more sandy, more pervious to moisture, and not so fertile as that of the sister stream. The banks which limit the floods of the river are in this district some thirty miles apart, and between these the main channel is continually shifting; numerous islands intersect the stream, and of these several, together with the river banks, are cultivated down to the water's edge. Between the patches of cultivation the bank is covered with shrub jungle.

The Jhung district is considered a healthy one. The annual rainfall averages 10 inches, varying from 5 to 16 inches; the fall is mainly in the months of July and August.

Goitre is very prevalent in the district in places situated in or near the low country along the left bank of the Chenaub. Especially is it so at Chiniot, a town near the river bank in the northern part of the district. The inhabitants believe that the water from wells which have their springs in a red sandstone rock highly impregnated with iron is a cure for the disease, and, writes the Civil Surgeon, Dr. Deane,¹ 'it is a fact that no goitre exists in the five subdivisions of the town which have their water from this formation, while in all the remaining twenty-one subdivisions there is more or less of the disease. The disease is most prevalent in a

¹ *Special Report* 1875.

subdivision which is inhabited by the lowest class of people, who moreover use a very foul water supply.

*Shahpore.*¹ North of the Jhung district is that of Shahpore, which embraces a considerable stretch of the Jhelum river southwards from the Salt range, and extends across the Jetch Doab, that is the tract of country between the Jhelum and Chenaub rivers, up to the right bank of the latter river. Throughout this extensive area cultivation is limited to the belts of low land, varying from three to fifteen miles in breadth, which skirt the rivers. From the low land there is a general slope upwards, generally gradual, more rarely almost abrupt, to the central high and dry expanse of land which is known as the Bār. In the Bār, though the soil is good, water is so far from the surface that irrigation is out of the question, and crops are raised only here and there in hollows which receive and retain the surface drainage; the rest of the Bār is mere jungle which is employed as pasture land for great herds of cattle. The zones of cultivation along the rivers embrace the alluvial tract immediately upon the bank, which is inundated, and where the crops need little or no artificial irrigation, and a strip of country outside this in which tillage is dependent upon wells, where the villages are fewer and smaller, and the cultivation less vigorous than in the tract which the rivers inundate.

The general climatic conditions of the Shahpore district² 'have but little to distinguish them from those of other tracts of country similarly situated with reference to the Himalayas; over all the heat is practically the same, and the healthiness of each locality appears to depend mainly on the quantity of moisture deposited on the surface combined with the efficiency of the machinery for drainage; the rule being that the less the moisture and the better the natural drainage the healthier the place, and *vice versâ*. As the average rainfall on the plains of the Shahpore district throughout the year is only 15 inches, and as the texture of the soil in most parts is sufficiently loose to absorb moisture rapidly, the district is generally healthy, excepting only the low tracts immediately bordering upon the river, where in the autumn months after heavy floods fever prevails and commits great ravages.' The mean temperature of the year averages about 80·5; the maximum in the shade has been known to reach 126°.

The sub-district of Midh, in which goitre is very prevalent, occupies the south-east corner of Shahpore, lying along the low

¹ For statistics of district see table at p. 346.

² *Settlement Report*, by Major Davies, of the district.

right bank of the Chenaub, which here extends from five to seven miles from the stream. The western limit of the bank is very abrupt, and is marked by a sudden drop of about twenty feet from the Bār. Midh, a small town with about 2,200 inhabitants, is situated three miles from the river's edge, within the limits of the autumn floods, and is about thirty miles north of Chiniot, but on the opposite side of the river. The land about the town is very fertile and highly cultivated, the soil humus, and beneath it sand and sometimes clay.

Opposite to Midh is one of the many islands which divide the stream of the Chenaub; it has an area of about 2,300 acres, and has a surface somewhat higher than that of the Bār, where it limits the alluvial tract. In part the island is subject to the floods, but the water rapidly drains off. The islanders, about nine hundred in number, are relatives of their neighbours on the adjacent bank of the stream, but they suffer less from fever and dysentery, and there is no goitre amongst them; they drink Chenaub water only.

Goitre is exceedingly common in the town of Midh, and in the neighbouring villages within five miles of the river. Men and women are equally liable to the disease, and strangers are commonly attacked within a year of settling in the locality. This is strikingly the case as regards the men of the detachment of police stationed at Midh; they are pretty generally affected after about a year's service there. Tradition says that goitre has been prevalent at Midh for very long; two or three cretins are known in the town, and there may be others, though their existence is concealed. The Mahomedan population suffers less than the Hindoos, 'and this,' says the native officer who reports on the subject, 'because they live on good nourishing animal diet.' The outchers, too, according to a special report from the Civil Surgeon, Dr. Deane, are as a class unaffected. This is attributed to their habit of using the milk of goats and sheep freely. The native inhabitants attribute the disease to the use of well water, and believe that individuals who drink Chenaub water suffer but little. There is however no satisfactory evidence to establish this point, excepting that to be derived from the case of the inhabitants of the island already mentioned, and it is clear that in their case the circumstances which render them less liable than their neighbours to malarious affections may account for their freedom from goitre.

The town of Shahpore is about forty-five miles west of Midh, on the left bank of the Jhelum. Here there is no goitre. Dr. Deane, the Civil Surgeon, could not find a single case in the town,

but at Khushab, a town about five miles distant from Shahpore, on the opposite side of the river, he found thirteen cases indigenous to the place, while at Bherah and Miani, places some thirty and forty miles north-east of Shahpore, on the same side of the river and within the limits of the annual inundation, the disease is pretty common. The latter place is almost opposite Pind Dadun Khan, where, as we have seen (p. 427), goitre is exceedingly prevalent.

Tracing the Chenaub northwards from Shahpore we find the district of Gujranwallah on the opposite bank to Shahpore, and still further north, between these districts and the hills, the districts of Gujrat and Sealkote. Throughout this stretch of the river goitre is unknown till the irrigated sub-montane patch of land described at p. 420 is reached. The history of the disease along the banks of the Chenaub clearly points to its dependence upon a cause which may be developed very locally, and is unconnected with any peculiarity in the quality of the river water.

CONCLUSIONS.

THE following conclusions seem warranted by the facts which have been set forth in the foregoing pages :—

1. That a large portion of the most important diseases of Northern India have a common origin under certain conjoint conditions of soil and climate, which we recognise as generating 'malaria' and 'marsh miasma.'

2. That not only fevers of various kinds, and visceral enlargements, but such diseases as dysentery, cholera, goitre, elephantiasis, arise under similar conditions, and obey very similar laws, and would probably prove amenable to the same sanitary and preventive measures, could these be carried out.

3. While thus recognising a concurrence of certain physical conditions as essential to the production of these diseases, we cannot regard these conditions themselves as the cause of the diseases, but only as fostering a *materies morbi* with the nature of which we have no precise acquaintance, but which we conjecture to be some low form of living organism.

4. That, however similar the germs in these different diseases may be, we must assume a specific difference, inasmuch as (while for the most part prevailing together) we have witnessed a very remarkable limitation of some one disease to a well-defined area to the exclusion of others, the conditions being apparently the same.

5. The facts which have been now brought together, while thus indicating certain widely ranging influences as the chief factors in the production of a group of diseases, afford no support to the special views which have been entertained at different times as to the influence of certain kinds of water, electrical and other changes in the atmosphere, chill, infection, and the like, in the production of some of them, except it be as secondary and subordinate agencies.

APPENDIX.

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TABLE III.

Goalparah. N. Lat. 26° 11', E. Long. 90° 40'. Elevation above sea- level 386 feet	Direction of winds and mean diurnal movement in miles												Mean relative humidity 1874											
	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean temperature of the air	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean movement	
January	1875 110	50	61	70	18	76	30	56	77	3.3	.83	8	1	8	22	8	1	1	4	4	1	16	67	64
February	1876 114	52	63	73	19	77	27	57	74	2.2	.02	1	4	6	21	2	—	5	5	5	14	65	59	
March	1875 125	55	69	80	22	86	34	60	62	.7	.3	1	1	3	15	2	—	3	18	7	7	52	53	
	1876 125	53	68	79	23	86	39	57	56	1.2	—	1	2	4	12	5	1	1	15	9	9	88	—	
April	1875 127	62	74	84	20	91	35	66	69	3.3	1.6	7	3	5	17	2	1	2	7	4	1	173	69	
	1876 136	60	76	88	26	96	39	64	56	1.8	1.2	1	2	20	14	5	1	4	25	6	1	120	—	
May	1875 134	68	77	85	16	95	30	72	78	3.7	11.2	12	5	13	20	2	—	3	3	6	5	165	81	
	1876 140	67	80	90	21	99	34	69	62	2.6	2.9	11	5	12	14	6	4	3	8	5	7	117	—	
June	1875 140	70	79	87	15	93	27	73	79	3.6	11.2	18	3	8	31	7	4	1	1	3	1	163	82	
	1876 137	70	77	84	14	94	28	—	—	5.	13.9	21	6	8	27	7	4	4	6	1	5	140	—	
July	1875 140	75	81	86	11	95	25	77	88	6.4	35.	23	1	8	20	8	3	3	6	1	8	124	85	
	1876 132	75	80	86	11	93	22	—	—	7.3	33.7	26	3	5	15	10	3	6	5	3	13	78	—	
August	1875 141	77	83	89	12	95	21	79	85	5.9	13.4	24	2	2	23	13	7	3	4	1	6	108	81	
	1876 142	76	82	87	11	91	17	—	—	6.3	10.7	23	1	3	19	7	7	4	9	6	13	71	84	
September	1875 138	75	81	87	11	92	20	78	87	5.7	17.9	18	1	5	13	9	7	1	3	8	8	80	—	
	1876 148	76	82	88	11	93	19	78	85	6.	9.6	19	3	3	13	10	4	4	8	8	10	58	77	
October	1875 141	75	82	87	13	94	21	77	83	4.2	5.4	14	2	3	13	7	4	5	9	6	23	49	—	
	1876 148	75	82	89	13	95	22	77	84	5.1	7.2	16	3	2	14	7	1	3	5	2	7	109	70	
November	1875 136	69	79	88	17	91	26	73	75	1.7	.63	2	1	6	32	9	—	—	5	3	7	109	—	
	1876 133	66	75	82	14	89	36	71	83	3.3	8.1	8	—	2	31	2	1	1	5	3	13	74	70	
December	1875 128	59	71	82	21	87	32	65	72	.3	—	—	2	3	26	11	—	—	—	2	4	95	72	
	1876 131	59	70	79	17	82	28	65	76	1.7	.29	2	2	9	29	8	—	4	—	1	21	56	—	
	1875 118	52	63	74	21	80	31	59	74	2.5	.29	1	6	7	26	5	—	1	—	—	—	—	—	
	1876 116	52	65	75	21	79	28	59	—	.16	.06	1	—	—	—	—	—	1	—	—	—	—	—	
The year	1875 132	65	75	83	16	95	49	70	—	3.4	97.6	128	—	—	—	—	—	—	—	—	—	—	73	
	1876 134	65	75	83	17	99	52	—	—	3.6	87.9	129	—	—	—	—	—	—	—	—	—	—	—	

Mean of two observations, from the *Bengal Meteorological Report* for 1874.

TABLE IV.

Sebsauror. N. Lat. 26° 59', E. Long. 94° 40'. Elevation above sea- level 332 feet	Direction of winds and mean diurnal movement in miles												Mean relative humidity 1874 ¹
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean movement			
January .	1875 .	2	20	13	3	7	6	5	5	1	46	82	
February .	1876 .	10	25	8	5	1	2	5	5	1	43	—	
March .	1875 .	7	17	15	3	4	4	1	3	3	48	77	
	1876 .	6	23	12	1	3	5	3	5	1	56	—	
April .	1875 .	4	24	19	3	3	3	1	1	4	70	75	
	1876 .	3	20	25	8	—	3	1	1	1	81	—	
May .	1875 .	5	23	16	2	1	5	2	2	2	74	81	
	1876 .	3	22	21	5	3	2	1	1	2	81	—	
June .	1875 .	8	19	10	4	2	8	6	6	1	67	86	
	1876 .	—	17	21	4	2	4	4	3	3	78	—	
July .	1875 .	5	17	14	5	3	8	4	8	2	69	82	
	1876 .	1	10	8	6	6	8	10	7	4	74	—	
August .	1875 .	7	12	9	6	5	11	8	3	1	78	83	
	1876 .	2	9	8	6	3	11	14	6	3	88	—	
September .	1875 .	6	11	9	3	6	14	7	6	—	83	82	
	1876 .	2	10	9	6	5	10	14	6	—	80	—	
October .	1875 .	3	14	11	5	7	11	7	2	—	66	82	
	1876 .	5	13	10	1	3	8	9	6	5	71	—	
November .	1875 .	2	11	8	6	7	17	6	4	1	45	78	
	1876 .	2	19	21	6	2	3	2	—	7	51	—	
December .	1875 .	—	23	23	7	—	3	—	1	3	36	73	
	1876 .	4	16	18	7	—	—	1	3	11	36	—	
The year	1875 .	1	21	15	6	4	8	2	1	4	35	78	
	1876 .	3	22	24	1	2	2	1	—	7	35	—	
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¹ From the mean of two observations. *Bengal Meteorological Report for 1874.*

TABLE V.

