GENERAL REPORT

ON THE OPERATIONS

OF THE

GREAT TRIGONOMETRICAL SURVEY OF INDIA,

DURING

1866-67,

Prepared for submission to the Government of India.

Map of the Pundits route along the Sappu River to Lassa.

BY

LIEUT.-COLONEL J. T. WALKER, R.E., F.R.S., &c.,

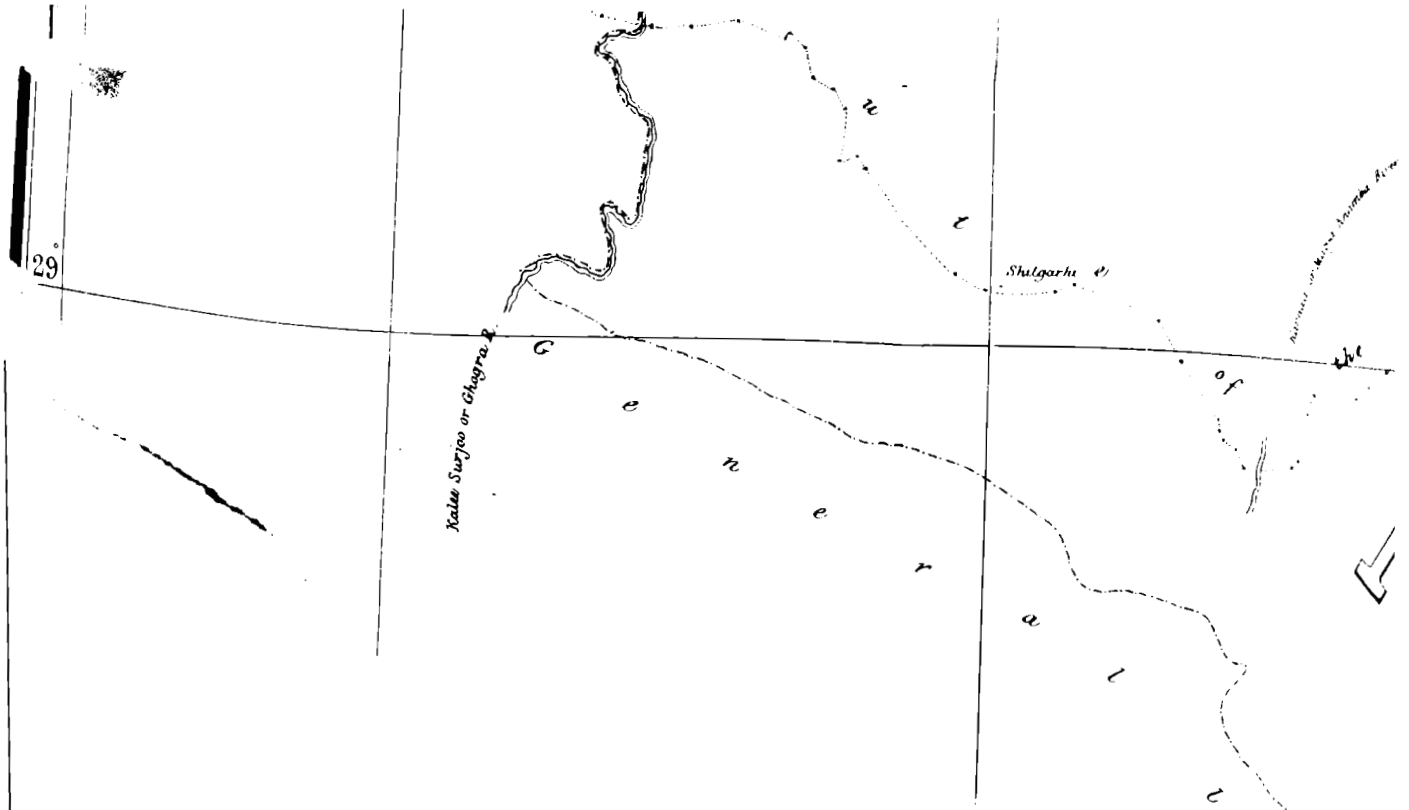
SUPERINTENDENT G. T. SURVEY.

Dehra Doon:

PRINTED AT THE OFFICE OF THE SUPERINTENDENT G. T. SURVEY.

T. KEIGHTLEY.

1867.



ROUTE SURVEY

FROM

BRITISH INDIA INTO GREAT TIBET

through the

LHASA TERRITORIES

AND ALONG THE UPPER COURSE

of the

BRAHMAPUTRA RIVER OR NARI-CHU-SANGPO

Made by

Pundit .....

AND

Compiled from the Original Materials

BY

CAPTAIN T.G. MONTGOMERIE, R.E; F.R.G.S.

C.T. SURVEY OF INDIA

Scale 16 Miles = 1 Inch

10 5 0 10 20 30 40 50

28°

27°

80°

81°

GENERAL REPORT

ON THE OPERATIONS

OF THE

GREAT TRIGONOMETRICAL SURVEY OF INDIA,

DURING

1866-67,

Prepared for submission to the Government of India.

BY

LIEUT.-COLONEL J. T. WALKER, R.E., F.R.S., &c.

SUPERINTENDENT G. T. SURVEY.

Dehra Doon:

PRINTED AT THE OFFICE OF THE SUPERINTENDENT G. T. SURVEY.

T. KEIGHTLEY.

1867.

THE OPERATIONS OF THE
GREAT TRIGONOMETRICAL SURVEY OF INDIA
IN 1866-67.

(1.) These operations may be classified as follows:—

I. *Trigonometrical;* the Longitudinal Series of triangles between Calcutta and the Eastern Frontier.

II. *Trigonometrical;* the Eastern Frontier Series.

III. *Trigonometrical;* the Meridional Series which will connect Jubbulpore with Madras.

IV. *Trigonometrical;* the Longitudinal Series west of Calcutta.

V. *Trigonometrical;* the two Series on the meridian and parallel of Bangalore.

VI. *Trigonometrical;* the Series on the meridian of Mangalore (75°).

VII. *Topographical;* the Surveys of the districts of Kumaon and Gurhwal, and the stations of Masoori and Landour.

VIII. *Topographical;* the Surveys of the provinces of Kattywar and Guzerat.

IX. *Geographical;* exploration of Trans-Himalayan regions.

X. *Astronomical;* determining the latitudes of certain stations on the Calcutta Longitudinal Series.

XI. *Astronomical;* determining the latitudes of certain stations on the Series on the meridian of 75°.

XII. *Miscellaneous;* Leveling Operations, and arrangements for the future better protection of the stations of this Survey.

XIII. *Geodetic and Magnetic;* determining, at certain stations of the Great Arc, the number of diurnal vibrations of two pendulums, the property of the Royal Society of London, and measuring the Magnetic Dip, Declination, and Total Force, at the same stations.

XIV. *Computations;* the final examination, reduction and publication of the Trigonometrical and Astronomical Observations.

XV. *Cartography;* the preparation and publication of the various Charts and Maps.

(2.) The out-turn of work has been as follows:—Principal Triangulation* with the great theodolites, 116 triangles (the errors of which are shown in the margin), covering an area of 21,800 square miles, and completing about 709 miles in length of the several chains of triangles; secondary and minor triangulation with theodolites of various sizes, 7,386 square miles, defining the positions of 886 points, of 162 of which the heights were also determined; Cadastral Surveying, on the scale of 12-inches to the mile, 2,121 acres; Topographical Surveying, on scale of 2-inches to the mile, 617 square miles, and on scale of 1-inch to the mile, 1,620 square miles; Spirit-Leveling, 156 linear miles; and Geographical exploration, along a line of route about 1,200 miles in length, in Great Thibet.

Series.	Probable Errors of Observed Angles.		Errors of Triangles.	
	Number.	Amount.	Number.	Amount.
I ...	33	±0″·24	11	0″·49
II ...	99	0·36	33	0·50
III ...	57	0·20	19	0·50
IV ...	51	0·22	17	0·38
V ...	57	0·19	19	0·57
VI ...	51	0·24	17	0·52
Averages, ...		± ·26	...	± ·50

(3.) I proceed as usual to report on the general operations of the respective Survey Parties and Offices; further details will be given in the Appendices, which contain selections from the annual Narrative Reports of the Executive Officers, and a special Report by Captain T. G. Montgomerie, on the Trans-Himalayan Explorations.

No. I.—TRIGONOMETRICAL.

THE EAST CALCUTTA LONGITUDINAL SERIES.

(4.) This chain of triangles crosses the districts of Jessore, Furreedpore, Dacca, Backergange, Bhullooah, and Tipperah, and extends from the meridian of Calcutta to the Eastern Frontier. It was commenced in 1863 by Lieutenant Thuillier, R.E., who has had the satisfaction of completing it during the present year.

PERSONNEL.

Lieut. H. R. Thuillier, R.E., Surveyor 3rd Grade.
Mr. C. J. Neuville, Civil Assistant 4th Grade.
„ F. W. Ryall, Sub-Assistant 2nd Grade.
„ G. A. Harris, Sub-Assistant 3rd Grade.
„ W. J. O'Sullivan, Sub-Assistant 3rd Grade.

* The Great Theodolites which are employed for the Principal Triangulation have azimuthal circles of 24 to 36 inches in diameter, which are read by 5 equidistant microscopes, and vertical circles of 15 to 18 inches in diameter, which are read by 2 microscopes. The system of observing the principal horizontal angles is as follows:—The telescope is pointed to some convenient signal, with the zero microscope set to 0° 0′; the surrounding stations are then observed in order round the horizon, an entire revolution of the instrument bringing the telescope back to the referring-mark, which is again observed; this completes a single round of measures, at each of which all the 5 microscopes are read; the round is, as a rule, repeated twice, but if the 3 measures of any angle differ by more than 2″, the observations of that angle are repeated as often as may be considered desirable; the telescope is then turned through a semi-revolution in altitude and in azimuth, and pointed to the referring-mark; the zero microscope is thus brought over 180° on the azimuthal circle, and the face of the vertical circle becomes transposed from the observer's left to his right hand, or *vice versâ*; three rounds of measures are then taken, and this completes an entire group of observations of each signal, on "face right and face left," and on 10 equidistant graduations of the azimuthal circle. Five complete groups of measures are invariably made in a similar manner, the setting of the zero microscope being shifted in each group, so as to bring 50 equidistant graduations under the microscopes, and to vary the position of the axis in its socket as much as possible, in the course of the whole of the observations to each signal. For this purpose the arc, 72°, between the microscopes, is added to the arc, 7° 12′, which expresses the fiftieth part of the circumference of the circle, to obtain the requisite change of graduation; thus the successive settings of the zero microscope are 0°, 79° 12′, 158° 24′, 237° 36′ and 316° 48′. The signals which are employed are invariably luminous, heliotropes by day, and lamps by night, most of the observations being taken by night, when the atmosphere is usually most favorable.

The quality of the principal triangulation with the Great Theodolites is tested by the probable errors of the observed angles, and by the triangular errors. The nature of the probable error may be defined as being such that the chances of the actual error exceeding or falling short thereof are equal; it is determined by a formula which takes into consideration the accidental errors of each single observation, and of the graduations of the circles on which the measures are made. The triangular error is the amount by which the sum of the observed values of the three angles of a triangle exceeds or falls short of 180° + the spherical excess.

(5.) Though originally intended to be formed of triangles arranged in polygonal figures, in order to afford mutual verification, and to cover the largest possible area, circumstances made it necessary to abandon this intention, and to carry out the series as a chain of single triangles. Many plantations of cocoa-nut, betel-nut, and other valuable trees, and an extensive amount of forest and jungle, were met with, while the ground was a level plain, devoid of hills, undulations, or even mounds of any kind. Thus, in order to carry on the triangulation, it was necessary to surmount the curvature of the earth by building lofty towers at each of the stations of observation, and to cut openings or rays through the forests and other obstacles on the sides of the triangles, to enable the contiguous stations to be mutually visible. From long experience it has been found more economical and expeditious, as a rule, to clear away all obstacles on the lines, than to raise the towers materially higher than is necessary to surmount the earth's curvature. But in this series either process would have been very expensive; the prices of materials and labor had risen enormously, and very heavy compensation had to be paid for the trees which had to be felled on the lines; thus it became necessary, after the completion of the first polygon, to alter the design of the triangulation to a chain of single triangles, which involves a minimum amount of line cutting and station building.

(6.) The direct distance spanned by this Series from the side of the Calcutta Meridional triangulation where it commences, to that of the Eastern Frontier Series where it terminates, is 210 miles, and the number of triangles is 41.

(7.) It might be supposed that an undertaking of this nature, commencing in the vicinity of the town of Calcutta, and crossing districts, some of which have been longer under the British Government than any other portion of the Indian Empire, would be a simple and easy operation, in comparison with the triangulation in other parts of the Empire. But the very reverse has been found to be the case; for the portion of Eastern Bengal through which the triangulation was carried is so intersected with rivers and tidal creaks, and so liable to be flooded when rain falls or the rivers rise, and the district roads are so few and bad, that it was always more or less difficult, and often impossible to move about from point to point, and the Surveyors have repeatedly been delayed for days together on the bank of a river, waiting for a favorable turn of the weather to permit of their crossing in the fragile native boats which were alone available for the purpose. The difficulties arising from the absence of hills, undulations, or even artificial mounds, which contribute so much to the speedy and easy completion of trigonometrical operations, have already been described. Besides which, the country appears to have been unusually unhealthy during the last three years, and the Survey Parties have suffered severely in consequence, no less than 14 per cent. of the native establishment having died of fever and cholera in the season of 1865-66. Thus the difficulties to be combatted with and surmounted have been unusually great, and Lieutenant Thuillier is to be commended for having conducted his operations to a successful termination.

(8.) The operations of the field season under review comprise the measurement of 11 principal triangles, nearly equilateral, extending over a direct distance of 62 miles, and covering an area of 530 square miles; a verificatory azimuth was observed; several secondary points, and 13 trijunction stations of the Revenue Survey Department, were fixed, which will serve to connect the operations of the two Surveys, and enable the fiscal maps to be projected on correct co-ordinates; 222 miles

of lines were cleared through jungle and forest all more or less dense; and 5 stations were selected in advance on the new triangulation, which will now be undertaken by Lieutenant Thuillier, and which will trend northwards along the meridian of 90° from the Series recently completed, until it reaches a side of the Assam Longitudinal Series, somewhat to the west of Goalpara.

No. II.—TRIGONOMETRICAL.

THE EASTERN FRONTIER SERIES.

PERSONNEL.

W. C. Rossenrode, Esq., Assist. Surveyor 1st Grade.
Mr. H. Beverley, Civil Assistant 3rd Grade.
„ W. C. Price, Sub-Assistant 3rd Grade.
„ A. Moore, Sub-Assistant 4th Grade.

(9.) This triangulation traverses the Eastern Frontier, and, in previous years had been carried down from Assam, across the Kossia and Jynteah hills, through British and Foreign Tipperah, and along the hill frontier of the districts of Chittagong and Akyab, to within a short distance of the town of Akyab. During the last field season the triangles were carried in a south-easterly direction through the province of Arracan, for a distance of about 166 miles, the operations closing on the hills between Tongoup and Prome, which form a portion of the great range dividing Arracan from Burma. This range is about 100 miles broad at the part which is crossed by the triangulation, and is quite uninhabited; consequently, the arrangements for supplying food to the men of the Survey establishment, and for obtaining workmen to construct paths to the hill summits, for the passage of the large theodolite, and for clearing the rays of the numerous forest trees which had to be cut down, were very troublesome, and caused much anxiety. Happily Mr. Rossenrode, the officer in charge of these operations, has had much experience in overcoming difficulties of this nature, and possesses considerable energy, tact and judgment; he has managed to accomplish an unusually large amount of work, of excellent quality, in the face of all the difficulties with which he has had to contend.

(10.) The out-turn of work consists of 33 principal triangles, arranged so as to form 6 quadrilateral figures and a double polygon, stretching over a direct distance of 166 miles, and covering an area of 3,314 square miles; an azimuth of verification was also measured. In the course of the preliminary operations for the triangulation of next season, 13 stations were selected over a distance of 92 miles in advance, and 180 miles of road were cleared through forests; 2,520 square miles of secondary triangulation were also executed, in laying down the positions of 25 points of importance for topographical operations.

No. III.—TRIGONOMETRICAL.

THE JUBBULPORE MERIDIONAL SERIES.

(11.) This triangulation emanates from the great Longitudinal Series

connecting Karachi with Calcutta, and trends southwards on the meridian of 80°, having the towns of Jubbulpore and Madras near its northern and southern extremities. In previous years the triangulation between the parallels of 24° and 20° 32′, which passes over portions of the Saugor and Nerbudda districts and the Central Provinces, had been completed by Mr. Shelverton, while that between the parallels of 16° 25′ and 13°, which passes over the districts of Guntoor, Nellore, Northern Arcot, and Chingleput, had been completed by Captain Basevi. Thus a belt of rather more than 4°, between the parallels of 20° 32′ and 16° 25′, remained to be completed. Mr. Shelverton has succeeded during the present year in extending the triangulation of the northern section down to the parallel of 18° 35′, by 19 principal triangles, arranged so as to form two hexagons and a heptagon, and covering an area of 5,546 square miles; stations were also selected in advance down to the nearest side of the southern section, which will enable a symmetrical junction to be effected by means of 4 polygonal figures. Azimuths of verification were observed at three of the principal stations.

PERSONNEL.

G. Shelverton, Esq., Assistant Surveyor.
Mr. M. C. Hickie, Civil Assistant 4th Grade.
„ F. Bell, Sub-Assistant 1st Grade.
„ L. J. Pocock, Sub-Assistant 3rd Grade.
„ A. Wrixon, Probationary Sub-Assistant.

(12.) The country through which the operations were carried is notoriously unhealthy, but this year the Survey establishments suffered less than usual, though the number of Europeans and natives who were prostrated for a time by illness was sufficient to cause much embarrassment and anxiety. Fortunately the Party entered the valley of the Wein Gunga after a sudden and severe visitation of cholera and typhus fever had disappeared; but its traces were everywhere visible, more particularly in the beds of streams, in which corpses had been hastily buried, and covered over with brambles; cremation had apparently been abandoned as the mortality increased, though at one village the encamping ground was found to be strewed with charred human bones. The zeal and energy which Mr. Shelverton has displayed, and the success with which he has carried his operations through every difficulty, are very commendable.

No. IV.—TRIGONOMETRICAL.

THE WEST CALCUTTA LONGITUDINAL SERIES.

(13.) For the reasons which have already been explained in para. 52 of my Administration Report for 1864-65, it was found necessary to revise this Series, which was executed in the years 1825 to 1830 with instruments of such inferior quality that the triangulation will not suffice to serve as an adequate basis for the several meridional chains of triangles, no less than 15 in number, which have been or will have to be carried from it northwards to the Himalayas, and southwards to the east coast of the Madras Presidency. In former years the revisionary operations had been carried from the Great Arc (in longitude 77½°) eastwards as far as the meridian of 85°, leaving 3½° to be done in continuation to complete the revision by bringing it up to the Calcutta base-line.

PERSONNEL.

H. Keelan, Esq., Surveyor 3rd Grade.
Mr. H. E. Keelan, Sub-Assistant 1st Grade.
„ H. Peychers, Sub-Assistant 3rd Grade.
„ J. Trotter, Sub-Assistant 3rd Grade.
„ E. J. Connor, Sub-Assistant 4th Grade.

(14.) During the present year Mr. Keelan has extended the operations to the meridian of 87° by 17 triangles, arranged so as to form a double polygon, and a pentagon, and covering an area of 7,270 square miles. Stations were also selected in advance as far as is necessary for the completion of the operations, which it is hoped will be accomplished next field season. It is feared however that many difficulties may be met with in clearing the lines of the trees which have sprung up since the stations were first built; the inhabitants of the district are proverbially litigious, and disinclined to assist in any operations to which they are not accustomed; in consequence of the want of any legislative enactment to support the officers of the Survey Department, much time will be lost both in obtaining the sanction of the villagers to the ray cutting, and in getting them to assist in the operations. But I feel that I can repose every confidence in Mr. Keelan's tact in conciliating the people of the district, and securing their co-operation, and I have every expectation therefore that the next field season will witness the successful completion of this triangulation, which is all that is now required to finish the operations of this Survey in the extensive regions between the meridian of Bikaneer and that of Calcutta, the parallel of Calcutta, and the Himalayan mountains.

No. V.—TRIGONOMETRICAL.

THE TWO SERIES, ON THE MERIDIAN AND PARALLEL OF BANGALORE.

(15.) The longitudinal triangulation had been carried along the parallel of 13° from Madras westwards to within a short distance of Bangalore in the preceding year. This year it has been extended 40 miles further, to a point west of Bangalore, where it will eventually be met by a series of triangles from Mangalore, to be executed by the Bombay Party. On reaching this point the operations were diverted to the meridian of Bangalore, and carried southwards a distance of 56 miles towards Cape Comorin. In all 19 triangles were measured, arranged in polygonal figures, and covering an area of 3,044 square miles.

PERSONNEL.

Lieut. W. M. Campbell, R.E., Assist. Surveyor.
Mr. A. W. Donnelly, Civil Assistant 4th Grade.
„ J. W. Mitchell, Sub-Assistant 2nd Grade.
„ O. V. Norris, Sub-Assistant 4th Grade.
„ C. D. Potter, Sub-Assistant 4th Grade.

(16.) In my Report for 1865-66 I stated that two contiguous triangles which had been measured in that year had been injuriously affected by the grazing of the rays of light against the slope of an intervening hill, on the side common to both triangles; it was therefore necessary to reject these triangles, and introduce new ones free from these objections; this has now been effected, and with marked benefit, the errors of the new triangles averaging 0″·72, while those of the old ones averaged 3″·85.

(17.) In the course of the preliminary operations for next season, 15 stations have been selected, and the triangulation has been laid out in advance for a distance of 92 miles.

(18.) A site for the measurement of a base line of verification has also been selected in the vicinity of Bangalore. Here one of the first base lines of the Trigonometrical Survey was measured by Colonel Lambton in the year 1804, but with instruments so rude, in comparison with Colby's apparatus of compensated bars and microscopes, which was brought out to this country in 1830 by Colonel Everest, and has been used in the measurements of the lines on which nearly the whole of the triangulation of the Empire has been based, that Colonel Lambton's base would be quite inadequate to serve the purpose of verifying the triangulation of the present day. Moreover some uncertainty exists as to his unit of measure. Consequently, it is indispensably necessary either to re-measure the old base, or to measure a new one. The former alternative would have been preferred, and might have been carried out, as the terminal marks are still in existence and in good preservation, but the surface of the country has undergone many changes in the period of upwards of sixty years which has elapsed since Colonel Lambton was engaged in his labors; large tanks for irrigation purposes are now to be met with on various parts of his line, and a railroad crosses it on a lofty embankment. Thus it became necessary to select a new line for the base, which I hope to measure during the ensuing season, and to connect with the old line by appropriate triangulation.

(19.) Lieutenant Campbell has displayed much energy and ability in his operations, and though often retarded by causes beyond his control, has succeeded in accomplishing a large amount of work. His great theodolite was out of order, and its defects had to be corrected before it could be used; in doing this Lieutenant Campbell received valuable assistance from Mr. Doderet, mathematical instrument maker to the Madras Government, but all the delicate corrections and adjustments had to be made by himself. Before entering the ghats to the south of Bangalore, he endeavored to ascertain the most healthy season for field operations, and was informed that the months most favorable for observations were "simply deadly from fever;" happily he did not permit this to deter him, and by a rare good fortune his camp was never so free from fever as it has been during the present field season.

No. VI.—TRIGONOMETRICAL.

THE MANGALORE SERIES, MERIDIAN 75°.

(20.) The triangulation on this meridian will, when completed, be of a length equal to that of the Great Arc, and considerably longer than any other meridional series in India. It will extend from the mountains of Kashmir and Ladak, on the parallel of 35°, to the parallel (13°) on which the towns of Madras, Bangalore and Mangalore are situated. Of the 22° comprised between these parallels rather more than 19°, bringing the triangulation down to 15½°, had been completed in former years. Thus, when Lieutenant Trotter commenced his operations in the present year, about 180 miles remained for completion; half of this has been done in the present year, by the measurement of 17 principal triangles, arranged in polygonal figures, and covering in area of 2,142 square miles.

PERSONNEL.

Lieut. H. Trotter, R.E., Assistant Surveyor.
Mr. G. Anding, Sub-Assistant 2nd Grade.
" A. Christie, Sub-Assistant 3rd Grade.
" J. Bond, Sub-Assistant 4th Grade.

(21.) Under ordinary circumstances the triangulation should be finished in another field season, but it has now reached the dense and deadly jungles of North Canara, which can only be traversed with impunity by Europeans or unacclimatized natives during two or three months of the year; these, unfortunately, occur at the time when the villagers burn the grass in the jungles, whereby the atmosphere becomes so obscured by smoke and fog that it is almost impenetrable by the signals employed in the observations; thus the progress of the work may be much retarded.

(22.) Lieutenant Trotter took the field in November, and employed himself for some weeks, under my instructions, in executing some minor triangulation in the Indarpoor talooka of the Poona district, to fix points for the use of a Revenue Survey which is now in progress, under the superintendence of Major Francis. He then went to Goa, to measure three triangles which were required to complete the link connecting the Mangalore with the South Konkan Coast Series.

(23.) From the Governor and officials of the Portuguese settlement at Goa Lieutenant Trotter received most cordial assistance; orders were issued to the Custom-house authorities all over the settlement to pass the baggage free not only of custom dues, but of the annoyance of examination and search; sepoys were also attached to the camp, to aid in procuring supplies. But the settlement appears to be almost destitute of good roads, or even fair footpaths; it is intersected by numerous rivers, and thus nearly all travelling is done in boats, and the Governor himself is said not to possess a horse. Consequently it was with no small difficulty that the large theodolite was carried up from the banks of the rivers up to the stations of observation on the summits of the adjoining hills, notwithstanding all the assistance which was afforded by the Portuguese officials.

(24.) By the time that the triangulation was completed the season was sufficiently advanced for Lieutenant Trotter to enter the unhealthy districts of Canara. He ascended the ghauts, and was at work for four months, from January to May, in North Canara. Comparatively few of the party suffered from ill-health until after the fall of the first heavy rains in April; the season of fever then commenced, and the sick list increased with rapidity, until very few men were left fit for work. Lieutenant Trotter remained at his post until the month of May was far advanced, but on the very day that he had succeeded in finishing the measurement of the last of the angles required to complete the programme of the season's operations, he and his observatory assistant were struck down with fever, and were obliged to leave the district as quickly as it was possible to move the camp into a healthier locality. Lieutenant Trotter has suffered so much that he has been compelled to proceed to Europe on sick leave, with the object of regaining his health in a better climate. His devotion to his work, and the judicious forethought which marks all his arrangements, are highly commendable.

No. VII.—TOPOGRAPHICAL.

THE SURVEY OF KEMAON AND GURHWAL.

(25.) This survey was commenced three years ago by officers detached from

the operations in Kashmir and Ladak, which were then approaching their termination, and have since been completed. The whole of the Kashmir Party is now employed in Kemaon and Gurhwal, with the exception of certain assistants who were compelled to proceed to Europe on sick leave on the close of their arduous labors in the stupendous ranges of the northern Himalayas.

PERSONNEL.

Lieut. T. T. Carter, R.E., Surveyor 3rd Grade.
" A. Pullan, Staff Corps, Assistant Surveyor 1st Grade.
" J. Hill, R.E., Assist. Surveyor 2nd Grade.
Mr. E. C. Ryall, Civil Assistant 3rd Grade.
" J. Peyton, Civil Assistant 3rd Grade.
" J. Low, Sub-Assistant 1st Grade.
" G. W. E. Atkinson, Sub-Assist. 2nd Grade.
" C. Braithwaite, Sub-Assistant 2nd Grade.
" H. Todd, Sub-Assistant 4th Grade.
" C. Bryson, Sub-Assistant 4th Grade.
" A. Low, Sub-Assistant 4th Grade.

(26.) In order to facilitate the introduction of a change in the style of hill drawing from the geographical scales of four or eight miles to the inch, which were used in the provinces of Kashmir and Ladak, to the topographical scale of one mile to an inch, which is required for the delineation of districts which have long been under British rule, and are well cultivated and crowded with villages, it was necessary to practise the Surveyors in delineating ground on a larger scale than that to which they had previously been accustomed. For this purpose I determined to employ them in making a survey of the stations of Masoori and Landour, on the scale of 12-inches to the mile, to replace the old Revenue survey which was made in 1844 by Major Browne, and which does not contain more than half the number of houses that are at present in existence. This work is carried on in the recess season, so as to interfere as little as possible with the progress of the field operations of the survey of Kemaon and Gurhwal. 4,353 acres were completed up to the date of my last report, and 2,121 acres have been subsequently added. Almost the whole of that portion of Masoori in which houses are numerous, and the greater part of Landour, have now been finished; some of the maps have already been printed, and are available to the public, and additional maps will soon be ready for publication.

(27.) The operations in Kemaon and Gurhwal have proceeded satisfactorily, and Lieutenant Carter, who supervised the whole of the field work, has done all in his power to ensure the accuracy of the topography, by making a scrupulous examination of the work of each Surveyor, and enforcing the principle that a comparatively small area done well is preferable to a large outturn of work hurriedly executed. The total area of the topography amounts to 1,620 square miles, of which the portions executed by each of the assistants employed in this branch of the operations is shown in the margin.

Lieut. Pullan, ... 224 square miles.
Mr. E. C. Ryall, ... 401 "
" J. Peyton, ... 262 "
" J. Low, ... 182 "
" C. Braithwaite, 270 "
" H. Todd, ... 281 "

(28.) The triangulation embraces an area of 1,124 square miles, fixing the positions of 293 points as a basis for future operations; the heights of 112 of these points have been determined.

	Area in square miles.	Number of points fixed.	Points of which the heights were determined.
Lieut. Carter, ...	246	104	23
" Hill, ...	473	98	37
Mr. Bryson, ...	405	91	52

(29.) The topography of the present year was carried on principally in the Gurhwal forests, which skirt the plains of Bijnour; the whole of the belt of land extending from Gaori Ghat on the Ganges to the Koti Rao Sote, the boundary

between Gurhwal and Kemaon, and including the Kotli, Patli, and Chokum Doons, has now been completed. Much interesting information has been collected by Lieutenant Carter and his senior assistants regarding the manners and customs of the inhabitants, the resources of the districts, their fauna and flora, and the numerous traces of a civilisation far higher than that of the present day, and probably anterior to the Mahomedan invasion of India, which have been met with. Similar researches will be carried on *pari passu* with the topographical operations, in order to provide a collection of materials for the preparation of a descriptive report of the district, on the completion of the survey.

No. VIII.—TOPOGRAPHICAL.

THE SURVEYS OF GUZERAT AND KATTYWAR.

(30.) In my last Administration Report it will be seen that the Party employed in topographical operations in the Bombay Presidency was deputed to the Island of Bombay to construct, with the aid of a Revenue Survey party, a map of the Island, on a scale of sufficient magnitude to exhibit a correct outline of all the various estates and houses in the town and suburbs, because property of all descriptions had risen enormously in value, and in some parts land had become as costly as it is in London. When our Surveyors had completed a sufficient amount of triangulation and traversing to serve as a basis for the internal measurements which will be made by the Revenue Surveyors, they were transferred to the province of Kattywar, to resume the survey which was commenced in 1864, but suspended in the following year in consequence of a famine which visited the province in 1865.

PERSONNEL.

Captain D. Nasmyth, R.E., Surveyor 2nd Grade, (on special duty).

Executive Officer.

Captain C. T. Haig, R.E., Surveyor 3rd Grade.
Lieut. Dummler, R.E., Asst. Surveyor 2nd Grade.
Mr. J. M'Gill, Civil Assistant 2nd Grade.
„ A. D'Souza, Civil Assistant 4th Grade.
„ N. Gwinn, Sub-Assistant 3rd Grade.
„ C. H. McA'Fee, Sub-Assistant 4th Grade.
„ T. Rendell, Sub-Assistant 4th Grade.
„ E. N. Wyatt, Sub-Assistant 4th Grade.

Native Surveyors.

Wasojee Ragonauth, Gopal Narayen, Ramchunder Vishnu, Crishnajee Govind, Gopal Vishnu, and four others.

(31.) When the Party was about to return to Kattywar, the Bombay Government suggested that its destination should be changed to Guzerat, as the want of a topographical survey of that province was greatly felt. But on being informed that the work already done in Kattywar would be thrown away if the mapping and filling in of the details were deferred, His Excellency the Governor in Council considered this a sufficiently cogent reason for prosecuting the operations. But he was anxious that the survey of Guzerat should not be indefinitely postponed, and that a second party should be deputed to that province as early as possible.

(32.) No party is available for the purpose, nor can the survey of Guzerat be commenced for many years to come, without detriment to surveys in progress elsewhere, unless a special party is organized for the purpose. Before submitting

any proposals on the proposition of the Government of Bombay for the consideration of the Government of India, it was necessary for me to make enquiries whether the fiscal surveys of the portions of the province belonging to the British Government, which have been made in the Revenue Department, might be connected together by triangulation, so as to furnish a portion of the details required for a good topographical map. I therefore, with the consent of the Bombay Government, directed Captain Nasmyth, R.E., who had recently been re-appointed to this Survey, on return from Europe, to proceed to Guzerat, and draw up a report on the operations of the Revenue Survey, showing to what extent they might be available for the purpose required.

(33.) His report, which has already been submitted for the consideration of the Government, shows that a good deal of the work of the fiscal surveys may probably be employed to assist in the formation of a topographical map; it comprises a variety of details which, in the words of Captain Nasmyth, "will suffice for all ordinary engineering requirements in the laying out of railways, tramroads, and canals for irrigation, such as the growing necessities of this fruitful province are evermore urgently demanding." The fiscal surveys have been mapped on scales varying from 8 to 12 inches to the mile, and though they cannot be expected to be free from error, being the work of native surveyors and draftsmen, who "as a body are paid materially less than village artisans," and can only use instruments of the rudest class, yet it is highly probable that the errors will be found to be practically inappreciable, when the village maps are reduced to the ordinary scales of topographical maps.

(34.) Still however there are certain peculiarities of the fiscal operations which will have to be amended before a correct survey can be produced; for instance, in the village maps a tank is represented, not by its actual area, but by that of the whole of the surrounding waste ground, "the land in fact withdrawn from cultivation for the purposes of the tank;" again, the site of a village or town is represented, not by the area actually covered by buildings, but by the whole space "assigned by custom for village purposes, and defined by the nearest limits of the surrounding fields;" thus the areas shewn are greatly in excess of those actually covered by the tanks and villages. Moreover there has necessarily been a total absence of any attempt to delineate the configuration of the ground, for when the fiscal surveys were commenced, it was decided that the qualifications for the conduct of topographical and fiscal surveys were so distinct "that any attempt to combine the two employments would certainly endanger, if it did not render impracticable, the successful accomplishment of both."

(35.) I may conclude these remarks on the proposed topographical survey of the province of Guzerat, by recording my conviction that the survey should be commenced as soon as possible. The area of the whole province is stated by Captain Nasmyth to be 31,752 square miles, of which only 10,736 belong to the British Government, the remainder appertaining to independent and tributary Chiefs. The Revenue Survey has dealt with the British Collectorates only, and the existing maps of the province as a whole, are known to be rude, inaccurate, and unreliable.

(36.) I will now proceed to report on the operations in Kattywar. When they were originally commenced, Major Keatinge, V.C., Political Agent, urged the necessity of undertaking, conjointly with the topographical operations, a minute

delineation of the boundaries of every village and estate, as the survey would then become "a complete work, tending directly to the facility of administration, and to the suppression of violent crime in the province." As this would greatly increase, and probably double, the cost of the survey, he suggested that the expenditure should be borne by the native Chiefs, to whom almost the whole of the province belongs, as they would be so much benefitted by the measure. I readily acceded to a proposal which would unquestionably increase the accuracy and general utility of the survey, without throwing any additional expenditure on the Government of India.

(37.) But when operations were resumed last year, Major Keatinge reported that "the tenor of several despatches lately received from Her Majesty's Government shows that it is not wished that measures of improvement should be urged upon the Kattywar Chiefs." He could not hope that they would willingly incur the expense, and he considered that the boundary surveys must be abandoned, unless the Government were prepared to pay for them. Nothing further was decided until November last, when, in the course of my annual tour of inspection, I went to Kattywar to discuss the subject with Major Keatinge. It appeared to us to be inexpedient to undertake a boundary survey of all the towns, villages and estates in the province, as this would entail an amount of expenditure which there might be some difficulty in meeting; but, on the other hand, it seemed advisable to undertake a boundary survey of all the talookas, or chief sub-divisions of the native States, because, *first*, some of the principal difficulties connected with the political administration of the province arise from the disputes as to the boundaries of these talookas, and it is highly desirable that they should be demarcated and measured once for all; *secondly*, their delineation on the maps of the survey would greatly enhance the utility of the maps; and, *thirdly*, the measurements taken for the purpose would much increase the accuracy of the survey.

(38.) We therefore recommended that a small additional establishment should be entertained, at the cost of the Government, for the purpose of measuring the talooka boundaries, while the preliminary expenses of defining and demarcating the boundaries should be borne by the native Chiefs, who were believed to be ready to undertake this share of the operations. The Government has recently assented to these proposals, which will be carried out as soon as possible.

(39.) Another question, connected with the survey of Kattywar, had been discussed when the operations were commenced, but without arriving at any satisfactory decision. It was proposed that the survey should be executed on the scale of 6-inches to the mile, after the methods of the Ordnance Survey of Great Britain, instead of on the scale of 1-inch to the mile, by plane-tabling on the basis of triangulation, according to the methods which have long been employed in the Survey of India. Captain Nasmyth warmly advocated the introduction of the Ordnance Survey system, and his views were supported by the Bombay Government. But it is obvious that the application of this system, with its accurate delineation of minute details, to a province of which the area exceeds 20,000 square miles, must necessarily have either caused a considerable increase to the present annual cost of the survey, in providing a sufficient establishment to complete the additional measurements in a moderate period of time, or it must have indefinitely protracted the completion of the survey, if no additional establishment were provided. It was clear that no increase to the present expenditure would be sanctioned, while on

the other hand, it is certain that a good map of the province is urgently required; consequently the idea of assimilating the operations to those of the Ordnance Survey had of necessity to be abandoned.

(40.) But the ordinary *modus operandi* of the Indian Topographical Surveys is susceptible of a modification by which the accuracy and general utility of the maps may be increased, without any material increase of cost. It is customary to draw the details of the ground in the field sketches on the same scale as that adopted for the final maps, whereas all European Surveys which are intended for publication on the standard Indian scale of 1 mile to the inch are executed in the field on some larger scale, which is never less than double the scale for publication. The advantages of so doing are obvious, for it is impossible under the manifold difficulties and inconveniences of working in the field under exposure to all the vicissitudes of the weather, to draw the details with the full degree of accuracy which the scale for publication permits; consequently by the employment of a larger scale for the field work, errors which would otherwise have escaped observation become readily visible, and may at once be corrected; while the errors which pass unnoticed should be so minute as to become insensible when the field work is reduced to the scale for publication.

(41.) Now, by adopting this system, and executing the field work on a scale twice that of the maps for publication, on the understanding that the object in view is not to introduce more details on the large scale field sketch than can be shown on the published map "without creating confusion and destroying the unity of the general effect",* but to enable such details as are ordinarily shown on the published map to be delineated with a higher degree of accuracy than would otherwise be possible, the operations may be completed as rapidly as appears desirable, while the expense should not be materially increased; moreover, the field sketches will be of much greater use to the political authorities, for they will exhibit the boundaries of the talookas on a scale sufficiently large to serve the purpose of tracing their course in the settlement of the numerous disputes which arise regarding them. I have therefore directed Captain Haig, the officer in charge of the survey of Kattywar, to employ the scale of 2-inches to the mile for his plane-tabling in the field, and retain the 1-inch scale for the general map of the province.

* *Vide* the principles enunciated by Sir Andrew Waugh in his topographical instructions.

(42.) Maritime surveys of the coast of Kattywar were made years ago by officers of the Indian Navy, and are now in general use. An application has been made to the India Office in London for the return of the original charts, which, having been constructed on larger scales than the published charts, should be placed in the hands of the topographical Surveyors, in order that the operations by land and sea may be accurately connected together. I am not aware that any attempt has yet been made to combine the details of the maritime charts with those of the land surveys in this country; but it is obvious that such a measure is necessary, to do full justice to both operations, and secure a more accurate and valuable map of the coast than is produced by either taken singly.

(43.) Doctor Oldham, the Superintendent of the Geological Survey of India, has recently drawn the attention of the Government to certain questions which have been raised regarding secular changes in the relative level of the land and sea which are believed to be going on in various parts of the Bombay Presidency, and more

particularly at the head of the gulf which separates the province of Cutch from that of Kattywar. Dr. Oldham recommends that certain points should be selected on the south coast of Kattywar, and as far up the gulf as possible, and that the existing relative levels of land and sea should be determined at those points, by accurate tidal observations carried over as long a period as possible, the tidal stations being connected by lines of levels. Thus, by repeating the operations at a time sufficiently distant to allow the secular changes to reach an appreciable magnitude, this question, which is of much scientific importance, will be satisfactorily settled. The Government of India have sanctioned these measures, which will be undertaken by Captain Haig and his assistants as soon as possible.

(44.) The operations of the Kattywar Survey have progressed very satisfactorily during the present year, though the apparent progress is small, as much time has been occupied in training a number of newly-appointed Surveyors in the use of the plane-table, in triangulation, and in the system of traversing with a theodolite and chain, which will be employed to determine the talooka boundaries; but a good foundation has been prepared, and I have every reason to expect that the future rate of progress will be as rapid as is desirable. The area topographically surveyed amounts to 617 square miles, sketched in the field on the scale of 2-inches to the mile; of triangulation 2,680 square miles were completed, fixing the positions of upwards of 700 points, and the heights of 162 of these points. The share taken by each of the assistants in the several operations is shown in the margin.

AREA IN SQUARE MILES.

	Surveyed topographically.	Triangulated.
Lieut. Dummler, ...	70	280
Mr. M'Gill, ...	...	2,100
„ D'Souza, ...	70	300
„ Gwinn, ...	140	...
„ McA'Fee, ...	70	...
„ Rendell, ...	140	...
„ Wyatt, ...	140	...

No. IX.—GEOGRAPHICAL.

EXPLORATIONS OF TRANS-HIMALAYAN REGIONS.

(45.) While Captain Montgomerie was carrying on the survey of Kashmir and Ladak, he conceived the idea of employing natives of the upper Himalayan vallies in making geographical explorations of the southern regions of Central Asia, which are situated between the boundaries of the British and the Russian empires. These men are permitted to travel without molestation, as traders or in other capacities, through countries where Europeans would certainly be regarded with suspicion, and exposed to ill-treatment, and most probably would be murdered. It is only by means of native agency that any considerable portion of these little-known regions is likely to be explored, until the British and Russian frontiers become united; and it is only by training men whose homes are situated on the border of a province that has to be explored, or who are familiar with the manners and customs of the inhabitants, speak the same language, and are of the same religion,

that any degree of success can be anticipated. Thus it is necessary to employ Pathans to explore the northern and southern vallies of the Hindoo-Koosh range, the region between the sources of the Oxus and the Jaxartes, and the greater portion of the province of Atty-Shahr, or little Bokhara, in Eastern Turkustan, all which are mostly inhabited by a Mussulman population; while for explorations of Great Tibet, and the regions which are subject to the Chinese government, and mostly inhabited by a Budhist population, it is necessary to employ Bhotiyas, or Tibetans, the inhabitants of the upper vallies of the Himalayas which are subject to the British Government.

(46.) The explorers are taught to make a route-survey by taking bearings with a compass, and pacing the distances; they are also taught to take astronomical observations with a sextant, for determining latitudes; observations for determining absolute or differential longitudes are evidently beyond their capacities, but they soon learn to observe the meridian altitudes of certain of the principal stars with sufficient accuracy for all practical purposes. They are purposely not taught how to reduce their observations, nor supplied with astronomical tables, in order that they may not be able to fabricate fictitious observations; the resulting latitudes and the co-ordinates of the route are computed in this Office on the explorer's return. The astronomical latitudes serve the purpose of determining the correction which has to be applied to the latitudinal co-ordinates of the traverse, in consequence of variations in the length of the explorers paces when travelling over difficult or easy ground; a corresponding correction is applied to the longitudinal co-ordinates. This process is of course rude and approximate, but it is the only one that can be adopted in operations in which all surveying instruments must necessarily be concealed as much as possible, to prevent suspicion and opposition on the part of the inhabitants of the country. With all its disadvantages, it furnishes materials for defining the positions of the chief towns, which are vastly more accurate than any other materials in existence, and it furnishes a large amount of new geographical information.

(47.) The first exploration made in connection with the operations of this survey was that of the route between Ladak and Yarkand, *viâ* the Karakoram Pass, which was effected by a native of the name of Mohamed-i-Hamid, who died shortly after his return to Ladak. It has been described by Captain Montgomerie in a report published by the Royal Geographical Society. One result was the determination of the position of Yarkand to be in latitude 38° 20′, longitude 77° 28′ east of Greenwich, very approximately. The values adopted by Klaproth, Humboldt, and Ritter are latitude 38° 19′, longitude 76° 18′, nearly agreeing in latitude, but differing 70 minutes in longitude. In support of the shift of position to the east, it may be mentioned that the position of Kokan has been shifted in the most recent Russian maps from 41° 23′ by 70° 30′ to 40° 18′ by 71° 1′, that the position of Ilchi is now accurately known, and that the new co-ordinates of Yarkand assign it a position between Kokan and Ilchi, which agrees with the latest and most valuable itineraries of this route, published in the Punjab "Report on the Trade and Resources of the Countries on the North-Western Boundary of British India."

(48.) The next exploration was that of the route between the Mansarowar lake and Lhasa, *viâ* Tadum, and between Tadum and Kathmandû, which is described at length by Captain Montgomerie in an accompaniment to this report. It extends over a distance of upwards of 1,200 miles, and affords an admirable base from which

explorations may be carried through Great Tibet to the eastern portion of the Tian Shan range, and the borders of the desert of Gobi. The native employed in this operation is a Bhotiya, a subject of the British Government; his work has been carefully examined, and has satisfactorily stood every test which it has been possible to apply; and I feel very sure that Captain Montgomerie's digest of the operations, the translations from the Pundit's diary and field books, and the map of the Pundit's route will be accepted as a most valuable contribution to geographical science.

No. X.—ASTRONOMICAL.

LATITUDE OBSERVATIONS ON THE PARALLEL OF 23°.

(49.) This Party was employed in observing the latitudes of certain stations on the Calcutta Longitudinal Series, near the extremities of the meridional chains of triangles which will eventually be converted into geodetic arcs. Observations were taken at three stations; the quality of the work appears to be good, but the amount is less than Mr. Taylor should have accomplished, as he has had considerable experience in operations of this nature. While marching back to head-quarters at the end of the field season, he became involved in a quarrel between some of his camp followers and the inhabitants of a village near Agra, and conducted himself in such a manner as to necessitate his dismissal from the Survey Department. A full report on this subject having already been submitted to the Government, it is now unnecessary for me to advert to it further than to record my regret at this unfortunate ending to a career which has hitherto been so honorable and useful.

PERSONNEL.

H. Taylor, Esq., Assistant Surveyor 2nd Grade.
Mr. G. W. Atkinson, Sub-Assistant 2nd Grade.

No. XI.—ASTRONOMICAL.

LATITUDE OBSERVATIONS ON THE MERIDIAN OF 75°.

(50.) This Party was employed in determining the latitudes of certain stations in the northern portion of the triangulation on the meridian of 75°, which I have already described in para. 20 of this Report as one of the longest chains of triangles in the Indian Survey. Lieutenant Heaviside, R.E., was appointed to the charge of the party on the transfer of Lieutenant Campbell to the Madras Presidency. Having had no previous experience in astronomical observations, he was

PERSONNEL.

Lieut. W. J. Heaviside, R.E., Assistant Surveyor 2nd Grade.
Mr. J. Wood, Sub-Assistant 2nd Grade.
" G. Belcham, Sub-Assistant 3rd Grade.

put through a course of training during last recess by Mr. Hennessey, under whose supervision he determined the latitude of the observatory at Masoori. On having mastered all the practical details of the observations, he proceeded to Umritsur, and commenced operations. He has succeeded in determining the latitudes of four stations between the parallels of 29° and 32°, by observations of 24 to 26 pairs of north and south stars of the Greenwich Seven-Year Catalogue at each station, each star being observed on eight days, with one of the large astronomical circles which were brought out to this country by Colonel Everest, and are described in his account of the measurement of the Indian Arc.

(51.) When the season was too far advanced for further observations, Lieutenant Heaviside made a minute examination of the trigonometrical stations on his meridian, to a distance of about 300 miles to the south of his last station of observation, in order to select the positions to which a preference might be assigned for future determinations of latitude, in their comparative freedom from local irregularities which might affect the direction of the plumb-line. He has sent in an excellent report on this subject, and his out-turn of work of all descriptions has been most creditable.

No. XII.—MISCELLANEOUS.

LEVELING OPERATIONS, AND PROTECTION OF THE SURVEY STATIONS.

(52.) This Party was employed in carrying branches from the main line of levels of the Trigonometrical Survey to connect the levels of the Canal and Railway Departments at Delhi, Meerut, Saharunpore, Umballa, Loodiana, Lahore, and Mooltan, in order that the latter might be reduced to a common datum, as a preliminary to future publication. 156 miles of branch levels were executed independently by Mr. Lane and his native assistant, fixing the height of 329 bench-marks, in conformity with the rigorous method of procedure, which has been described briefly in former Reports, and is explained in detail in the introduction to the volume of Tables of Heights in Sind, the Punjab, N. W. Provinces, and Central India, which was published in 1863.

PERSONNEL.
C. Lane, Esq., Surveyor 3rd Grade.
Mr. L. Clarke, Civil Assistant 4th Grade.
Ram Chund, Native Leveler.

(53.) Mr. Lane was also directed to make arrangements for carrying out the measures described in para. 56 of my Report for 1865-66 for the protection of as many of the stations of this Survey as were within a convenient distance of his operations, and also to depute an assistant to repair the stations of the Great Arc, and place them in charge of the village officials. All the Executive Officers of this Department are now required to take similar steps for the protection of the stations which are added each year to the triangulation. Thus during the past field season 142 stations have been specially placed under protection.

(54.) Rules for the guidance of the officers in charge of all the British districts and native states in the three Presidencies have been circulated under the

orders of the Government of India, and I am constantly receiving communications on the subject from all quarters. There is therefore every reason to expect that the importance of preserving the stations of this Survey from wilful injury and the action of the weather, will not be lost sight of in future.

No. XIII.

PENDULUM AND MAGNETIC OPERATIONS.

(55.) In my Report for last year I stated that Captain Basevi had commenced the operations for determining the force of gravity at certain of the stations of the Great Indian Arc, which had been suggested by General Sabine, the President of the Royal Society. For this purpose he had been supplied with two pendulums and other instruments, the property of the Royal Society, which had already been employed in similar investigations in other parts of the globe, and with which a complete series of observations had been made at the Kew Observatory shortly before the instruments were despatched to India, to facilitate the eventual combination of the results of the operations in this country with all previous or future operations of a like nature.

PERSONNEL.

Captain J. P. Basevi, R.E., Surveyor 1st Grade.
Mr. M. Lemarchand, Sub-Assistant 3rd Grade.
„ J. M'Dougall, Sub-Assistant 3rd Grade.

(56.) I may here repeat that a fact of great scientific importance was elicited from the results of the work of last year, that the density of the strata of the earth's crust under and in the vicinity of the Himalayan mountains is less than that under the plains to the south, the deficiency increasing as the stations of observation approach the Himalayas, and being a maximum when they are situated on the range itself. The stations at which observations were taken during the present year are far remote from the influence of the Sub-Himalayan strata, and the results obtained at them are now only very slightly in defect of the theoretical values of the force of gravity; they thus tend to confirm the evidence of the first year's operations as to the deficiency of matter in the Sub-Himalayan strata.

(57.) With a view to imparting the utmost accuracy and precision to the determination of the number of vibrations made by each pendulum at the several stations of the Indian Survey, the President and Council of the Royal Society recommended that the observations should be made in a vacuum; the necessary apparatus for this purpose was constructed in London, and sent out with the pendulums. Numerous difficulties were at first met with in the management of the vacuum apparatus; the receiver is necessarily of considerable magnitude to admit of the vibrations of a pendulum of a length of 5 feet, and the powers of the air-pump were found inadequate to the labor of repeatedly exhausting so large a body of air; moreover, the receiver was liable to occasional leakage. All these difficulties however have been satisfactorily surmounted, and the apparatus is now in such good working order that the pressure can be reduced below 2 inches, and retained at an average of about 3 inches, throughout a set of observations lasting eight or nine hours.

(58.) But in experimental investigations of this nature it is often found that improvements which are introduced in order to remove known sources of error or uncertainty, bring to light others which had not previously been suspected. This has now happened in Captain Basevi's operations; the vacuum apparatus which was supplied to enable the vibrations to be measured under so slight a pressure that the effects of any uncertainty in the determination of the co-efficient of pressure might be reduced to a minimum, has admirably answered the purpose for which it was intended, and has further improved the quality of the observations by protecting the pendulums from the action of currents of air, and from the incidence of dust which often pervades the atmosphere in great quantities; the observations appear to be much more delicate and precise when a pendulum is swung inside the vacuum apparatus, than when it is swung in the air, the correction for pressure is reduced to a minimum, and the variations of temperature are slower, more uniform, and can be measured with greater accuracy. But, on the other hand, the correction for temperature is uncertain, and causes much embarrassment; its significance in the reduction of observations of a wide range of temperature is considerable, for a variation of 1° Fahrenheit alters the number of vibrations in twenty-four hours by nearly half a vibration.

(59.) Before proceeding to describe the steps which have been taken to determine this correction, I may observe that the temperatures are measured by a pair of thermometers inserted in a bar of the same dimensions as the pendulums, and of similar metal; the bar is fixed inside the receiver, and is consequently within a few inches of the pendulum under vibration. The calibration errors of the thermometers have been very carefully determined by comparison with a standard calibrated thermometer, and the index errors of the freezing points are ascertained in the usual manner from time to time. A further correction is however necessary, when the observations are made in a vacuum, for the exhaustion of the air reduces the pressure on the bulbs of the thermometers, and causes the column of mercury to fall, as may be seen by placing a thermometer enclosed in an air-tight tube by the side of an unenclosed thermometer, and comparing the indications of both as the pressure is diminished. On the other hand, the friction of the particles of air against each other and against the sides of the receiver causes heat to be generated both in exhausting and re-admitting the air; the increase of temperature is not shown so readily by the enclosed as by the unenclosed thermometers, consequently the effects of the pressure on the bulb of the latter cannot be ascertained until a sufficient period of time has elapsed for both thermometers to be equally affected by the temperature of the air inside the receiver. If, meanwhile, the temperature of the observatory is changing, additional complications are introduced. However by patient observation and careful arrangements the effects of pressure on the bulbs of the thermometers have now been accurately determined, and found to be about two-tenths of a degree for 27 inches of pressure, varying of course with different thermometers.

(60.) The actual temperatures being ascertained, the next point is to determine the precise effect of a given variation in temperature on the number of vibrations in twenty-four hours. Hitherto it has been supposed that a knowledge of the co-efficient of expansion of the metal of which the pendulum is constructed would suffice to enable this effect to be computed by the ordinary theoretical formula, and this supposition has been supported by the evidence of certain experiments which were made by General Sabine in 1824 with one of the pendulums now in India.

General Sabine observed the number of vibrations which the pendulum made at a station in London at the temperatures of 47° and 84°, and found that they gave a factor of expansion which coincides with the known factors of similar metals, as determined from direct measurement. But his investigations had been restricted to one of the two pendulums; the other had never been tested, and it was therefore necessary for Captain Basevi to ascertain its expansion. While so doing it was decided to extend the investigations to General Sabine's pendulum, because a period of nearly half a century had elapsed since its expansion had been determined, and because it seemed desirable that as all the Indian observations are made in a vacuum, the observations for determining their temperature corrections should also be made in a vacuum.

(61.) Consequently Captain Basevi observed a complete series of vibrations at Kaliana, the northern station of Colonel Everest's Arc, in December 1865, under a temperature of 58°, and again in June 1866, under a temperature of 89°, the pressure being about three and a-half inches in both cases. The resulting expansions of both pendulums were very consistent, but they were more than a tenth larger than that previously deduced by General Sabine for his pendulum, and indeed were larger than any previously deduced expansions of similar metals. It was therefore necessary to re-determine them by independent processes of investigation.

(62.) In the first instance, experiments were made by vibrating the pendulums in the Observatory at Masoori, 6,700 feet above the sea, under the natural pressure of the air, 23·5 inches, at the temperatures of 55° and 84°. Twelve sets of observations were made with each pendulum at each temperature, six with the face and six with the back of the pendulum turned towards the observer. Each set lasted nearly three hours, the three first, three last, and two intermediate coincidences being observed.

(63.) The expansions were then determined by direct micrometrical measurement at the Survey Office in Dehra Doon, 2,300 feet above the sea. For this purpose two frames were constructed, each capable of carrying a pendulum when freely suspended in a vertical position; they were lined from top to bottom, on three sides, with metal cases, which were intended to contain hot water, for the purpose of raising the temperature of the pendulum to any desired point; they were further adapted to move on rollers in a tramway leading to the micrometer microscopes, which were firmly attached, one above the other, to a large pyramidal block of stone, resting on an isolated masonry pillar. The distance between the microscopes being 45·5 inches, fine marks were made at the same distance apart near the shoulder and on the tail-piece of each pendulum. The greatest care was taken to prevent the pendulums from being injured by the removal of any portion of the metal; thermometers were attached to them temporarily by springs, the bulbs being plunged into oil cups made of wax and resin, which could be easily made to adhere temporarily to the surfaces of the pendulums, and might be removed at pleasure.

(64.) The pendulums were first compared together when at the natural temperature of the experimenting-room; then one of them was removed (in its frame) into an adjoining room, and heated by causing a stream of hot water to flow continuously through the metal cases, until the pendulum had acquired the desired temperature; it was then brought back (in its frame, with the metal cases full of hot water) into the experimenting-room, and again compared with the other

pendulum which had remained at the temperature of the room. After a sufficient number of comparisons had been made to deduce the relative lengths of the heated and unheated pendulums, the former was allowed to cool down to the natural temperature of the experimenting-room, and the latter was heated, and then both were again compared; twenty comparisons were thus made between the pendulums when both were cold, twenty-six when one was hot and the other cold, and as many more when the temperatures were reversed. The resulting equations of condition were reduced by the method of minimum squares.

(65.) The factors of expansion which have been deduced at Kaliana, Masoori and Dehra are as follows, for each pendulum, No. 4 being that employed by General Sabine, with which he obtained a mean factor of ·000,~~001~~,01 by two sets of experiments, under an atmospheric pressure of 29·8 inches, in London, in the year 1824:— 0/0.

Pendulum No. 4.

Station.	Pressure in inches.	Factor of expansion.	Probable error.	
Kaliana, ..	3·8	·000,011,27	± 000,000,05	By vibrations.
Masoori, ..	23·5	·000,009,76	± 000,000,08	By vibrations.
Dehra, ..	27·7	·000,009,84	± 000,000,13	By direct measurement.

Pendulum No. 1821.

Kaliana, ..	3·2	·000,010,93	± 000,000,05	By vibrations.
Masoori, ..	23·5	·000,010,26	± 000,000,08	By vibrations.
Dehra, ..	27·7	·000,009,61	± 000,000,12	By direct measurement.

Mean of both Pendulums.

Kaliana, ..	3·5	·000,011,10	By vibrations.
Masoori, ..	23·5	·000,010,01	By vibrations.
Dehra, ..	27·7	·000,009,73	By direct measurement.

(66.) The above results indicate a greater degree of expansion at low than at high pressures; there are inconsistencies between the determinations at Masoori and at Dehra, under a difference of only 4·2 inches of pressure, but these inconsistencies are probably due to the circumstance that a pendulum is necessarily from its shape ill-adapted to investigations of this nature; in these pendulums, the "bob" alone contains about thirty-four cubic inches of metal, while the mass of the remainder is only thirteen cubic inches; consequently it is improbable that the metal will be of an uniform temperature throughout, for the variations of temperature must be slower in and near the bob than in any other part of the pendulum; the thermometers are however so placed as to take account of this as far as possible.

(67.) Still, making every allowance for errors in the above results, it is impossible to escape the conclusion that expansions determined by the vibrations of pendulums under a very low pressure are materially greater than those obtained by vibrations in the air, or by direct measurement. Whether this is due to an actual increase of expansion for a decrease of pressure, or to the action of other phenomena which are at present unknown or only imperfectly known, is a problem for future solution.

(68.) Captain Basevi was necessarily much delayed by having to undertake the above investigations, which were protracted into the middle of the late field season. Nevertheless he was able to take complete sets of observations in the

usual manner at three stations of the Great Arc: Pahargurh, lat. 24° 56′, Kalianpur, lat. 24° 7′, and Ehmudpur, lat. 23° 36′; he hopes in the ensuing field season to carry his operations down to Bangalore, lat. 13°.

(69.) During the present year he has commenced a series of magnetic observations, which will be carried on in future simultaneously with the pendulum operations. He employs one of the two sets of magnetic instruments, consisting of a unifilar magnetometer and declinometer, and a dip circle, which were constructed for the use of the Indian Survey, under the superintendence of General Sabine and Mr. Balfour Stewart, and tested at the Kew Observatory. The other set has been used at head-quarters, by myself at Masoori, and by Mr. W. H. Cole, M.A., at Dehra, whenever leisure permitted.

(70.) The results of the observations which have been made hitherto are as follows:—

By Captain Basevi.

Station.	Month of observation.	Dip and number of determinations.		Declination and number of determinations.		Total force in British units, and number of determinations.	
		° ′		° ′			
Masoori, ..	October 1866.	41 41·5	2	..	..	..	..
Dehra Doon, ..	Dec .66, Jan. 67.	41 27·6	4	2 54·2 E	4	9·7229	7
Meerut, ..	January 1867.	39 7·2	2	2 45·6 E	3	9·5473	3
Agra, ...	February „	36 1·4	2	2 46·2 E	3	9·3449	4
Pahargarh, ..	March „	31 59·3	4	2 10·0 E	5	9·0914	6
Kalianpur, ..	April „	30 17·8	2	1 49·0 E	2	9·0873	4
Ehmadpur, ..	April „	29 53·8	2	2 6·2 E	2	8·9531	4
		At Head-Quarters.					
Masoori, ..	May 1867.	41 39·9	4	2 37·3 E	2	9·7526	4
Dehra Doon, ..	June „	41 30·2	3	..	..	9·7356	3
„ ..	July „	41 31·2	1	..	..	..	..
„ ..	August „	41 26·1	3	..	..	9·7244	2
„ ..	Sept. „	41 29·5	2	..	..	9·7203	1

No. XIV.

THE COMPUTING OFFICE.

(71.) Mr. Hennessey and his assistants have been fully employed, not only in current duties appertaining to the reduction of the triangulation, but in a variety of

matters connected with the general operations of the Department. Among the chief of these I may mention the verification of the old standards of length of the Indian Survey; the determination of the factors of expansion of the pendulums by direct measurements, and the reduction of the results; the preparation of descriptive lists of upwards of 1,500 of the stations of this Survey in the three Presidencies of Bengal, Madras and Bombay, each officer in charge of a British district or native state having to be furnished with a separate list. Mr. Hennessey had also to train three officers in the general duties of this Department, and to teach the process of photozincography to three officers employed under the Surveyor General. His unwearied zeal and devotion to his duties, and the skill with which he accomplishes whatever he undertakes, deserve every commendation.

PERSONNEL.

J. B. N. Hennessey, Esq., Surveyor 1st Grade, in charge.
Lieut. Rogers, R.E., Assistant Surveyor.
W. H. Cole, Esq., M.A., Assistant Surveyor.

Computing Branch.

Mr. C. Wood, Sub-Assistant 1st Grade.
Bahoos Gunga Pershad, Gopal Chunder Sircar, Dwarkanath Dutt, Caly Mohun Ghose, and 13 native computers.

Printing Branch.

Mr. T. Keightley.

Photozincographic Branch.

Mr. C. G. Ollenbach.