Sillchar. N. Lat. 24° 49', E. Long. 92° 50'. Elevation above sea- level 874	Direction of winds and mean diurnal movement in miles										Number of days rain was measured	Inches of rainfall	Mean proportion of clouded sky	Mean relative humidity	Temperature of evaporation	Absolute range	Highest maximum	Mean daily range	Mean of maxima	Mean air tem- perature	Mean nocturnal radiation temperature	Mean solar radiation temperature	
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean move- ment													
January	1875	1	4	14	15	2	5	6	2	13	49	1.04	5.	57	35	80	22	74	61	47	134		
February	1876	1	1	21	7	4	9	15	9	2	57	—	2.4	57	35	80	25	76	63	46	138		
	1875	—	1	15	11	7	7	11	3	1	62	.41	2.5	61	37	87	25	81	67	50	143		
March	1876	1	8	14	10	1	7	13	1	3	75	2.3	4.2	59	42	86	23	79	67	49	141		
	1875	6	5	18	7	1	5	4	4	12	68	14.6	5.	68	37	91	19	85	73	62	146		
April	1876	2	9	29	7	3	3	3	3	3	94	22.1	6.5	68	28	87	18	82	72	60	148		
	1875	2	4	16	9	—	4	4	4	5	55	16.3	6.7	74	25	92	15	88	78	69	147		
May	1876	4	5	22	9	6	1	3	5	5	79	15.2	5.	72	26	91	16	86	78	66	151		
	1875	2	4	12	6	1	2	8	8	19	49	15.	5.6	74	28	93	17	88	79	69	149		
June	1876	5	9	18	5	1	3	6	8	7	99	16.7	6.7	74	26	94	15	87	79	70	152		
	1875	6	8	18	6	—	4	5	7	6	65	27.2	8.4	78	24	97	12	89	81	76	146		
July	1876	7	10	14	4	3	2	9	5	6	78	28.5	7.8	78	23	96	12	89	82	76	149		
	1875	4	3	15	4	2	5	18	6	5	69	17.7	8.	79	22	97	13	91	83	77	153		
August	1876	4	6	14	7	4	6	12	9	—	83	23.5	8.4	78	19	94	12	89	82	76	151		
	1875	8	5	11	6	—	4	16	3	9	69	26.9	8.3	77	17	91	11	87	81	75	—		
September	1876	5	9	19	2	1	1	15	9	1	75	14.5	7.7	78	25	97	13	90	83	76	150		
	1875	2	3	18	5	1	3	10	9	9	62	11.6	6.	78	22	96	15	91	82	74	152		
October	1876	4	6	14	2	2	2	13	12	5	71	12.7	7.	78	21	95	12	89	83	75	153		
	1875	3	3	14	7	7	4	14	5	5	44	1.8	4.6	75	25	93	15	88	80	70	148		
November	1876	6	13	20	2	3	—	5	4	9	64	4.1	5.7	73	30	92	15	84	77	67	142		
	1875	—	2	19	8	7	7	8	2	7	47	—	1.9	67	37	89	23	84	72	57	145		
December	1876	1	6	19	4	—	2	7	1	20	49	2.03	3.8	67	30	86	19	81	72	—	136		
	1875	1	2	23	4	4	8	9	3	8	52	.14	1.9	60	32	83	25	79	70	49	140		
The year	1876	—	7	19	5	6	6	1	—	18	33	—	2.2	60	34	80	24	77	66	—	135		
	1875										165	5.3	77	71	52	97	18	85	75	65	—		

TABLE VII.

Puneah. N. Lat. 25° 50', E. Long. 87° 34'. Elevation above sea- level 125 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity ¹	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles										Mean relative humidity 1874 ²
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean movement	
January .	1875 123	—	59	72	23	77	37	54	75	3·	·7	2	4	8	5	5	2	8	18	12	—	—	—
February .	1876 132	—	62	77	30	81	41	54	60	·4	·13	1	—	—	—	3	6	11	27	9	—	—	—
March .	1875 144	—	66	80	28	88	45	58	58	1·4	—	—	—	—	—	—	—	—	—	—	—	—	—
April .	1876 152	—	67	83	32	92	54	56	53	·6	—	—	1	13	17	3	1	7	13	4	3	—	—
May .	1875 146	—	76	92	30	102	48	67	55	1·8	·73	1	3	13	14	1	—	2	18	9	—	—	—
June .	1876 148	—	77	93	33	102	50	62	48	2·2	·5	1	2	33	16	10	—	1	—	—	—	—	79
July .	1875 146	—	85	99	27	102	33	74	56	2·6	4·4	8	—	—	—	—	—	—	—	—	—	—	81
August .	1876 148	—	79	92	25	98	37	73	83	7·4	4·7	10	—	—	—	—	—	—	—	—	—	—	81
September .	1875 150	—	—	97	—	105	—	—	—	2·6	16·5	9	—	—	—	—	—	—	—	—	—	—	86
October .	1876 155	75	84	91	12	94	18	79	84	7·7	13·4	19	1	—	5	17	13	5	4	4	—	—	69
November .	1875 145	65	79	90	21	94	37	72	62	1·2	—	—	1	1	1	6	2	11	30	10	—	—	59
December .	1876 135	—	77	86	17	91	27	72	78	4·7	—	—	1	2	—	—	1	9	28	14	—	—	62
The year	1875 1876	—	—	—	—	—	—	—	—	2·7	44·2	79	—	—	—	—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—	—	64·9	82	—	—	—	—	—	—	—	—	—	—	—

¹ Of 1875 from the 10 A.M. observation only.² Mean of two observations, from the Bengal Meteorological Report for 1874.

TABLE VIII.

Patna. N. Lat. 25° 37', E. Long. 85° 8'. Elevation above sea- level 179 feet	Mean solar radiation temperature	Mean nocturnal radiation temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles										
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean movement	
January .	128	44	60	71	22	75	34	54	65	2.6	1.3	5	1	4	6	5	9	12	22	3	—	60	
February .	120	45	61	75	26	82	40	54	58	1.	—	—	—	2	6	—	1	1	41	6	5	43	
March .	134	50	66	78	24	87	44	57	56	3.	.11	2	1	1	2	—	4	13	23	12	—	95	
April .	132	48	67	82	31	92	50	56	49	1.7	—	—	—	—	2	8	1	2	46	4	2	65	
May .	146	60	80	94	29	103	48	65	43	.7	—	—	1	5	12	—	3	12	16	5	—	94	
June .	142	59	79	93	29	102	46	62	40	5.6	.04	1	1	2	—	—	2	4	48	5	—	92	
July .	153	71	90	103	28	110	39	71	37	1.6	.21	1	1	5	16	1	—	2	29	6	—	157	
August .	161	66	87	102	30	110	48	68	38	2.	.02	1	—	3	12	2	2	4	29	6	2	85	
September .	150	73	86	99	21	111	42	76	61	2.3	2.6	6	1	11	33	7	3	—	5	2	—	136	
October .	160	75	90	104	26	111	40	75	52	2.5	.06	1	—	6	31	5	1	2	11	2	4	99	
November .	150	76	88	96	14	104	28	79	69	6.5	18.1	12	2	13	16	16	1	3	2	7	—	128	
December .	160	80	91	102	20	111	34	80	64	7.7	.75	8	1	5	41	4	—	—	3	3	3	73	
The year	149	78	86	92	12	98	21	81	75	8.	9.3	17	—	6	29	9	4	4	7	3	—	108	
	154	79	86	93	12	101	26	80	79	9.1	5.1	19	—	3	50	4	—	1	1	1	2	108	
	146	77	84	90	10	95	18	80	82	8.3	8.4	17	1	9	30	7	2	1	10	1	1	108	
	148	78	84	90	10	95	18	79	84	8.4	14.7	18	—	—	34	2	—	4	20	—	2	52	
	148	77	85	91	12	96	20	79	78	7.4	5.4	10	1	13	26	5	—	2	8	3	2	97	
	142	77	84	90	11	95	18	79	82	8.5	11.3	15	1	3	40	—	—	1	9	—	6	43	
	144	66	81	91	20	93	34	71	59	2.7	.03	1	—	2	7	1	2	9	33	7	1	67	
	134	66	77	84	14	90	25	71	76	5.	5.5	7	—	3	11	—	1	5	42	4	8	48	
	137	51	71	84	28	90	38	60	54	.9	—	—	—	2	—	—	1	6	38	6	4	48	
	137	50	70	82	24	86	38	62	64	1.6	—	—	—	—	—	—	1	6	39	5	9	33	
	129	47	63	76	25	83	38	57	65	1.7	—	—	1	—	1	—	1	5	42	4	8	48	
	129	42	62	74	26	77	32	55	64	1.1	—	—	—	1	1	—	3	2	43	1	11	32	
	143	64	78.4	89	20	111	70	69	62	3.8	45.4	71	—	—	—	—	—	—	—	—	—	—	—
	143	64	78	89	22	111	70	68	62	4.5	37.5	70	—	—	—	—	—	—	—	—	—	—	—

* Mean of two observations only.

TABLE IX.

Benares. N. Lat. 25° 20', E. Long. 83° 2'. Elevation above sea- level 268 feet	Mean solar radiation temperature	Mean nocturnal radiation temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874		
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement	
January	1875	43	60	75	28	78	38	48	70	2·	1·4	5	4	3	9	4	4	9	14	15	—	77	65	
February	1876	43	62	77	29	86	45	—	—	·7	·05	1	—	3	7	—	—	1	43	2	—	138	—	
	1875	50	66	84	31	92	51	52	64	2·3	·1	2	—	3	3	3	1	12	17	14	—	103	56	
March	1876	46	67	85	34	93	51	55	—	1·	—	—	—	2	3	—	2	4	42	2	—	158	—	
	1875	59	77	96	34	101	49	60	56	·7	—	—	—	—	5	3	9	5	22	11	—	127	44	
April	1876	57	76	92	30	99	43	61	39	3·8	·02	1	—	1	5	1	3	4	38	9	—	149	—	
	1875	71	86	106	31	109	42	68	44	1·	—	—	—	2	6	—	2	2	23	13	—	169	35	
May	1876	63	85	103	34	112	51	65	31	1·	—	—	—	4	5	1	4	2	28	15	—	155	—	
	1875	77	90	106	27	110	37	73	54	1·	·09	2	10	12	18	—	2	5	7	8	—	140	31	
June	1876	76	92	108	28	113	42	73	40	1·3	·01	1	3	14	11	—	5	1	10	18	—	147	—	
	1875	81	90	101	19	111	34	76	64	4·7	5·8	10	7	7	16	1	1	3	11	13	—	153	78	
July	1876	83	95	107	22	114	37	79	49	3·5	·85	4	8	8	8	3	1	7	19	6	—	138	—	
	1875	75	84	92	12	96	21	79	86	6·5	11·9	20	5	11	18	1	5	11	8	3	—	137	84	
August	1876	78	84	94	14	118	36	79	80	7·9	11·3	21	4	8	26	4	4	8	4	2	—	143	—	
	1875	79	82	89	11	94	19	77	89	7·3	17·3	22	3	9	20	3	2	6	12	7	—	124	88	
September	1876	77	84	90	11	96	20	79	82	7·	4·9	14	—	6	22	—	4	16	14	—	—	148	—	
	1875	78	83	91	13	95	20	77	86	5·1	8·3	14	4	16	19	2	1	8	4	6	—	116	83	
October	1876	75	82	91	13	98	27	78	80	7·	5·9	14	1	7	14	12	2	5	15	4	—	113	—	
	1875	64	77	91	22	94	33	—	—	1·7	·08	1	3	8	7	4	3	8	24	4	1	90	76	
November	1876	64	75	86	20	92	31	70	74	3·2	1·7	6	7	11	3	2	4	11	10	13	—	79	—	
	1875	50	69	84	30	89	39	—	—	—	—	—	—	3	—	—	1	11	35	8	1	81	70	
December	1876	49	68	83	28	87	41	60	61	·7	—	—	—	2	5	—	1	16	32	3	—	91	—	
	1875	46	62	77	27	84	40	—	—	1·4	—	—	—	6	6	—	2	6	34	4	—	76	68	
The year	1876	40	60	76	30	79	37	53	61	·6	—	—	—	2	1	1	5	14	33	6	—	73	—	
	1875	64	77	91	24	111	71	—	—	2·8	44·8	76	—	—	—	—	—	—	—	—	—	—	65	—
	1876	63	78	91	24	114	73	—	—	3·1	24·8	62	—	—	—	—	—	—	—	—	—	—	—	—

From Meteorological Report of North-West Provinces for 1874.

TABLE X.

Goruckpore. N. Lat. 26° 46'. E. Long. 83° 18'. Elevation above sea-level 256 feet	Mean solar radiation	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	•Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January .	128	—	58	73	25	77	35	53	74	2.6	.3	1	—	1	12	7	5	16	65	18	—	—	62
February .	129	—	60	77	28	81	39	—	—	—	.7	1	1	1	1	6	—	16	24	13	—	—	59
March .	133	—	64	79	25	86	42	58	71	2.6	.2	1	1	2	11	4	2	9	71	13	—	—	45
April .	138	—	66	85	34	90	47	—	—	—	.2	1	1	1	—	7	2	8	27	12	—	—	34
May .	149	—	77	93	28	101	47	67	59	.7	—	—	—	6	33	14	3	8	41	19	—	—	32
June .	150	—	77	91	28	98	43	—	—	2.3	—	—	16	3	2	—	—	4	40	12	—	—	80
July .	158	—	88	101	26	108	37	71	44	1.	—	—	5	2	3	15	—	—	38	28	—	—	86
August .	155	—	84	101	30	106	44	—	—	.7	1.3	1	1	14	68	23	—	1	22	14	—	—	87
September .	156	—	85	97	24	105	34	75	64	1.8	1.7	5	1	2	3	45	1	4	6	8	—	—	83
October .	155	—	89	101	23	106	35	—	—	1.2	.8	2	1	13	62	16	4	6	12	6	—	—	69
November .	149	—	87	98	17	106	31	79	73	4.7	7.9	9	1	2	6	42	—	3	3	12	—	—	63
December .	157	—	90	101	19	109	34	80	61	2.5	2.	4	—	2	56	18	9	4	2	—	—	—	62
The year	151	—	84	93	13	97	23	79	82	5.4	8.2	13	—	23	3	50	3	4	2	—	—	—	63
	149	—	86	95	14	105	29	79	72	4.3	5.	6	—	3	42	33	3	5	6	9	—	—	62
	146	—	82	90	11	93	20	78	87	6.4	16.4	22	—	1	25	33	3	5	6	9	—	—	63
	145	—	85	91	11	97	20	79	79	3.7	10.9	9	—	1	8	35	—	1	9	8	—	—	69
	149	—	83	91	13	95	23	78	82	3.5	3.3	8	—	1	64	19	1	6	16	11	—	—	63
	147	—	83	91	13	98	26	78	78	4.8	15.3	10	—	12	5	29	—	6	1	7	—	—	62
	151	—	79	91	22	93	29	71	69	1.	—	—	—	2	—	10	—	20	63	29	—	—	63
	141	—	76	86	17	92	27	70	71	2.5	3.5	7	—	9	1	10	—	3	1	37	—	—	62
	141	—	69	84	28	89	36	—	—	.5	—	—	—	1	1	2	6	12	19	19	—	—	62
	138	—	68	82	25	87	36	61	59	.3	—	—	—	—	—	—	—	10	31	19	—	—	62
	131	—	63	77	25	82	35	—	—	.9	.1	1	—	—	1	10	—	22	24	5	—	—	63
	130	—	61	76	27	78	32	55	59	.4	—	—	—	2	—	2	—	1	26	31	—	—	63
	145	—	76.5	89	21	108	66	—	—	2.6	38.	60	—	—	—	—	—	—	—	—	—	—	63
	145	—	77	90	22	109	66	—	—	—	39.7	41	—	—	—	—	—	—	—	—	—	—	63

From the Meteorological Report of the North-West Provinces for 1874.