(72.) The verification of the standards of length of this Survey had become necessary for the following reasons:—The principal standards are two simple bars of iron, ten feet in length, known as standards **A** and **B**, which were sent out to India for Colonel Everest in 1832, with six compensated bars of iron and brass, also of a length of ten feet, intended for measuring base-lines. Standard **A** had been employed with the compensation bars at eight base-lines in different parts of India, and had travelled over a distance of many thousand miles. Standard **B** was sent back to Europe, to be lodged in the Royal Observatory at Greenwich. At each successive base-line it was found that the relative lengths of standard **A** and the compensation bars were altering, the difference increasing year by year; there were also variations in the lengths of the compensated bars *inter se*, but these were comparatively small; had there been only one or two compensated bars which exhibited this discordance with the standard, no doubt could have been felt as to their having altered, and not the standard, for they are necessarily by construction more liable to vary in length than a simple bar of metal; but as there were six compensated bars, and all told the same tale, it seemed possible that their lengths had remained nearly constant, while that of the standard had changed.

(73.) The differences between standard **A** and the general mean of the six compensated bars are shown in the following table:—

Base Lines.	Year of measurement.	Excess of mean of six compensated bars over standard, in millionths of a yard.	Increment on value at Calcutta base-line, in millionths of a yard.
Calcutta, ...	1832	112·19	..
Dehra Doon, ..	1835	132·59	20·40
Sironj, ...	1838	144·30	32·11
Bider, ...	1842	183·57	71·38
Sonakoda, ..	1848	178·65	66·46
Chuch, ...	1854	183·38	71·19
Kurrachee, ..	1855	195·86	83·67
Vizagapatam, ..	1863	209·93	97·74

(74.) It is evident that any alteration in the length of the standard would necessitate the application of corresponding corrections to the lengths of all the base-lines, and the sides of the triangles dependent thereon; and that the results of the Indian geodetical operations could not be combined with those of similar operations in other parts of the world until these corrections had been determined and applied.

(75.) Consequently two new standards, each ten feet in length, one of steel, the other of bronze, were constructed for the Indian Survey under my superintendence, when I visited England in 1864. Fortunately, Captain Clarke, of the Ordnance Survey of Great Britain, was engaged at that time in making an elaborate series of comparisons between the several standards of length of England, France, Belgium, Prussia, Russia, India and Australia, and he obligingly undertook to compare the new standards with standard **B**, and with the English standards; he also determined the factors of expansion of the new bars, and the errors of the new standard thermometers, which were required to complete the apparatus. I have every reason to be much indebted to Captain Clarke, for his able and laborious investigations; they have been published at length, by order of the Secretary of State for War, in a volume entitled "Comparisons of the Standards of Length of England, France, &c."

(76.) The new standards arrived at Dehra in 1866. As soon as practicable they were compared, together, and with standard **A**. It was ascertained that their relative length had not been sensibly affected by the journey to India and change of climate, for the measures at Southampton and at Dehra differ by only ·06 of the millionth of a yard, a smaller quantity than the probable errors of the determinations. The comparisons with standard **A** show that the relative length of **A** and **B** is at present almost identical with what it was in 1834, when **B** was determined by Colonel Everest, to be 1·28 millionths longer then **A**, whereas its excess is now 3·08 millionths. Captain Clarke has shown that the existing relation of **B** to the standard ten-foot bar of the Ordnance Survey differs by less than one millionth from the relation in 1831, and "agrees all but precisely with the mean of the results of the comparisons between these bars in 1831 and 1846."

(77.) Thus it may be considered certain that the lengths of both the old Indian standards have not altered appreciably, and that the increment of nearly 100 millionths of a yard in the mean of the six compensated bars on standard **A**, which occurred between the years 1832 and 1863, must have been solely due to changes in the compensated bars.

(78.) The length of the standard six-inch scale of this Survey which determines the values of the compensated microscopes employed in the base-line measurements, has hitherto been assumed to be exactly one-twentieth part of the length of standard **A**. The precise relation of these two standards has been recently determined, and found to agree so closely with the assumed value, that the requisite corrections to the measured base-lines will not exceed half an inch in seven miles.

No. XV.

CARTOGRAPHY.

(79.) Mr. Scott has been engaged in compiling a new map of Central Asia, based on fresh materials which have mostly been received from Russia, since the compilation of the map which was published by this Office in 1866. The new map is on a larger scale than its predecessor, contains a great deal of additional information, and has rectified the positions of a number of places of importance, chiefly in the provinces of Kokan, Kashgar and Yarkund. It is called "Turkestan, with the adjoining portions of the British and Russian Territories," and has been compiled in four sheets, two of which will be ready for publication in a few days; new editions will be issued from time to time, on the receipt of additional information.

PERSONNEL.

W. H. Scott, Esq., Civil Assistant 1st Grade, and Chief Draftsman.
6 native Draftsmen, and 10 native apprentices.

(80.) A series of maps is also being prepared showing all the lines of levels which have been executed for canals, railroads, and the operations of this Survey, in the districts between and adjoining the Jumna and the Ganges; the levels are reduced to the common datum of the mean sea level of Karachi harbour. No little difficulty has been experienced in obtaining the several data, which are required to make the maps as complete as possible, from the different offices in which they are preserved; the labor of examination and correction is also very considerable; but the maps should be all the more valuable in consequence, and every person who has had a share in the original leveling operations cannot fail to be gratified to see his work published in a form which will ensure its preservation, and increase its general utility.

(81.) The maps of Kashmir and Ladak have now been completed and sent to England, to be engraved as parts of the Indian Atlas, on the scale of four miles to the inch; photozincographs, on the reduced scale of eight miles to the inch, will be prepared in this Office, and published as soon as possible, to serve as a *pis aller* until the engravings are completed and published; 18 charts of triangulation and skeleton maps have been zincographed, and 15 topographical and geographical maps have been photozincographed; 7,118 copies of these maps and charts, and 5,152 copies of forms for calculations and office work, have been printed, the former for issue to the public, the latter for employment in the Department.

(82.) An abstract of the out-turn of work executed by the Trigonometrical and Topographical Parties of this Survey during the year under review is given on the next page.

J. T. WALKER, LIEUT.-COLONEL R.E.,
Superintendent G. T. Survey of India.

Dehra Doon,
20th December 1867.

ABSTRACT OF THE OUT-TURN OF WORK EXECUTED BY THE TRIGONOMETRICAL AND TOPOGRAPHICAL PARTIES OF THE G. T. SURVEY, DURING THE OFFICIAL YEAR 1866-67.

Description of Details.	1 East Calcutta Longl. Series. 24-inch Theodolite.	2 Eastern Frontier Series. 24-inch Theodolite.	3 Jubbulpore Meridional Series. 36-inch Theodolite.	4 West Calcutta Longl. Series. 24-inch Theodolite.	5 Bangalore Mrdl. & Longl. Series. 24-inch Theodolite.	6 Mangalore Meridional Series. 24-inch Theodolite.	7 Kumaon and Gurhwal Survey. 14-inch Theodolite.	8 Kattywar Survey.	Total Out-turn of Work.
Number of Principal Stations, ...	12	19	19	16	20	13	...	...	99
Number of Principal Triangles completed, ...	11	33	19	17	19	17	...	...	116
Area of Principal Triangulation, in square miles, ...	530	3,314	5,546	7,270	3,044	2,142	...	...	21,846
Lengths of Principal Series, in miles, ...	62	166	132	156	96	97	...	...	709
Average Triangular Error, in seconds, ...	0·49	0·50	0·50	0·38	0·57	0·52	...	...	...
Average Probable Errors of Angles, in seconds, ±...	0·24	0·36	0·20	0·22	0·19	0·24	...	...	...
Azimuths Observed, ...	1	1	3	...	...	...	...	...	5
Number of Secondary Triangles, of which all three angles have been observed, ...	18	3	1	...	...	...	56	229	307
Area of Secondary and Minor Triangulation, in square miles, ...	238	2,520	...	...	...	851	1,124	2,653	7,386
Lengths of Secondary Series, in miles, ...	36	...	...	...	...	...	100	...	136
Number of Intersected Points, ...	4	25	...	...	...	21	237	657	944
Number of Secondary Stations whose heights have been fixed, ...	10	21	1	...	...	...	112	162	306
Number of Revenue Survey stations fixed, ...	13	...	...	...	...	82	...	...	95
Area Topographically Surveyed on scale of 1 inch = 1 mile, in square miles, ...	...	...	...	...	...	...	1,620	...	1,620
Area Topographically Surveyed on scale of 2 inches = 1 mile, in square miles,...	...	...	...	...	...	...	...	617	617
Area Topographically Surveyed on scale of 12 inches = 1 mile, in acres, ...	...	...	...	...	...	...	2,121	...	2,121
Number of Principal Stations selected in advance, ...	5	13	...	...	15	...	...	...	33
Lengths of Approximate Series, in miles, ...	21	92	245	...	92	...	...	...	450
Number of Towers constructed, ...	...	...	...	1	...	...	...	...	1
Do. Platforms constructed for Principal Stations,	...	14	17	13	15	6	...	...	65
Do. Secondary Stations, ...	16	3	...	...	...	42	...	...	61
Do. Miles of Rays cleared, ...	222	...	...	70	...	...	...	...	292
Do. Roads made, ...	6	180	...	22	...	21	...	...	229
Do. Hill tops cleared of forest and jungle, ...	3	20	17	17	...	8	...	...	65
Do. Principal Stations whose elements were computed,	20	50	14	19	...	6	...	29	138
Do. Secondary ditto, ...	90	72	40	...	...	64	343	...	609
Do. Preliminary Charts of Triangulation, ...	1	1	1	...	...	...	1	...	4
Do. Principal Stations placed under official protection,	9	16	...	...	...	4	...	...	29
Do. Tower Stations protected and closed, ...	10	...	...	...	...	...	...	...	10
Do. Platform, ...	...	...	...	16	...	...	4	...	20

APPENDIX A.

EXTRACTS FROM THE NARRATIVE REPORTS

OF THE

EXECUTIVE OFFICERS IN CHARGE

OF THE

TRIGONOMETRICAL SURVEY PARTIES.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT H. R. THUILLIER, R.E., SURVEYOR 3RD GRADE, IN CHARGE EAST CALCUTTA LONGITUDINAL SERIES, NO. 199, DATED 29TH AUGUST 1867.

(2.) The party, which consisted of the members as per margin, assembled at Calcutta in the beginning of November, and after making the necessary arrangements for taking the field, the camp started by boats on the 28th November, proceeding through the Sundarbuns, *vid* Burrisal, to the left bank of the Megna river, up to which point the Series had been carried at the close of the field season of 1865-66.

Lieut. H. R. Thuillier, R.E., Surveyor 3rd Grade.
Mr. C. J. Neuville, Civil Assistant 4th Grade.
„ F. W. Ryall, Sub-Assistant 2nd Grade.
„ G. A. Harris, Sub-Assistant 3rd Grade.
„ W. J. O'Sullivan, Sub-Assistant 3rd Grade.

(3.) The camp disembarked at Raipur, in the Bhullooah district, on the 9th December, and the assistants were then separated from the main camp for the various detached duties which had been allotted to them. Mr. Neuville was deputed to complete the final rays between the few stations near the Eastern Frontier left from the previous season's work. Mr. Ryall was ordered to execute a minor series of triangles from the side Kalishpur T. S., Kodalpur T. S., up the river Megna towards Dacca, for the purpose of connecting that city. Mr. Harris was sent to make arrangements for erecting platforms at the towers from which observations were to be taken, and to make roads for the theodolite up to the three hill stations on the frontier. Mr. O'Sullivan remained with me to act as observatory recorder.

(4.) Before proceeding to give the details of the work of each party, I have the pleasure to report that the junction of the East Calcutta Longitudinal Series with the Eastern Frontier Series was brought to a conclusion on the 5th March.

(6.) The tract of country through which the triangulation was carried this season was through the densely populated districts of British Tipperah and Bhullooah, from the left bank of the Megna river up to the Eastern Frontier hills. This part of the country is flat, and of a low level, and, being subject to heavy rains, the greater portion is for half the year under water. All the open ground is cultivated with rice, and even in December these portions were still under water. It is also intersected by a net work of small rivers and nullahs, which are navigable for small boats during the rainy season, and communication is chiefly kept up by that means during those months; but during the dry season the village roads are resorted to; these being merely pathways, are quite impracticable for wheeled carriage. The want of roads is a great drawback, for I may say that there is only one road which has any claim to that name in the two districts, viz., that which leads from Dacca *vid* Comillah, skirting the hills to Chittagong. The most expeditious, and, in fact, the only method of carriage for a large camp during the dry months or surveying season is therefore by means of elephants. As I had procured the loan of five elephants from the Commissariat Department, I met with no difficulty on the point of carriage this year. It was intended that these elephants should be transferred permanently to the Survey Department, but, in consequence of a communication from the Commissary General, stating that these identical elephants had been trained to khedda work as koonkies, and therefore could not be spared, they were returned to the Chittagong khedda at the close of the field season, on the understanding that five other efficient animals would be issued to me in their place.

(7.) The triangulation passed through extensive plantations of betel-nut, cocoa-nut, and other valuable trees, in which those districts abound, and this, combined with the dense forest-jungle which skirts the banks of the rivers, caused a good deal of delay in clearing our rays, and was a source of expense to our operations.

(10.) Considerable delay was experienced during the early part of the season in the principal observations from the thick mist and fog which invariably rose after sunset, and quite

precluded any work being obtained to lamps. Up to the end of January I might almost say that no angles whatever were taken to lamps, nor even to morning heliotropes, for the mist rarely cleared off before 9 or 10 o'clock in the morning. The period, therefore, each day in which horizontal angles could be observed was very limited. Later in the season the atmosphere got clearer, and I was able to push on more rapidly.

(11.) Before proceeding into the rajah of Tipperah's territory, I addressed the Commissioner of the Division, requesting him to apply to the rajah for a mookhtear, to accompany my camp while engaged in his territory. This request was complied with, and the mookhtear, and a small guard that came with him, rendered my camp every assistance that was necessary.

(12.) After completing the principal observations of the Series, I determined to revise one of the triangles (viz., Lakinagar, Gupti and Basakpur), in consequence of its triangular error (2·83 seconds in defect) being large, and as I had to pass those stations on my way back, it would not involve much material delay. I returned to Basakpur T. S. for this purpose on 11th March, and completed a fresh set of observations on 13th, which gave a difference in the mean of 4·68 seconds in defect from the original measure. I then proceeded to Gupti T. S. and Lakinagar T. S., respectively, and took an independent set of observations at each station. At Gupti the second set differed from the first by 5·56 seconds in excess, at Lakinagar by 6·14 seconds also in excess. This gave the triangular error by the new set of observations to be 4·19 seconds in excess.

(13.) It is very difficult to account for these large discrepancies. The rays were perfectly clear, and passed over ordinary ground, viz., rice fields and village sites. The towers, which were hollow paka ones, the mark being referred to the ground, were well raised, which may be gathered from the fact that the vertical observations from each of the stations were taken between the hours of 1 and 2 P. M., the time of minimum refraction. The instrument also was in apparently good working order. The first set of observations were taken in December and January, and the second set in March. At the former period the rice fields are all under water, and the air is laden with moisture. At the time of my second visit the water had evaporated, so that the rays now passed over a dried surface of ground. On the first occasion the signals were invariably bad, and nearly the whole of the observations were taken to heliotropes, the lamps being invisible, owing to heavy fogs. On the second occasion, in March, when the atmosphere was clearer, the signals were very fair indeed, and the greater portion of the observations were taken to lamps. It will be observed that the measures in each set of observations agree very fairly *inter se*, but there is one feature noticeable, that the values obtained from lamps are invariably larger than those obtained from heliotropes. These differences however are not unusually large, nor do they furnish any indication for anticipating the considerable constant difference that exists between the two sets of measures. I am thus led to the conclusion that it is owing to lateral refraction acting tolerably steadily, but in different degrees at different periods of the season. The mean of the two sets have been used in the computations, which gives a triangular error 0·68 seconds.

(14.) Before leaving the district of Tipperah, I received intelligence that the Haripur tower required some slight repair, I therefore sent a mason there with instructions to remedy it. On reaching that place, he found that the arched openings, which had been bricked up on the completion of the observations, had been broken down, and the upper mark-stone dug up, but not taken away. This must evidently have been done from sheer mischief, and I addressed the magistrate of the district on the subject, requesting him to institute an enquiry through the police. They failed however in ascertaining how and by whom the damage was committed. The chowkidar, in whose mehalla the tower is situated, and in whose charge it was placed, explained that, as his house was six miles from the village of Haripur, which contains only five houses, he seldom went there, and so was not aware of the damage done. Another instance occurred of damage to a tower in the Bhullooah district, but not of such serious consequence. The arched openings, which had been bricked up, being merely broken down, the mark-stone remaining untouched. The magistrate of Bhullooah, to whom I reported the circumstance, failed to reply to me, so I am not aware whether any steps were taken to discover the offenders.

(15.) The revision of the Gupti, Lakinagar, Basakpur triangle was completed on the 18th March, when the main camp became available to take up the approximate work of the Brahmaputra Series. I had previously made arrangements for boats from Noacolly to convey the party to our new ground, and on the 20th March I left Raipur, accompanied by Mr. O'Sullivan. We proceeded up the Megna and Ganges rivers, and experienced bad weather, which delayed our arrival at Furreedpur till 25th March. At this time of the year the "chota-bursat" sets in in Eastern Bengal, accompanied with heavy north-westerly storms, and though this weather causes great relief from the excessive heat experienced in March, it is far from advantageous for carrying on survey operations in the field. The entire country is of such a low level that it requires very little rain to submerge it.

(16.) According to the instructions conveyed in your letter No. $\frac{11}{606}$, dated 18th October 1866, this new undertaking is to consist of a direct series of triangles, arranged in quadrilaterals or polygons, emanating from the East Calcutta Longitudinal Series, and to run northwards along the meridian of 90°, as far as the Assam Longitudinal Series. This meridian closely follows the course of the Ganges, Juboona, and Brahmaputra rivers, which run through a sandy soil, and shift their banks very considerably every monsoon. These rivers, as shown in the revenue survey maps which were executed about eight or nine years ago, are in many places quite unrecognisable, and I therefore anticipate some difficulty in procuring permanent sites for my stations. On this subject, however, I cannot yet speak with confidence, and I trust, on revisiting the district after the present rains, I shall be able to report favorably.

(20.) I would here beg to recommend that the work for the ensuing field season may be confined to the approximate series, on account of the time it occupies to raise our towers. Owing to the moist climate of Bengal, these structures have to be made paka throughout. The bricks, which have to be moulded at the tower sites, take a considerable time to dry, before they can be burnt. The other necessary materials have to be conveyed from long distances, over a most difficult country for communication, in which labor is scarce and hard to procure, and rain often falls, to retard the progress of the operations. One assistant only will be available for this object. I therefore could not anticipate having a sufficient number of towers ready for observation before the middle of March, at which time of the year, as reported on in para. 15, the country is most unfavorable for travelling, and the difficulty in transporting the big theodolite at such a season would be very great; under these circumstances, therefore, I trust that my recommendation will meet with your approval.

(22.) With regard to secondary triangulation, about ten triangles remain to connect the city of Dacca, and I propose to employ Mr. Ryall on this undertaking at the commencement of next field season. The country between the stations of Dacca and Mymensing appears to consist of thick forest jungle throughout its entire length, and it would be a tedious operation to carry a minor triangulation through it. As the Brahmaputra Series will pass within 28 miles of Mymensing, over fair country, I would recommend that that station be connected hereafter therefrom.

(23.) I now have to report on the work executed by each assistant:

Mr. C. J. Neuville, Civil Assistant 4th Grade, was employed during the early part of the season in completing the clearance of the final rays near the frontier. This occupied him till nearly the end of February, when he had cleared 41 miles of rays and 3 hill tops. He had been much delayed by the heavy forest timber which had to be felled at two of the stations in the hills, but was able to get the rays clear in sufficient time to prevent any delay in the observations. Mr. Neuville rejoined my camp on 27th February, when I gave him instructions for carrying a minor series of triangles with a 7-inch theodolite, to fix the civil station of Noacolly, from the base Matabi T. S. Kadra T. S. of the East Calcutta Longitudinal Series, the country between these stations being tolerably open, and favorable for breaking up into minor triangles. The direct distance which required to be triangulated was about 15 miles, which I anticipated Mr. Neuville would have accomplished with ease in two months; but, though employed for nearly two and a-half months on the undertaking, for more than a month of which time he had the assistance of Mr. Harris, I regret to report that he failed entirely in his object, not having taken a single observation.

(24.) Mr. F. W. Ryall, Sub-Assistant 2nd Grade, was transferred from the Madras Coast Series, where he suffered much from ill-health, and posted to this party, as it was thought that the climate of Bengal would be better suited to his constitution. He joined the office on the 11th November. The duty I allotted to Mr. Ryall was to carry a minor series of triangles, with one of the new 14-inch theodolites, from the East Calcutta Longitudinal Series, up the river Megna, for the main purpose of fixing the city of Dacca. On the arrival of my camp at Raipur, I sent Mr. Ryall to Dacca, to procure suitable and serviceable boats for the conveyance of himself and party, and also that he might have the opportunity of reconnoitering the line of country over which his triangulation would run. He rejoined my camp on the 18th December, and left again with his party on 20th idem, when he commenced his operations. On closing work on 3rd June his out-turn consisted of 18 triangles, covering an area of 238 square miles, in a direct distance of 36 miles. Pillars and platforms were constructed at 10 stations, and 68 miles of rays cleared through heavy jungle. All the permanent Revenue Survey stations and pillars in the vicinity of his triangulation were connected, and vertical observations were taken throughout the Series. This is a very fair and creditable season's work, considering the difficulties and delays met with. The navigation of the Megna river during the stormy months of April and May is a dangerous and tedious proceeding, and much anxiety and delay was experienced during those months on this account alone. The very thick forest jungle which skirts the banks of the river also considerably retarded his progress in the selection of the stations. The following extract is taken from Mr. Ryall's report :—

"After getting over the serious obstacles presented on my rays, I had other natural difficulties, equally great, to contend against. April and May proved to be very stormy months. Short intervals were only obtained for observations. Sometimes eight and even ten days were passed in utter inactivity, owing to the impracticable condition of the river from storms and rain. After much anxiety and suffering from fever during the greater portions of these months, I succeeded in getting through six stations. I need not enter into particulars descriptive of the dangers attending the navigation of the great Megna river, for, doubtless, your own experience would verify all I could say about it. Frequently days were lost in attempting to cross, and as it rarely happened that the calm conditions of the river and the times for my crossing it were coincident, I naturally lost much time from this circumstance alone. Throughout the course of my experience I never met with greater privations and difficulties."

Mr. Ryall's camp returned to Calcutta on the 15th June.

(25.) Mr. G. A. Harris, Sub-Assistant 3rd Grade, was employed up to the middle of March in erecting platforms and staircases at the various tower stations, and in making roads for the theodolite up to the three stations situated in the hills. On the 20th of March I sent him to pay the compensation for trees cut down on two rays, which remained to be settled. After accomplishing this, he joined Mr. Neuville on the 1st of April, to assist him in the Noacolly triangulation, which has been previously reported on. Whatever Mr. Harris undertakes is always done well, but he is slow, and there is great room for improvement in his activity and energy. I propose employing him during the next season in building the towers of the Brahmaputra Series.

(26.) Mr. W. J. O'Sullivan, Sub-Assistant 3rd Grade, acted as observatory recorder throughout the observations done during the season. In addition to the ordinary office work, the duplicate angle books were, for the most part, brought up independently by him in the field. He is neat and very accurate in his recording, and is a good computer, having taken part in all the principal computations lately done. On the completion of the observations of the East Calcutta Longitudinal Series, he accompanied me, to assist in the approximate work of the Brahmaputra Series, and gave me great satisfaction in everything he did. He is intelligent and energetic, and I cannot speak too highly of his endeavours.

EXTRACT FROM THE NARRATIVE REPORT OF W. C. ROSSENRODE, ESQ., ASSISTANT SURVEYOR, IN CHARGE EASTERN FRONTIER SERIES G. T. SURVEY, NO. 28, DATED 17TH JULY 1867.

(3.) In my narrative of last season I mentioned that the bearers wished to leave, and that I had induced sixteen of them to remain. Not to be entirely dependent upon them, I made arrangements for recruits from Oude and Hazaribaug, so that the Azimgurh bearers attached to the Series may not again presume to dictate terms to me. The Hazaribaug men were readily obtained; food was scarce, and they were glad to take service. The tindal who was sent for recruits to Oude was not so successful, owing to the imprudence of one of the men on leave. This man had been to Kyouk Phyoo and Akyab, the two penal settlements of former years, and he informed the people of his village that he had been to the much dreaded Kala Pani, or penal settlement; had seen life convicts of all countries, and had personally spoken to a countryman of his who had been transported many years ago. This information spread rapidly, and the people of the adjacent villages, hearing that the Survey was being carried on in the vicinity of Kala Pani, refused to enlist, and it was only three days before the men on leave were preparing to rejoin that a few offered to take service, being then convinced that this belied country could not be so very bad as it had been represented, when their countrymen on leave actually intended returning to the party. These recruits, as well as the men from Hazaribaug, joined me at Thettong H. S. late in November.

(4.) The Chittagong men, who had been trained to direct signals, obtained leave, on faithfully promising to return on the 1st November. They would on no account sign an agreement on stamp paper, and were resolved to resign if they were not permitted to visit their homes. I had therefore no other alternative but to give them leave. On reaching Chittagong, they wrote to me that they were willing to return, provided I agreed to give each signalman 15 rupees a month. The treachery of these men not only disappointed, but crippled me greatly, five out of the number being lampmen. Had I possessed magisterial powers, the fear of my exercising them would have deterred them from keeping away. I found myself powerless, knowing that they could not be punished, or compelled to serve in a country where free trade and free labor prevails. It was absolutely necessary to replace these signallers; I therefore lost no time in training the most intelligent and promising men with me, and succeeded in substituting the required number, and was able to detach them to occupy the stations in advance a week before I resumed field operations. Sickness in the beginning of the season prostrated a large number, and a couple of lampmen were completely incapacitated from work; one subsequently died, and the other was crippled with rheumatism, and remained under medical treatment almost the whole season.

(5.) I have tried to introduce Chittagong men, as well as Mugs and Burmans, into the establishment. The former are intelligent, and answer very well as signalmen, but they set a high value on their services. The Mugs and Burmans, after repeated trials, have proved failures. They are unworthy of trust, being a lazy, apathetic race, given to opium smoking, toddy drinking, and gambling. They also demand high pay, 12 rupees a month being the rate for a common coolie. Out of thirty Mugs and Burmans only one man has afforded satisfaction; he was employed under the Deputy Commissioner of Kyouk Phyoo, and, on my applying to him for an interpreter, this Burman was selected. A better choice he could not have made. I found the man very useful, intelligent, and reliable. He did good service throughout the season, and I have retained him to instruct the native establishment in the Burmese language.

(6.) During this season boats were used five months out of the six. The country crafts were employed, no others being procurable. These are constructed of single planks varying in thickness from one and a-half to two inches, with cane fastenings; they are buoyant and elastic. The very best of these frail primitive boats were selected, and every precaution was taken for the safety of the instrument. The valuable records and treasure were always placed in my boat,

and accompanied me, and I am indeed very thankful to say the party returned to Akyab, after a very trying season, without a single accident, notwithstanding that immense rivers, formidable bays and estuaries had to be crossed and recrossed in conducting the final operations. An inspection of the chart which accompanies this narrative will shew the expanse of water surrounding some of the principal and secondary stations, and it certainly required nerve, prudence, foresight, and judgment to visit stations in such frail crafts as are only to be had in this province for use in the formidable tidal streams above referred to, these streams varying in breadth from one to twenty miles.

(7.) Water was plentiful, but none to drink, except at particular localities, or at the sites of villages. The Burmans and Mussulmans carried their water, and took their meals on board, but in this peculiar country the Hindoos, of which my establishment is chiefly composed, fared very badly. To add to my already overtaxed responsibilities and anxieties, I had to regulate the movements, and select the route for the fleet, in order that so large a number of men, whose very lives depended on my arrangements, should have their meals at stated times. Favorable tides were frequently lost, and circuitous routes were often taken to provide the men with water for food and drink. The springs are few and far between. They are, when found, enclosed with pucka masonry, and no expense is spared to ensure a permanent supply. I was informed that the inhabitants contribute their mite in constructing these wells and tanks for the benefit of travellers.

(8.) Much delay and inconvenience was experienced during the latter portion of the field season from coolies not being procurable. From the 21st November, when the party took the field, to the 13th March, fifteen principal stations were completed, and from 21st March to 12th May final observations were taken at only four stations. On comparing the above dates, the delay will be apparent.

(14.) The chain of mountains dividing Arracan from Burmah is crossed by a high road, over which elephants can travel comfortably with three-fourths of their usual loads. This road was made by the Public Works Department, and cost the Government a large sum of money. I am told it was completed in 1857. The road is very good, having mostly a gradient of a foot in seven; in some parts the ascent is greater. I believe this highway was made for wheeled conveyances, to increase the trade between Arracan and Burmah, as well as to facilitate the movements of troops between the above-named places. The country through which it passes is totally uninhabited throughout its whole length and breadth. The encampments were all cleared, marked, and named after each water spring, and travellers and traders are met with in large bodies, fully equipped and provided, crossing this desert, where wood and water alone are procurable. The police patrol this road once a week, to prevent dacoities, which were formerly of frequent occurrence. The road not being metalled, is much cut up, and carts cannot now be used; they may have been employed before, when it was originally opened. Such was the country through which the final work was to be carried when the boats were abandoned.

(15.) I proceeded to Ran-Khotong H. S., which lies to the south-east of the town of Tongoop, and then sent on all the elephants, laden with supplies, to Yeobogi encampment, which was centrically situated with reference to my forward stations. At this place a large depôt was established, with a guard to protect it. This depôt answered admirably, and the supplies sufficed until the last signal party left this inhospitable region.

(16.) After completing the observations at Ran-Khotong H. S., I purposed visiting Koguentonggri, hearing that the ascent was easy, and that the elephants could convey the baggage to the summit; but, on subsequently learning that Tongoh H. S. was situated in the wildest part of this wild country, six stages removed from the nearest village, and that the ascent was so great and continuous that it was impossible for elephants to ascend it, and, lastly, that water was ten miles from the station, whereas Koguentonggri could be supplied with provisions from two stages, in case the depôt failed, I altered my plans, and proceeded first to Tongoh, the station which offered greater difficulties, and I am glad I did so. After the 4th March, in the direction of Tongoh, I found the road which had been prepared for the great theodolite was not adapted

for elephants, the ascent being too great. Scouts were sent out, and a hill was found offering all the facilities for a good road for crossing over the intermediate ranges.

(17.) The new road was completed, and made to join on to the old, passing over the ridge, and we proceeded on our journey, crossed the ranges, and encamped at the foot of Tongoh, on the stream, which derives its name from the hill from whence the ascent to the station commenced. I here met one of the assistants of the lampman in charge of Tongoh H. S., and he informed me that there was no water nearer the station than where we stood, and that a supply was daily taken from this stream to the signalman.

(18.) We ascended the hill next day, and reached its summit in the afternoon. On my arrival I found the signalman was prostrated with fever. I learned from him that the ray to Koguentonggri was completely closed by the immense forest trees left standing on the hill itself. Two days were taken up in removing all the obstructions on this ray. The water was ten miles distant, and the men, with the duffadar in charge of the signal party, made one trip daily, by supplying him with water, and returning to the stream, sleeping there, and ascending the hill the next day with water, and returning again to the stream, thus travelling twenty miles daily. Search was made for water, and it was found at a distance of two miles from the station. The formidable difficulties which were represented to me were in a great measure overcome, and the delay that would have inevitably occurred, from the ray being obstructed, was removed by my visiting this station, instead of going on to Koguentonggri.

(19.) I have to bring to your notice the praiseworthy conduct of Ahmed Ali, duffadar in charge of this station. His assistants were ill, he sent them down to remain at the stream, one man was to bring him water, and return to his companions below. He continued at his post alone, on the platform night and day attending to the signals, he being ill with fever. I have presented him with 5 rupees as a reward for not deserting his post, isolated as he was in a wilderness abounding with wild animals, elephants being the most numerous. I beg to recommend him for promotion to 12 rupees a month.

(20.) The difficulties, privations, and dangers on this Series have been so often represented to you that I will not reiterate them, but I earnestly trust you will be pleased to sanction an increase of a rupee to each member of the native establishment. I am compelled to urge this measure from the very great difficulty of obtaining recruits, owing to the wages of all menial servants being so very high in British Burmah. Coolies cannot be procured for less than 8 annas each per diem, and even at this high rate the supply is very limited. No Burman will serve for less than 12 rupees a month as a carrier in the establishment. 10 rupees is the lowest pay given to servants. Carriers who have been discharged as useless from my establishment have readily obtained employment in Akyab as punkah-coolies, durwans, and chowkidars at 10 rupees a month. Since assuming charge of this Series I have used my very best endeavours to curtail the expenditure; the exigencies of the service alone demand the general increase I have recommended.