TABLE XI.

Lucknow. N. Lat. 26° 50', E. Long. 81°. Elevation above sea-level 369 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean movement	Mean relative humidity 1877
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		
January .	1875	—	39	60	76	33	83	50	52	60	2.9	.1	1	2	1	—	6	5	20	22	—	61	71
February .	1876	137	42	61	75	30	82	45	51	53	1.4	.1	1	—	—	5	4	6	15	32	—	47	59
March .	1875	138	47	66	80	29	89	54	57	58	5.4	.4	2	—	1	3	1	2	18	24	—	79	—
	1876	148	45	66	81	32	90	48	52	37	1.5	—	—	—	—	—	—	—	—	—	—	61	48
April .	1875	155	55	80	97	37	105	57	60	40	1.9	—	—	3	5	4	1	2	18	24	—	90	—
	1876	157	56	75	88	28	97	47	59	39	5.4	.7	1	1	4	1	1	—	40	11	—	68	—
May .	1875	162	65	90	106	32	109	46	67	32	1.2	.1	—	—	7	11	2	—	20	18	—	126	42
	1876	163	62	85	100	32	112	55	63	27	1.4	.1	1	—	—	—	—	—	—	—	—	76	—
June .	1875	164	71	90	106	28	111	42	72	44	2.4	—	—	5	13	15	6	4	7	6	—	119	38
	1876	158	72	92	107	30	114	44	71	36	1.4	—	—	4	1	24	1	6	4	21	—	87	—
July .	1875	151	79	92	104	21	114	37	79	58	5.5	.8	5	3	14	13	9	4	6	7	—	120	48
	1876	166	75	95	107	25	114	43	77	47	3.9	3.6	5	4	—	10	2	7	3	19	—	77	—
August .	1875	151	77	88	98	17	106	29	80	74	7.7	8.3	13	6	20	12	4	3	6	8	—	123	61
	1876	153	77	87	96	15	107	30	79	70	8.4	7.3	12	4	5	35	2	11	2	1	—	86	—
September .	1875	140	75	83	91	12	94	18	80	85	8.9	19.7	18	3	12	9	7	7	12	9	—	74	59
	1876	144	74	84	92	13	97	23	79	80	7.3	7.3	10	4	2	17	2	8	13	12	—	59	—
October .	1875	—	73	83	90	15	98	28	76	76	6.4	14.4	15	1	21	8	10	9	5	4	—	82	48
	1876	143	59	77	92	15	99	24	79	83	7.3	3.2	10	—	2	20	3	17	1	4	—	68	—
November .	1875	138	61	75	86	22	92	33	68	66	1.1	.84	—	3	2	4	1	3	21	19	—	37	60
	1876	141	46	68	86	35	91	46	—	—	.7	—	2	3	—	7	5	4	4	31	—	42	—
December .	1875	140	47	68	82	30	89	43	58	55	.8	—	—	2	—	—	2	1	22	30	—	24	55
	1876	132	44	63	78	31	89	49	—	—	.2	—	—	—	—	—	4	—	4	52	—	45	—
	1875	134	38	61	76	32	79	41	52	56	1.5	—	—	—	—	—	2	1	33	25	—	13	72
	1876	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	47	—	33	—
The year .	1875	—	61	78.4	92	27	114	81	—	3.8	43.6	55	—	—	—	—	—	—	—	—	—	—	—
	1876	—	60	78	90	25	114	77	66	3.4	23	42	—	—	—	—	—	—	—	—	—	—	—

TABLE XII.

Bareilly. N. Lat. 28° 31'. E. Long. 79° 27'. Elevation above sea-level 568 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874 ¹
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January .	127	39	55	71	26	78	44	49	64	2.3	.35	2	—	—	—	—	—	2	74	46	50	63
February .	125	40	60	75	29	87	50	52	60	1.7	—	—	3	—	—	—	—	2	25	16	9	18
March .	134	46	61	—	—	—	—	55	67	4.	2.4	—	—	1	2	3	1	6	27	49	27	78
April .	134	44	64	79	29	87	49	54	53	1.9	—	—	—	—	1	11	1	3	33	9	6	84
May .	153	55	75	92	32	102	50	62	51	.8	—	2	—	—	—	3	1	—	31	24	56	64
June .	146	53	73	88	29	96	47	61	52	3.5	.34	2	—	—	—	12	—	8	30	10	8	80
July .	163	63	86	103	31	108	43	68	38	.6	—	—	1	—	—	1	2	—	19	24	14	65
August .	153	59	83	97	31	111	54	69	49	1.2	.91	1	—	2	3	28	1	1	30	9	14	100
September .	163	72	89	104	27	109	38	72	49	1.8	.23	3	—	1	1	11	12	1	16	2	11	69
October .	155	—	89	106	29	113	44	73	46	.9	.7	3	—	—	—	19	1	3	10	11	13	—
November .	164	78	90	105	23	112	38	78	60	4.4	2.5	4	—	2	2	8	6	1	17	5	16	77
December .	158	—	94	109	25	114	41	75	39	1.5	1.4	2	—	—	—	25	—	1	7	25	9	22
The year .	154	77	85	96	16	102	28	80	80	6.8	28.3	14	—	6	—	18	—	—	18	1	18	66
	147	—	85	96	16	112	37	79	74	6.9	11.3	17	—	—	1	22	—	7	1	2	21	—
	156	76	82	91	13	94	18	79	86	7.8	16.9	16	—	—	—	19	—	—	17	—	26	56
	122	—	83	91	12	96	22	78	77	6.	7.8	14	—	7	4	4	6	4	3	11	27	—
	153	74	81	91	14	97	24	78	84	5.7	6.5	9	—	3	22	1	1	—	7	1	26	76
	122	—	81	91	15	100	30	76	75	5.3	4.9	10	—	9	9	6	—	1	4	9	22	85
	148	58	74	89	25	91	35	67	68	.3	.02	1	—	—	—	—	—	—	—	—	—	43
	—	—	74	87	21	92	31	66	61	1.	1.6	3	—	—	1	4	1	2	5	15	33	67
	145	46	67	83	30	89	40	—	—	.6	—	—	—	—	—	—	—	—	—	—	—	32
	—	—	65	81	30	86	45	57	58	.3	—	—	—	3	6	—	—	3	15	20	10	73
	132	42	60	76	28	87	47	—	—	1.8	.07	1	—	—	—	—	—	—	—	—	—	37
	129	—	57	74	32	81	42	51	62	.6	—	—	—	—	1	—	—	7	19	13	20	59
	149	60	76	—	—	—	—	—	—	3.	57.3	51	—	—	—	—	—	—	—	—	—	—
	—	—	76	90	25	114	77	66	59	2.6	29.1	52	—	—	—	—	—	—	—	—	—	—
	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876	1875	1876

¹ From the North-West Provinces Meteorological Report for 1874.

TABLE XIII.

Meerut. N. Lat. 29° 41', E. Long. 77° 41'. Elevation above sea- level 737 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1871
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January	1875 1876	114 123	36 39	57 58	72 73	30 29	77 83	44 45	50 54	62 63	2 2	—	—	—	—	—	—	2	74	46	50	75
February	1875 1876	116 131	43 43	62 64	74 80	25 33	85 88	47 52	54 64	63 52	1 3	2	—	1	—	—	—	2	49	7	70	68
March	1875 1876	135 135	56 51	77 71	93 86	33 30	101 96	52 49	64 60	52 51	3	2	—	1	11	1	—	31	24	56	64	60
April	1875 1876	143 143	67 56	87 81	102 97	32 33	108 109	46 56	64 64	40 40	1	1	—	—	12	—	—	8	24	15	71	52
May	1875 1876	140 153	70 66	87 89	100 105	27 31	109 112	43 47	71 71	42 42	—	4	—	3	28	1	—	1	24	13	82	49
June	1875 1876	145 156	78 72	93 94	105 108	24 27	111 113	39 43	76 76	44 44	—	3	—	8	19	1	—	1	5	16	77	50
July	1875 1876	142 143	76 70	89 86	96 94	16 15	109 110	34 35	79 79	76 76	—	2	—	—	8	—	—	18	20	15	76	56
August	1875 1876	142 147	73 68	85 85	92 92	15 14	98 97	25 22	79 79	8 8	—	9	—	1	29	1	—	1	18	18	60	50
September	1875 1876	137 141	72 66	82 81	90 92	15 18	98 106	27 40	79 76	78 76	6	2	—	3	22	1	—	7	2	26	56	43
October	1875 1876	136 140	58 57	74 74	87 88	25 27	90 94	36 40	66 66	65 65	1	2	—	—	4	—	—	33	—	25	44	60
November	1875 1876	128 135	47 46	65 66	82 83	31 32	87 88	39 46	57 57	56 56	—	—	—	—	—	—	—	31	4	22	44	57
December	1875 1876	124 128	43 41	60 58	75 75	29 33	84 79	45 40	50 50	59 59	—	—	—	—	—	—	—	24	4	30	32	74
The year	1875 1876	134 140	60 56	76 76	89 89	25 27	111 113	78 77	—	—	34 17	37 29	—	—	—	—	—	—	—	—	—	—

TABLE XIV.

Roorkee. N. Lat. 29° 52'. E. Long. 77° 56'. Elevation above sea-level 887 feet	Direction of winds and mean diurnal movement in miles													Mean relative humidity 1874 ²							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Mean movement											
January .	118	36	56	70	29	75	44	51	57	1.7	.16	2	—	4	5	7	—	2	21	45	73
February .	116	39	56	71	28	80	44	50	66	3.	.04	1	1	—	2	2	—	2	15	110	—
March .	115	45	60	72	24	82	47	55	63	5.	4.3	6	1	1	2	2	—	2	22	71	68
April .	129	41	61	78	33	86	52	51	50	3.	.2	2	1	3	—	4	1	2	9	88	—
May .	141	54	75	90	31	99	51	64	41	1.7	—	—	1	4	2	18	2	3	22	81	58
June .	136	50	69	85	31	94	47	58	49	4.	1.9	2	1	—	8	—	—	4	9	80	—
July .	151	64	85	100	32	106	46	68	30	1.2	.05	1	1	1	—	13	—	6	16	94	34
August .	145	58	80	96	34	110	59	61	34	1.5	.6	3	1	1	2	9	1	2	3	102	—
September .	149	71	86	99	26	107	42	71	39	2.6	1.9	8	1	4	4	23	1	5	3	110	29
October .	152	70	89	104	30	111	47	69	36	.8	1.	3	1	—	2	26	—	2	7	112	—
November .	148	79	91	102	23	110	39	78	49	2.2	.8	2	1	—	1	22	2	1	8	19	72
December .	155	78	94	108	27	114	42	74	38	1.1	.23	1	1	—	4	11	—	1	5	16	—
The year .	143	79	85	94	15	101	28	79	74	6.	15.4	16	—	—	1	27	—	1	10	20	83
	134	78	84	92	13	113	39	79	78	6.9	18.4	22	1	1	3	22	3	7	2	20	66
	138	77	83	91	14	95	23	78	77	6.	16.3	14	1	—	3	24	1	4	2	20	86
	134	—	83	90	13	98	24	78	82	6.7	14.6	18	—	2	2	16	2	5	1	20	51
	140	74	82	90	15	98	27	77	72	5.5	7.7	11	—	—	3	21	1	—	4	31	78
	139	72	82	91	17	98	32	76	74	5.4	2.1	6	1	1	1	25	2	3	9	12	62
	137	59	74	87	26	89	38	69	60	.6	.6	1	—	3	6	10	—	1	4	15	23
	139	57	72	85	24	92	38	66	70	1.6	2.8	5	—	2	1	18	2	2	3	21	46
	131	45	65	82	32	87	41	61	56	.6	—	—	—	—	2	7	—	1	3	34	60
	134	43	63	79	30	84	43	57	66	1.2	—	—	—	—	1	9	1	—	4	19	39
	122	41	59	75	29	85	46	56	66	2.	—	—	—	—	—	7	—	1	12	27	49
	127	37	56	72	31	75	36	51	70	1.3	—	—	—	1	—	14	2	1	8	16	38
	136	60	75	88	25	110	79	67	67	3.	47.3	61	—	—	—	—	—	—	—	—	63
	137	—	74	88	62	114	80	64	59	3.	41.9	63	—	—	—	—	—	—	—	—	—

¹ For 1875 from the 10 A.M. observation only, for 1876 from the mean of the daily observations.² From the *Meteorological Report of the North-West Provinces for 1874*.

TABLE XV.