(21.) The men of the native establishment are from Hazaribaug, Azimgurh, and Oude; they have worked cheerfully and well throughout the season. Whenever necessary, they have put down the instrument, and readily handled the spade, hatchet, or pickaxe, and commenced work. They were subjected to greater hardships this season, owing to labor not being procurable.

(27.) One serious occurrence took place at Khnungdong H. S. The signalmen were attacked by dacoits, and two of them were seriously wounded on the head and body with dows (small swords), and robbed of all the money they had with them. On my return from Thamadong I saw these poor men with gashes in depth half and one inch respectively, and three and five inches respectively in length. The inflammation was so great that their heads appeared immensely large. I reported the circumstance to the Deputy Commissioner of Sandoway, as it occurred in his district. I have not yet learned whether the perpetrators of this dacoity have been apprehended. These men were in hospital for two months. One of these, Jurawan Bhooj, is a fine old man, who commenced life under Sir George Everest in the Great Arc, and has served, without a break, for thirty-seven years.

(30.) Notwithstanding the difficulty in obtaining labor, the delay in assembling coolies in an uninhabited tract, and collecting provisions and building materials, Mr. Beverley succeeded in selecting thirteen stations during the season, and extending the approximate triangulation ninety-two miles direct distance. Had his arm not been injured, his energy and zeal, for which he is conspicuous, would have enabled him to have added to his well-earned labors five or six stations more. His selections in the uninhabited portion between Tongoop and Prome were most judicious; by fixing them as he did, he crossed the desert by the fewest number possible. Mr. Beverley is a most deserving and useful assistant, both in the field and quarters, and I am very much obliged to you for promoting him.

(31.) Mr. Price, Sub-Assistant 3rd Grade, was left at Akyab on the 21st November to construct the tidal-mark station. He has this season built sixteen rectangular piles, three secondary masonry pillars. Of secondary work observed with a 12-inch theodolite at Agandu tidal-mark, Chirigea and Boronga stations, on twelve zeros at each of the above. Cleared rays from Boronga to Chirigea, Maopratong, Painasa and Kuainchum stations. He was delayed a month and a-half at Boronga owing to his illness, the illness of his establishment, and from the signals not being simultaneously seen. Mr. Price was ill off and on from December 1866 to March 1867 from bronchitis and fever, and he suffered from the latter again on his return to quarters. His boat twice grazed over rocks, and was nearly dashed against them at other times. He was in great peril of drifting out to sea on three different occasions. He had bad crews, one and all being opium smokers. He could not replace them, owing to the difficulty of obtaining men during the rice season, the trade being then brisk, and the wages earned very high, in consequence of the great demand for labor. Mr. Price is very energetic and persevering, and, had his health been good, he would have accomplished the quantity of work I marked out for him.

(32.) Mr. Alfred Moore, Sub-Assistant 4th Grade, was employed in recording the observations during the whole season, and assisting generally in all other duties. He has afforded me very great satisfaction during the time he has been in the Department. His cheerfulness, the alacrity with which he performs his duties, his intelligence, and aptitude in acquiring professional knowledge, makes him an acquisition to this Series, the more especially as he is hardy and enduring. He has this season walked with me every inch of each successive stage over the roughest ground ever traversed, with blistered and sore feet, without complaining, and notwithstanding the fatigue and painful state of his limbs, he has readily joined me in the observatory, leveled, and plummed the stand of the instrument himself, and took up his position as recorder, while I put up the instrument and adjusted it. In the boats no office work could be attended to, in fact, to write was impossible, he had therefore to bring up all arrears on reaching the next station, in addition to his duties in the observatory. When work was to be done, he did it with a will, and if he saw me handle a hatchet he took up another, and felled trees, or led on a party of the road-makers; such an example cannot but instil zeal, confidence, and devotion on the part of the native establishment towards their officers.

EXTRACT FROM THE NARRATIVE REPORT OF G. SHELVERTON, ESQ., ASSISTANT SURVEYOR, IN CHARGE JUBBULPORE MERIDIONAL SERIES, CONTAINED IN LETTERS NO. 6, DATED 3RD AUGUST, AND NO. 9, DATED 23RD AUGUST 1867.

(1.) Mr. Hickie was employed in extending the approximate series from the parallel of 20° to the junction with the Madras Meridional Series, in latitude 16° 25′. Mr. Hickie had, during the previous field season, reconnoitered the country between the parallels of 19° and 20°, and was thus able, soon after reaching his ground, to select finally the stations of the Ankorá and Burgpailí polygons. He then suffered from a severe attack of malarious fever, which compelled him to seek medical aid at the civil station of Seroncha. After his recovery he selected the Kotajpúr-Bolíkonda double polygon, two quadrilaterals and a heptagon, closing on Maniám H. S. to Dhulipálá station, the northernmost side of the Madras Meridional Series. Mr. Hickie also built platforms, cut roads, and cleared jungle at ten principal stations. His progress was very satisfactory. By incorporating stations of former surveys, he extended the approximate series a direct distance of 245 miles.

(2.) Mr. Bell was at first employed in building six platforms of the Aukorá polygon. He was then ordered to join Mr. Hickie, whose state of health at the time was causing me serious anxiety. Mr. Bell, on his way to Mr. Hickie's camp, was also obliged to visit Seroncha for medical advice. He subsequently built a platform at Inaparati H. S., and shifted a station previously selected to a hill about three miles to the south-east of it, reporting that the old point was not practicable for the 36-inch theodolite, except at a great expenditure of time and money. After Mr. Bell's return to Jubbulpore, I sent him to complete the observatory at Karaondí H. S.

(3.) Mr. L. J. Pocock assisted me in the observatory. He suffered occasionally from fever, but was always at his post. Just before closing the principal observations I detached him to determine the height above the sea level of the civil station of Seroncha, which he did well enough. He was then sent to build an observatory at Karaondí H. S., but his progress was so slow and unsatisfactory that, though he had nearly completed the building, I was compelled, after he had been engaged for about two months on the work, to recall him, as I apprehended that he would take a long time over the little that remained to be done.

(4.) Mr. E. E. Wrixon was, on account of the unhealthy nature of the country, retained in my camp, to assist in the observatory, in case of Mr. Pocock's illness. Mr. Wrixon suffered in health a great deal. He recorded my angles at two stations, and was also employed in current business, and in making duplicates of my angle books. He has learned the simpler computations, and has made himself generally useful.

(5.) No secondary work was attempted, as the country had been extensively triangulated by the party of the Hydrabad Topographical Survey. Checks for this minor triangulation are afforded by the sides of the triangle Sonda H. S., Aukorá H. S., Raotá H. S., and the side Aukorá H.S., to Jhillerá H. S., which are common to both surveys. The heights above sea level are also tested at these stations.

(6.) Observations for latitude at Karaondí H. S. could not be taken before the setting in of the rains, as the observatory was not ready in time. These observations will be commenced as soon as the weather permits.

(6.) The principal triangulation of field season 1866-67 embraced an area of 5,546 square miles, covering more than half of the Chándá district, some part of the Ahírí jaghir and Tálúká Seroncha, and nearly the whole of the Chinúr pargana in Hydrabad. The country through which the party worked is notoriously the most unhealthy portion of the valley of the river Wein Gunga. Cholera and typhus fever, after committing great havoc in the villages, had happily

disappeared for a time, leaving their traces however in the beds of every stream, where their victims had been hastily interred in the sand, and covered over with brambles, cremation having apparently been abandoned as the mortality increased. At the village Pinchkalpet my encamping ground was strewed with charred human bones. All of us experienced a great sense of relief when we marched away from this locality.

(7.) A good many suffered in camp from fever and dysentery, but I am glad to say that there were no deaths. The signal-men were never in good health, owing, I believe, to their sedentary occupation, and to want of change, as they seldom quit one post for another in less than three weeks. With temperate men of their class attacks of fever rarely last long, or terminate fatally, if timely remedial measures are adopted, and this is of great importance as they are so speedily prostrated, but I have not yet succeeded in persuading them to take the most ordinary precautions, though they are supplied with good medicines, which they have been taught to use. In my own camp medical aid was at once afforded under my superintendence, and constant change of place helped convalescents to regain strength rapidly.

(8.) Viewed from a sanitary point, the great annual conflagrations of forest undergrowth must do the country an immense amount of good; these fires, however, are supposed to be very destructive to young timber, and attempts have been made to check them, but, fortunately, they spring up without human agency, and are perfectly uncontrollable.

(9.) The forests of Ahíri (leased I was told to a European contractor) contain most valuable timber, teak, in particular, grows abundantly, and attains a great size. Logs can be floated down the Wein Gunga and Godavery rivers to the coast. In the Chándá district the hills and valleys are also thickly wooded, but the timber is not so good. During the rains, when the rivers are swollen, a small steamer plies between Chándá and Masúlipatam.

(10.) The Sirkonda hill, where I have a station of observation, has sometimes been occupied as a sanatarium by invalids from Seroncha. The path up is very good. There are ruins of bungalows on the hill top. Seroncha lies about twelve miles to the south-west of the hill near the junction of the rivers Godavery and Wein Gunga.

(11.) Near my station of Rámgír in the jághír of "Fakírán Múlk," a son-in-law of the Nawab Salar Jung of Hydrabad, there is a formidable fort, situated on a precipitously scarped sandstone range. It is approached from the east by a broad zigzag path, very strongly paved, and in some places literally hewn out of the hill side, being commanded through its entire length by strong natural defences, inacessible to an attacking party, but from which a most murderous fire could be kept up with little risk to the defenders. The wall, which is of astounding thickness and great height, with bastions judiciously disposed, forms on the hill top an enclosure of about three or four miles in circumference; this is divided into six strongholds, which communicate with each other by massive gateways, and are themselves perfect little forts. The walls are faced with hewn stones of immense size, quarried from the hill; some of the blocks used are seven feet in length, six inches in width, and four feet in depth; the space between the two faces being filled up with rubble. Though the tanks have been very much neglected, there is no scarcity of water, but, with proper arrangements, these reservoirs, all of which are within the fort, could be made to hold an inexhaustible supply for a large garrison. There are said to be sixty guns in position; I, however, saw very few. One that I measured was twelve feet long, with a bore of nine inches; they are made of longitudinal strips of iron four inches wide welded together, and coils shrunk on them. Since the occupation of the country by the Mahomedans, the top of the wall has been disfigured with little minarets and cupolas, a summer-house built, and some additions made, which look quite contemptible alongside of the mighty conceptions by which they are surrounded. The tombs on the hill top would indicate that at no distant time the place was occupied in great force by the Mahomedans, but there is nothing now to shew that it is considered of any importance. On the walls there are well-executed bas-reliefs of antediluvial animals; a double-headed eagle grasping monsters in its talons is conspicuous over every gateway. There is an Arabic inscription over the principal entrance, but I was not able to understand it. With the exception of one breach, the outer wall is in excellent preservation.

(12.) During my short stay of two days I could not get any reliable information about the origin of such a remarkable place, but, on my return to Rámgír, I hope to collect material for a more interesting report, and to send you a sketch of the fort on a large scale. Tradition says that it was built by Pratab Rúdra, who received supernatural help, that his laborers were daily paid with stones, which were soon converted into bread, but the original story, doubtless, was that the workpeople starved.

(14.) The great hardship of the season was our being obliged to employ pack buffaloes for our baggage. These animals were thoroughly knocked up as soon as the weather became warm. For half the time that we were in camp a proper meal could not be served up before four o'clock in the evening, and sometimes we had to wait for it till ten o'clock at night. Messrs. Pocock and Wrixon, whose arrangements were not so good as mine, frequently passed the night under trees. The direct distance gone over, while the work was in progress, is shown by the sides of the triangles to be 505 miles, but, as we were compelled to adopt most circuitous routes, I think that about 1,000 miles of road must have been travelled.

EXTRACT FROM THE NARRATIVE REPORT OF H. KEELAN, ESQ., SURVEYOR 3RD GRADE, IN CHARGE SAMBALPORE MERIDIONAL SERIES, NO. $\frac{70}{382}$, DATED 15TH AUGUST 1867.

(2.) The party proceeded by rail to Chunar, from whence it marched on the 19th November, and arrived at Kasiatu H. S. on the 10th December, and, in accordance with instructions conveyed in letter No. $\frac{7}{614}$, dated 22nd October last, continued the revision of the Calcutta Longitudinal Series eastward. The approximate series was entrusted to Mr. 1st Grade Sub-Assistant Keelan, who was directed to form the single series of triangles into a double one. Mr. Sub-Assistant Trotter was detached at the same time to construct roads and platforms, and Mr. Sub-Assistant Peychers had the preparation of materials, and the building of the rectangular pillars. Mr. Sub-Assistant Connor's services were retained in the office and the observatory.

(9.) With the exception of the towers at the extremities of the base-line, and Satten and Chinsurah stations of the Calcutta Meridional Series, all the old towers have been inspected. The old telegraph towers introduced into the triangulation on the south flank, and noted in the margin*, are reported to be as good as when originally built, except that the whole of the wood-work in them has decayed, and will require to be renewed. Of the old tower stations on the north flank, noted in the margin†, Akistapúr and Aknapúr are reported to have tumbled down entirely. A column of brick masonry, about seven feet at base, and upwards of fifty feet high, marks the station of Madpúr, used apparently by means of a scaffolding. Balki tower appears to be in such a dilapidated state, that it is proposed to build an isolating pillar within, leaving the angular walls standing for the support of the stage for the observers, and Bholá is a pucka hollow tower. From the foregoing description of Balki, Madpúr and Bholá it would appear that there are no two towers alike, but built up haphazard. Madpúr tower will have to be re-constructed, as also new towers built at Akistapúr and Aknapúr.

* Ganjúá Tel. T. S., 75 feet high.
Mobárakpúr, do.
Dilákas, do.
Nibriá, do.

† Balki T. S., 35 feet high.
Madpúr column 58, do.
Akistapúr, do.
Aknapúr, do.
Bholá, do.

(10.) The districts in which the approximate series party was employed, after leaving the hilly ground, were Bancoorah and Bheerbhoom, both under the jurisdiction of the Commissioner of Burdwan, to whom a communication‡ was forwarded early in February, applying for assistance. As the operations will now approach the neighbourhood of Calcutta, the expenses will be enhanced, and great anxiety will be felt in carrying the work through, as the inhabitants of Bengal, particularly in the vicinity of the metropolis, are proverbially the most litigious people in all India; it is hoped, however, by tact and careful management, that disturbances and disagreements with owners of trees, with whom the members of the party will be brought into contact, will be avoided. I might also add that the expenditure attending the construction of towers will be greater than under ordinary circumstances, as the prices of every description of building materials are exceedingly high, and laborers cannot readily be procured, without the interposition of the services of a class of men called "coolie contractors." In fact, the principles of free trade are carried out in Bengal to the fullest extent, and buyers must pay the prices demanded, or subject themselves to being summoned before the local courts.

‡ Extract hereto appended.

(13.) In closing this report, I beg, in justice to him, to bring to your special notice the services of Mr. Keelan, junior, who has conducted the duties of the approximate series so ably and successfully during the past three seasons in a comparatively difficult country; as also of Mr. Peychers, both of whom I consider qualified, by their work and abilities, for promotion, if the rules of the Department will admit of their advancement.

(14.) I have likewise to express my satisfaction with Messrs. Trotter and Connor; the former acquitted himself well in tower building, which necessitated his keeping the field to a late period, and the latter rendered me efficient assistance in the observatory, and in the current duties devolving on a junior hand.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT W. M. CAMPBELL, R.E., ASSISTANT SURVEYOR, IN CHARGE MADRAS PARTY G. T. SURVEY, DATED 5TH JULY 1867.

(1.) I assumed charge of the Madras Longitudinal Series from Captain Branfill on the 28th May 1866, on which day he left Madras, on leave to Europe on sick certificate. At that time the party consisted of one Civil Assistant and four Sub-Assistants, as per margin. Of the latter, Mr. O'Neill had been called upon by you to send in his resignation some months previously, but was permitted to continue in his situation till the close of the field season (1865-66), when he was to quit the Department.

Mr. A. W. Donnelly, Civil 2nd Assistant.
" F. W. Rynll, 1st Class Sub-Assistant.
" J. W. Mitchell, 2nd Class Sub-Assistant.
" J. R. O'Neill, 2nd Class Sub-Assistant.
" O. V. Norris, 3rd Class Sub-Assistant.

(2.) It was originally your intention that this party should only carry the Longitudinal Series up to the meridian of Bangalore, when it should take up the revision of the section of the Great Arc between Bangalore and Cape Comorin. Owing, however, to some misunderstanding, Captain Branfill believed that the party was intended to work westward to the coast, and, accordingly, at the close of the field season he had one polygon, as already mentioned, prepared for observation to the west, but no preparations had been made to the south. On my representation of this state of affairs, you sanctioned my completing the polygon to the west before commencing operations to the south, thus giving time for approximate operations in the latter direction. You also directed me to revise a portion of the work of season 1865-66, and to make arrangements for the remeasurement, in season 1867-68, of the old base-line, measured by Colonel Lambton in 1800 or 1804, in the neighbourhood of Bangalore.

(3.) In the middle of November Messrs. Donnelly and Mitchell took the field, the former to make required arrangements for the base-line, and the latter to carry on the approximate series to the south.

(4.) Alterations, which you had authorized in the 24-inch theodolite, required my passing a considerable time in Madras, and I did not finally take the field until 2nd January 1867, when Messrs. Norris and Potter accompanied me as recorders and general assistants. I detached Mr. Norris on 1st March to close the stations at which I had completed observations. Mr. Potter remained with me until the close of the field season, on 18th May, when the party returned to Bangalore for recess.

(5.) Having now given a brief outline of the years' work, I shall proceed to enter into detail, under the heads of "Recess Work," "Field Season," and "Personal Reports on Assistants."

The Recess Work.

(6.) The party had been very short-handed during the recess season of 1865, owing to which Captain Branfill handed over to me considerable arrears of computations, including one set of star observations for azimuth of season 1864-65, and secondary work of seasons 1863-64 and 1864-65. Moreover, a large quantity of the duplicate angle books of season 1865-66 had to be written up, and nearly all recomputation and comparison remained to be done. Thus the work to be done during the recess was very much heavier than usual, and it was finished with some difficulty.

The Field Season.

(8.) The principal observations were commenced on 2nd January at Halsurbetta, and were continued without intermission until the 10th May, when the season was closed at Bódamalle H. S. The details are given in tables appended.

(13.) The Great Arc Series passes almost immediately into a difficult country, hilly and

jungly tracts being numerous, and cart roads few. Proceeding southwards, the difficulty of the country increases, and all cart roads disappear as the edge of the Mysore plateau is gained. A wide belt of hill country, or the ghâts, separates the high land from the plains, and throughout this district carts are unknown, while the roads are often tracts barely practicable for laden bullocks. Large villages are rare, and labor and provisions difficult to procure. In some parts the jungles abound with wild elephants and other game, and the natives dread passing through them except in parties.

(14.) Having applied for the loan of Commissariat elephants, which was refused, I was obliged to adapt the *impedimenta* of my camp to suit the means of carriage (bullocks and coolies) available. To this end I discarded the office and other heavy tents, taking only one small double-fly tent for office use, and shuldaries.

(15.) Most of the stations of the first figure of the Series, the Dewarabetta hexagon, are on the high ground, in comparatively open country, but the whole of the next, or the Ponási-betta hexagon, is situated in the wild hilly country. Through the middle of this latter polygon the river Cauveri runs, three stations lying on the right, and four on the left bank. These stations are generally on high hills, and the valleys between them being deep, the time occupied in marching was excessive. I may instance one case, in which a march of about nineteen miles in direct distance occupied eight days.

(16.) In addition to the difficult nature of the ground, the progress of the work was considerably retarded by clouds by day and fogs by night, with occasional rain, and the first of May found me in the middle of observations at the last station but one of the figure, after which rain fell nearly every day, the sky was almost constantly clouded, and storms were frequent. Under these circumstances I considered myself fortunate in finishing the figure (including the four angles of continuation of the next polygon) on 10th May, when I closed work for the season, marched to Salem, and despatched the main portion of the party by rail to Bangalore, where they arrived on 19th.

(17.) It was with great reluctance that I felt myself obliged to return to quarters when I did, as I had been particularly anxious to complete another figure. One great object was, that I might be able to take a set of star observations for azimuth, of which I have now none to show for the season. An azimuth must be observed in the neighbourhood of Bangalore, but as one end of the proposed base-line will afford the most desirable station, I postponed the observations until the base-line should have been chosen, and the stations built, keeping in view your expressed wish that azimuths should only be observed at stations suitable also for the observations of latitude. My observing one in the country through which I passed was quite out of the question, the nature of the ground giving promise of local attraction enough to vitiate the result of any such observations. The two southern stations of the third hexagon, however, are situated in plain country, and both well adapted for azimuth and latitude observations, hence I had looked forward throughout the season to closing at one of these stations with the observation of an azimuth.

(18.) I can only hope that this, my first season's triangulation, may meet with your approbation both in quantity and quality. With regard to the latter, I think it may have been slightly impaired by certain defects in the instrument, into which I shall presently enter at length. It is satisfactory to me to note the very apparent progressive improvement in the quality of my work, as indicated by the weights of the angles and the triangular errors.

(19.) All duplicate angle books were completed in the field, including recomputation and comparison, being generally kept up to date. I also computed one complete set of weights of angles.

(20.) I regret that I have very little secondary work to show. The country generally presented few points worth observing, and throughout the season I was so short-handed that I could but ill-spare signallers for secondary work. I took observations (horizontal and vertical angles) from the top of St. Andrew's Church in Bangalore, with an 8-inch theodolite. I

also had a heliotroper for many days on the highest peak of the Neilgherri hills, hoping to obtain a signal for observation at two or more of my stations, about seventy miles distant. In this however, I failed, the weather never being clear enough to afford much chance of working with such long rays. I also established a secondary station on the Shevaroy hills, which lie within easy observing distance of some of the Great Arc stations. To this point I obtained both horizontal and vertical angles at one station, Gardi-konda, but as I did not reach any other suitable station for observations, it remains unfixed.

(21.) If I had succeeded in these observations, I intended visiting both the Shevaroys and Neilgherries with the 14-inch theodolite, for the purpose of observing the third angles of the triangles and the back vertical angles. I had further hoped to be able to fix a second point on each range within a few miles of the first, in order to afford convenient bases for small surveys of the hills, if such should at any time be desired. I do not anticipate any difficulty in both these projects being carried out during the observations of the next polygon of the Great Arc.

(22.) My field season commenced very late, or not till 2nd January, but the season was such that but very little work could have been done earlier, the north-east monsoon having been unusually late and heavy. Even in January I was considerably troubled by fogs and clouds in the plains, and by rain on the hills. Throughout the season clouds were prevalent, and fogs almost invariably closed over the hills during the night and early morning.

(23.) Before entering the ghâts I made careful inquiries as to the healthy seasons, and the reports I received were most discouraging; one gentleman going so far as to write on 26th March, in answer to a letter in which I had named the stations I proposed visiting,—"For the next three months the country you wish to visit is simply deadly from fever." Notwithstanding these reports, I have never had my camp so free from fever as during the past season, although I observed at nearly all the stations referred to above. I should have had some hesitation in doing this, after so strong a warning, but fortunately my receipt of the letter containing it was delayed until my signallers had been in the country alluded to for some weeks without ill effects.

(24.) The difficulty of obtaining reliable information on such subjects is very great, and no rule can be invariably applied to all jungles. The only one I know which very generally obtains is, that all jungle is dangerous while drying after the cessation of rain. As an instance of the uncertainty of general rules, I may point to the fact that the jungles of northern India, the Terai and Dehra Doon, are considered deadly during rain, whereas in many of the jungles of the south, the healthiest season is that of the heaviest rain.

(25.) In some parts of the country, where bamboo jungles were extensive, I found the seed of that plant much used by the inhabitants as food. I tried chupatties made of the seed flour, and considered them excellent.

Personal Reports.

Mr. A. W. Donnelly, Civil Assistant 4th Grade (formerly "Civil 2nd Assistant").

(44.) I have already stated that Mr. Donnelly remained in the field (season 1865-66) till 18th June, completing the stations of one polygon in advance of the principal work. During the recess season he was a good deal troubled by fever. He took the field again on 13th November, to make the first arrangements for the proposed base-line measurement.

(45.) You originally attached some importance to the remeasurement of the identical line measured by Colonel Lambton, the end-marks of which still exist, and, at your desire, I made a reconnaissance of that line in October. I found the obstacles to remeasurement very serious, as the line passes through extensive tanks, and crosses the railway, where the latter is on an embankment of about fifteen feet; and, on my report to this effect, you decided to abandon the old line, and directed me to choose a site for a new line, and to arrange for the connection of the old line therewith, by direct triangulation, if practicable.

(46.) As the railway cut the old base-line near the north end, I had hopes that, by stopping short of it, and prolonging the line beyond the south end, the required length for a new line might be obtained coincident through two-thirds of its extent with the old; while, by making the old south end one of the section stations of the new line, and extending the minor triangulation to the old north end, I should obtain the length of the old line in the most direct way possible, failing actual re-measurement. I accordingly gave Mr. Donnelly instructions to arrange this, if possible. His search, however, proved that this plan could not be satisfactorily carried out, and I directed him to abandon the old line altogether, and look for a new site.

(47.) I was obliged to interrupt Mr. Donnelly in this work, and send him to open a road for the 24-inch theodolite to the station of Sávandrúg, on the summit of a high hill of difficult approach, a piece of work which proved long and troublesome.

(48.) Mr. Donnelly resumed his base-line work towards the end of February, and, after two or three trial lines, he fixed upon one, the particulars of which have been submitted to you, meeting with your approval. This line, though not without objections, the ground being more undulating than desirable, will, I hope, prove satisfactory. It lies close to Bangalore in open country, and admits of simple and intimate connection with both the Longitudinal and Meridional (Great Arc) Series.

(49.) I regret that I cannot report on Mr. Donnelly so favorably as I could wish. His style of working shows carelessness, not creditable to an officer of his standing in the Department.

Mr. F. W. Ryall, Sub-Assistant 2nd Grade.

(50.) Mr. Ryall was transferred on account of his health to the East Calcutta Longitudinal Series, and left Bangalore for Calcutta, as already mentioned, on 5th November. While he was with me, during the recess, he gave me satisfaction.

Mr. J. W. Mitchell, Sub-Assistant 3rd Grade (formerly 2nd Class Sub-Assistant).

(51.) As mentioned in para. 7, Mr. Mitchell rejoined head-quarters on 8th August, after an absence of nearly two years, on secondary work, in the neighbourhood of Masulipatam, of which I shall here give some details.

The work consisted of a series of triangles emanating from the side Anantawáram-Bezwáda of the Coast Series, running south-east for some distance to the neighbourhood of Repalli, a place of some importance on the right bank of the river Kistna. Here a check series from the side Bobapilli-Pálapáru of the Madras Meridional Series meets the first, and the two are continued in a double series eastward till close to the coast, when single triangles are thrown out to fix the point Divi lighthouse, and several prominent points in Masulipatam.

The country being generally a flat plain, much overgrown with jungle, composed chiefly of prickly pear, necessitated the use of short rays and much clearing, and no less than forty-four triangles were used.

(52.) The work had been begun by Mr. Clarkson (late a Civil Assistant of this Department), in season 1863-64, at the origin Anantawáram-Bezwáda, where he observed six triangles. The greater portion of the rays were also cleared, and station pillars built during the same season, by Messrs. Ryall and Mitchell. Mr. Mitchell took up the work towards the end of January 1865. During the interval the terrible cyclone of November 1864 had inundated the whole country, destroying many of the stations prepared. Mr. Mitchell thus found a great deal of work necessary in again preparing stations and re-clearing rays, which in many cases he found partially closed. He worked nearly continuously till 15th August, when, at Captain Branfill's order, he went into recess quarters at Masulipatam.

(53.) During this time Mr. Mitchell appears to have persevered against many difficulties, the atmosphere, which, in a flat country, is very seldom favorable for observations, was rendered much more dense than usual by an impalpable sand, which having been deposited by

the inundation, was raised in clouds by the wind after the water had dried up. From this cause his repetitions in observing are, in some cases, very numerous. He remained in the field long after the south-west monsoon had set in, and, in fact, till the country had become an impracticable marsh.

(54.) Mr. Mitchell again took the field on 25th October, and again met with considerable delay in clearing rays from the growth of last monsoon, and repairing delapidated pillars. He completed the work on 17th July, and proceeded at once to join me at Bangalore, arriving on 8th August.

(55.) On 14th November 1866 I gave Mr. Mitchell charge of the approximate series on the Great Arc, work quite new to him, but notwithstanding this, and the difficult nature of the country to be traversed (which I have already described in paras. 13, 15), increased by a good deal of wet weather, he arrived at Salem, having definitively chosen two hexagons, on 4th January 1867. After a few days rest at Salem, of which he and his party stood much in need, he returned by my orders to Bangalore by rail, and commenced the work of building platforms, &c., on the chosen stations, a work which he carried on rapidly and economically, completing it early in April, after which he selected and built the stations of another hexagon before returning to quarters on 18th May. He also throughout the season kept up his correspondence with me with praiseworthy regularity.

(56.) I consider Mr. Mitchell has done excellent work during the past season, and it gives me great pleasure to recommend him strongly for promotion.

Mr. O. V. Norris, B.C.E., Sub-Assistant 4th Grade.

(58.) Mr. Norris joined the Department on 25th April 1866. He was a student of the Madras University and Engineering College, and graduated as a Bachelor of Civil Engineering of the former in 1865. He was regular and diligent in office during the recess, with the exception of about one month's leave for sickness.

(59.) I kept Mr. Norris with me till the end of February, in order that he might become acquainted with the duties of recorder. I then detached him to close the stations of the Sávandrúg polygon, at which I had completed observations, and gave him a 7-inch theodolite, with instructions to do some secondary work. He returned to quarters on 18th June, after completing his work, by closing six stations.

(60.) Mr. Norris has not worked very judiciously, losing much time in endeavouring to obtain observations in very unfavorable weather, thereby delaying the work of closing the stations, the importance of which over secondary observations I had impressed on him; I believe, however, he has worked hard, and he has been most regular in his correspondence with me.

Mr. C. D. Potter, Sub-Assistant 4th Grade.

(61.) Mr. Potter was also a pupil in the Madras University and Engineering College, and entered the Department with a strong recommendation from Captain Edgcome, R.E., the Principal of the latter, joining on 29th October. Mr. Potter has been with me as recorder and assistant throughout the field season (excepting a few days' sickness in January), and has steadily improved in efficiency. He is now a good recorder, and appears to take an interest in his work. Mr. Potter regularly kept up the duplicate angle books, and greatly improved his style.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT H. TROTTER, R.E., ASSISTANT SURVEYOR, IN CHARGE BOMBAY PARTY G. T. SURVEY, NO. $\frac{18}{8}$, DATED 29TH AUGUST 1867.

(1.) On the departure of Captain Nasmyth to Europe, and the consequent transfer of Captain Haig from the charge of the Bombay to that of the Kattiawar Party, I was ordered down at the end of September 1866, from Department head-quarters at Deyrah Doon, to take charge of the former party. Proceeding by Lahore, Karrachee and Bombay, I reached Poona on the 25th October, and took over charge on 1st November from Captain Haig, then officiating in charge of both parties.

(2.) The first thing to be done on arrival was to arrange the programme of the season's work. Captain Haig in the previous season had carried the principal triangulation of the Mangalore Series (meridian 75°) through the open country about Sattara, Belgaum, and Dharwar, down to the outskirts of the dense and unhealthy jungles of North Canara. From a flank side of his last figure he commenced a single branch series westwards to Goa, to meet the South Konkan Series which, partly single, partly double, runs down the west coast from Bombay (latitude 19° N.) to Goa (latitude 15½° N.), a distance of about 240 miles. He had nearly completed this, when he received a summons to proceed immediately to Bombay, to relieve Captain Nasmyth, who had been ordered away on sick leave. There then remained three stations on the west end of this branch series which it was necessary for me to visit, in order to complete the connection with the Konkan Series. The western ghâts lay between these stations and the south end of the Main Series, a distance of only eighty miles in a direct line, but, in reality, a tedious and difficult journey, owing to the want of roads and means of transport. The jungles of North Canara, in which I had to take up the principal triangulation, have of late years borne such a deadly character, that it was of the utmost importance to obtain accurate information as to the best season of the year for working therein. The result of my enquiries showed that the earliest time I could work in those jungles, with a reasonable chance of not having my party paralysed from fever, was the beginning of February; this conclusion was confirmed by the fact that, in the previous year, Mr. Sub-Assistant Christie, in charge of a building party, under Captain Haig, was attacked by fever in the middle of January at one of the first stations I had to visit. He, and all the men under him, were obliged to go in to Dharwar, and although they afterwards remained in the field, the progress of the work was much retarded during the remainder of the season, owing to the constant recurrence of attacks of fever. To ensure my reaching this district at the time above mentioned, as a limit, I determined to leave Bombay early in January, so that I might complete the required observations in the Goanese territory, and then get across the ghâts in good time for commencing observations on the Main Series. I had thus to find employment for myself and assistants for the latter part of November and for December. This was soon found, as Major Francis, the Revenue Commissioner North Division Bombay Presidency, was very anxious to get some of his revenue boundary-marks laid down carefully by trigonometrical observations, as a test of the accuracy of the work of his own assistants, and for the purpose of having accurate data for the construction of his own maps; and also, as an experiment for ascertaining in what manner the Trigonometrical and Revenue Surveys could best combine their operations.

(3.) I accordingly proceeded on 18th November with my whole party, of strength as per margin*, to the Indarpoor talooka of the Poona district, for the purpose of making arrangements and starting the work, which I proposed leaving in charge of Mr. Anding. Mr. Christie was to assist the latter until the season should admit of his going south to build stations in advance of my own work, and Mr. Bond, who had only joined the Department a few days previously, was taken, to enable him to learn something about his work.

* Mr. G. A. Anding, Sub-Assistant 2nd Grade.
„ A. Christie, Sub-Assistant 3rd Grade.
„ Jas. Bond, Sub-Assistant 4th Grade.
Wittoba Bappojee, Native Doctor.

(4.) We reached Indarpoor, the village from which the talooka is named, in ten marches, the whole office having been employed on the road, and afterwards in the district, when not otherwise engaged, in sorting and arranging the records of the Bombay Party for the past thirty-five years, with a view to their transmission, as directed by you, in separate sets, original and duplicate, to your head-quarters.

(5.) At Indarpoor I met by appointment Major Francis and Major Waddington (who had had charge of the survey of that district), and who explained to me exactly what they wished to be done.

(6.) The Revenue Survey map of the Indarpoor district is merely a map of fields on a very large scale; the boundaries of these fields are laid down with considerable accuracy by the chain alone. Traverse circuits are run round the boundaries of the different villages with theodolite and chain. Major Francis provided me with an index map of the whole district, in which all the traverses were plotted on the scale of one mile to an inch, and the points of junction of the village boundaries shewn by symbols. The origin or starting point of the traverses was not shewn, nor was there any north and south line. The traverses were protracted in, and made to accord as best they could, no attempt having been made to combine the work with our trigonometrical points, one of our principal stations, Kalas H. S., in the centre of the district, not even being shewn.

(7.) Major Francis wished me to lay down accurately the positions of as many as possible of these junctions or "tewndas" (as they are technically called), in order that he might be able to prepare an accurate index map of the district on the same scale as the one supplied to me. He further requested that I would, if possible, have the ground delineated topographically.

(8.) Considering the weakness in numbers, and want of topographical experience of my Sub-Assistants, and as, moreover, my ability to spare Mr. Anding for this exceptional work was entirely dependent on the remaining two Sub-Assistants keeping their health in the Canara jungles, and in the absence of any existing reliable topographical map which could be elaborated, I had no alternative but to decline to attempt the execution of any topographical details. I therefore determined to confine my endeavours to fixing geographically as many of these tewndas as I could, and to furnish during the next recess, as soon as I should be able to prepare it, a chart on the scale of one inch to a mile, with all these points accurately protracted, giving also our G. T. S. points, both principal and secondary, not one of which was shewn in the map supplied to me.

(9.) In considering the best means of effecting the end in view, the first thing to be ascertained was the state of the secondary stations of the Great Trigonometrical Survey, whose operations had passed through a portion of the district. On examination, none of our secondary points were to be found (with one single exception), although the names were in existence in our records, and their latitudes, longitudes, heights, and azimuths had been duly and accurately determined. It appears that in many instances these stations had originally consisted of a single stone imbedded, perhaps, in the centre of a large flat field, on the top of a high piece of ground, with no means whatever of identifying the same. These marks were useless without the most minute and accurate description of their whereabouts, from the simple fact that the ground is either so mildly undulating that search might be made for hours before the highest point in the neighbourhood could be discovered, or else consists of high, flat table-lands extending from one-fourth of a mile to several miles in length, and generally covered with stones large and small. These table-lands are so flat that, if three or four different men were sent at different times, they would probably none of them select the same spot as the highest. Unless, therefore, very careful descriptions of these stations were forthcoming, it was almost useless making search for them. Unfortunately, no descriptions of any sort were to be found, and hence only one station was discovered. The station at Indapore itself could not be found, although the old man who originally gave signals from it was present in my camp, and aided in the search for it. From these considerations it appeared to me, 1st, that it was little

or no use attempting to make use of any former secondary work; and, 2ndly, that to make the work of any practical utility to future detail surveyors, it was essentially necessary to build permanent stations at all secondary points, or, rather, at all chief points of my proposed minor triangulation. I determined therefore to break up the principal triangulation afresh, and to cover the whole of the district to be surveyed with a net-work of triangles having sides from three to five miles in length. At each of these stations I directed my assistants to build, with large stones, a platform eight feet square and two feet high, surrounding an isolated pillar of lime and stone for the instrument to rest upon, of the same depth, and two feet in diameter. From these stations the tewndas and other points were to be fixed by intersection if possible, otherwise by a series of minor triangles.

(10.) Mr. Anding received instructions to write in his angle book such a description of every station that any stranger coming to the country should easily be able to recognize it. He was also directed to hand over the stations to the care of the neighbouring village authorities, and these latter were warned, at my request, by the revenue officials that they would be held responsible for all wilful damage done.

(11.) I regret to say that Mr. Anding did not strictly adhere to the former part of these directions, as I found, when he rejoined me at Bangalore, at the end of the field season, that of *thirty* platform stations only nine were described in such a manner as to enable them to be easily found. Fortunately, in this particular case, this neglect of orders will not be productive of much inconvenience hereafter, for owing to the number of tewndas fixed, the stations can always be easily found by any one provided with a chart of the triangulation, the exact positions of the tewndas being well-known to the village officials.

(12.) I remained some time with Mr. Anding in the field to start the work, and to determine the best means of accomplishing the end in view. I found it was impracticable to take the principal observations and *cut in* the tewndas at the same time, owing to the large number of signalmen that would be required, and the difficulty, or rather impossibility, of discovering the whereabouts of the different tewndas within sight at one station within the time required for the principal observations at each station. I directed him, therefore, first to complete the whole of the net-work triangulation, and, while so employed, to send men round from each camp to accompany the village pátels (head men) round their respective village boundaries. At each tewnda these men were to note what stations were visible, and a book containing all their reports was to be kept, and filled in every evening. By adopting this plan he had ready, when the principal triangulation was completed, a rough approximate chart, by means of which he was enabled, when visiting the stations a second time, to fix, with as little delay as possible, the different village marks, which unfortunately are often placed in hollows and on low ground, invisible from any of our chief stations, and to fix which (should it be of sufficient importance to warrant the extra trouble) a minor series was to be carried from one of the principal sides. This extra labour was only to be undertaken when the tewndas in question occupied large gaps, in the vicinity of which no other boundary-marks existed, or could be conveniently fixed.

(13.) The instrument employed was a 12-inch theodolite, easily carried with its stand by three men. At the chief stations observations were taken on two pairs of zeros, two observations being taken on each face. For the intersection of tewndas, &c., &c., one observation on F. R. and one on F. L. was considered sufficient.

(14.) As at the time of writing this report the observations are only in process of being reduced, I can scarcely form an opinion as to the manner in which Mr. Anding (who was employed on this work throughout the whole of the past season) has carried out the instructions that were given him, but I propose making a special report on the subject hereafter. I will now merely state that he remained at work in the field up to the 8th May, when he proceeded *vid* Poona, Bombay and Cochin, to my recently established head-quarters at Bangalore, which place he was unable to reach until the 12th June, having been greatly delayed by the monsoon on the west coast.

(15.) Whilst I was employed in starting the work described above, all available assistants

were occupied in arranging, sorting, and completing the old records of the Bombay Party, prior to despatch to head-quarters, Deyrah Dhoon. It was very essential to complete this work before starting to commence the principal triangulation, as it would never have done to have risked carrying about with me by land and water the valuable records of so many years.

(16.) I returned to Poona at Christmas (leaving Mr. Anding in the Indapore districts), and despatched thence the original records, leaving the duplicates in charge of the executive engineer. I then proceeded to Bombay, and engaged pattemars (coasting craft) to take myself and establishment down to Goa, where, accompanied by Mr. Bond, I arrived on the morning of the 12th January, after a journey of two and a-half days in a ten ton boat. The instruments and establishment did not arrive till three days later, having been in a heavier and slower boat.

(17.) When Captain Haig had visited Goa in former years, the Bombay Government had applied to His Excellency the Governor General of Portuguese India for permission for our Survey operations to be carried through his territory. As permission was then granted, I did not deem it necessary to apply again through the Bombay Government, but wrote direct to the Chief Secretary to the Government at Goa, requesting the good services of His Excellency in carrying on the work. I must here cordially acknowledge the handsome manner in which every assistance was given to me by the Governor General and staff in facilitating the progress of the operations. Orders were issued to the custom-house authorities all over the district to pass my baggage free, not only of custom duties, but of the usual annoyance of examination and search. Sepoys also were attached to my camp, to aid in procuring supplies. No amount of assistance however could avail to remove the physical obstacles presented by the mountains and rivers which had to be traversed to get from one station to another. Hence, although but three stations, Bori, Salili, and Agoada, had to be visited, and in no case had more than two angles to be measured at a station, the weather being fine and clear, yet I was the better part of a month in getting through this small amount of work.

(21.) I had hoped to get straight across the ghâts to Dharwar, but this was found impracticable, owing to the difficulty of procuring carriage. The road, moreover, was reported as being just then exceedingly unhealthy, so, Agoada being on the sea coast, I had determined to proceed *vid* Karwar; accordingly, the day after closing work, I got everything on board pattemars, and started for Karwar.

(22.) We reached Karwar on the evening of the 3rd February, but were detained until the 6th by difficulty of procuring carriage, when we started, marching *vid* the Arbyl Ghât, a very roundabout but a good road, and proceeding by the regular marches to Samtrani, twenty-four miles north of Yellapoor. We there exchanged our carts for bullocks and coolies, and diverged to Kanserudi H. S., one of the west flank stations of the Ganigud polygon, which we reached on the 16th instant. The south-west flank and centre stations of this polygon are in the dense Canara forests, the best wooded, I believe, in western India.

(24.) After the checks already mentioned as having been met with in the Goa districts, the work of the principal triangulation proceeded smoothly enough till I reached Indur, at the end of March. In Goa the air was clear, and the weather, on the whole, very favorable, the morning heliotropes being best and steadiest, a very unusual occurrence, as far as my experience goes, but caused, I imagine, by the sea breeze, which at that time of the year used not to set in till evening, continuing till late at night, causing wonderfully clear mornings, and a very steady atmosphere. As the sun got up mists gradually rose, and by ten or eleven o'clock the air would be very thick, getting later on in the day impenetrable by rays from either afternoon heliotropes or lamps, which latter would generally be good signals early in the morning.

(25.) Above the ghâts, when I took up the Main Series, the weather was somewhat the same in that before the sun rose the air used to be very clear, but the moment the sun got above the horizon mists rose with it, and what was a few minutes before a verdant landscape, became almost miraculously transformed into an apparently foaming sea, with the tops of the highest hills towering above the general level like green and rocky islands, the tops of the moving clouds having the appearance of rolling billows, altogether a most magnificent spectacle,

not unimproved by the brilliant flashes of the heliotropes seen over this sea of clouds. This appearance is not lasting however, for the mists soon rise, enveloping everything, and not generally dispersing till nine or ten A.M.

(26.) These phenomena occurred early in the season, and of course morning heliotropes were rarely, if ever, attainable. The afternoons were generally thickish, but used to clear towards sunset, and the air, purified by the sea breeze, was generally good for lamps. Later in the season, however, these mists, instead of rising about sunrise, used generally to begin to form about eight or nine o'clock in the evening, when, just as we had fairly commenced working to lamps, then bright and clear, first one and then another would suddenly disappear, never to show again till the next evening, whilst the mists would at last rise and surround the observatory tent. These mists never cleared off in time for morning heliotropes, and consequently for the greater part of the season nearly the whole of the observations were taken in the afternoon, when the signals were generally good. On one occasion I took no less than fifty-seven single measures of angles working to afternoon heliotropes. In April and May the work was very much interfered with by passing storms, though these were so local that sometimes I have gone on steadily working to capital heliotrope signals, when, perhaps, the sun never shone on my own station the whole afternoon, and the hill seemed surrounded by storms.

(27.) The smoke from the burning jungles sadly interfered with work, especially when there was no wind stirring. A steady breeze was always of great service in clearing the air. The villagers begin to burn these jungles towards the end of February, and light them regularly at two or three o'clock in the afternoon, continuing this till the heavy rains set in. Of course one would avoid visiting these stations at that particular season of the year if possible, but it is, unfortunately, the only time they may be visited with impunity from fever, the curse of the district. Some idea of the virulence of this fever may be inferred from the fact of my having seen at Poona some printed recent correspondence of the Bombay Government, wherein it was proposed to withdraw the whole of the Public Works Establishment (European) from North Canara. This was of course not acted on, but I believe orders were issued that officers should be relieved every year.

(28.) My assistant, Mr. Christie, who was working in the district the previous season (January 1866), informs me that, when he was marching, the coolies used as a regular thing to put down their loads for two or three hours in the middle of the day, have their bout of fever, and then go on again.

(29.) By taking the precaution of not entering these jungles till the healthy season, my party escaped with comparatively little illness for a couple of months; but, after the first heavy rains had fallen in April, Mr. Christie's party, which was in advance building stations, was the first to suffer, and he wrote from the last station of the polygon I was then engaged on, to say that he could not move, the whole of his camp being down with fever. I ordered him to Sirey, the head-quarters of the district, as soon as he was able to move. From that time he was never able to do any independent work, there being no available men to send with him. From this date there was a good deal of sickness in my own camp, but, by taking Mr. Christie's convalescents, and withdrawing all the secondary signallers, I was enabled to keep on, and finish the observations of the Kalraniguda compound figure at Chanduguti on the 20th May.

(30.) I could not have done another day's work, for, on that same afternoon, I was attacked with fever myself, and on the following day my observatory assistant, Mr. James Bond, was seized with the same disease. All the signal parties that then came in were suffering more or less, besides nearly the whole of my standing camp. The fever was not of a malignant type, its effects, however, being unfortunately more insidious than outwardly visible, as is evident from the fact that although only one man actually died in the field, yet two have died at Bangalore since I arrived, out of a small party, and another died while on his journey home on leave.

(31.) When first entering those jungles, of which the natives have a strange, and not altogether unjustifiable, dread, I was very much annoyed by frequent desertions both amongst

my own servants and the Government khlassies. Fortunately none of the old hands went, all deserters being comparatively recently entertained men, but the utter impossibility of replacing any one, and the fear that I should soon be left very short-handed, induced me to take stringent measures to prevent it. A case occurred in which a man absconded, after robbing Government of a few rupees, and also some of his fellow khlassies. I fortunately succeeded in retaking him, and got him summarily disposed of with six month's hard labor. Not a single case of desertion occurred afterwards.

(32.) Owing to this cause and to sickness, and the consequent paucity of men, I was only able to observe to very few secondary points. The nature of the country is such, however, that there was scarcely ever a prominent temple or similar object to be seen, nothing but dense forests meeting the eye. Hence, with one or two exceptions, what secondary points were observed consisted of platforms built by Mr. Christie on his journey ahead of me. These were built on prominent hills, whose tops had generally to be cleared of forest, in order that the heliotrope should be visible therefrom.

(35.) Mr. Sub-Assistant Anding's work during the season has already been partially reported upon. Although Mr. Anding has not attended so carefully to the instructions he received as might have been desirable, yet he has, on the whole, done a good season's work, and appears to have worked hard and diligently when in the field.

(39.) I have every reason to be satisfied with Mr. Christie's work during the season. Had he met with any serious stoppage it would have put a temporary stop to principal operations, the stations he was constructing being immediately in advance, and inconveniently near to my own work. This could not have been avoided, illness having detained the building party the previous year, and it being unsafe to send parties into these jungles earlier than I entered them myself.

(41.) My observatory assistant throughout the season's operations was Mr. J. Bond, who was appointed to the Department as 4th Grade Sub-Assistant only a few days prior to my taking the field. I am very well pleased with the progress he has made, and he promises to become a useful and hard-working assistant.

(42.) The progress of the future operations of this party will now be necessarily slow, the physical features of the country and the bad climate being both difficult to overcome. The country over which the principal triangulation will pass is very hilly, wild, and thinly populated, and carriage is only to be procured with great difficulty.

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT T. T. CARTER, R.E., SURVEYOR 3RD GRADE, IN CHARGE KUMAON AND GURHWAL SERIES G. T. SURVEY, DATED 31ST AUGUST 1867.

During the season under review the Party has been employed on the Topographical Survey of Mussoorie and Landour, on the scale of twelve inches to the mile, and the Trigo-Topographical Survey of British Gurhwal and Kumaon on the 1″ scale.

Landour and Mussoorie Survey.

On the return of the Party from the field in the month of May 1866, the triangulation of Mussoorie and Landour was extended, and sufficient points were fixed to enable the plane-tabling to be continued; this was subsequently done after the cessation of the rains; 1,666 acres were surveyed by Mr. J. Peyton, Civil Assistant 3rd Grade, and 455 acres by Mr. J. Low, Sub-Assistant 1st Grade. The work completed by Mr. Peyton comprised the whole of Landour, and Mr. Peyton seems to have taken great pains, the detail, which, in some places, is intricate, having been carefully shewn. The whole of that portion of the Mussoorie settlement, where habitations are numerous and in close juxtaposition (with the exception of a small portion of Mr. Low's plane-table which requires to be finished), has now been completed.

Kumaon and Gurhwal Survey.

During the two previous field seasons the topographical work in British Gurhwal and Kumaon had been confined entirely to the inner hills. In the present season the operations were carried into the forests which skirt the plains of Bijnour. The difficulty of travelling about and obtaining supplies in this portion of the district I have mentioned in previous reports, and as Government had sanctioned the use of eight elephants for the Party for the season under review, I determined that the survey of this tract of country should be pushed on as vigorously as possible during the time that the Surveyors could work there, viz., from the 15th of December to the 15th of March, or to the 1st of April. I therefore personally superintended this piece of work, and deputed different officers to take up different portions, calling them down from the higher hills, to return when they had completed their portions of the low ground. Owing to the willingness and ready co-operation displayed by the different officers employed with me, I was enabled by the 1st of April to finish the survey of the whole of that band of forest land extending from Gaori ghát on the Ganges, to the fiscal boundary between Gurhwal and Kumaon, viz., the Koti Rao Sote. In addition to this piece of work, a considerable portion of the inner and higher hills was topographically surveyed, and a sufficient amount of secondary triangulation for the operations of next season was completed.

The work on which the different officers, as per margin, were employed during the field season, and the progress made by each, will now be noted separately.

Lieut. T. T. Carter, R.E., Surveyor 3rd Grade, in charge.
„ A. Pullan, B.S.C., Assistant Surveyor 1st Grade.
„ J. Hill, R.E., Assistant Surveyor 2nd Grade.
Mr. E. C. Ryall, Civil Assistant 3rd Grade.
„ J. Peyton, Civil Assistant 3rd Grade.
„ J. Low, Sub-Assistant 1st Grade G. T. S.
„ C. Braithwaite, Sub-Assistant 2nd Grade.
„ H. Todd, Sub-Assistant 4th Grade G. T. S.
„ C. Bryson, Sub-Assistant 4th Grade G. T. S.
„ A. Low, Probationary Sub-Assistant 4th Grade.

Towards the end of September preparations were made for the Party to take the field. The projection of plane-tables for the different Surveyors was commenced, the first to take the field being Mr. E. C. Ryall, Civil Assistant 3rd Grade, who left Mussoorie, *en route* for Gurhwal, on the 11th of October 1866. Between that date and the 1st of November the rest of the Assistants proceeded to take up work on the different portions of the district allotted to them. Having disposed of the different Assistants, until I required their services in the low forest ground or bhabur, which could not be taken up till the 15th of December at the earliest, and having therefore over a month before I could proceed to take up the triangulation of the bhabur, I determined to build over

and protect as many of the principal stations as I could in this time, and on the 1st of November I proceeded to the station of Ghundial, and subsequently to those of Manikuath, Ranigurh, and Marbegurh, the two former in the Teeree district, the two latter in Gurhwal.

I was also desirous of personally superintending the building up of the first few stations of the Series, with the view of ascertaining the cost, proportion of bricks to stone, and best way of covering up the pillars to protect them from rain, snow, &c. The bricks and lime had to be taken from Dehra; the former were the ordinary small bricks used by the natives, called lackouri, and these were well adapted for binding together the stone, with which the rest of the pillar was built. On each pillar not more than eighty of the small bricks were used, and chiefly at the junction of the plane surfaces of the pillar, the remaining portion of the pillar being built with well-cut stones. The top of the pillars consisted of two layers of brick, to the surface of which the station marks were transferred; as an additional protection the pillars were covered with piles of earth mixed with grass or rice straw, the latter being used where procurable, as it made the earth more adhesive. The station at Marbegurh was completed on the 5th of December, when I proceeded to Dehra to arrange for taking up work in the bhabur.

On the 17th December I marched to take up the triangulation of the bhabur. Between the 1st January and 15th February I observed from seventeen secondary stations, fixing ninety-three points, and computed out and projected the same on four plane-tables for Lieut. Pullan, Messrs. Ryall, Peyton and H. Todd. It was necessary that the whole of these points should be worked out and given to the plane-tablers at a not later date than the 15th February, as that would only allow them one and a-half months each to complete the work allotted to them. The working out of the computations connected with these points was carried on between the intervals of observing by myself and Mr. C. Bryson, Sub-Assistant 4th Grade. Mr. Bryson, who joined the Department in October 1865, is an accurate and rapid computer, worked cheerfully and well, and it is chiefly due to this that I was enabled to complete the survey of so much of the forest ground. Before leaving the low ground, the 1st of April, I had personally inspected on the ground a portion of the work of Lieut. Pullan and that of Messrs. Ryall, Peyton and H. Todd, marching through the country they sketched, and putting up plane-tables at different points. In mountainous countries, such as that of Gurhwal and Kumaon, I know of no better way of checking the work of the assistants, as a chain traverse check, as adopted by the Topographical parties in the plains, is totally impracticable.

In my instructions to each officer on taking the field I directed that he should note, to the best of his ability, such information, with reference to the particular district in which he was employed, as would assist in drawing up an interesting account of the whole district, when we shall have completed the survey of British Gurhwal and Kumaon. Officers on topographical work, employed as they are for some time in one particular portion of the district, have great opportunities of learning the manners of the people, the trades they work at, the crops, forest trees, and animals to be met with, also the history of any ancient remains, all of which will be most useful, and add greatly to the value of the survey. I am glad to mention that Lieutenant Pullen, Messrs. Ryall, Peyton and H. Todd have carried out my wishes in this respect, and have recorded much valuable and interesting information respecting the people, flora, fauna, &c., of that portion of the district they were respectively employed on, and I have appended to this report extracts from their respective journals. The district of Gurhwal and Kumaon abounds in ancient ruins of temples, and the flora and fauna is very varied, as it must be in a country extending from the plains up to the snowy range, 25,000 feet high.

Lieutenant A. Pullan, B.S.C., Assistant Surveyor 1st Grade G. T. Survey.

Lieutenant Pullan's work consisted chiefly of bhabur ground, with the exception of the upper portion of the plane-table section included between lat. 29° 45′ and 30° 0′ and long. 78° 15′ and 78° 30′, which he proceeded to take up, pending the arrival of the elephants. Lieutenant Pullan took the field the 10th of November 1866, and by the 1st of December had completed the survey of the upper portion of the above mentioned plane-table, but on completing the same, visiting the lower spurs that descend towards the Ganges, he unfortunately got an attack of jungle fever, which he never entirely shook off for the rest of the season; he was, however,

enabled to keep out at work till the 14th of March, finishing his first plane-table, and completing the lower half of the plane-table section lying between lat. 29° 30′ and 29° 45′, and long. 78° 45′ and 79° 0′ (the upper portion of which Mr. H. Todd completed). I was enabled to examine this portion of Lieutenant Pullan's work, and ascertained that it fairly represented the ground.

Lieutenant J. Hill, R.E., Assistant Surveyor 2nd Grade G. T. Survey.

Lieutenant Hill joined the Department on the 1st December, and, on his reporting himself to me, as directed, I requested him to join my camp, so that he might accompany me to learn his new duties. Lieut. Hill remained with my camp for three weeks, accompanying me on all occasions when observing, also practising independently with the instrument with which he was to extend the secondary triangulation. On the 15th of February he started to take up independent secondary triangulation, closing work on the 31st of May, during which time he visited twenty-one stations, observing twenty-six triangles, of which three angles were observed, and fixing seventy-two intersected points. The results of these observations, as determined since his return to head-quarters, have proved very satisfactory.

Mr. E. C. Ryall, Civil Assistant 3rd Grade G. T. Survey.

Mr. Ryall took the field on the 11th of October, and continued working in Gurhwal, in the higher hills, till the 1st of January 1867, when he proceeded to take up a plane-table of the low or bhabur ground, of which he completed 143 square miles. I inspected this portion of Mr. Ryall's work, visiting several high and commanding points, as well as other low ones, on the line I took through his board. The out-turn of Mr. Ryall's work is considerable, and I have much pleasure in certifying to the accuracy of the same, and the pains taken. Irrespective of the physical difficulties of the ground, were added those of procuring supplies, and coolies for cutting rays, &c., all of which Mr. Ryall overcame. On the completion of the work deputed to him of the low ground, Mr. Ryall proceeded to complete his first plane-table. I would beg to bring Mr. Ryall to your favorable consideration for promotion; as the Senior Civil Assistant attached to the Party he has given me every satisfaction.

Mr. J. Peyton, Civil Assistant 3rd Grade G. T. Survey.

Mr. Peyton took the field on the 1st November, and till the beginning of February was employed on the higher hills of Gurhwal and Kumaon. In February I deputed him to survey a portion of the bhabur ground, which he did to my satisfaction, on the completion of which he returned, and completed his plane-table section of the higher hills. Mr. Peyton's out-turn of work is good, but I should have preferred seeing less in quantity of a superior quality.

Mr. J. Low, Sub-Assistant 1st Grade G. T. Survey.

This officer took the field on the 1st November, and was employed till the 4th April plane-tabling in the Kumaon district, during which time he completed 182 square miles. On examination of Mr. Low's work in the field, I found that the main ridges, streams, and positions of villages were entered accurately, but Mr. Low's delineation of the features of the ground is such that it is impossible to pass his work, and it will have to be done over again.

Mr. C. Braithwaite, Sub-Assistant 2nd Grade G. T. Survey.

Mr. C. Braithwaite took the field on the 20th of October, and continued at work in the field till the 22nd of April. I inspected Mr. Braithwaite's work in the field, and have much pleasure in reporting that the same is accurately and carefully done, and I have no reason to change the favorable opinion expressed of Mr. Braithwaite in my last report.

Mr. H. Todd, Sub-Assistant 4th Grade G. T. Survey.

Mr. H. Todd took the field on the 15th of October, and continued working in the higher hills till the 1st January, when he took up a second plane-table, composed chiefly of bhabur ground. Mr. H. Todd has done his work most creditably, and I tested the accuracy of the same on the ground. He has taken much pains, and has succeeded very well in representing the characteristic features of the ground on which he was employed; his work will already bear favorable comparison with several of his seniors.

Mr. C. Bryson, Sub-Assistant 4th Grade G. T. Survey.

Mr. Bryson accompanied me till the 1st March, carrying on the current duties connected with the office, recording, and computing out the points necessary for topographically sketching the bhabur of Gurhwal. Connected with the triangulation for this portion of the district, observations were taken from 17 stations, 160 triangles were worked out in duplicate, fixing 93 points, of which the latitudes and longitudes of 33 were computed, and this between the 1st January and 15th February. Mr. Bryson, in assisting me with this work, after recording during the daytime, had frequently to work late at night, and always worked willingly. Mr. Bryson is a good computer, neat and accurate. While at work in the bhabur, I took the opportunity of training him in the use of the theodolite, the instrument being entirely dismantled, cleaned, and re-adjusted before him; and, having seen that he was capable of carrying on secondary triangulation, he was from the 1st March to the time of his return to head-quarters employed on independent secondary triangulation with an 8-inch theodolite. During this time he observed from 22 stations, fixing 72 secondary points. I have every reason to be well pleased with Mr. Bryson, and beg to bring him to your notice for promotion, as soon as the rules of the Department will permit of it.

In concluding this report, I would beg to place on record that every assistance has been offered by the civil authorities of the district, and in particular in the forest ground, where difficulties were enhanced from want of local information, there being no guides, &c. The forest officials rendered us every assistance, by placing their most intelligent rangers and patrols at the disposal of the Survey officers. I have in particular to thank Mr. R. Thompson, the Assistant Conservator of the Gurhwal Forests, for the readiness with which he always furnished assistance to the Surveyors when required. Mr. Thompson is, particularly, in charge of the Gurhwal forests. The operations of last year were not extended to those in Kumaon.

During the season under review I am happy to report that we were comparatively free of sickness, though cholera was raging during the whole time the operations were going on in the bhabur. Only five men died during the season, two from ordinary causes, and three from cholera, on the return of the Party to head-quarters.

EXTRACT FROM THE NARRATIVE REPORT OF CAPTAIN C. T. HAIG, R.E., IN CHARGE KATTIAWAR PARTY G. T. SURVEY, DATED POONA, 1ST JULY 1867.

(2.) As intimated in my last year's report, I received charge of this Party on the 3rd March 1864. It was then employed on the survey of the Island of Bombay, and it not having been decided until the 10th October that the field of our operations should be shifted to Kattiawar, the Party was employed during the whole of the recess on reducing the computations, and plotting the traverses, &c., of the survey of Bombay.

(3.) When I received charge of the Party the computations of the principal triangles (of which the three angles had been observed) had been computed, and the spherical co-ordinates of all the trigonometrical stations worked out. This had been done during the field season, in order to furnish the traverse surveyors with correct azimuths as soon as possible, for it was deemed advisable to test the traversing mathematically as it progressed, and for this purpose, in the absence of a correct azimuth, an approximate meridian had been assumed (which afterwards proved to be about 10′ inclined to the true meridian), and the traverses had been tested by Gale's circuit method.

(4.) The traverses consisted of simple circuits, without any off-sets, and were intended merely to furnish the Revenue Survey Party with a number of points of departure; but, on joining, I found that the traverses were being carried on almost entirely independently of the triangulation, which was very elaborate. I therefore had the traverses which had been previously computed connected with any trigonometrical points in their vicinity that offered, and gave directions to have the traverses in future run so as to strike as many trigonometrical points as possible.

(7.) Wishing to furnish the Revenue Survey with as accurate elements of all our points as possible, and wishing also to furnish them with elements of the trigonometrical points which they could understand (spherical co-ordinates being altogether beyond them), I determined on introducing a system of rectangular co-ordinates, to which I should refer all points whether trigonometrical or traverse stations, which of course necessitated the recomputations of the traverses.

(8.) This, as it turned out, was perhaps a work of supererogation, but I feel convinced that had the Northern Bombay Party returned to continue the Bombay Survey, we should have saved time, on the whole, by the introduction of the rectangular co-ordinates, and, as it is, I believe had I not introduced them, the whole of the elaborate triangulation would have been left entirely, or almost entirely, unused.

(9.) I therefore selected a central station, and made the ordinates of Y parallel, and the ordinates of X perpendicular to its meridian, and then computed the co-ordinates of all the trigonometrical points, which was the work of but three or four days.

(10.) This done, the co-ordinates of the traverse stations were computed with the assistance of a traverse-table. As each traverse closed on a trigonometrical station, a test of the accuracy of the traverses was afforded by the agreement of the co-ordinates of that station, as determined by the traverse, with those determined by the computations alluded to in para. 9, and discrepancies were proportionally distributed over all the intermediate traverse stations.