Dehra. N. Lat. 30° 20'. E. Long. 78° 8'. Elevation above sea-level 2,232 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Mean relative humidity ¹	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles								Mean relative humidity 1874 ²			
													N.	NE.	E.	SE.	S.	SW.	W.	NW.		Calm	Mean movement	
January .	1875 116	39	53	65	22	72	37	47	67	3·	·6	3	10	—	4	2	Not recorded	7	1	19	1	12	—	62
February .	1876 118	40	55	67	23	75	37	49	70	3·5	—	—	14	3	3	—	9	5	18	—	4	—	57	
March .	1875 120	44	56	69	21	75	37	51	73	5·3	·52	4	12	2	4	1	7	5	20	3	4	—	53	
April .	1876 128	42	57	72	26	80	46	50	62	3·	—	—	3	6	7	3	12	6	11	8	4	—	—	
May .	1875 142	54	70	83	25	90	42	60	51	2·3	1·7	4	16	1	2	5	6	5	24	2	1	—	33	
June .	1876 137	49	65	77	25	86	40	57	57	4·	·01	1	8	6	3	4	5	9	14	2	6	—	31	
July .	1875 152	63	80	93	26	96	37	65	41	1·4	—	2	3	1	3	4	6	3	26	3	—	—	74	
August .	1876 147	57	76	90	28	100	50	62	41	1·6	1·5	4	7	6	1	14	8	7	9	3	—	—	86	
September .	1875 149	64	79	91	22	100	39	70	56	4·3	4·6	12	10	12	3	9	6	5	11	3	—	—	—	
October .	1876 153	72	84	94	19	109	32	76	63	4·3	10·4	10	3	8	6	9	13	4	5	10	—	—	86	
November .	1875 144	72	80	87	13	90	19	76	86	8·	23·	28	3	3	3	1	19	5	7	1	12	—	86	
December .	1876 134	73	80	87	12	105	33	76	85	8·3	30·8	23	6	7	10	9	9	4	9	5	—	—	—	
The year .	1875 141	71	77	84	11	88	18	76	89	8·2	23	28	6	7	9	14	1	5	2	10	8	—	—	—
	1876 132	72	78	84	11	89	19	75	86	7·4	27·3	21	6	7	9	14	1	5	2	10	8	—	—	—
	1875 140	69	76	84	13	89	21	74	84	5·9	12·9	20	12	3	2	5	4	12	7	3	12	—	—	—
	1876 142	69	77	85	14	91	26	73	80	6·	12·8	15	18	2	3	5	11	5	5	2	9	—	—	—
	1875 139	57	69	80	21	84	30	65	70	1·3	1·2	4	1	4	1	2	5	—	9	6	34	—	—	—
	1876 134	56	67	79	20	84	31	63	72	2·2	4	8	11	2	6	2	11	3	10	4	3	—	—	—
	1875 129	49	62	75	24	79	32	58	68	1·5	—	—	11	—	3	—	6	4	13	1	14	—	—	—
	1876 127	47	61	74	23	79	36	56	64	1·5	—	—	21	—	1	1	9	1	21	2	4	—	—	—
	1875 118	43	57	69	23	77	37	52	67	2·	·05	1	18	—	5	—	11	3	18	4	3	—	—	—
	1876 121	41	56	68	23	71	30	51	65	1·3	—	—	14	—	6	1	11	6	11	2	3	—	—	—
	1875 137	58	70	81	20	101	66	64	68	4·	81·9	114	—	—	—	—	—	—	—	—	—	—	—	60
	1876 136	57	70	82	21	107	73	63	64	3·6	81·4	86	—	—	—	—	—	—	—	—	—	—	—	—

¹ From 9-30 A.M. observation up to the end of September 1876, and subsequently from the 10 A.M. observation.
² From the *Meteorological Report of the North-West Provinces for 1874*.

TABLE XVII.

Chuckrata. N. Lat. 30° 40'. E. Long. 77° 55'. Elevation above sea- level 7,052 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1877	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January	1875	120	17	37	49	22	61	42	34	73	·68	1	26	13	20	—	4	17	23	10	11	137	70
February	1876	120	21	42	55	26	67	48	43	—	2·8	4	2	2	21	3	4	7	17	1	5	79	—
	1875	112	25	41	53	23	68	45	38	72	6·4	6	17	26	22	1	—	9	12	2	23	131	66
March	1876	125	22	42	54	25	62	42	43	—	1·3	8	7	5	11	1	3	9	17	2	3	95	—
	1875	138	31	55	66	24	72	40	46	56	·44	3	17	12	30	2	1	6	39	13	4	97	65
April	1876	130	37	48	60	21	67	39	44	60	3·5	6	5	3	19	2	5	11	14	—	3	88	—
	1875	145	37	63	74	24	80	43	51	47	·44	1	14	2	6	1	7	16	49	9	16	59	59
May	1876	136	—	59	70	22	79	44	54	51	2·8	3	5	7	7	3	3	15	16	1	3	108	—
	1875	143	37	60	71	23	78	40	52	65	3·8	16	14	14	25	4	4	19	22	14	8	69	50
June	1876	143	—	64	75	21	81	44	60	57	2·9	7	3	4	10	1	1	20	18	4	1	124	—
	1875	139	45	66	74	21	80	33	61	79	11·9	15	10	5	3	1	5	30	43	15	1	106	63
July	1876	145	—	69	81	23	89	44	60	52	1·94	6	1	2	3	1	5	14	27	3	4	103	—
	1875	135	47	64	71	18	77	26	63	96	14·9	27	5	7	18	3	4	37	35	8	4	95	84
August	1876	131	—	63	70	13	84	31	64	—	20·7	22	4	3	7	—	2	9	32	2	3	76	—
	1875	131	45	62	69	17	73	24	61	97	27·9	27	5	10	13	8	6	23	34	6	13	72	83
September	1876	126	—	63	69	13	79	27	64	—	20·	23	1	2	2	—	1	11	34	3	8	66	—
	1875	134	42	61	69	20	75	31	60	95	10·6	18	5	11	31	8	9	11	34	3	8	81	71
October	1876	139	57	63	69	9	76	22	62	79	5·	11	2	2	6	2	3	10	31	2	2	72	—
	1875	136	33	54	64	24	69	36	52	85	1·02	2	16	9	32	2	3	5	44	8	5	81	57
November	1876	131	45	54	62	11	70	27	52	68	2·5	5	1	—	11	2	7	11	27	1	2	84	—
	1875	131	26	48	60	24	68	36	—	1·7	—	—	11	1	18	2	1	7	21	2	2	73	52
December	1876	129	39	50	58	14	65	25	47	56	—	—	2	—	13	3	7	3	28	—	4	75	—
	1875	129	23	45	58	25	64	38	—	2·7	·32	2	3	1	13	3	5	8	17	5	7	79	58
The year	1876	125	36	47	57	15	68	31	42	47	—	—	1	4	9	7	1	14	17	2	7	68	—
	1875	133	34	55	65	22	80	61	—	—	78·5	118											—

¹ For 1875 mean of four daily observations; for 1876 of 10 o'clock observation only.

TABLE XVIII.

Simla. N. Lat. 31° 6', E. Long. 77° 12'. Elevation above sea- level 6,953 feet	Mean solar radiation temperature	Mean nocturnal radia- tion temperature	Mean temperature of air	Mean of maximum	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Mean relative humidity ²	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874 ²		
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement	
January .	—	—	38	48	16	59	35	36	64	—	1.1	1	—	—	—	—	—	—	—	—	—	—	—	58
February .	—	—	43	55	19	67	40	40	40	—	—	4	—	—	—	—	—	—	—	—	—	—	—	38
March .	—	—	41	51	16	62	34	39	61	—	4.3	5	—	—	—	—	—	—	—	—	—	—	—	50
April .	—	—	42	55	19	65	39	41	45	—	1.7	—	—	—	—	—	—	—	—	—	—	—	—	34
May .	—	—	55	67	20	80	41	47	34	—	—	4	—	—	—	—	—	—	—	—	—	—	—	32
June .	—	—	47	59	20	70	38	46	48	—	2.3	—	—	—	—	—	—	—	—	—	—	—	—	64
July .	—	—	65	78	22	88	41	54	31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	86
August .	—	—	59	72	22	84	48	53	36	—	4.1	3	—	—	—	—	—	—	—	—	—	—	—	84
September .	—	—	62	77	22	85	35	58	49	—	5.2	10	—	—	—	—	—	—	—	—	—	—	—	74
October .	—	—	67	80	21	86	44	58	36	—	7.4	6	—	—	—	—	—	—	—	—	—	—	—	52
November .	—	—	68	80	18	87	33	63	56	—	8	8	—	—	—	—	—	—	—	—	—	—	—	60
December .	—	—	71	84	21	92	46	59	30	—	3.3	4	—	—	—	—	—	—	—	—	—	—	—	89
The year	—	—	64	73	13	78	22	65	88	—	21.9	19	—	—	—	—	—	—	—	—	—	—	—	60
	—	—	65	73	13	88	36	64	86	—	22	20	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	63	71	13	78	22	62	86	—	24.9	21	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	63	70	11	78	22	63	86	—	25	18	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	60	70	14	75	22	62	85	—	11.8	20	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	60	70	15	79	29	60	77	—	7.4	15	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	55	66	18	72	29	53	60	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	53	64	18	71	32	50	54	—	2.5	4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	50	61	18	69	31	46	46	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	48	58	17	62	27	44	35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	46	58	18	63	33	43	49	—	6	1	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	45	56	18	60	27	41	31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	56	67	17	88	64	52	59	—	79.1	87	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	55	66	18	92	66	52	50	—	75.7	79	—	—	—	—	—	—	—	—	—	—	—	—

¹ From the 10 o'clock observation.² From the *Meteorological Report of the Punjab for 1874*.

TABLE XIX.

Sealkote. N. Lat. 32° 29', E. Long. 74° 35'. Elevation above sea- level 829 feet	Mean solar radia- tion temperature	Mean nocturnal radiation temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Mean relative ¹ humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative ² humidity 1874	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January	103	—	53	74	36	79	53	50	46	3	—	—	6	13	5	7	—	—	27	4	—	—	67
February	80	39	51	68	27	81	47	48	72	4	.5	1	15	5	6	2	1	—	24	9	—	—	54
March	103	—	55	72	28	84	52	53	59	5	2.2	5	3	6	1	3	2	9	28	4	—	—	47
April	97	40	55	74	31	83	52	50	64	4	.2	2	10	3	4	1	4	—	30	6	—	—	29
May	123	—	71	93	38	118	73	62	38	4	—	4	7	10	3	2	1	—	28	9	—	—	20
June	109	49	64	82	30	94	50	57	62	5	2.1	—	3	9	9	8	5	3	25	12	—	—	40
July	137	—	83	107	39	116	57	67	21	2	—	1	5	4	5	1	3	2	14	9	—	—	60
August	124	55	75	97	37	111	62	61	39	2	1.5	1	11	4	18	7	1	1	21	18	1	—	57
September	139	—	87	109	35	118	54	71	31	3	.4	1	6	6	9	5	2	5	19	10	—	—	46
October	133	67	86	107	34	117	58	68	33	3	1.5	2	3	8	14	12	4	—	10	9	—	—	28
November	141	—	94	115	35	125	55	78	35	2	.6	2	10	4	3	4	2	3	22	12	—	—	33
December	137	72	92	112	33	120	53	70	30	2	1.3	1	9	13	24	15	—	—	—	1	—	—	39
The year	126	—	87	100	20	115	48	80	67	6	17.8	10	4	14	25	8	1	—	7	3	—	—	43
	1875	120	78	95	16	119	44	78	73	6	32.	12	—	8	17	11	—	3	14	9	—	—	—
	1876	124	76	83	18	107	36	80	67	4	22.4	9	—	1	7	43	4	—	3	4	—	—	—
	1875	123	—	82	20	108	40	77	65	5	5.1	4	17	6	13	7	6	—	1	10	—	—	—
	1876	122	70	81	19	98	33	74	69	3	4.	5	12	7	10	8	2	1	10	9	1	—	—
	1875	117	—	73	32	96	46	68	47	.7	.7	2	7	4	5	1	10	12	21	2	—	—	—
	1876	116	58	72	20	91	36	65	64	2	.6	4	8	11	16	6	2	—	5	14	—	—	—
	1875	98	—	63	33	93	31	60	50	2.	.3	2	12	3	—	—	—	—	30	13	2	—	—
	1876	117	45	—	—	85	—	56	—	3	—	—	12	3	2	2	1	4	14	22	—	—	—
	1875	83	—	55	28	79	40	56	63	3.	.5	1	—	1	3	3	7	3	38	—	7	—	—
	1876	106	38	53	28	79	43	50	69	3	—	—	6	8	3	3	5	9	21	7	—	—	—
	1875	118	—	74	30	125	99	67	49	3.2	49.	37	—	—	—	—	—	—	—	—	—	—	—
	1876	115	57	—	87	120	—	63	—	3.6	—	35	—	—	—	—	—	—	—	—	—	—	—

¹ For 1875 10 o'clock observations; for 1876 mean of three daily observations.² From the *Punjab Meteorological Report* for 1874.

TABLE XXII.

Rawul Pindi. N. Lat. 33° 4', E. Long. 73° 5'. Elevation above sea- level 1,650 feet	Mean solar radia- tion temperature	Mean nocturnal radiation temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Mean relative humidity ¹	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874 ²	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January . .	1875	105	31	47	69	35	74	50	46	47	3.	3	4	3	11	5	1	7	17	7	7	56	69
February . .	1876	93	36	47	58	20	69	38	43	67	3.4	6	3	3	8	1	—	4	29	13	1	75	—
	1875	98	38	49	66	26	79	48	51	68	2.6	7	7	1	6	—	—	1	18	16	2	70	63
March . .	1876	101	37	50	62	22	70	42	45	61	1.9	5	5	6	3	2	2	6	28	9	1	64	—
	1875	121	49	64	86	35	104	63	62	48	3	2	2	5	8	5	2	4	14	17	4	63	53
April . .	1876	116	46	58	71	23	82	41	52	59	3.5	8	2	6	9	2	1	8	18	15	1	66	—
	1875	—	59	76	102	40	112	62	69	41	.2	1	4	2	19	4	3	2	12	14	—	81	39
May . .	1876	148	53	69	86	30	99	56	61	55	2.8	3	4	3	12	3	—	5	24	8	1	97	—
	1875	—	67	84	105	33	113	58	73	44	1.4	4	7	9	16	7	2	1	4	12	4	88	30
June . .	1876	158	68	81	97	30	107	51	70	52	1.5	3	7	2	13	3	3	5	21	6	2	67	—
	1875	148	72	93	112	30	120	48	75	36	.9	5	6	4	18	7	4	4	9	1	7	57	44
July . .	1876	163	70	86	103	31	113	49	72	48	1.2	4	3	3	17	2	3	4	20	3	5	76	—
	1875	135	69	87	100	20	115	44	77	58	9.4	8	10	12	11	2	—	2	—	1	26	44	69
August . .	1876	160	77	85	96	18	114	44	79	73	10	9	3	3	38	5	3	2	—	—	6	59	—
	1875	138	67	82	98	23	106	39	77	64	14.3	11	14	7	19	5	—	—	—	1	16	30	63
September . .	1876	158	75	83	92	15	99	29	79	82	5.8	11	—	1	38	1	1	1	8	2	10	33	—
	1875	126	68	77	93	24	102	38	75	68	12.	11	1	2	26	4	1	2	10	4	10	24	54
October . .	1876	154	66	78	92	24	97	39	71	69	1.5	5	—	—	2	16	1	5	—	17	19	27	—
	1875	123	51	64	88	36	99	57	65	54	1.9	4	1	2	32	3	—	—	13	3	8	24	36
November . .	1876	141	55	67	83	27	91	41	61	67	1.3	5	3	2	17	—	6	2	13	1	18	28	—
	1875	111	42	56	77	34	89	51	57	—	.6	3	—	2	27	1	2	7	16	5	2	23	41
December . .	1876	129	—	56	77	33	84	49	51	68	2.3	4	—	5	7	1	2	1	6	11	14	32	—
	1875	99	39	51	63	22	68	34	51	75	4.1	5	2	4	8	1	—	2	30	12	3	30	43
The year . .	1876	124	—	50	68	31	73	41	46	70	.3	1	—	5	5	—	—	2	13	14	23	21	—
	1875	—	54	69	88	30	120	96	65	—	48.8	64	—	—	—	—	—	—	—	—	—	—	50
	1876	137	—	68	82	25	114	86	61	64	35.5	64	3.5	—	—	—	—	—	—	—	—	—	—

¹ For 1875 10 o'clock observation only ; for 1876 the mean of three daily observations.² From the *Punjab Meteorological Report* for 1874.

TABLE XXIII.

Murree. N. Lat. 33° 40', E. Long. 73° 8'.	Mean temperature of solar radiation	Mean temperature of nocturnal radiation	Mean temperature of the air	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Mean pressure	Mean temperature of evaporation at 10 A.M. ¹	Mean relative humidity at 10 A.M.	Mean proportion of clouded sky	Inches of rainfall ²	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874 ³	
														N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January	106	22	37	53	27	66	48	—	39	55	4	—	—	15	10	18	3	1	1	—	2	6	—	66
February	—	22	39	54	22	65	41	—	39	54	5	—	—	3	5	33	14	2	—	—	5	—	—	66
March	128	23	36	51	24	64	45	—	40	60	7	6.6	5	2	6	28	10	—	—	1	1	—	—	62
March	—	23	38	55	23	65	47	—	35	52	4	1.19	—	2	2	32	10	4	3	1	2	2	—	—
March	128	35	53	71	31	86	60	—	52	52	4	.2	—	6	8	25	3	—	2	7	7	4	—	—
April	—	31	46	64	25	75	48	—	46	49	5	3.14	11	4	3	29	13	8	—	2	3	—	—	—
April	129	43	60	82	35	94	60	—	58	42	3.5	—	—	5	6	32	9	1	1	3	3	—	—	47
May	—	40	58	76	26	90	57	—	53	39	3	3.12	4	1	5	20	10	10	1	6	5	—	—	—
May	126	41	60	84	41	94	62	—	62	52	3	3.1	—	4	3	21	16	4	4	5	3	1	—	—
June	—	49	68	86	27	95	56	—	62	41	3	3.2	7	7	4	14	8	4	2	7	13	3	—	—
June	134	43	66	93	47	103	70	—	69	47	3	3.3	—	3	4	28	16	3	1	3	—	—	—	—
July	—	53	73	89	27	102	58	—	63	40	3	2.5	7	9	5	15	11	6	3	3	—	—	—	—
July	118	57	68	82	23	94	41	—	69	81	8.5	20.5	—	4	6	35	7	1	2	6	1	—	—	81
August	—	59	67	76	15	99	45	—	67	80	7	18.97	18	11	10	33	4	1	—	—	—	—	—	—
August	120	52	63	81	26	91	44	—	66	79	7	20.5	—	4	10	22	14	1	2	5	—	—	—	—
September	—	58	66	75	13	81	25	—	66	88	7	18.83	24	8	17	17	10	4	—	—	—	—	—	—
September	125	52	64	79	24	86	36	—	56	78	6	6.6	—	11	8	28	5	2	—	2	—	—	—	—
October	—	48	63	73	15	79	32	—	60	65	3.4	3.05	9	6	9	16	15	1	2	2	—	—	—	—
October	121	39	57	75	27	79	39	—	53	50	2	3.9	—	19	4	11	10	3	2	1	—	—	—	—
November	—	37	53	65	17	72	32	—	51	62	4.9	4.4	9	3	15	14	13	4	7	2	—	—	—	—
November	103	30	50	66	24	74	38	—	48	55	3.4	5.7	—	20	12	24	—	—	—	3	1	—	—	—
December	—	27	46	59	17	70	39	—	44	50	4.8	1.92	5	3	13	17	21	—	2	2	—	—	—	—
December	91	28	46	59	21	67	37	—	44	58	6	.8	—	4	6	45	6	1	—	—	—	—	—	—
December	—	—	43	56	19	62	37	—	40	36	4.7	—	—	1	15	30	12	—	1	2	—	—	—	—
The year	117	39	55	73	29	103	85	—	56	59	4.7	71.2	—	—	—	—	—	—	—	—	—	—	—	—
1876	—	—	55	69	20	102	84	—	52	35	4.5	60.3	99	—	—	—	—	—	—	—	—	—	—	—

¹ Relative humidity at 10 hours and 16 hours are given, but not the mean, in Mr. Blandford's tables.
² Rainfall for 1875 from the Report of the Sanitary Commissioner of the Province.

³ From the Punjab Meteorological Report for 1874.

TABLE XXIV.

Dera Ismael Khan. N. Lat. 32° E. Long. 71° 5'. Elevation above sea-level 573 feet	Mean solar radiation temperature	Mean nocturnal radia tion temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Temperature of evaporation ¹	Relative humidity ¹	Mean proportion of clouded sky	Inches of rainfall	Days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1874 ²	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January .	136	—	49	72	41	77	56	45	39	1.8	—	—	5	12	1	14	—	6	—	24	—	23	58
February .	122	—	53	68	27	76	46	46	—	2.5	.2	1	1	23	—	9	—	6	1	22	—	52	—
March .	122	—	53	70	30	86	54	51	56	4.6	3.3	—	6	16	2	9	1	5	1	16	—	45	50
April .	124	—	—	71	—	78	—	48	—	2	.3	2	—	11	1	11	2	5	1	27	—	60	—
May .	150	—	70	94	41	110	67	62	29	1.9	.5	—	1	16	1	20	—	7	1	16	—	35	46
June .	133	—	—	78	—	89	—	56	—	3.2	1.	5	2	30	—	8	—	7	—	15	—	52	—
July .	163	—	81	105	43	119	65	67	17	1.4	—	—	—	11	—	18	2	4	—	25	—	51	34
August .	151	—	76	93	30	105	55	60	39	1	1.3	1	1	27	—	13	—	9	—	10	—	70	—
September .	165	—	87	110	40	119	58	71	22	.9	—	—	2	25	—	22	2	7	—	4	—	60	23
October .	157	—	88	103	28	114	50	67	33	1	—	—	1	22	—	26	—	3	—	10	—	65	—
November .	168	—	95	117	39	125	55	77	24	.6	1.5	—	5	25	—	27	—	2	—	1	—	66	36
December .	158	—	90	105	27	116	43	—	45	1.6	—	3	2	29	—	20	1	5	—	3	—	58	—
The year .	162	—	93	110	30	121	48	83	46	2.8	.4	2	—	15	—	32	2	9	—	5	—	93	54
	156	—	92	103	20	116	39	80	63	3.	1.	2	—	17	—	38	2	4	—	1	—	65	—
	161	—	89	105	30	113	45	81	50	1.3	1.	3	—	23	—	37	—	1	—	1	—	72	55
	153	—	89	98	17	107	33	79	69	2.5	2.4	3	2	14	1	27	4	9	1	4	—	61	—
	153	—	84	107	30	112	74	79	53	2.1	4.4	3	2	20	—	28	—	6	—	4	—	48	40
	147	—	84	97	24	102	33	72	59	.3	.4	2	—	26	—	28	—	2	—	3	1	44	—
	143	—	70	90	35	95	48	67	47	.3	—	—	—	30	1	24	—	2	—	5	—	39	29
	138	—	74	87	23	96	38	64	62	1.2	1.2	1	4	25	—	25	—	4	—	4	—	30	—
	130	—	60	81	37	89	49	59	54	2.6	—	—	1	28	—	19	1	2	—	9	—	18	39
	128	—	64	78	26	85	49	56	60	1.8	.4	1	2	13	—	24	—	7	—	13	—	24	—
	124	—	53	70	32	77	46	52	51	2.	.6	3	11	15	3	8	4	7	2	12	—	29	43
	123	—	56	73	32	80	44	49	57	2.3	—	—	1	10	—	21	2	8	1	19	—	16	—
	148	—	74	94	36	125	104	66	41	1.9	10.2	16	—	—	—	—	—	—	—	—	—	—	42.4
	141	—	—	—	—	116	—	—	—	1.9	9.7	21	—	—	—	—	—	—	—	—	—	—	—

¹ 1875, from the 10 A.M. observation; 1876, from the mean of three daily observations.² From the *Punjab Meteorological Report* for 1874.

TABLE XXV.

Mooltan. N. Lat. 31° 10', E. Long. 71° 33'. Elevation above sea- level 420 feet	Mean solar radia- tion temperature	Mean nocturnal radiation temperature	Mean air temperature	Mean of maxima	Mean daily range	Highest maximum	Absolute range	Mean temperature of evaporation	Mean relative humidity	Mean proportion of clouded sky	Inches of rainfall	Number of days rain was measured	Direction of winds and mean diurnal movement in miles									Mean relative humidity 1877	
													N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm		Mean movement
January	114	—	54	74	37	83	54	—	—	4	—	—	2	10	—	7	3	13	2	17	8	54	66
February	122 ¹	—	55	69	27	78	46	47	59	1.9	—	—	—	24	—	9	4	6	2	19	—	75	55
March	112	—	57	76	31	87	53	—	—	5	—	—	1	11	—	3	1	11	2	18	9	—	—
	132	—	59	75	29	83	46	50	51	3.3	—	—	4	23	—	6	2	5	2	12	4	—	—
	132	—	75	96	37	111	63	—	—	2	—	—	6	11	2	4	2	17	1	14	5	—	54
	137	—	69	86	29	95	52	58	51	3.6	—	—	7	15	—	4	3	7	—	16	10	77	52
April	142	—	85	107	39	121	64	—	—	2	—	—	1	10	—	2	2	28	2	14	1	—	—
	148	—	80	99	35	113	62	62	33	1.4	—	—	6	15	—	5	2	10	—	10	—	71	48
May	146	—	92	112	35	119	52	—	—	2	—	1	3	10	—	6	1	23	1	18	12	—	—
	160	—	90	114	38	118	52	69	32	.5	—	—	2	12	1	2	2	12	—	14	17	—	—
June	—	—	97	116	33	122	47	—	—	1.5	—	—	1	4	—	1	5	40	2	7	—	—	44
	157	—	93	110	29	115	44	74	45	1.4	1.3	4	1	18	—	2	1	18	—	1	19	79	—
July	145	—	92	107	24	115	42	80	57	2.8	1.1	3	3	2	—	8	8	32	2	7	—	—	52
	—	—	91	105	22	112	34	78	54	2.4	3.5	4	—	9	—	4	—	19	—	3	27	—	—
August	140	75	89	104	25	110	39	78	61	.8	1.1	1	2	22	—	3	7	16	—	12	—	—	56
	160	—	88	102	22	108	34	78	61	2.9	.9	2	—	15	—	15	1	20	—	1	10	—	—
September	147	74	87	103	25	116	48	77	59	2	.5	2	1	19	2	8	5	17	1	7	—	70	59
	154	—	86	100	26	108	42	75	58	1.3	—	—	—	15	—	4	—	10	—	3	28	—	—
October	136	55	76	96	35	103	52	65	52	.23	—	—	3	6	—	3	10	28	1	11	—	42	58
	150	—	78	92	25	98	44	68	55	.4	—	—	—	8	—	4	1	14	—	1	32	—	—
November	124	44	66	84	31	92	46	57	55	2	.3	1	2	20	—	17	1	14	—	7	—	—	49
	136	—	68	80	23	88	54	59	50	1.7	.5	1	5	6	1	4	4	9	2	7	22	—	—
December	119	35	58	72	25	77	40	52	66	1.7	.01	1	1	19	—	10	5	14	2	11	—	—	60
	133	—	56	74	34	77	45	50	57	.8	—	—	4	19	—	2	4	6	—	5	—	—	—
The year	—	—	77	96	31	122	93	—	—	2.2	3.7	9	—	—	—	—	—	—	—	—	—	—	—
1875	—	—	76	92	28	118	86	64	51	1.8	6.2	11	—	—	—	—	—	—	—	—	—	—	—
1876	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

¹ Owing to a mistake in the graduation of the thermometer in use in 1876, all readings above 120° were 10° too low.

² From the Punjab Meteorological Report for 1874.

TABLE XXVI.—Mean air temperature.