(13.) The following charts were prepared as the progress of the computations permitted:— One chart of triangulation in one sheet, scale one foot = one mile; one map in one sheet, one foot = one mile (commenced). All trigonometrical points and traverse stations were pricked on to it, and lightly marked in pencil, and a small portion of detail near Mahim plotted by reduction from the Revenue Survey maps. This was intended to be an office copy of the final map.

One map, scale twelve inches = 1 mile, in seven sections, each section containing four squares of 1,000 feet each side. All trigonometrical points and traverse stations were laid down on these sections by five points, and a small portion of detail in one section plotted by reduction from the Revenue Survey maps. These sections were intended to be forwarded, as the details were filled in, to your office, to be reduced to half size, but were ultimately handed over to the Superintendent of Revenue Survey Party.

(14.) The following is a list of data supplied to Major Laughton, Superintendent Bombay Revenue Survey Party :—

Traverse Field Books, Principal Circuits,
Do., Minor Do.,
Traverse Computations, Principal Do.,
Do., Minor Do.,
Table showing lengths of trigonometrical sides in feet and miles.

(16.) I now proceed to report on the operations of the Party, in connection with the survey of Kattiawar.

On the 16th October the Party left Poona for Kattiawar, I, myself, remaining behind to hand over charge of the Bombay Party to Lieutenant H. Trotter, who had not then arrived, and to wait your arrival and inspection of the Bombay Party records, according to your instructions received by telegram.

(19.) Lieutenant Trotter arrived in Poona on, I think, 25th October, and received charge of the Bombay Party on the 1st November.

(20.) I left Poona on the 15th November, you having in the meantime arrived and inspected the records of the Bombay Party, and started the previous day for Rajkote, and you afterwards joined my camp at Wartej on the 27th November, when I had called all the Assistants, with the exception of Messrs. McGill and Gwinn to meet you.

(24.) On your deciding that the survey of Kattiawar should be executed in the field on the scale of two inches to a mile, of course all the plane-tables had to be remounted, and it was also at once necessary to break up the triangulation much further than had previously been done; accordingly, I apportioned off twelve plane-table spaces, the triangulation of which was immediately required among Lieutenant Dummler, Mr. McGill, and Mr. D'Souza, directing them to furnish as many new points as would with the old give one point on an average to every four square miles, and I allotted to Messrs. Gwinn, McA'Fee, Rendell and Wyatt a plane-table each, directing them to commence at such parts as were already furnished with trigonometrical points, while the further triangulation of their plane-tables was being carried on.

(25.) On the 6th December we separated from Wartej, and started for our respective *loci operandi*. I accompanied Lieutenant Dummler for some days, until he acquired sufficient confidence to work alone, and then I returned to Gogo.

(27.) I deemed it advisable to start the organization of a boundary survey, in anticipation of the orders of Government, and therefore I undertook the survey of the boundary of the Gogo talooka.

(28.) Having Captain Nasmyth's ten-feet standard bar with me, I laid down a standard 100 feet on the wall of Gogo, each end-mark being a cut in the head of a brass screw, embedded in lead poured into a hole cut out with a stone chisel for the purpose.

(36.) As Mr. Gwinn was superintending the boundary survey at Chambardi, I sent for his board for a day to show Colonel Keatinge, and both he and Captain Watson, the Assistant Political Agent of the district, were very much taken with the two boards (Messrs. Gwinn's and Wyatt's). There happened at the same time to be a difficulty about selecting a line for a new road from Palitona through Soupuri, to join the Ahmedabad and Gogo road, and with the assistance of these two boards the best line for the road was immediately determined.

(42.) To Lieutenant Dummler I allotted the triangulation of the four plane-tables between parallels 21° 22′ 30″ and 21° 37′ 30″, and meridian 72° and 72° 15′. He commenced on the 8th December, and completed the observations on the 31st January, having been detained by an attack of fever, which compelled him to go into Gogo for medical attendance, where he remained a week. He then spent twelve days reducing his observations, after which, finding he had not quite sufficient points in the plane-table he was about to commence filling in, he spent a few days more in laying down some additional points, and commenced plane-tabling on the 20th February.

Lieutenant Dummler.

(43.) In the four plane-tables he laid down altogether seventy new points, which, with the old, gave an average of one point to 3·1 square miles. He worked with a 6-inch theodolite, taking four measures of each angle, two at F. R. 0°, and two at F. L. 180°, and one reading at each face to intersected points, vertical observations by rounds, one reading at each face to all stations and all intersected points which could be taken.

(44.) His triangle sheets exhibited an average triangular error of 24″, and the average discrepancy per mile in lengths of sides deduced from seventeen sides of comparison is 8·1 inches.

(45.) As he only commenced plane-tabling on the 20th February, he could but complete one plane-table, which he did with great care, working throughout on the back and forward ray principle, and making judicious use of the perambulator. His plane-table stations average 5·2 per square mile, and the check line of survey shows his work to be exceedingly accurate.

(46.) He completed his table on the 11th April, but he again fell sick with fever, otherwise I had intended him to lay down some additional points with a theodolite between Mr. McA'Fee's plane-table and the coast, but I was compelled to allow him to close his season's work, and proceed to Surat for a few days change, before joining my camp at Domus.

(48.) Mr. McGill, as mentioned in para. 21, had triangulated four plane-table sections before the order for the adoption of the two-inch scale had been issued; he fixed forty-eight new points, which, with the old, gave one point on an average to every 4·6 square miles.

Mr. McGill.

(49.) After meeting you at Wartej, Mr. McGill triangulated the block between parallels 21° 42′ and 22° 15′, and meridians 71° 30′ and 72° 15′, covering twenty-five plane-table sections, laying down 530 new points, which, with the old, give an average of one point to three square miles.

(50.) Mr. McGill worked with a 12-inch theodolite, but one which was not in good order. He took one observation at F. R. and one at F. L. to all objects. His average triangular error was 13″·5, and the average discrepancy per mile in lengths of sides deduced from twelve sides of comparison taken at random was 10·6 inches.

(51.) To Mr. D'Souza I allotted the triangulation of the four plane-table sections between parallels 21° 22′ 30″ and 21° 37′ 30″, and meridians 71° 45′ and 72°. He started from Wartej on the 6th December, and completed his observations on the 30th January, having laid down 101 new points, giving, with the old, an average of one point to 3·5 square miles. He worked with a 6-inch theodolite, taking four measures of each angle, two at F. R. 0°, and two at F. L. 180°, and one reading at each face to intersected points.

Mr. D'Souza.

(52.) Mr. D'Souza spent twelve days with Lieutenant Dummler to reduce his observations, during which time he also afforded assistance to Mr. McA'Fee in plane-tabling, as mentioned in para. 34, until the latter had fully overcome the difficulties of hill sketching, after which he (Mr. D'Souza) returned to his own ground, and commenced plane-tabling on the 14th February.

(53.) Mr. D'Souza was twice detained by sickness, once by a bite from some poisonous

insect, which caused his leg to swell so much, and produced such pain, that he was unable for several days to put his foot to the ground, this was accompanied by fever, and detained him a week; he was afterwards detained twelve days by an attack of dysentery, which compelled him to go to Gogo for medical attendance.

(54.) With these delays, and having but commenced his plane-tabling on the 14th February, he was only able to fill in one table, which is very neatly executed, and agrees well with the check-line. His average number of plane-table stations is 5·8 per square mile.

Mr. Gwinn.

(55.) Mr. Gwinn, as mentioned in para. 22, completed 25 square miles of plane-tabling on the one-inch scale before I recalled him to head-quarters to take up work on the two-inch scale. He started with his new plane-table on the 18th December, and finished it on the 14th March, having, however, in the meantime been employed superintending the Chambardi boundary survey from 22nd January to 14th February during my absence, as mentioned in para. 32. He commenced his second board on the 23rd February, and finished it at the close of the season. His work is very neatly executed. The average number of plane-table stations is 6·74 per square mile in his first table, and 3·75 in the second.

Mr. McA'Fee.

(56.) Mr. McA'Fee was transferred to this from the Bombay Party on the 1st November, consequently he started for Kattiawar somewhat later than the rest of the Party, and so had but a very few days instruction from Mr. D'Souza before your arrival at Wartej. His plane-table had but a very few old points in it; he was therefore detained some time assisting Lieutenant Dummler in computing the elements of the points he required. He was also laid up for a month, from 12th February to 12th March, with an attack of opthalmia. He remained during that time under the medical treatment of the apothecary at Gogo. Consequent on these delays, he only completed one plane-table. His average of plane-table stations was 5·8 per square mile.

Mr. Rendell.

(57.) Mr. Rendell completed two plane-tables. His execution is extremely neat. His average of plane-table stations was 8·4 per square mile on his first table, and 5·4 per square mile on his second.

Mr. Wyatt.

(58.) Mr. Wyatt also completed two plane-tables very neatly, with an average of eight stations per square mile in the first, and 3·5 in the second.

(60.) Wissagee Ruggoonath, Native Surveyor, was employed the whole season on the traversing. He made himself very useful in assisting me to instruct the new Native Surveyors.

Native Surveyors.

(62.) The six new Native Surveyors all promise well. Wishing to instil a thorough knowledge of the practical field operations, I postponed the mathematical reduction of the traverses until recess. Next season I expect each of them will be able to survey a boundary independently.

The Native Establishment.

(63.) The Native Establishment are almost, without exception, natives from the vicinity of Poona, and I found in Kattiawar that I could not engage men, even to serve in the burkundauze, on as low pay as I am paying the dekkanees. I do not think khalassies could be found in Kattiawar at all. The natives there are extremely loathe to take service which keeps them away from their village, even for a night, and are a lazy lot at any work.

Robberies.

(64.) The Party experienced some annoyance from thieves, who abound in the province, and who are very expert. Robberies occurred at five out of the eight camps. We were fortunate, however, in being able to recover compensation for our losses from the durbars of the States in which the robberies occurred; but as it is very disagreeable to Political Assistants to recover compensation, I, with the assistance

of Captain Watson, the Political Assistant, had to draw up a set of instructions regarding the proper measures to be taken for the protection of the camps, and the action to be taken in the event of robberies occurring. It entails rather a heavy charge for chowkidars, which, I believe, in other States are generally provided by the chiefs.

(65.) The following table shows at a glance the amount of each Assistant's work, and their comparative values :—

Names.	Plane-tabling.	Stations per square mile.	Triangulation area.	Mean triangular error.	Average per mile discrepancy.	Boundary survey.	Check lines.
	Square miles.		Square miles.		Inches.	Miles.	Miles.
Lieutenant Dummler, ...	70	5·2	280	24″	8·1	...	...
Mr. McGill, ...	...	...	2,100	13·5	10·6	...	...
„ D'Souza, ...	70	5·8	300	15·1	6 6	...	...
„ Gwinn, ...	140	5·25	...	...	...	...	...
„ McA'Fee, ...	70	5·8	...	...	...	...	...
„ Rendell, ...	140	6·9	...	...	...	...	...
„ Wyatt, ...	140	5·75	...	...	...	...	...
Native Surveyors, ...		...	...	...	...	44	36

EXTRACT FROM THE NARRATIVE REPORT OF LIEUTENANT W. J. HEAVISIDE, R.E., ASSISTANT SURVEYOR 2ND GRADE, IN CHARGE NO. 2 EXTRA PARTY G. T. SURVEY, NO. 1, DATED 28TH AUGUST 1867.

Take charge of the Party.

(1.) In accordance with Department Order No. 41, dated 8th October 1866, I took over charge of No. 2 Extra Party from Mr. J. B. N. Hennessey from the 1st of October 1866.

Make myself acquainted with the Astronomical Circle, &c.

(2.) After making myself acquainted with the necessary forms and calculations, I was instructed in the use of the astronomical circle by Mr. Hennessey. I am deeply indebted to him for the great trouble he took in teaching me all the details connected with the instrument, and with the method of observing; as also for the assistance he rendered me in all my difficulties.

Take a set of star observations at Másuri.

(3.) During October I took, under Mr. Hennessey's guidance, a set of star observations for the determination of the latitude of the Másuri observatory. These observations I finished on the 1st of November.

Stations of the Gurhagurh Series elected for observations.

(4.) In accordance with the instructions contained in your letter No. $\frac{7}{613}$, dated 19th October 1866, four stations of the Gurhagarh Series were selected between latitudes 28° and 32° 2′, at which it was proposed to take observations. The stations selected were—

Shahpoor T. S., latitude 32° 1′ 34″,
Sungutpoor T. S., „ 31° 17′ 35″, an azimuth station,
Khimonana T. S., „ 30° 22′ 15″,
Sirsa S., „ 29° 31′ 36″, an azimuth station.

Sirsa found unfavorable.

(5.) For reasons stated in para. 24, Sirsa proved unfavorable for observing at, and consequently observations were taken at Sawarepoor T. S., latitude 29° 39′ 14″.

Party, of whom composed.

(6.) The Party consisted of myself, Mr. 2nd Grade Sub-Assistant J. Wood, and Mr. 3rd Grade Sub-Assistant G. Belcham.

Leave Dehra.

(7.) Mr. J. Wood left Dehra with a portion of the camp on the 13th of October. He had received instructions to proceed to Shahpoor, and there build an observatory. I followed with the remainder of the camp and accompanied by Mr. G. Belcham on the 8th of November, and arrived at Shahpoor on the 3rd of December.

Commence observations at Shahpoor.

(8.) I found the observatory completed, and after putting up the instrument, I commenced observing on the 6th of December.

Cloudy nights.

(9.) Both at Shahpoor and Sungutpoor the nights were unusually cloudy, so much so that it was quite the exception to obtain all the stars on any one night, and occasionally only three or four intersections could be made during the night. At Khimonana and Sawarepoor the weather was much more favorable, but even at these stations I was a good deal delayed by cloudy nights.

(10.) Table showing dates of arrival at, and departure from, each station, with number of stars observed, &c. :—

Name of Station.	Date of arrival.	Date of commencing observations.	Date of departure.	No. of pairs of stars.	No. of stars observed.	No. of transits.	No. of micrometer readings.
Shahpoor T. S., ...	3rd Dec. 1866.	6th Dec. 1866.	11th Jan. 1867.	18	40	899	3,596
Sungutpoor T. S., ...	16th Jan. 1867.	22nd Jan. 1867.	19th Feb.	21	42	579	2,316
Khimonana T. S., ...	23rd Feb.	28th Feb.	16th March.	25	50	429	1,716
Sawarepoor T. S., ...	21st March.	28th March.	11th April.	25	50	418	1,682

(15.) Table showing some of the final results obtained from the season's observations :—

Stations.	Probable errors.	Geodetic observed latitude.	Latitudes by north stars — south stars.	
Shahpoor T. S., ...	0″·13	+0″·06	+6″·17	
Sungutpoor T. S., ...	0″·11	−0″·60	+5″·30	
Khimonana T. S., ...	0″·11	+3″·35	+6″·24	
Sawarepoor T. S., ...	0″·12	+1″·12	+7″·02	

Large value of N − S.

(16.) It will be seen from this table that there is a very marked difference between the results obtained at each station by north stars as compared with south stars; this is also the case in the observations I took at Másuri in October last. Although this great difference evidently cancels in the pairing of north and south stars, yet it is unsatisfactory to get such a difference; more especially as the mean value of N − S for eighteen stations observed at by Lieutenant Campbell, R.E., with the same instrument was only +0″·74.

Investigation into some of the causes affecting the value N − S.

(17.) Now for south stars :

Latitude = declination + zenith distance + refraction.

$$L = D + Z + R.$$

For north stars :

$$L_1 = D_1 - (Z_1 + R_1).$$

In the case of the above observations, the latitude from north stars being too great, and from south stars too small, it follows that declinations and refractions being correct, the zenith distances of both north and south stars are observed too small.

(I.) Suppose that the declinations, as given in the Seven-Year Catalogue, were all either too large or too small, then the latitudes from both north and south stars would be either too large or too small, which is not the case in these results.

(II.) Suppose that the refractions, as calculated from Bessel's tables, were all too large: Let δc be the error of refraction,

Then

$$L = D + \left\{ Z + (R - \delta c) \right\} \text{ for south stars.}$$

$$L_1 = D_1 - \left\{ Z_1 + (R_1 - \delta c) \right\} \text{ for north stars.}$$

$$= D_1 - Z_1 - R_1 + \delta c.$$

In this case the latitude from north stars would be too large by δc, and from south stars too small by δc.

(III.) If there be flexure in the telescope and the object end droops, then the zenith distances of both north and south stars will be read too small, or the latitude resulting from north stars would be too great, and from south stars too small.

The value of N − S not fully accounted for by the suppositions.

(18.) The second supposition may perhaps account for a portion of the quantity N − S, but only for a very small portion; moreover, as Lieutenant Campbell used the same refraction tables as have been employed in computing this season's observations, a possible error in the refractions can scarcely be considered to apply. It is difficult to imagine from whence the difference between the north and south stars can spring, more especially as each star has been observed both I.P.E. and I.P.W., and both on zeros A and B.

Country round the stations of observation.

(19.) The country round both Shahpoor and Sungutpoor is very flat. After crossing the Sutlej below Sungutpoor the country becomes very sandy. Twenty miles further south sand-mounds are numerous, and the Furreed-Kot district is covered with them. They are, for the most part, not more than ten feet in height, and shift with every change of the wind; some, however, reach twenty or thirty feet in height, and a full description of those round Khimonana has been attached to the calculations.

Furreed-Kot territory.

(20.) Khimonana is in the independent state of Furreed-Kot. There appears to be but little cultivation carried on in the State. This is no doubt partly due to the difficulty of irrigating the fields, as the water is from 100 to 150 feet below the surface, and wells are scarce. The people depend in consequence more on the autumn than on the spring crops. There are no nullahs or water-courses, the sandy soil apparently absorbing all the rain-fall.

Town of Furreed-Kot.

(21.) The town of Furreed-Kot is about three miles in circumference. It is surrounded by an earthen rampart and parapet. On some high ground in the middle of the town is a citadel with high walls, badly built of mud and bricks, and within it is the rajah's palace. I found the native officials very civil in this State.

Country between Khimonana and Sirsa.

(22.) About eight miles south of Khimonana there are fewer sand-hills, and the country soon after becomes perfectly level, and continues so up to Sirsa.

Buttinda fort, in the Putiala territory.

(23.) About ten miles south of Khimonana, at Buttinda, in the Putiala territory, there is rather a strong fort. It is built on a mound which rises from fifteen to about thirty-five feet above the level of the country. The fort is about 100 yards square inside, the straightness of the walls being broken at intervals by segmental curves, which, however, would give but a slight flanking defence. From the level of the ground within the fort retaining walls run up, and between these and the outer wall earth has been filled in, forming a rampart about thirty feet wide. From the ramparts alone a fire could be maintained, and this would be of such a plunging nature as to do but little damage. There are two gateways to the fort, one to the north, which is blocked up, the other to the east. It would not be easy to obtain an entrance by the eastern gateway. After passing the outer gate, there is a narrow passage turning sharply to the south, which passage runs under the ramparts of the fort, and could easily be blocked up. The walls of the fort are of brick and mud, in very fair repair. The town is built on the eastern side, outside the fort, the houses being close to the fort walls. There were about half a dozen well-mounted brass guns in the fort, field-pieces ranging from three to twelve-pounders.

Sirsa S. rejected in favor of Sawarepoor T. S.

(24.) Sirsa S. was the fourth station originally selected for observing at, but, while at Khimonana, I got a letter from Mr. Wood, giving a description of it. From this it appeared that the station was on a hill about sixty feet high, and three miles in circumference. As he reported at the same time that Sawarepoor T. S., the next station of the Series north of Sirsa, was in a level country, I thought it best to discard Sirsa, and take observations at Sawarepore instead.

(25.) During the field season Mr. 2nd Grade Sub-Assistant J. Wood was chiefly employed in building the observatories. These were all of the same plan, viz., thirteen feet square, with walls about nine feet high. The referring-mark was placed either due east or west of the station, and distant from one to one and a-half miles. The collimator was always placed in the meridian, and about nine to ten feet from the vertical axis of the astronomical circle. The pillars, both for the instrument and collimator, were isolated. I need not go into any further details, the work having been carried on in strict accordance with the instructions drawn up by Mr. J. B. N. Hennessey, and forwarded with your letter No. $\frac{7}{613}$, dated 19th October 1866.

Construction of observatories.

(26.) The manner in which Mr. Wood performed the work allotted to him was very creditable. The observatories were all neatly and strongly built, and the meridians accurately laid down by him. When away from me he kept the establishment which was with him in good order, and there were, in consequence, no complaints made against the klassies by the villagers. Moreover, from the experience Mr. Wood had gained with Lieutenant W. M. Campbell, R.E., he was enabled to afford me considerable assistance in obtaining good signals from the collimator, and referring-mark lamps, a matter of considerable difficulty to me at first.

Mr. 2nd Grade Sub-Assistant J. Wood.

(27.) Mr. 3rd Grade Sub-Assistant G. Belcham was chiefly employed in recording. This important part he performed with great care and attention. As a proof of it, I may mention that although the chronometer had a rate of 5" per day, and long intervals often elapsed between two stars, yet Mr. Belcham did not, I think, fail in a single instance either to give me the correct setting for the instrument, or to warn me of the approach of the star. Mr. Belcham is a quick and accurate computer, and works hard. I beg to recommend him for promotion, of which he is well deserving.

Mr. 3rd Grade Sub-Assistant G. Belcham.

(28.) The health of the Party throughout the season has been very good.

Health of the Party.

EXTRACT FROM THE NARRATIVE REPORT OF C. LANE, ESQ., SURVEYOR 3RD GRADE, IN CHARGE NO. 3 EXTRA PARTY G. T. SURVEY, NO. 180, DATED 15TH AUGUST 1867.

(2.) The main camp left Dehra on the 27th October for Saharanpore, and Mr. Civil Assistant L. H. Clarke started on the 28th for Ladpur Great Arc Station, *viâ* Meerut, Delhi and Goorgaon. At Saharanpore the railway bench-mark was connected with the G. T. S. bench-mark on the left bank of the Eastern Jumna Canal in the vicinity, at the crossing of the Grand Trunk Road. The railway bench-mark at their fortieth mile was next connected with the G. T. S. bench-mark at Sersawa, on the road to Umballa. Arriving at that station, some delay was experienced in procuring the necessary information from the railway district engineer, who was out in the district, during which while every search was made for the G. T. S. bench-mark embedded in the station church compound, but without success. At Umballa the railway bench-mark near the sudder bazar was connected with the G. T. S. bench-mark on the third step of the church. After this, leaving the camp to march to Ferozepore, I proceeded by dâk for the head-quarters of the Baree Doab Canal at Lahore, *viâ* Loodianah, at which place I had search made for the G. T. S. bench-mark, and fortunately it was discovered, and the fact announced to Major Crofton, Under-Secretary to Punjab Government Irrigation Works. Brick masonry pillars were also constructed along the road to Umballa to indicate sites of G. T. S. bench-marks. At Lahore I found the canal officers had left for their respective districts. I, however, obtained a rough trace of some points of the Baree Doab Canal, in the vicinity of the Grand Trunk Road from Ferozepore, for connection with our line of levels, and also a chart of trial levels for the Sutlej Canal from Roopur to Daoraha-ke-Serai. After this I returned by dâk to Ferozepore, and thence, with the aid of Ramchand, leveler, carried a double line of levels to Lahore, connecting *en route* three of the Baree Doab Canal bridges and a number of pucka points, and fixing a bench-mark at Anarkalli near mile-stone 316 Delhi, 49 Ferozepore, 1 Lahore, and another bench-mark close to the west side-wall of the railway station-house, on which wall, alongside, the letters $\frac{\text{G. T. S.}}{\text{B.M.}}$ were engraved, with the consent and assistance of the railway district engineer.

(4.) From Lahore railway station the double line of levels was continued to the neighbouring military station of Meean Meer, where a bench-mark was fixed in the compound of the church, subsequently to connection of the marble step and sill of the western doorway under the steeple tower. It was at this stage of the operations that Ramchand, leveler, lost his life by a fall from his horse, as duly reported.

(5.) Next, exclusive of men not likely to be immediately required for leveling, who were directed to march by double stages, the main party proceeded by rail to Mooltan, where, after instructing and practically testing Nursing Doss, recorder, in the use of a level, a double line of levels was commenced from Nawab Wally Mahomed's bridge to the railway station-house, and along the Grand Trunk Road carried to Khemwala T. S., *viâ* Mozuffergurh civil station and sub-division, connecting on the way a number of pucka bridges, and other remarkable points in the Derajat.

(7.) Measures were now taken for the transfer and protection of as many tower stations as practicable, by detaching people right and left, proceeding myself to Dehra Ghazee Khan, a centrical position, in order to facilitate, through the civil authorities, direct and watch proceedings for awhile, taking also the opportunity of searching out the G. T. S. bench-mark at the station, it being much wanted for connection and correction of levels of the irrigation canals of the Indus. The bench-mark was discovered, and a brick masonry pillar built to indicate the site.

(8.) After this, on the 2nd April, the main party returned, as on the last occasion, chiefly by rail, only a few men accompanying the camels by double stages to Lahore. Here a second time I endeavoured, with the view to connection with our bench-mark, to obtain information

regarding the levels of the proposed railway to Peshawur. Colonel MacLagan, Secretary to the Punjab Government D. P. W., was also kind enough to try to obtain the information for me, but without success, the railway engineer having gone off with all his papers, to lay them before the authorities in England. Delay was likewise experienced in obtaining the corrected and attested chart of the line of railway between Umballa and Delhi from the railway authorities at Lahore. I also obtained from Major Gulliver, R.E., Superintendent Baree Doab Canal, at Lahore, in the absence from the station of Major Crofton, R.E., the promise, there being no duplicates, and the originals being required by the canal officers, to get copies made for us of the charts of the Baree Doab Canal, exhibiting level values similar to the plans of the Ganges Canal, for incorporation in the general charts of levels in preparation in your office for publication. During this while advantage was taken to connect with our bench-mark at Lahore railway station the Delhi Gate present sill, with the view to determination of the original datum of the Punjab Railway. Particulars of the result were duly communicated.

(9.) On the 17th and 18th April the main camp proceeded, partly by rail, and partly by stages, to Umritsur, where again I endeavoured to obtain charts with numerical values of levels, but with the same result, a promise to be supplied with copies, there being none available. From this place the camp marched by regular stages through the stream of Hurdwar pilgrims, including the retinue of His Highness the Maharaja of Cashmere, and their numerous doolies, amidst the sick of cholera, the dead and the dying, till the party reached Loodianah, from whence the road was pretty clear to Umballa. By adopting prophylactic measures, no case of cholera occurred in camp, although it was prevalent in the station of Umballa, till the arrival of a camp follower from Dehra Doon, where the disease had also been raging. The first case now occurred in camp, was cured, and was quickly succeeded by others, so that in two or three days there were two cart-loads of sick men. Out of some fourteen cases of cholera I lost only one, and that I believe to have been, in a great measure, attributable to delay on the part of one of the men in giving information.

(10.) The main party reached Delhi on the 19th May, where two bench-marks of the Western Jumna Canal, a D.P.W. bench-mark of the city drainage levels, the East India Railway station-house, and the railway girder bridge were determined. Next, two bench-marks of the Eastern Jumna Canal, on the left bank of the Jumna, and after that the East India and the Delhi Railway stations at Gazecabad were connected. Then Moradnugger Ganges Canal bridge, as well as a great number of pucka points all along the line up to Meerut church were determined. At Meerut the Delhi Railway station-house rails and platform were also connected, and the whole line of levels from Delhi referred to the cross-mark cut by Captain Branfill on the surface of the stone slab opposite the north pillar of the central west doorway of the station church.

(11.) When the main camp reached Delhi it was already too late in the season for further field operations, but as you had expressed a wish for this work, and the officers of the Baree Doab Canal were also very anxious for our values of the termini of the Eastern and Western Jumna Canals, to check their levels, I resolved to accomplish it, despite all impediments and delays which were to be expected, and which were experienced from hot winds, dust gales, storms, and rain.

(12.) Mr. Civil Assistant L. H. Clarke passed through Delhi on the 22nd May, *en route* to Dehra Doon, which place he reached on the 8th June, and the main camp arrived on the 7th July.

(13.) The following is a summary of work performed :—

156 miles 28 chains of double leveling, embracing determination of 329 pucka points, and including crossing of the rivers Sutlej and Chenab.

4 G. T. S. bench-marks embedded, viz., one at Anarkalli, another at Lahore railway station-house, a third at Mecan Meer, and a fourth at Mooltan.

14 pillars constructed, to indicate sites of G. T. S. bench-marks.

70 tower stations of the Great Indus Series and Sutlej Series repaired, protected, and transferred to the charge of village authorities ; and

25 Great Arc platform stations ditto ditto.

EXTRACT FROM THE NARRATIVE REPORT OF CAPTAIN J. P. BASEVI, R.E., SURVEYOR 1ST GRADE G. T. SURVEY, IN CHARGE NO. 4 EXTRA PARTY, NO. 113, DATED 18TH SEPTEMBER 1867.

(2.) My arrangements for the field season were the same as for the previous one, Mr. W. M. Lemarchand, 3rd Grade Sub-Assistant, proceeding in advance to prepare the observatories, and my other Assistant, Mr. J. W. Macdougall, 3rd Grade Sub-Assistant, remaining with me to record and assist in current office duties.

(3.) During October and November I was employed in taking pendulum observations at the Mussoorie Observatory; I also compared my thermometers with the new Indian standard, No. 4142, and determined again their freezing-points. In this Mr. Hennessey kindly assisted me.

(4.) Whilst these operations were going on, an apparatus was constructed in the Deyrah workshops for determining the factors of expansion of the pendulums by direct micrometric measurements. It had been my original intention to take these experiments in the Mussoorie Observatory, which, having double doors and windows, was admirably adapted to the purpose; but the apparatus as first constructed proved defective, so I moved down to Deyrah, partly on account of the lateness of the season, and partly to superintend the re-construction of the apparatus. These experiments, which will form the subject of a separate report, were made eventually in an outer godown of the old Survey Office at Deyrah, the same one in which I took pendulum observations. They were completed only in time for me to take the field on the 12th of January. I would here express my obligations to Mr. Hennessey, who lent me most valuable assistance in everything connected with these experiments, devoting much of his time to devising and superintending the construction of the apparatus, and afterwards taking one of the microscopes in the measurement.

(5.) At Deyrah, and on my march down, at Meerut and Agra, and afterwards at Pahargarh, Kalianpúr and Ehmadpúr, whilst taking pendulum observations, I took a complete set of magnetic observations for dip, declination and total force. In determining the declination at the first two stations I used the transit mirror, but at the other stations I always employed a referring-mark. The results by the latter method are by far the most accordant.

(6.) I commenced pendulum observations at Pahargarh H.S. on the 24th February, and completed Ehmadpúr H.S., the third and last station, on the 25th April; I then proceeded by Hoosungabad to Chiculdah, for the recess, arriving there on the 20th May.

(7.) Mr. W. M. Lemarchand repaired the Pahargarh observatory, which had suffered from the rains during the last recess. He then built the Ehmadpúr observatory, making a survey of the hill during the building, and completed an observatory in advance at Budgaon, about twelve miles south of Budnaira. He did not come in from the field until the 21st of June. The out-turn of work is small, but it must be remembered that of the eight months he was in the field, over three were taken up in marching alone; he was also much delayed over the Budgaon observatory, on account of the free-labor system of the district, finding it difficult to procure any labor at all, or only at exorbitant rates. I may mention that the Budgaon observatory cost Rs. 511-2, and occupied Mr. Lemarchand two months in the building, whereas the one at Emadpúr, the most expensive one hitherto, cost but Rs. 155-4, and was built in half the time. I consider that Mr. Lemarchand's season's work, under the circumstances, is satisfactory.

(8.) Mr. J. W. Macdougall assisted me in recording the pendulum and magnetic observations, and, with me, brought up a great deal of the computations in camp. He has given me entire satisfaction in everything that he has had to do. I have already reported to you very favorably of him.