Stations	Years	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Leh	3-6	—	—	—	—	46	53	60	57	50	37	30	25	—
Murree	6-7	37.5	40	49	58	65	71	67.5	65.5	66	59	49	44	56
R. Pindi	9-10	48	52	61	71.5	82	90	87	84	80	69	57	51	69.4
Sealkote	9-10	51	56	64	76	85	90	86	85	83	74	61	52	72.
Lahore	8-10	53	60	69	81	89	93	88	87	84	77	65	55	75
Simla	4-5	40	42	49	60	63	68	64	63.5	61	55	49	45	55
D. Ismael Khan	8-10	51	56	65	77	87	93	91.5	89	85.	74.	61.	53	73.6
Mooltan	6-8	54	59	70	80	89	95	92	89	87	76	67	57	76.
Ajmere	9-10	59	66	76	86	92	91	84	82	83	79	70	63	77
Dehra	7-8	55	58	66	76	82	84.5	79	78	76	70	62	56.5	70
Roorkee	10	57	62	70	82	88	90	84	84	82	75	64	58	75
Ranikhet	5-6	46	50	57	67	69	72	68	67	66	61	55	51	60.7
Meerut	5-6	57	63	73	84	89	93	86	84	82	73	66	59	76
Bareilly	10	57	63	73	83	89	89	84	83	82	76	66	59	75
Agra	9-10	59	65	76	87	93	93	86	84	83	78	70	62	78
Lucknow	9	60	66	76	86.5	92	91.5	86	85	83.5	78	68	61	78
Goruckpore	8	59.6	65	75.5	85	89	87	83.5	83	82	78	69	61	76.4
Jhansi	9-10	62	68	78	88	94	92	83	82	82	79	72	64	78.7
Allahabad	7-8	60	66	78	87	92	90	84	82.5	82.5	77	68	61	77.3
Benares	8-10	60	67	76	87	92	91	85	84	84	78	69	60	77.7
Seesaugor	3	57	63	67	73	77	82	84	82.5	82	76	68	60	72.6
Gawalpara	8	63	68	74	77	78.5	80	81.5	82	81	78	71	65	74.9
Darjeeling	9	41	44	50	56.5	60	63	64	64	62	57	50	44	54.7
Purneah	3	—	—	—	—	—	—	—	—	83	79	73	65	—
Patna	8-9	61	66	78	86	89	88	85	84	83	79	70	62.5	77.6
Hazaribagh	8-9	61	66	75	84	86	82	79	78	78	74	68	61.5	74.3
Jessore	8-9	65	71	79	83	85	84	83	82	83	80	74	65.5	77.9
Dacca	7-9	66	72	79	83	83	84	83	84	83	81	75	68	78.4
Silchar	7-8	63	68	73	78	80	82	82	82	82	80	73	65.5	75.7
Calcutta	24	68	73	81	85	86	85	83.5	83	83	81.5	75	68	79.3
Akyab	7-9	69	73	79	83.5	84	82	81	81	82	81	77	72	78.7
Madras	9	75	76	80	84	86	86	84	83	83	80	77	75	80.8
Colombo	7-8	80	80	82	83	83	82	81	81	81	81	80.5	80	81.3
Bombay	26	72.5	74	78	82	84	83	81	80	79	80	78	75	73.8
Puchmarhi	4-5	58	62	72	80	84	78	69	69	69.5	65	59	57	68.5
Nagpore	7-8	69	74	82	89	94	86	79	79	79	77	71	68	78.7
Jubbulpore	8	62	66	75	85	91	87	78	78	78	74	66	62	75.2
Saugor	6-7	64	69	78	85	89	84	77	75	76	75	71	65	75.6

TABLE XXVII.—*Table of inches of rainfall.*

Stations	Years	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Punjab :														
Delhi .	17	.99	.51	.83	.29	.86	3.01	7.41	5.42	4.41	.31	.07	.30	24.41
Gurgaon .	16-17	.65	.25	.47	.35	.79	2.76	9.23	6.17	5.6	.5	.04	.23	27.
Umballa .	10	.54	1.26	1.13	.8	1.04	4.5	12.8	7.9	5.3	.3	—	.32	35.8
Simla .	11	1.0	1.8	3.24	1.9	3.7	8.15	18.6	16.8	6.06	.63	.03	.64	62.4
Leh .	1876	—	—	—	—	.16	.1	—	.18	—	—	—	—	.44
Jullundur .	10	.86	1.4	1.17	.47	1.26	2.3	8.44	7.6	5.5	.21	—	.3	29.5
Hoshiarpore .	10	.94	1.43	1.7	.72	1.03	3.4	9.	9.24	5.3	.3	—	.57	33.6
Dhumsala .	10	3.4	5.2	4.64	1.6	2.2	12.1	45.3	37.1	13.4	.95	.04	1.1	126.9
Sealkote .	10	1.02	1.54	2.3	1.3	1.14	2.7	14.3	10.	4.2	.3	.03	.4	39.1
Goordaspore .	10	.78	1.35	2.05	.33	1.04	2.7	9.8	8.1	3.9	.4	—	.32	30.7
Lahore .	10	.5	.91	.91	.27	.92	1.2	6.3	3.9	2.54	.6	—	.5	18.5
Gujranwalla .	10	.77	1.4	1.8	.97	.8	1.64	8.7	6.7	2.7	.6	.01	.4	26.4
R. Pindi .	10	2.05	1.8	2.8	1.63	1.2	2.	8.3	6.15	3.7	.64	.33	1.	31.6
Jhelum .	10	.78	1.06	1.5	.7	.7	1.63	4.9	4.7	2.	.3	.11	.36	18.6
Gujrat .	10	.96	1.4	3.1	1.2	.83	2.6	9.4	6.1	2.6	.6	.05	.4	29.2
Shahpore .	10	.35	.72	.81	.47	.81	1.6	2.8	3.07	1.53	.28	.16	.39	12.97
Mooltan .	14	.36	.23	.55	.47	.43	.31	2.3	1.2	.44	.18	.08	.28	6.8
Jhung .	10	.30	.35	1.43	.50	.34	.43	3.6	2.1	.9	.06	.04	.27	10.2
Montgomery .	10	.13	—	.47	.11	.20	.82	2.8	2.4	1.32	—	.02	.26	8.71
Muzafferghur .	10	.15	.18	.50	.23	.27	.35	1.24	1.9	.83	.11	.01	.41	6.21
D. Ismael Khan .	10	.25	.8	1.13	.6	.4	.9	1.7	1.4	.82	.13	.04	.32	8.4
D. Ghazee Khan .	10	.45	.16	.7	.26	.39	.5	2.03	1.6	.51	.07	.14	.35	7.15
Bunnoo .	10	.75	1.13	1.63	1.2	.53	.82	1.95	3.05	.65	.07	.07	.3	12.14
Peshawur .	10	1.32	1.26	1.6	1.25	.6	.21	1.8	2.6	1.06	.36	.31	.55	12.9
Kohat .	10	1.31	1.73	2.4	1.33	1.22	.81	4.3	3.4	2.27	.7	.35	.5	20.24
Abbotabad .	10	2.64	4.06	5.44	2.24	3.	3.7	9.5	8.9	3.4	1.5	.63	1.7	46.6

Table of inches of rainfall—continued.

Stations	Years	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
NW. Provinces:														
Dehra.	19	1.6	2.4	1.5	.54	1.6	7.4	24.7	22.4	10.4	.64	.04	.35	73.5
Chukrata	8	.75	1.45	3.8	1.2	2.5	8.	17.6	16.2	6.6	.7	.03	.7	59.5
Saharunpore	19	1.35	1.7	1.03	.24	.76	4.02	12.9	9.9	4.24	.3	.06	.25	36.8
Roorkee	16-17	1.87	2.01	1.07	.45	1.16	4.5	12.7	12.2	5.2	.6	.21	.56	42.5
Muzaffurnugur	19	1.15	1.16	.81	.37	.98	3.6	11.1	8.6	4.8	.33	.06	.19	33.2
Bulundshuhur	19	.66	.76	.37	.26	.63	2.9	8.8	7.6	4.8	.6	.04	.28	27.6
Meerut	20	.72	.84	.56	.4	.93	3.8	9.7	6.7	4.	.22	.02	.21	28.1
Bijnore	19	1.09	1.4	.8	.34	.8	4.2	11.9	9.8	6.2	.35	.08	.2	37.1
Moradabad.	20	.92	1.02	.64	.37	.9	4.9	14.	9.2	6.1	.5	.04	.2	38.8
Bareilly	19-20	1.05	.98	.53	.27	1.	5.6	15.2	8.6	7.3	.67	.06	.24	41.5
Budaon	19-20	.83	.5	.32	.06	.54	3.8	11.1	8.4	6.2	.43	.06	.35	32.6
Shajehanpore	19	.79	.75	.36	.18	1.3	5.23	12.5	8.06	6.96	1.03	.12	.29	37.6
Agra	22-25	.71	.42	.24	.13	.63	2.9	8.9	7.24	4.9	.22	.03	.16	26.4
Cawnpore	20	.7	.5	.24	.09	.56	3.4	9.2	7.8	5.4	.9	.09	.15	30.
Allahabad	19-20	.75	.57	.23	.18	.4	3.4	12.	10.7	6.6	2.5	.09	.15	37.6
Benares	20-21	.7	.47	.26	.15	.5	5.3	12.7	11.9	6.9	1.63	.05	.08	40.5
Goruckpore	20	.49	.55	.33	.26	1.6	6.6	13.5	11.9	8.2	2.7	.24	.09	46.4
Bustee	10-11	.44	.62	.23	.24	1.3	6.3	16.9	12.	9.7	1.7	—	.13	49.8
Almorah	20	1.44	2.	1.62	1.11	2.2	5.5	9.5	7.9	4.7	.9	2.	.37	37.4
Nynce Tal.	15-17	3.	2.7	2.7	1.5	2.5	13.9	20.3	24.	10.6	1.8	.03	.65	83.8
Ranikhet	6	1.22	2.6	1.3	1.	2.9	6.2	13.	12.1	6.7	.51	.1	.6	48.4
Lucknow	11	1.0	.16	.25	.19	.6	4.7	14.1	10.9	9.9	1.3	—	.34	43.4
Bengal:														
Calcutta	48	.43	.87	1.35	2.4	5.4	12.08	12.8	13.94	10.2	5.6	.55	.23	65.8
Jessore	14-17	.6	.62	1.7	3.7	7.4	13.5	10.8	11.5	8.8	5.6	.73	.12	64.9
Dinagore.	13-16	.2	.7	.6	2.8	7.3	19.2	15.4	13.2	12.7	6.7	.02	.04	78.7
Maldah	18-20	.46	.85	.86	1.9	3.2	9.9	10.2	9.6	10.7	4.5	.18	.4	52.6
Bouleah	14-17	.3	1.2	1.2	1.95	5.8	11.	12.3	10.3	10.9	5.2	.25	.04	60.3
Rungpore	14-16	.4	.33	.95	3.1	9.8	21.9	16.7	13.4	11.6	5.4	.04	.12	83.7
Bogra	12-15	.6	1.03	.75	4.6	9.1	16.6	16.6	11.2	13.6	5.5	.3	.1	79.9

Barjeeling .	14-17	35	1	1.25	3.8	6.1	24.8	27.2	24.6	15.8	7.2	.17	.15	112.5
Julpigoree .	7-8	.47	.28	1.75	4.5	9.1	30.5	25.4	23.7	23.8	6.2	.02	.03	125.7
Cooch Behar .	5-6	.6	.13	.62	7.	12.1	35.7	21.9	21.8	16.1	5.4	.05	—	121.25
Dacca .	23-25	.3	.83	2.3	6.4	9.5	12.8	11.6	12.1	9.5	5.5	.75	.18	71.9
Mymensingh .	10-12	.35	1.1	1.44	7.1	14.	22.	16.4	14.8	13.	4.9	.13	.05	95.1
Tipperah .	14-16	.79	.83	2.5	7.	11.4	19.	16.8	15.3	9.8	6.1	1.4	.08	91.
Hill Tipperah .	4-5	1.35	1.	3.3	5.2	10.1	14.4	10.9	16.4	8.	4.2	1.17	.2	76.3
Patna .	17-19	.65	.5	.25	.3	1.3	6.9	9.8	8.5	7.5	2.6	.13	.15	38.5
Chupra .	17-20	.7	.35	.5	.52	.93	5.9	8.8	8.8	7.	2.6	.02	—	36.1
Mozufferpore .	13-15	.7	.33	.62	.63	1.9	6.3	10.5	9.7	9.2	3.7	.03	—	43.5
Durbhunga .	6	.33	.18	.36	.9	1.7	7.2	12.9	9.8	10.9	1.8	—	.07	46.2
Moteeharee .	11-12	.37	.18	.83	.7	2.4	8.8	10.3	11.3	9.3	3.9	—	.14	48.2
Monghyr .	19-20	.4	.6	.4	.4	1.6	6.1	11.5	10.9	8.	3.6	.04	.1	43.7
Bhagulpore .	18-19	.46	.57	.34	1.1	2.3	8.5	11.	10.7	7.7	5.	.01	.08	47.8
Purneah .	6-7	.4	.43	.2	1.84	2.6	12.4	14.9	13.6	11	3.9	—	.05	61.2
Hazareebagh .	15	.48	.7	.62	.35	1.	8.6	13.	12.3	7.3	3.6	.24	.09	48.3
Silchar .	16-17	.5	.29	7.5	12.2	14.9	19.8	22.7	17.	14.	7.5	.82	.5	120.4
Sylhet .	17-21	.37	1.5	5.4	14.5	22.2	32.	25.9	24.4	17.6	8.7	.63	.12	153.3
Sebsaugor .	15-17	1.3	2.4	4.6	10.4	12.5	14.7	16.1	15.9	10.7	4.7	1.3	.63	95.
Gowalpara .	12-13	.38	.52	1.8	6.	13.1	27.2	18.4	11.8	11.4	5.3	.27	.14	96.3
Tura .	6-7	.7	1.2	1.4	5.3	15.1	23.8	23.6	15.5	20.6	8.3	.45	.09	116.2
Samagoodting .	7-9	.7	1.	2.	3.2	4.8	9.6	8.4	9.7	6.5	3.8	.15	.11	50.
Shillong .	10	.3	.74	1.7	3.2	9.8	16.5	16.	14.5	15.8	5.9	1.5	.23	86.3
Gowhatty .	19-21	.63	1.2	2.	6.2	10.3	13.2	12.	10.9	7.6	3.1	.6	.22	67.8
Tezpor .	18-21	.65	.96	2.2	6.6	10.3	14.	15.5	12.9	8.6	3.	.95	.62	76.4
Nowgong .	14-16	1.1	1.34	2.9	5.8	11.	11.5	16.1	16.	11.9	4.3	.3	.3	82.6
Dibrooghur .	8-10	1.4	3.7	5.6	9.8	12.1	21.7	21.8	19.	14.6	5.9	1.3	.47	117.3
Colombo .	7	2.35	1.7	6.5	10.4	13.7	6.3	27	2.4	3.3	13.9	11.5	4.3	79.1
Madras .	64	.98	.29	.44	.71	2.05	2.01	3.8	4.5	4.8	10.8	13.	5.03	48.5
Jubbulpore .	32-33	.6	.5	.5	.13	.35	7.7	18.4	14.1	8.6	1.3	.3	.19	52.6
Saugor .	19-20	.61	.68	.14	.2	.6	6.2	18.3	12.	8.5	1.01	.31	.27	48.8
Nagpore .	29-30	.58	.46	.66	.43	.68	8.5	12.6	8.4	7.4	1.9	.33	.36	42.4
Bombay .	30-60	.13	.01	—	.04	.5	20.7	24.3	15.2	10.6	1.5	.5	.04	73.6
Akyab .	16-18	.37	.22	.6	1.9	10.2	57.	52.8	38.1	24.8	13.6	4.3	.2	203.9