(9.) I will now detail the observations and method of observations at each station:

Mussoorie.—There were two series of observations taken at this station, one hot and the other cold, each consisting of twelve sets with each pendulum, six sets face M. (maker's name) to front, and six sets face P. (plain) to front. Each series was taken at the natural pressure of the atmosphere in the vacuum cylinder, and lasted nearly three hours. The first three and last three and two intermediate coincidences were observed. In the hot series the chinks in the doors and windows were pasted up with paper, each door was further protected by a purdah. The clock and apparatus were erected, the clock started, and the room was then raised to the required temperature by means of a charcoal stove. The pendulums were kept in the room, so that they acquired the high temperature gradually at the same time as the room, and observations were not commenced until the temperature of the room had stood over 80° for several days. The pendulums were swung in order, first No. 4, and then No. 1821. The clock used was a mean-time one by Jones, belonging to the Survey, as the clock Shelton, belonging to the apparatus, was under repair. Transits were taken every night to a sidereal chronometer, Frodsham, No. 3,379, which was compared with the clock immediately before and after the transits. The hot series was commenced on the 2nd October, and completed on the 10th October. The temperature was very constant, never falling below 81°, nor rising above 87°. The hot series concluded, the doors and windows were all thrown open, and the room allowed to assume the natural temperature, but observations were not commenced until the 1st of November, in order to get as low a temperature as possible. Observations were commenced with No. 1821 Pendulum, and No. 4 Pendulum was completed on the 10th November, the temperature ranging from 51° to 58°. Clock Shelton was used for the transits in this series, being compared directly with clock Jones immediately before and after the transits. From these observations I have computed the temperature coefficients of the pendulums, that is to say, the variation in the number of vibrations made in one mean solar day due to an increment or decrement of 1° Fahrenheit. The values are—

No. 4 Pendulum 0·420 ± ·0035
No. 1821 do. 0·441 ± ·0032
} Mean Pressure 23·5 inches.

The values obtained at Kaliana (recomputed) are—

No. 4 Pendulum ·485 ± ·0021
No. 1821 do. ·470 ± ·0023
} Mean Pressure 3·8 inches.

From General Sabine's observations with No. 4 Pendulum at London in 1824, which I have recomputed in part, using the Kew coefficient for reduction to a vacuum, I obtain for

No. 4 Pendulum 0·428 ± ·0007, Mean Pressure 29·8 inches.

From an examination of these quantities it appears that both pendulums follow the same law; in both the coefficient at the low pressure is the largest, and in both the coefficient at the full pressure of near thirty inches is nearly the same as at the Mussoorie pressure of 23·5 inches. This agreement can, I think, be hardly accidental. The results of the Mussoorie observations reduced to vacuo, to mean temperature 72°, and approximately to mean sea-level, are—

No. 4
1st Series, 86,074·721 ± ·042
2nd Series, 74·723 ± ·094
Mean, 86,074·722 ± ·051

No. 1821
1st Series, 85,973·995 ± ·060
2nd Series, 73·999 ± ·073
Mean, 85,973·997 ± ·047

(10.) Pahargarh H. S.—The observations here were conducted in the same way as last season, with the exception that six sets only were taken with each pendulum instead of ten. Transit observations were taken both in the evening and morning to a mean-time chronometer (Dent No. 2,730), which was compared with the pendulum clock before and after the transits. The mean number of vibrations in vacuo at mean sea-level reduced to 72° Fahrenheit are—

No. 4 Pendulum 86,060·744 ± ·079
No. 1821 do. 85,960·413 ± ·044

The probable error of a star's transit over a single wire was ± 0·090, so that the probable error of the clock's rate deduced from four stars (the average number taken each evening and morning) = ± ·028

The Pahargarh observatory was built over the Trigonometrical station. The hill is low and flat-topped, rising less than 100 feet above the general level of the country. The soil is a dense sandstone.

(11.) KALIANPUR.—The observations were taken in the room adjoining the astronomical observatory built by Sir George Everest for an office. It is in excellent preservation. It is built of finely-dressed stone, the beams of the roof are of stone, and the roof itself of large flat stones laid in cement, the floor also is paved with stones. The same number of observations were taken here as at Pahargarh, and transits were taken both evening and morning. The results reduced to vacuo, to mean sea-level, and to 72° Fahrenheit are—

No.	4 Pendulum	86060·389	± ·058
No. 1821	do.	85960·187	± ·053

The probable error of a star's transit over a single wire was ± ·077, and of the clock's rate from four stars ± ·024.

Kalianpúr is situated on undulating ground near the edge of the ridge bounding the Sironj valley, which is about 200 feet lower. The soil is, I believe, laterite.

(12.) EHMADPUR is on a low isolated hill elevated about 260 feet above the general level of the country. The soil is a hard sandstone. A rough survey of the hill was made by Mr. Lemarchand, which afforded data for computing with sufficient approximation the effect of the hill on the vibrations of the pendulum. The results at this station are reduced as before :

No.	4 Pendulum	86058·400	± ·018
No. 1821	do.	85957·574	± ·066.

The probable error of a star's transit over a single wire ± ·072, and of the clock's rate deduced from six stars ± ·019.

The observatory was not built over the Trigonometrical station, but a short distance east of it, and on ground about twenty feet lower.

(13.) The results of the past season's operations are all reduced to vacuo, to mean sea level, and to 72° Fahrenheit. This mean temperature was taken simply on account of its being almost exactly the mean temperature of all the stations observed at in India, but I would suggest that it be now adhered to as a standard temperature.

(14.) These results cannot be considered final, there being still an uncertainty about the temperature and pressure coefficients. The temperature coefficient determined at Kaliana, and which has been used throughout these reductions, will be found, I believe, eventually to be too large. Several circumstances point this out, amongst them I may mention that last year's work was all approximately computed with an assumed coefficient, 0·435 for 1° Fahrenheit, and the probable errors are in almost every case smaller with this coefficient than with the Kaliana one. I consider that the pressure and temperature coefficients should be determined simultaneously, by taking at least four series of observations, two at low pressure and extremes of temperature, and two at high pressure and extremes of temperature. The value of such observations would be greatly increased by introducing two more sets taken at an intermediate pressure. By building an observatory for the express purpose in some suitable locality, where a low natural temperature can be obtained, such experiments might be still further extended without exceeding the limit of an ordinary field season. A small constant correction will have to be applied eventually on account of a thermometer reading less in vacuo than in air, owing to the removal of the atmospheric pressure. I have been taking experiments at Chikulda, for the purpose of determining this correction; it apparently will not exceed two-tenths of a degree.

EXTRACT FROM THE NARRATIVE REPORT OF J. B. N. HENNESSEY, ESQ., SURVEYOR 1ST GRADE G. T. SURVEY, IN CHARGE COMPUTING OFFICE, DATED 1ST MAY 1867.

(1.) *Calculating Branch.*—On 31st August 1866, Mr. Lane was removed to the charge of the Leveling Party, giving place to Lieutenant M. W. Rogers, R.E. The latter gentleman has accordingly acted as my assistant for the chief portion of the past year. Lieutenant H. Trotter, R.E., worked under my directions for a couple of months, with the object of acquiring a more intimate acquaintance with the processes and calculations of the Survey Department. He was successful in his studies, and I have little doubt that he will prove equally successful in the discharge of any professional duties that may be assigned to him. Lieutenant W. H. Collins, R.E., also did duty with me for some time last winter. The state of his health, consequent on the terrible physical damages he received in the Bhootan campaign, made it essential that he should return to England, and the Computing Office accordingly lost his services. Five of the native computers were induced to leave the office, as they gave no promise of qualifying for an efficient discharge of their duties.

(2.) *Printing Branch.*—This department has undergone no sensible change in establishment.

(3.) *Photozincographic Branch.*—The duties of this branch were conducted by Captain H. H. Godwin-Austen up to the 27th July, when he gave place to Lieutenant J. Waterhouse, R.A. The latter gentleman joined the office for the purpose of becoming acquainted with the process of photozincography, and when duly qualified, he was removed to the charge of the similar office in the Surveyor General's Department at Calcutta. Mr. W. H. Cole, M.A., succeeded Lieutenant Waterhouse on 3rd January, and has continued to conduct the duties of the establishment. This appears a suitable place to notice that Captain A. B. Melville was also instructed in the process last winter, and became well acquainted with it in due course. He was thus able to relieve Lieutenant Waterhouse of the Surveyor General's Department at Calcutta, when the latter gentleman was obliged to proceed to England on medical certificate. Four officers have thus already been instructed in the process at your Dehra Office. The three presses in this branch are now all at work. Two are employed for printing purposes, while the third is unavoidably reserved for chromo-carbon transfers.

(4.) *Calculating Branch.*—The following table exhibits the amount of ordinary calcula-
Progress. tions, and other work performed :—

Subject.	Quantity.
Numbered pages and indexed,	177 volumes of angle books.
Micrometer readings, copied,	1020 openings of an angle book.
Do., compared,	1281 do.
Do., examined (special),	145 do.
Mean readings, examined or computed,	1684 do.
Do., compared,	1642 do.
Angles, examined or computed,	1875 do.
Do., compared,	1198 do.
General means and level corrections (of vertical angle book) examined or computed,	312 openings.
Do. do., compared,	754 do.
Abstracted observed angles,	203 angles.
Computed weights of observed angles,	205 do.
Made synopsis of results of above,	29 do.
Computed spherical excesses,	84 triangles.
Computed principal triangles,	267 do.
Extended computation of principal triangles to 8th place of logs.,	347 do.

Subject.	Quantity.
Computed principal latitudes, longitudes and azimuths,	164 double deductions.
Computed corrections to figures by the method of least squares, ...	1 quadrilateral, 5 simple polygons, 7 compound figures.
Made consistent to 5 in the eighth place of logs., figures already reduced, ...	9 quadrilaterals, 27 simple polygons, 13 compound figures.
Computed weights of sides of continuation, ...	36 triangles, 21 quadrilaterals, 39 simple polygons, 18 compound figures, 5 do. partially computed.
Computed the observed latitude at, ...	10 stations.
Number of observations reduced in above, ...	1810 observations.

(5.) There are also the following ordinary duties to notice :—The compilation of "copy" for the press, and the daily careful examination of proofs. These duties have been carried on as usual, so that 476 pages of the book on the North-West Quadrilateral were printed in 1866-67; and as 215 pages of this volume were printed in 1865-66, there remain 66 pages more to complete the subjects of "Alphabetical Lists," "Numerical Lists," "Descriptions of Principal Stations," and "Observed Angles." The preparation of lists of all the principal stations o the Great Trigonometrical Survey for the civil authorities, with the object of transferring these stations to their care, required a considerable amount of time and labor. The larger portion of these lists stands disposed of.

(6.) I had the pleasure last winter of assisting Captain J. P. Basevi, R.E., in determining the coefficients of expansion of the two brass pendulums with which he is conducting the pendulum experiments. The resulting equations were reduced in the Computing Office, by the method of least squares.

(9.) I next turn to the comparisons of thermometers and of standard bars. To admit of the linear standards being compared, it first became necessary to compare our thermometers, since the working thermometers, which Captain A. R. Clarke, R.E., of the Ordnance Survey, was good enough to compare for us, were broken almost without exception on their way from England to your head-quarters. These experiments were duly made by Lieutenant Rogers and myself.

(10.) We were thus enabled to compare the following ten-foot standards :—

Bronze Bar, or I_B,
Steel Bar, or I_S,
G. T. Survey Iron Bar, or A,

with one another. The observers in this case were—The Superintendent of the Great Trigonometrical Survey, Captain T. G. Montgomerie, R.E., J. B. N. Hennessey, Esq., Lieutenant M. W. Rogers, R.E.

(11.) The comparisons thus made at your head-quarters, Dehra, were these :—

I_B with I_S,	.. ..	25 comparisons.
I_B with A,	.. ..	36 „
I_S with A,	.. ..	28 „

whence the following statement :—

$I_B - I_S$, as determined at the head-quarters of the Great Trigonometrical Survey, ... = 131·40 millionths of a yard.

$I_B - I_S$, as determined at Southampton by Captain Clarke, R.E., (see Comparisons of Standards of Length, page 280, ... = 131·46 millionths of a yard.

(12.) Accepting Captain Clarke's value as a constant, in accordance with your directions, the remaining 64 equations furnish

$$\left.\begin{aligned} I_B - A &= 221{\cdot}35 \text{ millionths of a yard,} \\ I_S - A &= 89{\cdot}59 \text{ millionths of a yard,} \end{aligned}\right\} (1).$$

(13.) Combining either numerical value from (1) with the results at page 280 of "Comparisons of Standards of Length," it appears that $\frac{10}{3} Y_{55} - A = 20{\cdot}51$ millionths of a yard.

(14.) Again, by a similar process, the means of comparing the ancient and modern values of B − A are obtained, where B* is the 10-foot Iron Standard of the Indian Survey deposited in England, thus,—

By comparisons made by Captain Clarke at Southampton 1865, and others made at Dehra by Lieutenant-Colonel Walker and his assistants in 1867, ..	B − A = 3·08 millionths of a yard.
By comparisons made by Colonel Everest 1834-35, ..	1·28 millionths of a yard.
Difference =	1·80

(15.) It thus stands proved that, during the interval of 30 years, the difference B − A has not altered sensibly, and this is all the more satisfactory, since A has been carried over full ten thousand miles of land, besides the voyage to India, and that from Calcutta to Vizagapatam; while B has sailed twice round the Cape to and from India, and has also been taken from England to Russia, and back home.

(16.) *Miscellaneous Duties.*—The following are some of the duties which fall under this denomination:—The list of points on the Himalaya mountains, more than 16,000 feet above sea level, was completed by Mr. Lane, and he was subsequently employed in reducing certain levels of the Ganges Canal to Great Trigonometrical Survey datum. Lieutenant W. J. Heaviside, R.E., was instructed in the use of the astronomical circle, and a paper of directions on the subject was prepared for his use. The field books of the Trans-Himalayan explorers were translated into English. Their observed latitudes and the heights from their readings of the boiling point of a thermometer computed. Their traverses were also projected by themselves, under my direction. A new edition of the Geodetical Tables is in course of preparation. All the old auxiliary tables have been extended from 8° to 5° of latitude, so as to include Ceylon; and, in accordance with your wishes, certain new tables are being constructed, which will enhance the utility of the compilation. A list of stars observed on the Great Arc was drawn up for the Astronomer Royal, to admit of special observations being taken at Greenwich for the more accurate determination of their places. Colonel Lambton's papers were arranged and indexed. Directions for taking tidal observations were prepared for Mr. Rossenrode. A quadrangular library shelf, as well as a trough for comparing thermometers, and the isolated supports necessary for bar comparisons were designed and constructed. Three candidates for Sub-Assistantships were examined in the usual subjects. The meteorological observations were taken as usual, and a copy of the readings supplied to the Reporter on Meteorology N. W Provinces, &c., &c.

(17.) *Printing Branch.*—This department composed 756 pages (foolscap size), and struck off 93,411 impressions. It has been provided with an Athol hot-press, as well as such descriptions of type as were necessary to increase its efficiency.

(18.) *Photozincographic Branch.*—The following table exhibits the work performed:—

Forms zincographed, 34 subjects, 116 pages, ...	5,152 prints.
Charts of triangulations, skeleton maps, &c., zincographed, 18 subjects,	2,251 do.
Maps and charts photozincographed, 15 subjects, involving 59 negatives,	4,867 do.

* This Bar is designated as I_b in the "Account of the Measurement of the Lough Foyle Base," and also in the "Comparisons of Standards of Length."

Conclusion.

(19.) In concluding this report, I have much pleasure in acknowledging the valuable assistance I have received from Lieutenant M. W. Rogers, R.E. Very willing to work, quick and energetic, he has not only taken a leading share in designing and carrying out projects, but he has also acquired a sound knowledge of the ordinary departmental processes of calculation. I have every reason to hope that his experience and skill in the use of instruments will prove exceedingly useful at the Bangalore base, on which it is your intention to employ him next winter.

(20.) I am also much obliged to Mr. Wood, and to Baboos Gunga Pershad and Dwarka Nath Dutt for their hearty co-operation in discharging the duties of the Computing Office. Baboo Cally Mohun Ghose has made considerable progress towards qualifying himself as a leading computer. Baboo Gopal Chunder Surcar continues a very steady and careful assistant. The other computers have all given me satisfaction.

(21.) In the Photozincographic branch, Mr. Ollenbach has continued to make fair progress in the process. His skill in putting together and transferring the transfers to zinc promise ere long to help in producing superior prints. This department is now quite able to print all the Departmental forms, and these will in future be prepared by the Computing Office in accordance with your wishes.

P.S.—Subsequent to the date of this report, the 6-inch brass scales of the compensated base-line microscopes were compared with the central 6-inch space (d. l.) on the Indian Standard steel foot.

The observers were—Captain T. G. Montgomerie, R.E., J. B. N. Hennessey, Esq., Lieutenants H. R. Thuillier, R.E., W. J. Heaviside, R.E., M. W. Rogers, R.E., and each scale was compared 20 times with the space (d. l.)

Reducing these observations in the usual way, and combining our results with those given on page 280 of "Comparisons of Standards of Length," we obtain the following differences expressed in millionths of a yard:—

$$\frac{A}{20} - M = -\ 4{\cdot}56 \qquad \frac{A}{20} - T = +\ 1{\cdot}04$$

$$\frac{A}{20} - N = -\ 13{\cdot}00 \qquad \frac{A}{20} - U = -\ 11{\cdot}05$$

$$\frac{A}{20} - R = -\ 9{\cdot}46 \qquad \frac{A}{20} - V = +\ 3{\cdot}35\ *$$

$$\frac{A}{20} - S = +\ 0{\cdot}57 \qquad \frac{A}{20} - W = +\ 0{\cdot}89$$

The value of the ninth scale is not given here, as its dots have become seriously distorted, and you decided on using it no longer.

The relative length of the scale P, absent in England for repairs, to its microscope is expressed by—

$$\frac{A}{20} - P = -\ 13{\cdot}28.$$

Remarking that our 6-inch scales have hitherto been reckoned in terms of a 6-inch brass standard scale (the one now unserviceable), the effect of the above relations will be to increase the lengths of all our base-lines. The maximum augmentation falls to the Bider base-line, that being our longest side of verification, and here the correction amounts to + 0·51 inches.

---

* A denotes the 10-foot iron standard of the G. T. Survey; M, N, R, S, T, U, V, W are the brass scales appertaining to the corresponding base-line compensated microscopes.

ANNUAL RETURN OF WORK EXECUTED IN THE DRAWING BRANCH OF THE OFFICE OF SUPERINTENDENT G. T. SURVEY FROM 1ST MAY 1866, TO 30TH APRIL 1867.

Map of Central Asia, scale 48 miles = 1 inch.
Sheet No. 5, or Section No. 11, Kashmir Survey, for Home Government.
Section No. 11 Kashmir Survey.
Preliminary Chart of the Jubbulpore Meridional Series, season 1864-65.
Ditto of the East Calcutta Longitudinal Series, seasons 1862 to 1866, on transfer paper.
Chart shewing arrangements of general sheets of the Kumaon and Gurhwal Survey.
Projected Graticules and inserted details in the 6 sheets, to exhibit G. T. Survey, Railway, and Ganges Canal Leveling Operations.
Made a Tracing of the Drainage Survey of the Seyngurh and Sursoo Nuddees, continued from the Survey of 1859-60.
Made Tracings of 3 Maps, continuation of the Survey of the Etawah Terminal Branch Ganges Canal.
Completed and reduced Cawnpoor Branch Ganges Canal in 4 sheets from 1 to 2 miles = 1 inch.
Ditto Futtygurh ditto 6 maps ditto.
Ditto Cross Section left main Rujbuha to the Kalee Nuddee Cawnpore Branch.
Ditto Line of Levels from Roorkee Bridge to Dadoopoor Escape Dam.
Ditto Map of the Koel Branch, No. 26.
Ditto Map of the Etawah Branch, No. 15.
Reduced Skeleton Map of Cross Section between Dasna and Jewur.
Ditto ditto between Jewur and Reyah.
Reduced to one-fifth Plan of the Contour Survey or Levels N. and S. of the Ganges Canal.
Reduced Map of the Drainage Survey of the Seyngurh and Sursoo Nuddees, continued from the Survey of 1859-60.
Reduced 3 Maps, continuation of the Survey of the Etawah Terminal Branch Ganges Canal.
Reduced Route Map of Lhasa.
Map of the Ganges and Jumna Doab, showing the line of levels taken in 1864 (in 2 sheets).
Prepared an Extract from the N.-W. Himalaya Survey, between lat. 30° 5′ and 31° 55′, and long. 77° 45′ and 77° 55′.
Projected Graticule, and inserted details in Map of Dehra Doon, scale 2 miles = 1 inch.
Completed Sheet No. 8, or Section No. 14, Kashmir Survey, for Home Government.
Completed an Index to the G. T. Survey, up to 1st May 1866.
Preliminary Chart of the Eastern Frontier Series, season 1864-65.
Ditto ditto, 1865-66.
No. 1 Preliminary Chart of the Revised Calcutta Longitudinal Series, season 1863-64.
No. 2 Ditto ditto, 1864-65.
Preliminary Chart of the Kumaon and Gurhwal Series, seasons 1864-65-66.
Sheet No. 7, part of British Gurhwal, season 1865-66, scale 1 mile = 1 inch.
Sheet No. 1, Ditto, 1864-65, ditto.
Skeleton Sheet No. 7, part of British Gurhwal, season 1865-66.
Ditto No. 1, Ditto, 1864-65.
Sheet No. 9 Mussoorie and Landour, season 1865-66, scale 12 inches = 1 mile.
Skeleton Sheet No. 9, Ditto, ditto, on transfer paper.
Ditto No. 7, Ditto, ditto, ditto.
Preliminary Chart of portions of the Bombay Longitudinal and Mangalore Meridional Series, seasons 1862-63-64-65.
Ditto of the Madras Meridional Series, season 1864-65, on transfer paper.
Colored 505 copies of Maps.
&c., &c., &c.

REPORT

ON

THE TRANS-HIMALAYAN EXPLORATIONS,

IN CONNECTION WITH THE

GREAT TRIGONOMETRICAL SURVEY OF INDIA,

DURING 1865-67.

DRAWN UP BY

CAPTAIN T. G. MONTGOMERIE, R.E.,

IN CHARGE OF THE TRANS-HIMALAYAN SURVEY PARTIES.

NARRATIVE REPORT OF A ROUTE-SURVEY MADE BY PUNDIT *————, FROM NEPAL TO LHASA, AND THENCE THROUGH THE UPPER VALLEY OF THE BRAHMAPUTRA TO ITS SOURCE, DRAWN UP BY CAPTAIN T. G. MONTGOMERIE, R.E., OF THE G. T. SURVEY, IN CHARGE OF THE TRANS-HIMALAYAN SURVEY PARTIES.

Exploration beyond the frontiers of British India has, for many years, made but little comparative progress, and (as far as Europeans have been concerned) has been confined to points not many marches beyond the border.

A European, even if disguised, attracts attention when travelling among Asiatics, and his presence, if detected, is now-a-days often apt to lead to outrage. The difficulty of redressing such outrages, and various other causes, has, for the present, all but put a stop to exploration by Europeans. On the other hand, Asiatics, the subjects of the British Government, are known to travel freely without molestation in countries far beyond the British frontier; they constantly pass to and fro between India and Central Asia, and also between India and Tibet, for trading and other purposes, without exciting any suspicion.

In 1861 it was consequently proposed to take advantage of this facility possessed by Asiatics, and to employ them on explorations beyond the frontier. The Government of India approved of the project, and agreed to support it liberally.

With a view to carry out the above, Colonel Walker, the Superintendent G. T. Survey, engaged two Pundits, British subjects, from one of the upper vallies of the Himalayas. These men were recommended by Major Smyth, of the Educational Department, as likely to have great facility in travelling through various parts of Tibet, their countrymen having always been granted by the Chinese authorities the privilege of travelling and trading in Nari-Khorsum, the upper basin of the Sutlej. Such promising recruits having been secured, they were at once sent to the Head-Quarters of the G. T. Survey, in order to be trained for Trans-Himalayan exploration.

On Colonel Walker's departure for England, these Pundits were put under Captain Montgomerie, who completed their training. They were found to be very intelligent, and rapidly learnt the use of the sextant, compass, &c., and before long recognized all the larger stars without any difficulty. Their work, from actual practice, having been found to be satisfactory, Captain Montgomerie directed them† to make a route-survey from the Mansarowar lake to Lhasa, along the great road that was known to exist between Gartokh and Lhasa. From Lhasa, they were directed to return by a more northerly route to Mansarowar. The route to Lhasa was selected by Captain Montgomerie, because it was known, from native information, to be practicable as far as the road itself was concerned. If explored, it was likely to define the whole course of the great river known to flow from near the Mansarowar lake to beyond Lhasa. Hitherto the sole point on the upper course of this great river, the position of which was known with any certainty, was a point near Teshooloomboo, or Shigátze, as determined by Captain Turner in 1783. The position of Lhasa, the capital of Great Tibet, was, moreover, only a matter of guess, the most probable determination having been derived from native information as to the marches between Turner's Teshooloomboo and Lhasa. In fact, the route from the Mansarowar lake to Lhasa, an estimated distance of 7 or 800 miles, was alone a capital field for exploration.

An attempt was made by the Pundits to advance direct from Kumaon, *vid* Mansarowar, to Lhasa, but they did not find it practicable. Whilst in Kumaon, they came across some British subjects, Bhotiyas, who had been robbed whilst trading in the Chinese territories, near Gartokh.

---

* The two Pundits being still employed on explorations, their names are, for obvious reasons, omitted.

† *Vide* Captain Montgomerie's letter of instructions in Appendix.

These Bhotiyas thought that, if the matter was properly represented, they might get redress from the Lhasa Government, and hearing that the Pundits were going to Lhasa, asked them to be their agents (vakeels), in order to recover what they could. The Pundits consented, and one of them returned to Captain Montgomerie for fresh instructions. The attempt by the Mansarowar lake having failed, it appeared to Captain Montgomerie that the best chance of reaching Lhasa would be through Nepal, as the Nepalese Government has always maintained relations of some kind with the Government of Lhasa. Traders from Nepal, moreover, were known to visit Lhasa, and Lhasa traders to visit Nepal.

Captain Montgomerie thought that the wish to recover money for the Bhotiyas of Kumaon would afford a plausible excuse for the Pundit's journey to Lhasa, an excuse the Nepalese would thoroughly understand, and he trusted the frequent intercourse with Lhasa would eventually afford the Pundits a good opportunity of travelling to that place in company with traders or others.

The Pundits were consequently ordered to go to Kathmandû, and from thence to try and make their way to the great road between the Mansarowar and Lhasa. Their instrumental equipment consisted of 2 large sextants*, 2 box sextants, prismatic and pocket compasses, thermometers for observing temperature of air and of boiling water, pocket chronometer, and common watch, with apparatus, the latter reduced as much as possible.

The Pundits started from Dehra, reached Moradabad on the 12th January, and Bareilly on the 23rd January 1865. At Bareilly they took latitude observations, and commenced their route-survey. They crossed the Nepalese frontier at Nepalgunj, Jung Bahadur's new town, and from thence went by the Cheesaghurri road to Kathmandû, reaching the latter place on the 7th March 1865.

In Kathmandû they made inquiries on all sides as to the best route to Lhasa; they found that the direct one by Kûti (or Nilum), across the Dingri plain, (or Tingri Maidan, as it is called), was likely to be very difficult, if not impassable, owing to the snow at that early season (March, April). They consequently determined to try the route by Kirong, a small town in the Lhasa territory, as that route was said to be passable earlier than the Kûti route. Having made their arrangements, the Pundits started full of hope on the 20th March 1865, accompanied by 4 men, whom they had hired as servants.

On the 26th they reached Medangpodo village, and here they changed their mode of dress to one better known to the people of Lhasa. They also gave out that they were Bisahirist, and were going to buy horses, at the same time to do homage at the Lhasa shrine. The character of Bisahiris was assumed, because they knew that those people had from time immemorial been privileged to travel in the Lhasa territory without question. On the 28th March they reached the neighbourhood of Kirong, but, much to their disappointment, they were stopped by the Chinese officials, who questioned them as to the object of their journey, and searched their baggage. Fortunately the instruments (which had been ingeniously secreted in a false compartment of a box) escaped detection; but still, though nothing suspicious was seen, the plausible reasons given for the journey did not satisfy the jealousy of the Chinese authorities. In spite of everything urged, they were not allowed to pass until a reference had been made to the Kirong governor. The Kirong governor seems at once to have noted the weak points of their story, and having pointed them out with inexorable logic, declined to let them pass on any consideration; they were therefore reluctantly forced to retrace their steps to Shabrû. At Shabrû the wily Pundit managed to persuade a high official that they were no impostors, and induced him, moreover, to certify that in a letter to the Kirong governor. Armed with this letter, they returned towards Kirong, with hopes of better luck, and no doubt under ordinary circumstances, would have succeeded; but on the road they fortunately discovered that the Kirong governor was an individual who had known the Pundit's brother personally, when he was chief of

---

* Only one large sextant was taken to Lhasa.

† From the British valley of that name north-east of Simla.

Taglakote near Mansarowar; his brother had in fact been frequently in close and friendly relations with him. This at once put a stop to all hopes of his advancing by the Kirong route, as the governor well knew he was no Bisahiri. The other Pundit thought of proceeding by himself, but, being able to devise no feasible method, he gave up the idea, and the party consequently marched back, reaching Kathmandû on the 10th April. Here they made fresh inquiries as to some more promising way of getting to Lhasa. At last they heard of two opportunities, the first by accompanying the camp of a new agent (vakeel) that Jung Bahadur was about to send to Lhasa, and the second by accompanying a Bhot merchant. In order to increase their chances of success, they decided that one should go with the Nepal agent, and the other with the merchant. The vakeel at first agreed to take one of them with him, but ultimately refused.

Failing with the vakeel, it was impossible for the Pundit, who was known to the Kirong governor, to go with the Bhot merchant, as he intended to take the Kirong route; he consequently decided to try a more circuitous route, by Muktináth, but in this he failed, owing, according to his own account, to loss of health, and the unsafe state of the roads, but, no doubt, in a great measure due to his own want of determination. After a long journey through the upper parts of the Nepal territory, he returned to British territory. The account of his proceedings is referred to separately. The other Pundit, at first, was not much more successful with the merchant than his brother had been with the vakeel. The merchant, Dawa Nangal, promised to take the Pundit to Lhasa, and on the strength of that proceeded to borrow money from him. The merchant, however, put off starting from day to day, and eventually the Pundit had to start with one of the merchant's servants, the merchant himself promising to follow in a few days. The Pundit assumed the dress of a Ladáki, and, to complete his disguise, added a pig-tail to his head. This change was made, because he was afraid that the Kirong officials, who stopped him the first time, might recognise him again.

Starting on the 3rd June with one servant and Dawa Nangal's man, he reached Shabrû on the 20th of June, having been delayed six days by a bad attack of fever. At Shabrû he was kindly received by Dawa Nangal's family, but Dawa Nangal himself never made his appearance, and it became evident that he did not intend to keep his promise. In his perplexity the Pundit appealed to Dawa Nangal's uncle, and told him how he had been treated. The uncle, a man of some authority, said he sympathized with him, and gave him a pass to Kirong, and a letter to Dawa Nangal's brother, who had just returned to Kirong from Lhasa. In the letter he mentioned that the Pundit's claim against Dawa Nangal was just, and, in consequence, requested him to arrange for the Pundit's journey to Lhasa, and, if necessary, to stand security for him.

Starting on the 6th July with one of the uncle's servants, the Pundit managed to make his way into Kirong. Here he found Dawa Nangal's brother, by name Chúng Chú. Chúng Chú, on hearing the state of the case, promised to assist the Pundit on to Lhasa, but refused to pay his brother's debt. Chúng Chú proved himself a better man than his brother, for, though permission to travel by the direct route was refused, he ultimately succeeded in getting the Pundit permission to travel onwards; by this means he reached Tadúm monastery, a well-known halting place on the great road between Lhasa and Gartokh. Starting on the 13th August from Kirong, he reached Lue on the 23rd. From Kathmandû up to this point vegetation and jungle had been abundant, but, beyond, the mountains were throughout bare, and all but barren.