TABLE XXVIII.—*Mean*

Stations	N. Lat.	E. Long.	Elevation above sea- level in ft.	Years	January	February	March
Leh	34° 10'	76° 42'	11,502	1875	19·570	·595	·727
Peshawur	34° 2'	71° 37'	1,389	—	—	—	—
Murree	33° 40'	73° 8'	—	1876	23·794	·790	·787
Rawul Pindi	33° 4'	73° 5'	1,652	1876	28·240	28·213	28·193
Sealkote	32° 29'	74° 35'	830	1876	—	—	—
Lahore	31° 34'	74° 20'	732	3-4	29·273	29·244	29·116
Simla	31° 6'	77° 12'	6,953	1876	—	23·186	23·175
Delhi	28° 40'	77° 16'	719	1876	29·249	29·205	29·123
D. I. Khan	32° 0'	71° 5'	573	1876	29·467	29·429	29·332
Mooltan	31° 10'	71° 33'	420	1876	29·584	29·568	29·490
Chukrata	30° 40'	77° 55'	7,052	1876	23·238	·192	·210
Dehra	30° 20'	78° 8'	2,232	1876	27·694	·656	·603
Roorkhee	29° 52'	77° 56'	887	10	29·108	29·050	28·965
Ranikhet	29° 38'	79° 29'	6,067	1875	24·036	24·081	24·075
Meerut	29° 41'	77° 41'	737	3-4	29·259	29·214	29·098
Bareilly	28° 21'	79° 27'	568	1876	29·396	·339	·265
Agra	27° 10'	78° 5'	555	1876	29·413	·368	·302
Lucknow	26° 50'	81°	369	4-5	29·641	·596	·481
Goruckpore	26° 46'	83° 18'	256	1876	29·703	·643	·556
Allahabad	25° 26'	81° 52'	307	1876	29·681	·626	·541
Benares	25° 20'	83° 2'	268	8-9	29·771	·700	·607
Patna	25° 37'	85° 8'	179	8-9	29·850	·792	·676
Durbhanga	26°	86°	166	1876	—	—	—
Purneah	25° 50'	87° 34'	125	1876	—	29·781	·695
Darjeeling	27° 3'	88° 18'	6,912	8-10	23·382	·368	·364
Seebaugor	26° 59'	94° 40'	332	3	29·706	·646	·565
Gowalpara	26° 11'	90° 40'	386	8	29·610	·544	·459
Jessore	23° 9'	89° 7'	33	9-10	29·989	·929	·837
Dacca	23° 43'	90° 27'	35	8-10	29·973	·924	·834
Silchar	24° 49'	92° 50'	87	6-8	29·928	·892	·821
Calcutta	22° 33'	88° 21'	18	10	30·007	29·945	·853
Nagpore	21° 9'	71° 9'	1,025	8	28·940	·900	·810
Bombay	18° 54'	4° 51'	37	26	29·947	·918	·872
Madras	13° 5'	80° 17'	22	9	29·944	·921	·895
Colombo	6° 56'	79° 50'	40	7-8	29·863	·868	·856
Rangoon	16° 46'	96° 12'	41	1876	29·933	·883	·810

Atmospheric Pressure.

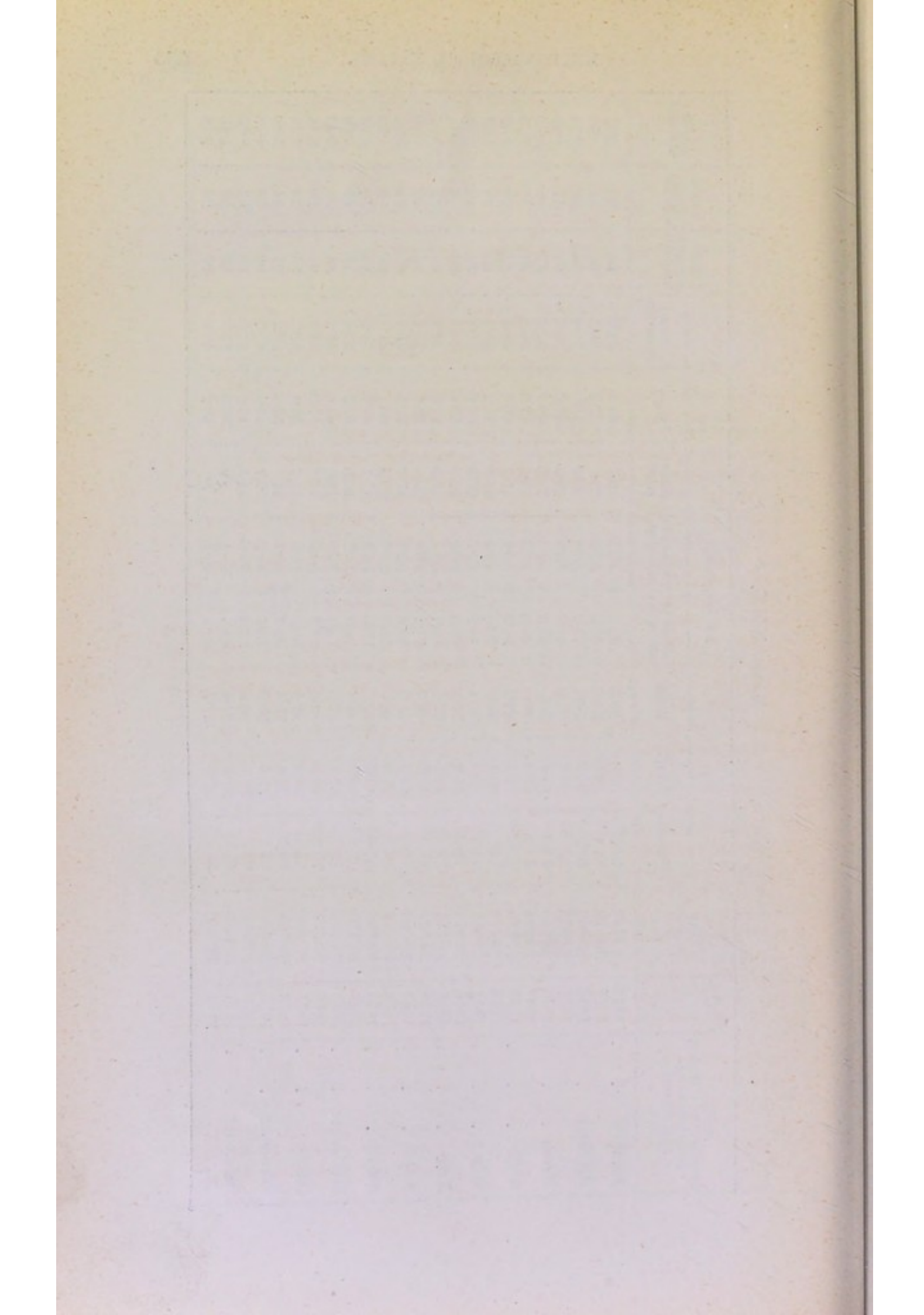
April	May	June	July	August	September	October	November	December	The year
·715	·683	·642	·605	·627	·718	·710	·742	·707	·670
—	—	—	—	—	—	—	—	—	—
·778	·749	·712	·632	·719	·807	·890	·893	·934	·790
28·109	27·994	27·900	27·825	27·943	28·066	28·231	28·282	28·370	28·114
28·901	·767	·668	·627	·753	·878	29·082	29·142	29·246	—
29·019	28·891	28·729	28·733	28·832	28·939	29·128	29·311	29·343	29·047
23·134	23·148	23·091	23·049	23·142	23·220	23·323	23·339	23·354	23·196
28·972	28·892	28·757	28·721	28·860	28·966	29·161	29·235	29·344	29·040
29·171	29·024	28·927	28·836	28·962	29·129	29·335	29·439	29·532	29·215
29·330	29·221	29·146	29·046	29·190	29·315	29·540	29·578	29·682	29·391
·207	·150	·137	·111	·172	·214	·273	·267	·300	·206
·500	·438	·326	·308	·422	·523	·686	·721	·791	·556
28·853	28·740	28·616	28·631	28·699	28·800	28·965	29·102	29·150	28·890
24·039	24·025	23·914	23·895	23·949	24·029	24·079	24·152	24·138	24·034
28·988	28·868	28·761	28·758	28·850	28·940	29·122	29·265	29·311	29·036
·150	·068	28·959	28·926	29·027	·128	·328	·387	·494	·206
·151	·033	28·950	28·907	29·045	·141	·347	·416	·523	·216
·348	·261	·135	·138	·234	·322	·503	·651	·696	·417
·420	·354	·259	·215	·232	·436	·669	·714	·836	·511
·388	·300	·199	·153	·294	·385	·606	·670	·787	·469
·481	·375	·260	·261	·337	·426	·596	·743	·801	·530
·560	·466	·347	·352	·428	·515	·681	·828	·888	·615
—	—	—	—	29·322	·433	·628	·675	·803	—
—	—	·452	·392	·488	·601	·784	·832	·958	—
·363	·337	·276	·269	·314	·374	·436	·472	·449	·367
·486	·414	·309	·277	·335	·422	·558	·682	·747	·512
·383	·303	·213	·193	·256	·343	·461	·593	·641	·417
·738	·661	·547	·537	·601	·686	·828	·962	30·017	29·778
·748	·673	·563	·554	·608	·691	·818	·948	30·004	29·778
·742	·661	·557	·545	·600	·680	·793	·921	·974	·760
·753	·664	·551	·541	·608	·691	·836	·976	30·033	29·788
·707	·625	·542	·540	·611	·657	·810	·946	·984	·756
·807	·766	·666	·660	·725	·782	·843	·914	·944	·820
·843	·773	·744	·777	·790	·807	·847	·922	·965	·852
·810	·806	·806	·826	·831	·852	·851	·859	·875	·842
·746	·745	·742	·730	·727	·793	·859	·892	·967	·819

TABLE XXIX.

[illegible]

TABLE XXX.

Station. Osborne (Isle of Wight). Height above sea- level 172 feet	Mean pressure	Air temperature							Mean degree of humidity	Number of days rain fell	Amount collected
		Highest	Lowest	Range	Mean of all highest	Mean of all lowest	Daily range	Mean			
January	1875 1876	53.1 54.4	26.6 22.8	26.5 31.6	49.1 43.3	40.1 32.3	9. 11.	44.5 37.5	96 95	20 11	4.3 .91
February	1875 1876	53.2 56.	24.8 24.1	28.4 31.9	41.7 47.3	30.8 36.9	10.9 10.4	36. 41.8	96 92	10 17	2.74 3.02
March	1875 1876	58.9 61.1	28.9 25.1	30. 36.	48.8 49.5	34.1 35.5	14.7 14.	40.9 41.5	87. 89	8. 17	.69 3.74
April	1875 1876	72.6 64.	30.1 30.1	42.5 33.9	57.2 56.6	38.1 40.4	19.1 16.2	46.4 47.	87 89	10 13	1.07 1.62
May	1875 1876	79.2 72.6	38.9 32.8	40.3 39.8	66.2 62.5	45.7 40.4	20.5 22.1	54.6 50.8	92 81	11 5	1.21 .15
June	1875 1876	81.1 84.9	44. 42.2	37.1 42.7	68.7 71.1	50.2 49.1	18.5 22.	57.5 58.5	84 84	13 10	1.97 1.10
July	1875 1876	93.9 85.6	47.8 47.9	46.1 37.7	78.5 72.6	56.1 55.2	22.4 17.4	59.4 62.0	82 85	14 10	3.23 .39
August	1875 1876	92.3 79.7	44.9 49.1	47.4 30.6	75.2 71.1	54.7 54.6	20.5 16.5	63.7 61.0	78 84	13 11	1.05 1.43
September	1875 1876	74.2 65.3	42.0 35.9	32.2 29.4	66.2 56.8	50.9 45.3	15.3 11.5	57.0 50.4	91 86	20 19	4.14 5.11
October	1875 1876	69.2 58.1	32.4 27.6	36.8 30.5	59.2 48.4	48.1 38.7	11.1 9.7	53.3 43.4	91 89	14 16	1.86 4.48
November	1875 1876	60.7 52.4	27.1 22.8	33.6 29.6	52.0 43.3	39.6 34.4	12.4 8.9	45.8 39.2	89 93	18 14	3.63 1.20
December	1875 1876	55.2 55.2	27.5 27.5	27.7 27.7	49.1 49.1	40.1 40.1	9. 9.	45.2 45.2	92 92	26 26	7.28 7.28



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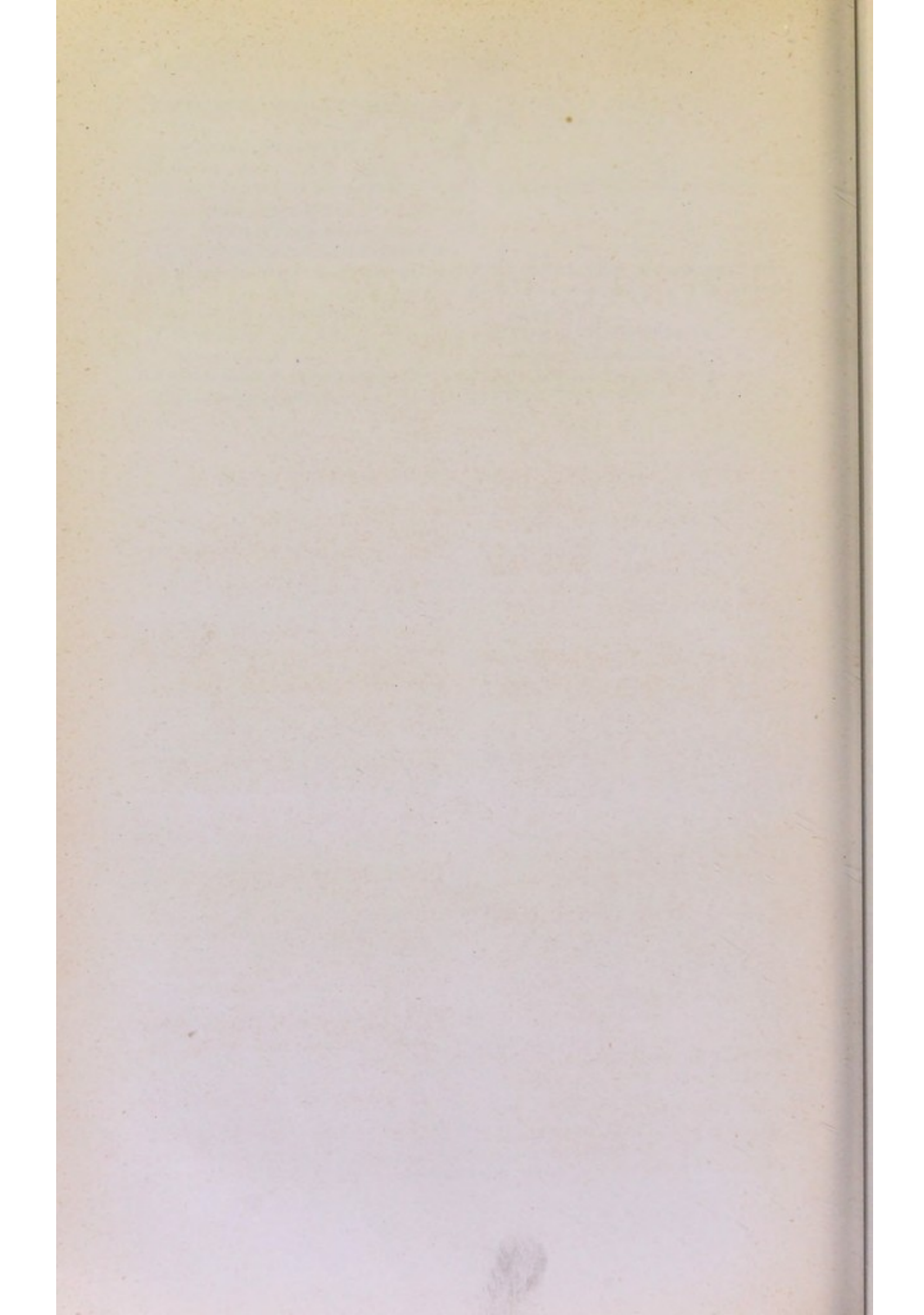
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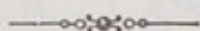




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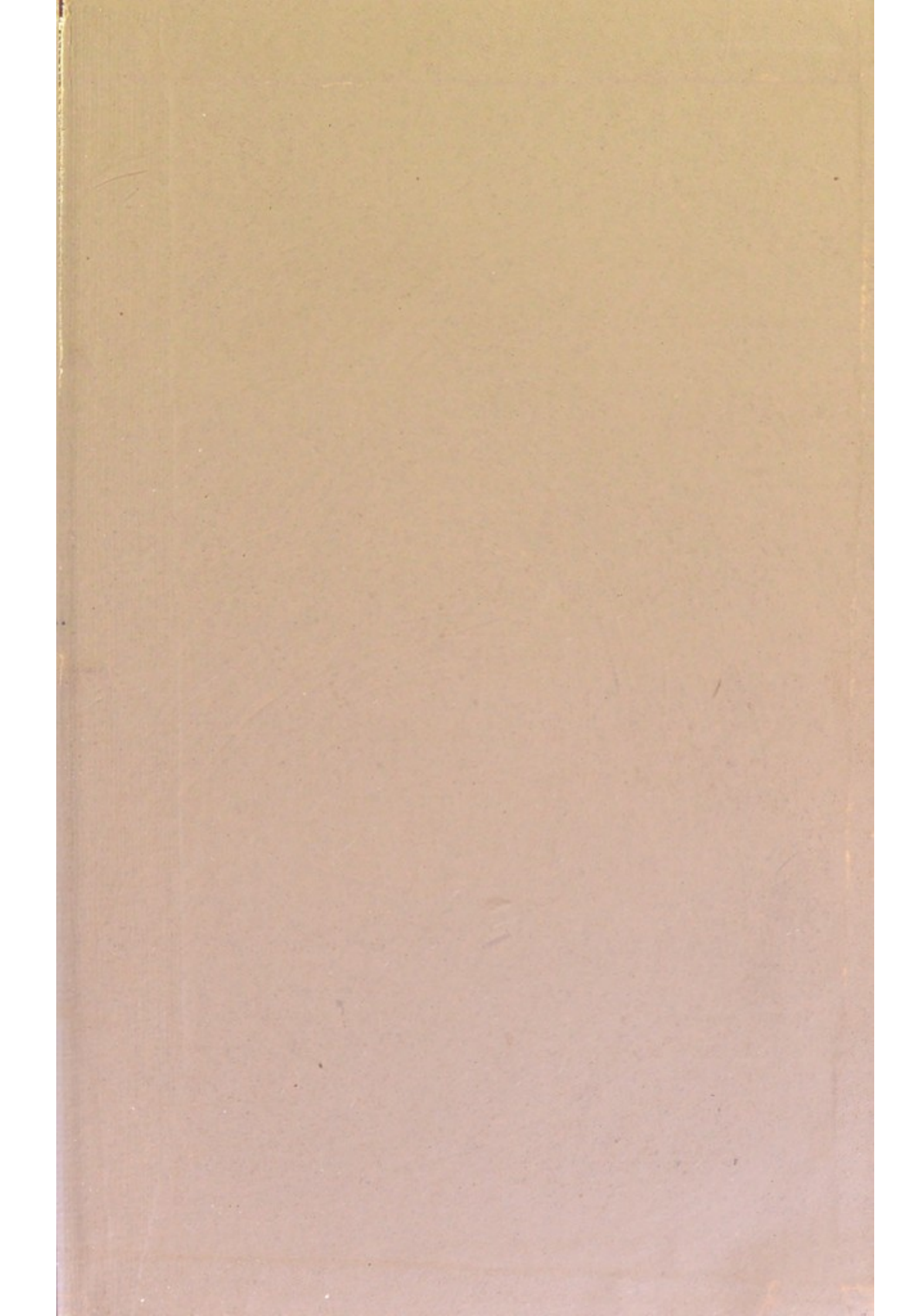
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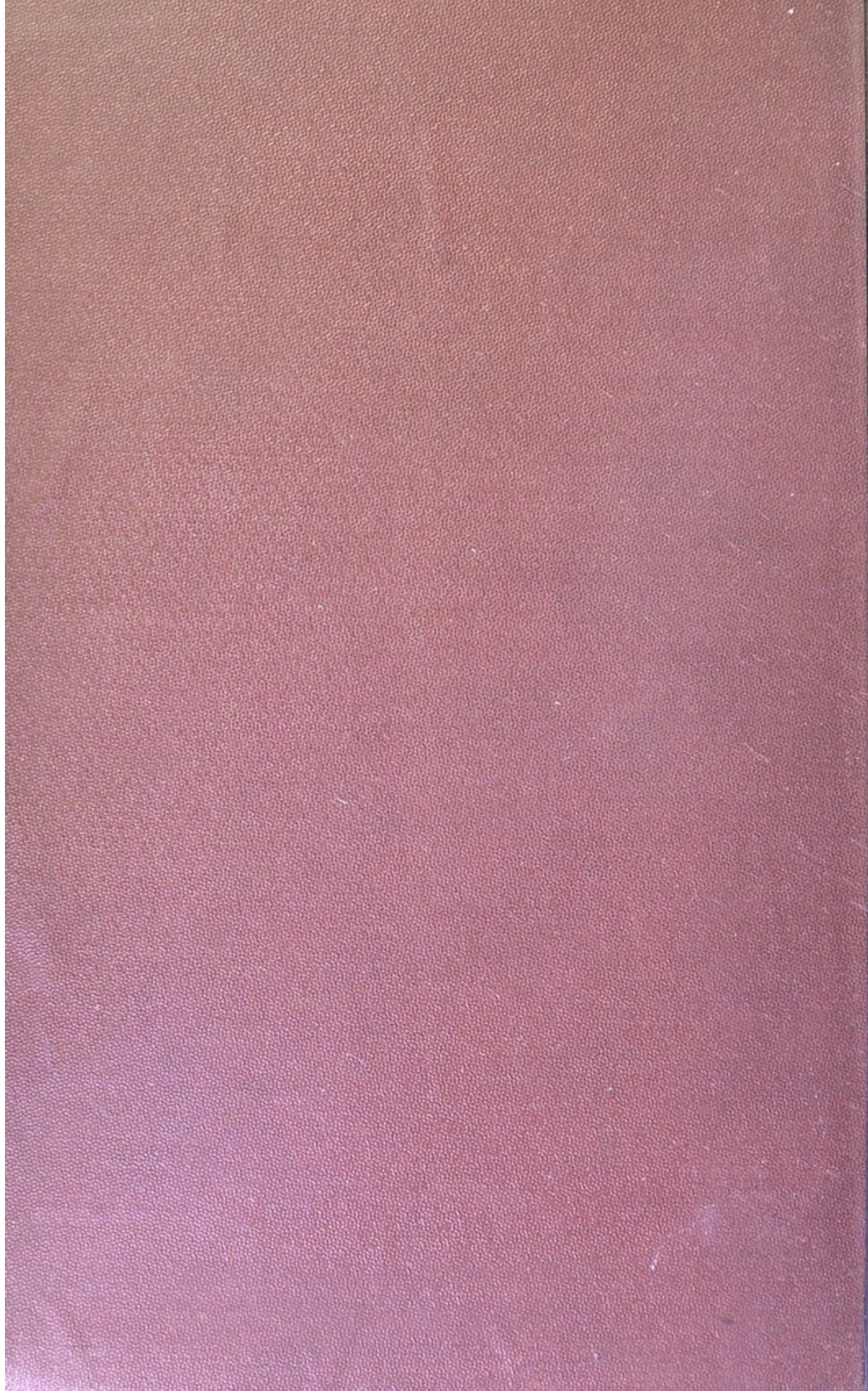
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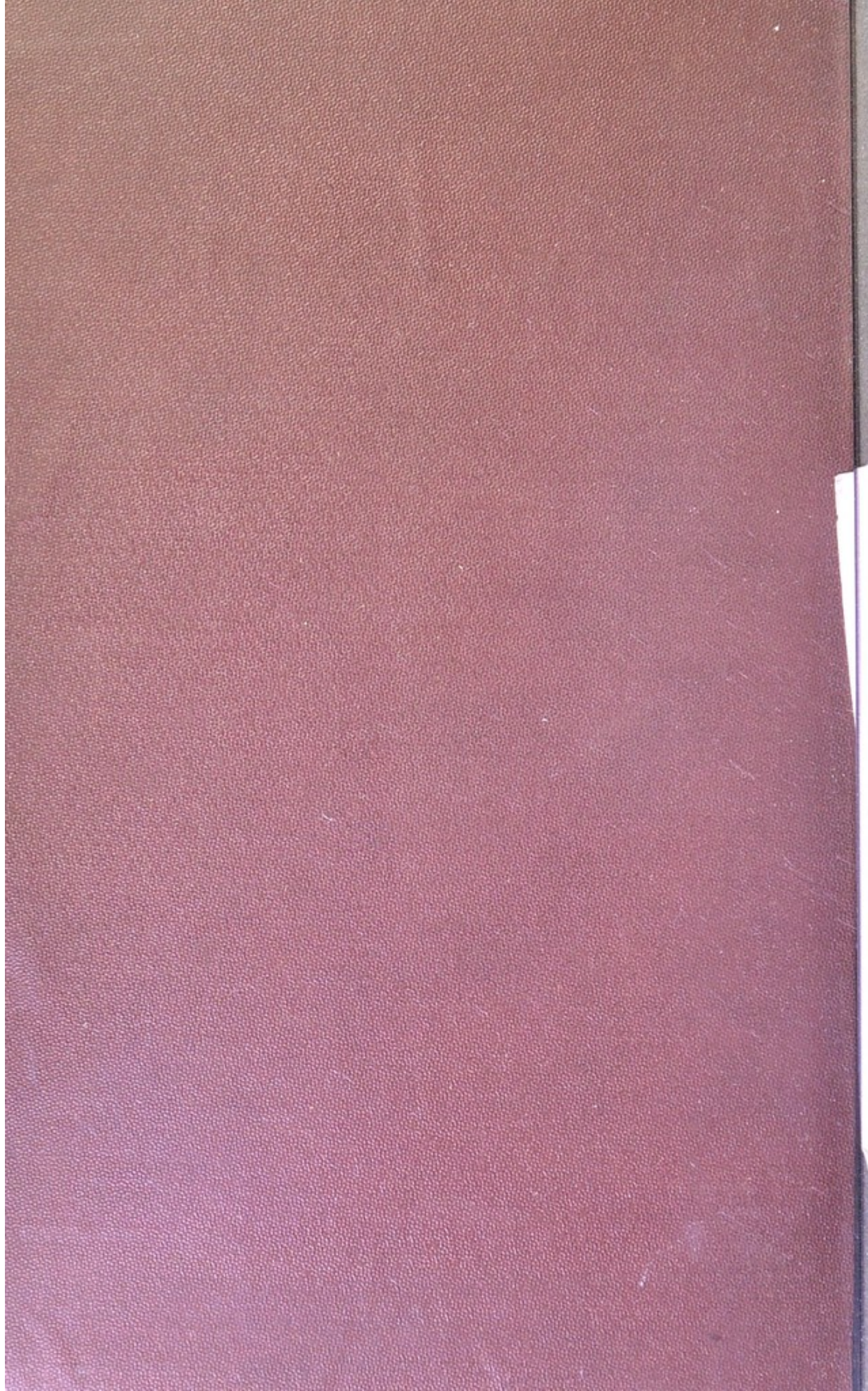
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