On the 24th August the Pundit joined a large trading party, travelling *vid* Tadúm to Mansarowar, and was allowed to accompany them. On the 30th he reached Talla Labrong, and there first caught sight of the great river* that flows towards Lhasa. His first acquaintance with this river was calculated to inspire him with respect for it, as three men were drowned in front of him, by the swamping of a ferry boat. Alarmed by this occurrence, the party marched a short distance farther up the river to a better ferry, by which they crossed in safety to the Tadúm monastery on the 6th of September. At Tadúm the Pundit feigned sickness, as a reason for not going on to Mansarowar, and he was accordingly left behind. Continuing to feign illness, he

* The Brahmaputra.

at last found an admirable opportunity of going to Lhasa, viz., by accompanying a Ladák merchant in the employ of the Kashmir Maharaja, who was that year going to Lhasa, and was to pass through Tadúm. On the 2nd of October the merchant's head man, Chiring Nirpal, arrived, and on hearing the Pundit's story, at once consented to take him on to Lhasa. Starting on the next morning with the Ladaki camp, he marched eastwards along the great road, reaching the town of Sarkajong on the 8th October. So far everything had gone smoothly, but here the inquiries made by the authorities rather alarmed the Pundit, and as his funds, owing to the great delays, had begun to run short, the two combined made him very uneasy. However, he manfully resolved to continue his journey. He became a great favorite with Chiring Nirpal and the whole of the Ladáki camp. On the 19th October they reached Ralang. From Tadúm to this point no cultivation was seen, but here there was a little, and a few willow trees, and onwards to Lhasa cultivation was met with nearly every day.

On the 22nd October the party reached the town of Janglache, with a fort and fine monastery on the Nárichú*, the great river first met with near Talla Labrong. From this point people and goods are frequently transported by boats to Shigátze, 5 days march (85 miles) lower down the river. Most of the Pundit's companions went by boat, but he having to survey, count paces, &c., went by land. On the 29th October they reached Digarcha, or Shigátze, a large town on the Penanangchú river near its junction with the great Nárichú river. At Shigátze, Chirung Nirpal had to wait for his master, the head merchant, called Lopchak. The Pundit consequently remained in that town till the 22nd of December. The Lopchak, who arrived on the 16th November, saw no objection to the Pundit continuing with the party, and, moreover, promised to assist him at Lhasa. Whilst at Shigátze the Pundit and his companions remained in a large sort of caravanserai called Kunkhang. The only incident during their long stay there was a visit that he and the Ladákis paid to the great Tashilumbo monastery. This monastery lies about half a mile south-west of the city, and is the same as that visited, and fully described by Turner. The Pundit would rather not have paid the Lama a visit, but he thought it imprudent to refuse, and therefore joined the Ladákis, who were going to pay their respects to him. The Pundit confesses that, though personally a follower of Brahma, the proposed visit rather frightened him, as, according to the religion of his ancestors, who were Budhists, the Lama ought to know the secrets of all hearts. However, putting a bold face on the matter, he went, and was much relieved to find that the Lama, a boy of 11, only asked him three simple questions, and was, according to the Pundit, nothing more than an ordinary child, and did not evince any extra intelligence. At Shigátze the Pundit took to teaching Nepalese shopkeepers the Hindee method of calculation, and thereby earned a few rupees.

The great road, which had hitherto been more or less close to the great Nárichú river, from Shigátze goes considerably south of that river. On the 25th December they reached the large town of Gyangze, on the Penanangchú river, which was then frozen hard enough to bear men. Crossing the lofty Kharola mountains, they arrived on the 31st December at Nang-ganche jong, a village on the Yamdokcho lake, with the usual fort on a small hill. For two days the Pundit coasted along the Great Yamdokcho lake†. On the second day he nearly fell a prey to a band of robbers, but, being on horseback‡, he managed to escape, and on the 2nd January reached Demálang, a village at the northern angle of the lake. From Demálang the lake was seen to stretch some 20 miles to the south-east. The Pundit estimated the circumference of the lake to be 45 miles, but, as far he saw, it was only 2 to 3 miles in width. He was informed that the lake encircled a large island, which rises into low rounded hills 2 or 3,000 feet above the surface of the lake. These hills were covered with grass up to the top. Between the hills and the margin of the lake several villages and a white monastery were visible on the island. The villagers keep up their communication with the mainland by means of boats. The Pundit was told that the lake had no outlet, but as he says its water was perfectly fresh, that is probably a mistake; if so, the Pundit thinks the outlet may be on the eastern side, where the mountains

* The Brahmaputra river.

† The margin of the lake was frozen.

‡ With reference to this, the Pundit on being questioned said that the paces of this portion, and of one or two other parts, were counted on his return journey.

appeared to be not quite so high as those on the other sides. The evidence as to the lake encircling a very large island is unanimous. Almost all former maps, whether derived from the Chinese maps made by the Lamas, or from native information collected in Hindustan, agree in giving the island a very large area, as compared with the lake in which it stands. This is however a very curious topographical feature, and as no similar case is known to exist elsewhere, it might perhaps be rash to take it for granted, until some reliable person has actually made the circuit of the lake. Meantime the Pundit's survey goes a considerable way to confirm the received theory. The lake, from the Pundit's observations, appears to be about 13,500 feet above the sea; it contains quantities of fish. The water was very clear, and said to be very deep.

The island in the centre must rise to 16,000 feet above the sea, an altitude at which coarse grass is found in most parts of Tibet.

From the basin of the Yamdokcho lake the party crossed over the Khambala mountains by a high pass, reaching the great Nárichú (the Brahmaputra) at Khambabarche; from thence they descended the river in boats to Chusul village. Near Chusul they again left the great river, and ascending its tributary, the Kichu Sangpo or Lhasa river, in a north-easterly direction reached Lhasa on the 10th of January 1866.

The Pundit took up his abode in a sort of caravanserai with a very long name, belonging to the Tashilumbo monastery; he hired two rooms that he thought well suited for taking observations to stars, &c., without being noticed. Here he remained till the 21st of April 1866. On one occasion he paid a visit to the Goldan monastery, two marches up the great road to China, which runs from Lhasa in a north-easterly direction. He also attempted to go down the Brahmaputra, but was told that it was impossible without a well-armed party of a dozen at least. His funds being low, he was obliged to give up the idea, and indeed, judging from all accounts, doubted if he could have done it with funds. The Pundit's account of the city of Lhasa agrees, in the main, with what has been written in Messrs. Huc and Gabet's book as to that extraordinary capital, which the Pundit found to be about 11,400 feet above the sea. He particularly dwells upon the great number, size and magnificence of the various monasteries, and the vast number of monks, &c., serving in them.

He had an interview with the Grand Lama, whom he describes as a fair and handsome boy of 13 years of age. The Lama was seated on a throne six feet high, and on a lower throne to his right was seated his chief minister, the Gyalbo* or Potolah raja, as he is called by the Newár people. The Gyalbo is evidently the actual ruler of Lhasa, under the Chinese ambán or resident, the Grand Lama being a puppet in the hands of the Gyalbos.

It is curious that the few times these Great Lamas have been seen by reliable people, they have been always found to be small boys, or fair, effeminate-looking young men. Moorcroft remarks on the emasculated appearance given to them in all the pictures of them that he saw during his journey to Gartokh, and the same may be remarked as to the pictures of Lamas in the monasteries of Ladak. M. Huc says that the Delai Lama at Lhasa, during their visit in 1846, was nine years of age, and had been Grand Lama for only six years, so that he must have transmigrated once, at any rate, between that time and the Pundit's visit in 1866, possibly oftener, as M. Huc says that, during the time one Nomekhan or Gyalbo was in office, "three successive Delai Lamas had died very soon after reaching the age of majority." Turner found the Grand Tashilumbo Lama quite a child in 1783. From the above it would appear that the poor Lamas are made to go through their transmigrations very rapidly, the intervals being probably in inverse proportion to the amount of trouble they give to the Gyalbo. If the Pundit is right in saying that the Lamas are only allowed to transmigrate thirteen times, and the present Delai Lama is in his thirteenth body, some changes may be expected before very long in the Lhasa Government. The Pundit gives a very curious account of the festival observed at Lhasa on and after their new year's day.

Having been so long away, the Pundit's funds had arrived at a very low ebb, and he

---

* Or Gyalpo.

was obliged to make his livelihood by teaching Nepalese merchants the Hindee method of accounts. By this means he got a little more money, but the merchants, not being quite so liberal as those of Shigátze, chiefly remunerated him by small presents of butter and food, on which he managed to subsist. During his stay in Lhasa the Pundit seems to have been unmolested, and his account of himself was only once called in question. On that occasion two Mahomedans of Kashmiri descent managed to penetrate his disguise, and made him confess his secret. However they kept it faithfully, and assisted the poor Pundit with a small loan, on the security of his watch. On another occasion the Pundit was surprised to see the Kirong governor in the streets of Lhasa. This was the same official that had made so much difficulty about letting him pass Kirong; and as the Pundit had (through Chúng Chú) agreed to forfeit his life if, after passing Kirong, he went to Lhasa, his alarm may easily be imagined. Just about the same time the Pundit saw the summary way in which treachery was dealt with in Lhasa: A Chinaman, who had raised a quarrel between two monasteries, was taken out and beheaded without the slightest compunction. All these things combined alarmed the Pundit so much that he changed his residence, and from that time seldom appeared in public.

Early in April the Pundit heard that his Ladáki friends were about to return to Ládak with the tea, &c., that they had purchased. He forthwith waited on the Lopchak, and was, much to his delight, not only allowed to return with him, but was told that he would be well cared for, and his expenses paid *en route*, and that they need not be repaid till he reached Mansarowar. The Pundit, in fact, was a favorite with all who came in contact with him.

On the 21st April he left Lhasa with the Ladáki party, and marching back by the great road as before, reached Tadúm monastery on the 1st of June.

From Tadúm he followed the great road to Mansarowar, passing over a very elevated, tract of country from 14 to 16,000 feet above the sea, inhabited solely by nomadic people, who possess large flocks and herds of sheep, goats and yaks. On the road his servant fell ill, but his Ladáki companions assisted him in his work, and he was able to carry it on. Crossing the Mariam-La mountains, the watershed between the Brahmaputra and the Sutlej, he reached Darchan, between the Mansarowar and the Rakas Tâl, on the 17th of June. Here he met a trader from British territory who knew him, and at once enabled him to pay all his debts, except the loan on his watch, which was in the hands of one of the Ladákis. He asked his friends to leave the watch at Gartokh till he redeemed it.

At Darchan the Pundit and his Ladáki companions parted with mutual regret, the Ladákis going north towards Gartokh, and the Pundit marching towards the nearest pass to the British territory, accompanied by two sons of the man who had paid his debts.

The Pundit's servant, a faithful man from Zá-kar in Ladák, who had stuck to him throughout the journey, being ill, remained behind. He answered as a sort of security for the Pundit, who promised to send for him, and at the same time to pay all the money that had been advanced. Leaving Darchan on the 20th June, the Pundit reached Thájung on the 23rd, and here he was much astonished to find even the low hills covered with snow in a way he had never seen before. The fact being that he was approaching the outer Himalayan chain, and the ground he was on (though lower than much of the country he had crossed earlier in the season) was close enough to the outer range to get the full benefit of the moisture from the Hindustan side. The snow rendered the route he meant to take impracticable, and he had to make a great detour. After an adventure with the Bhotiyas, from whom he escaped with difficulty, he finally crossed the Himalayan range on the 26th June, and thence descended into British territory after an absence of 18 months. As soon after his arrival as possible, the Pundit sent back two men to Darchan, with money to pay his debts, and directions to bring back his servant. This was done, and the servant arrived all safe, and in good health.

The Pundit met his brother, who failing to make his way to Lhasa, had returned by a lower road through the Nepalese territory. This brother had been told to penetrate into Tibet, and, if possible, to assist the Pundit. The snow had however prevented him from starting. He was now, at the Pundit's request, sent to Gartokh to redeem the watch, and to carry on a route-survey

to that place. The Pundit handed over his sextant, and told him to connect his route with the point where the Bhotiyas had made the Pundit leave off. The brother succeeded in reaching Gartokh, redeemed the watch, and after making a route-survey from the British territories to Gartokh and back, he rejoined the Pundit, and they both reached the Head-Quarters of the Survey on the 27th of October 1866.

During the regular survey of Ladák, Captain Montgomerie had noticed that the Tibetans always made use of the rosary and prayer-wheel*, he consequently recommended the Pundit to carry both with him, partly because the character of a Budhist was the most appropriate to assume in Tibet, but, still more, because it was thought that these ritualistic instruments would (with a little adaptation) form very useful adjuncts in carrying on the route-survey.

It was necessary that the Pundit should be able to take his compass bearings unobserved, and also that, when counting his paces, he should not be interrupted by having to answer questions. The Pundit found the best way of effecting those objects was to march separate with his servant either behind or in front of the rest of the camp. It was of course not always possible to effect this, nor could strangers be altogether avoided. Whenever people did come up to the Pundit, the sight of his prayer-wheel was generally sufficient to prevent them from addressing him. When he saw any one approaching, he at once began to whirl his prayer-wheel round, and as all good Budhists whilst doing that are supposed to be absorbed in religious contemplation, he was very seldom interrupted.

The prayer-wheel consists of a hollow cylindrical copper box, which revolves round a spindle, one end of which forms the handle. The cylinder is turned by means of a piece of copper attached by a string. A slight twist of the hand makes the cylinder revolve, and each revolution represents one repetition of the prayer, which is written on a scroll kept inside the cylinder†. The prayer-wheels are of all sizes, from that of a large barrel downwards; but those carried in the hand are generally four or six inches in height by about three inches in diameter, with a handle projecting about four inches below the bottom of the cylinder. The one used by the Pundit was an ordinary hand one, but instead of carrying a paper scroll with the usual Budhist prayer "Om mani padmi hom," the cylinder had inside it long slips of paper, for the purpose of recording the bearings and number of paces, &c. The top of the cylinder was made loose enough to allow the paper to be taken out when required.

The rosary, which ought to have 108 beads, was made of 100 beads, every tenth bead being much larger than the others. The small beads were made of a red composition to imitate coral, the large ones of the dark corrugated seed of the udrâs. The rosary was carried in the left sleeve; at every hundredth pace a bead was dropped, and each large bead dropped, consequently, represented 1,000 paces. With his prayer-wheel‡ and rosary the Pundit always managed in one way or another to take his bearings and to count his paces.

The latitude observations were a greater difficulty than the route-survey. The Pundit required to observe unseen by any one except his servant; however, with his assistance, and by means of various pretences, the Pundit did manage to observe at thirty-one different places. His observations for latitude were all taken with a large sextant, by Elliot, of 6-inch radius, reading to ten seconds. The Pundit was supplied with a dark glass artificial horizon, but Captain Montgomerie finding that it was far from satisfactory, ordered the Pundit not to use it, unless he found it impossible to use quicksilver. A shallow wooden trough with a spout was made for the quicksilver, but as anything in the shape of a glass cover could not be carried, the Pundit was directed to protect his quicksilver from the wind as he best could, by sinking it in the ground, &c. The Pundit had invested in a wooden bowl§, such as is carried at the waist by all Bhotiyas. This bowl

---

* The mani-chuskor, or prayer-wheel.

† This prayer is sometimes engraved on the exterior of the wheel.

‡ The Pundit found this prayer-wheel free of all examination by Custom House or other officials. In order to take full advantage of this immunity, several copper prayer-wheels have been made up in the G. T. S. workshop, fitted for compasses, &c.; these will be described hereafter.

§ The Tibetans are very curious as to these drinking bowls or cups, they are made by hollowing out a piece of hard wood, those made from knots of trees, being more especially valued. A good bowl is often bound with silver. The wood from which they are made does not grow in Tibet, and the cups consequently sell for large amounts.

is used by the Bhotiyas for drinking purposes; in it they put their water, tea, broth, and spirits, and in it they make their stirabout with dry flour and water, when they see no chance of getting anything better. The Pundit, in addition, found this bowl answer capitally for his quicksilver, as its deep sides prevented the wind from acting readily on the surface. Quicksilver is a difficult thing to carry, but the Pundit managed to carry his safely nearly all the way to Lhasa, by putting some into a cocoanut, and by carrying a reserve in cowrie shells closed with wax. At Piáhtc-jong however the whole of his quicksilver escaped by some accident; fortunately he was not far from Lhasa, where he was able to purchase more. The whole of his altitudes were taken with the quicksilver.

Reading the sextant at night without exciting remark was by no means easy. At first a common bull's-eye lantern answered capitally, but it was seen and admired by some of the curious officials at the Tadúm monastery, and the Pundit, who said he had brought it for sale, was forced to part with it, in order to avoid suspicion. From Tadúm onwards a common oil wick was the only thing to be got. The wind often prevented the use of it, and, as it was difficult to hide, the Pundit was at some of the smaller places obliged to take his night observation, and then put his instrument carefully by, and not read it till the next morning; but at most places, including all the more important ones, he was able to read his instrument immediately after taking his observations.

The results of the expedition delivered at the Head-Quarters consists of—

1*st*.—A great number of meridian altitudes of the sun and stars, taken for latitude at thirty-one different points, including a number of observations at Lhasa, Tashilumbo, and other important places.

2*nd*.—An elaborate route-survey, extending over 1,200 miles, defining the road from Kathmandû to Tadúm, and the whole of the Great Tibetan road from Lhasa to Gartokh, fixing generally the whole course of the great Brahmaputra river from its source near Mansorawar to the point where it is joined by the stream on which Lhasa stands.

3*rd*.—Observations of the temperature of the air and boiling water, by which the height of thirty-three points have been determined, also a still greater number of observations of temperature, taken at Shigátze, Lhasa, &c., giving some idea of the climate of those places.

4*th*.—Notes as to what was seen, and as to the information gathered during the expedition.

The latitude observations were taken with a large sextant of 6-inch radius, and have been reduced in the G. T. S. Computing Office. There is no doubt but that the Pundit is a most excellent and trustworthy observer. In order to see this, it is only necessary to look at the accompanying list, *vide* Appendix. At any one point the results deduced from a variety of stars differ *inter se* so very little, that it is not too much to say that the mean must be true within a limit of a minute.

The merits of the route-survey are more difficult to decide upon, but the means of testing the work are not wanting. The bearings from point to point were observed with a compass, and the number of paces between were counted. From the bearings and number of paces there was no difficulty in computing the latitude and departure in paces, or the number of paces that the route had advanced in latitude, and also in longitude. In order to determine the value of the pace, there was first the latitudes derived from the astronomical observations determined during the route-survey, and second the latitudes and longitudes of Kathmandû, of the Mansarowar lake, of places in Kumaon, and, lastly, the longitudes which Turner determined by his route-survey running nearly due north from the Chumulárí peak. Turner's route forms a most important check upon the Pundit's work, and prevents any accumulation of error which might occur in a route-survey carried over such a great space as 9 degrees of longitude. As far as the longitudes are concerned, that of Kathmandû, which has hitherto been accepted as approximately correct, was not found to be quite in accordance with the data forthcoming. It was consequently necessary to re-determine the longitude.

Colonel Crawford's trigonometrical survey and map undoubtedly still supply the most reliable data available as to the position of Kathmandû, though his observations were made as far back as the year 1802.

No member of the G. T. Survey of India has hitherto been allowed to use a surveying instrument in Nepal, but, by means of stations in British territory, a number of peaks have been accurately determined to the north of the Nepal valley. Several of these peaks have fortunately proved to be identical with those determined by Crawford.

Crawford's Mount	Daibun,	or	L,	corresponding	with	G. T. S.	No.	XXV
Do.	D			do.		do.	„	XXI
Do.	C			do.		do.	„	XX
Do.	B			do.		do.	„	XVIII.

Now, on page 264 of London edition of Vol. XII of the "Asiatic Researches" Crawford's distance of Mount Daibun (or XXV G. T. S.) from Kathmandû is given as $35\frac{5}{7}$ geographical miles.

Do. of D	(or XXI	do.	)	do.	do.	48	„	„
Do. of C	(or XX	do.	)	do.	do.	59	„	„
Do. of B	(or XVIII	do.	)	do.	do.	68	„	„

Taking the G. T. S. positions of the above points, we find that the distances given above intersect in points varying in longitude from 85° 16½′ to 85° 19′, and varying in latitude from 27° 42′ to 27° 43′. According to Crawford's map* the Daibun peak lies 25° E. of north from Kathmandû; that bearing with the distance given above, viz., $35\frac{5}{7}$ geographical miles, would put Kathmandû in latitude 27° 43′, longitude 85° 16½′. Crawford's latitude of Kathmandû by astronomical observations† is 27° 42′. From the above it has been concluded that Kathmandû is in N. lat. 27° 42½′, and E. long. 85° 17′ 45″.

It is greatly to be regretted that the Messrs. Schlagintweit did not finally determine the longitude of Kathmandû in 1857, when they received permission to use their instruments in the Nepal valley. The longitude might have been determined with indisputable accuracy by the simple expedient of observing the azimuth of one or more of the G. T. S. peaks north of Kathmandû. The Messrs. Schlagintweit state that they saw these peaks, and recognized them as those fixed by the G. T. Survey; it is consequently all the more difficult to imagine why this great opportunity was lost. Their longitude of Kathmandû was determined by a chronometer, but as the time depends upon a single day's set of altitudes taken too near to the meridian, it cannot be accepted as conclusive, but, as far as their observations can be relied on, they tend to confirm the longitude‡ adopted above, viz., 85° 17′ 45″.

The longitudes of the points in Kumaon have been derived from the Strachey's map§, and are known from the adjacent G. T. S. peaks to be correct within a very small limit. The longitude of Gyangze-jong (or Jhansû-jong) has been taken from Turner's survey of the road from Bhootan to Tibet, made in 1783. Turner's longitude of the Chumulári peak is 89° 18′, the G. T. S. longitude being 89° 18′ 43″. This coincidence no doubt is fortuitous, as there is an error of 11′ in the longitude of the origin of his survey; however it may have happened, Turner's longitudes up to Chumulári seem to be correct, for Captain Godwin-Austen, whilst surveying in Bhootan, ascertained that the village of Phári, close to the Chumulári, is very nearly in the longitude ascribed to it by Turner. Turner moreover puts Tassísudon in longitude 89° 41′, and Captain Austen in 89° 40′.

It may consequently be assumed that the longitude of Turner's route near the Chumulári peak is nearly correct. From the neighbourhood of the Chumulári to Jhansû-jong, Turner's route runs nearly due north, and therefore any error in his estimate of distances would have a

---

* A MS. map in the G. T. Survey Office.

† See page 255 Vol. XII "Asiatic Researches," London edition.

‡ The Schlagintweit's longitude of Kathmandû in terms of the G. T. Survey is 85° 15′ 34″.

§ Compiled in the Surveyor General's Office, Calcutta, April 1850.

very small effect on the longitude. This is fortunate, as it is not known how Turner measured his distances, though he specially states that he took bearings with a compass. The distance between Chumulárí and Jhansá-jong is only about 80 miles, and as the bearing is so northerly (viz., 20° E. of N.), it may be concluded that any error in the distance has had but small effect on the longitude. The longitude of Gyangze has therefore been assumed from Turner to be 89° 31′. Turner observed the latitude at Tashilumbo (Shigátze), and made it 29° 4′ 20″, the Pundit makes it 29° 16′ 32″. Turner's latitude of Chumulárí is 28° 5′, the G. T. S. latitude is 27° 50′. Turner very possibly was not accustomed to take latitudes, and as the Surveyor (Lieutenant S. Davis) sent with him was not allowed to go beyond Tassísudon, it is not to be wondered that there are differences in his latitudes. The comparison of several latitudes now well-known, tend to show that the semi-diameter of the sun may have been omitted by Turner, as his observations were to the sun only.

The Pundit's observations at Shigátze extend over many days, and include thirteen observations to the sun and a variety of southern stars, as well as to the pole star. The latitudes derived from these observations agree capitally *inter se*. The Pundit was thoroughly practised in the method of taking latitudes, and as his determinations of many well-known points, such as Bareilly, Moradabad, &c., have proved to be correct with only a pair of observations, there can be no doubt about accepting his latitude of Shigátze, where he took so many. The Pundit followed the same river as Turner for 50 miles between Gyangze and Shigátze. They agree in making the bearing between those places 62° west of north. The bends of the river as given by them agree in a general way, but the distance by Turner is 39 miles, and by the Pundit 46 miles. As the former appears to have only estimated his distances by guess, while the latter paced them carefully, the result by the Pundit has been adopted as the most correct.

In a route-survey where bearings, distances and latitudes only are available, it is obvious that a route running meridianally is the most easily checked. Unfortunately in this route-survey the only part that runs very favorably is that from Kathmandû to Tadúm, where there is a difference of latitude of 118′ to a difference of longitude of only 75′. The length of the pace derived from the difference of latitude is 2·6074 feet, or 31 inches. The remainder of the route from the Mansarowar to Gyangze runs so nearly east and west that the differences of latitudes between the various points are too small to give a reliable value for the pace, but, as far as they go, these differences indicate a longer pace than that derived from Kathmandû to Tadúm. The direction of the route not being favorable for determining the pace from the latitudes, recourse has been had to the known differences of longitude between Kumaon, Kathmandû, and Gyangze, derived as above. The difference of longitude between Kathmandû and Kumaon makes the length of the Pundit's 2·53 feet, or 30 inches. The difference between Kathmandû and Gyangze makes the length of the Pundit's pace to be 2·75 feet, or 33 inches.

The route between Kathmandû and Kumaon taken by the Pundit is the worst part of the whole of his route. It crosses the Himalayas twice, and also several high passes, and the road on the Cis-Himalayan side is particularly rough and rocky, with great ascents and descents. It was consequently to be expected that his pace would be somewhat shorter than on the route between Tadúm and Gyangze, which runs the whole distance by the easiest slopes possible, without crossing a single steep pass. The Pundit's pace, as derived from his own difference of latitude between Kathmandû and Tadúm, is 2·61 feet, or 31 inches. If this pace were adopted between Kathmandû and Kumaon, the difference of longitude between the two would be only 13′ larger than the assumed difference, or in 320′ (5° 20′) only a discrepancy at the rate of 4 per cent. If this same pace were used between Tadúm and Gyangze the difference of longitude would be 17′ less than the assumed difference, viz., 328′ (5° 28′), or a discrepancy at the rate of only 5 per cent.

The two lengths of the pace, derived from the difference of longitude, agreeing so closely with that derived from the Pundit's difference of latitude between Nepal and Tadúm, the one being slightly shorter in the roughest ground, and the other slightly longer in the easiest ground, it seems reasonable to conclude that the lengths of pace derived from the longitudes are quite in accordance with all that is known of the route. The Pundit was practised to walk

2,000 paces in a mile, or say a pace of 31½ inches, and he has certainly adhered very closely to it. From Gyangze to Lhasa the road is very similar to that between Tadúm and Gyangze, and the same value of pace, viz., 2·74* has been used. This gives a difference of longitude of 1° 28′ 7″. The Pundit's latitude of Lhasa is derived from twenty separate observations to the sun and stars. It is probably within half a minute of the correct value. From the above it is concluded that Lhasa is in north latitude 29° 39′ 17″, and east longitude 90° 59′ 43″.

Between the Mansarowar lake and Lhasa the Pundit travelled by the great road called the Jong-lam† (or Whor-lam), by means of which the Chinese officials keep up their communications for 800 miles along the top of the Himalayan range from Lhasa, north of Assam, to Gartokh, north-east of Simla. A separate memorandum is given hereafter as to the stages, &c., on this extraordinary road. Starting from Gartokh on the Indus, at 15,500 feet above the sea, the road crosses the Kailas range by a very high pass, descends to about 15,000 feet in Narí Khorsum, the upper basin of the Sutlej, and then coasting along the Rakas Tâl, the Mansarowar, and another long lake, rises gradually to the Mariham-la pass, the watershed between the Sutlej and Brahmaputra, 15,500 feet above the sea. From the Mariham-la the road descends gradually, following close to the north of the main source of the Brahmaputra, and within sight of the gigantic glaciers, which give rise to that great river. At about 50 miles from its source the road is for the first time actually on the river, but from that point to Tadúm it adheres very closely to the left bank. Just before reaching Tadúm the road crosses a great tributary, little inferior to the main river itself. The Tadúm monastery is about 14,200 feet above the sea.

From Tadúm, the road follows down the Brahmaputra, sometimes close to it, sometimes several miles from it, but at 80 miles east of Tadúm the road leaves the river, and crossing some higher ground, descends into the valley of the Raka Sangpo river, which is a great tributary of the Brahmaputra; leaving the Rakas valley, the road crosses over the mountains, and again reaches the Brahmaputra at about 180 miles below Tadúm. About 10 miles lower the road changes from the left bank to the right bank, travellers having to cross the great river by ferry-boats near the town of Janglache. Below Janglache, the road follows the river closely to a little below its junction with the Raka Sangpo. From that point the road runs some 10 miles south of the river, crossing the mountains to the large town of Shigátze, 11,800 feet above the sea. From Shigátze the road runs considerably south of the river, it ascends the Penanangchú river, and crossing the Kharola pass, 17,000 feet above the sea, descends into the basin of the Yamdokcho lake. For two long stages the road runs along this great lake, which is 13,700 feet above the sea, then rising sharply, crosses the lofty Khamba-la pass, and descends to the Brahmaputra again, now only 11,400 feet above the sea. Following the great river for one stage more, the road (which has hitherto been running from west to east) here leaves the Brahmaputra, and ascends its tributary, the Kichu Sangpo, in a north-easterly direction for three stages more to Lhasa, which is 11,700 feet above the sea. The total distance is about 800 miles from Gartokh to Lhasa.

This long line of road is generally well-defined, though it is not a made road, in the European sense of the word. The natural slopes over which the road is carried are however wonderfully easy. The Tibetans have, as a rule, simply had to clear away the loose stones, and only in three or four places, for a few miles, has anything in the way of making a road been necessary.

In many parts there appears to have been considerable danger of losing the road in the open stretches of the table-land, the whole surface looking very much like a road; but this danger is guarded against by the frequent erection of piles of stones, surmounted with flags on sticks, &c. These piles, called lapcha by the Tibetans, were found exceedingly handy for the survey; the quick eye of the Pundit generally caught the forward pile, and even if he did not,

---

* The direction of the road between Pinhtejong and Lhasa is rather more favorable for making use of the Pundit's latitudes. If used they would give a pace of 2·86 feet, a proof that the pace was longer than between Tadúm and Kathmandú. This pace would put Lhasa in longitude 91° 3′ 36″.

† Lam means road in the Tibetan language.

he was sure to see the one behind, and in this way generally secured a capital object on which to take his compass bearings. The Tibetans look upon these piles partly as guide posts, and partly as objects of veneration; travellers generally contribute a stone to them as they pass, or if very devout and generous, add a piece of rag; consequently, on a well-used road, these piles grow to a great size, and form conspicuous objects in the landscape. Over the table-land the road is broad and wide enough to allow several travellers to go abreast; in the rougher portions the road generally consists of two or three narrow paths, the width worn by horses, yaks, men, &c., following one another. In two or three places these dwindle down to a single track, but are always passable by a horseman, and, indeed, only in one place, near Phuncholing, is there any difficulty about laden animals. A man on horseback need never dismount between Lhasa and Gartokh, except to cross the rivers.

The road is, in fact, a wonderfully well-maintained one, considering the very elevated and desolate mountains over which it is carried. Between Lhasa and Gartokh there are 22 staging places, called Tarjums, where the baggage animals are changed. These Tarjums are from 20 to 70 miles apart; at each, shelter is to be had, and efficient arrangements are organized for forwarding officials and messengers. The Tarjums generally consist of a house, or houses, made with sun-dried bricks. The larger Tarjums are capable of holding 150 to 200 men at a time, but some of the smaller can only hold a dozen people; in the latter case, further accommodation is provided by tents. At six Tarjums tents only are forthcoming. Each Tarjum is in charge of an official, called Tarjumpá, who is obliged to have horses, yaks, and coolies in attendance whenever notice is received of the approach of a Lhasa official. From ten to fifteen horses, and as many men, are always in attendance night and day. Horses and beasts of burden (yaks in the higher ground, donkeys in the lower) are forthcoming in great numbers when required; they are supplied by the nomadic tribes, whose camps are pitched near the halting houses.

Though the iron rule of the Lhasa authorities keeps this high road in order, the difficulties and hardships of the Pundit's march along it cannot be fully realized, without bearing in mind the great elevation at which the road is carried. Between the Mansarowar lake and the Tadúm monastery the average height of the road above the sea must be over 15,000 feet, or about the height of Mont Blanc. Between Tadúm and Lhasa its average height is 13,500 feet; and only for one stage does the road descend so low as 11,000 feet, whilst on several passes it rises to more than 16,000 feet above the sea. Ordinary travellers with laden animals make two to five marches between the staging-houses, and only special messengers go from one staging-house to another without halting. Between the staging-houses the Pundit had to sleep in a rude tent that freely admitted the biting Tibetan wind, and on some occasions he had to sleep in the open air.

Bearing in mind that the greater part of this march was made in mid-winter, it will be allowed that the Pundit has performed a feat of which a native of Hindustan, or of any other country, may well be proud. Notwithstanding the desolate track they crossed, the camp was not altogether without creature comforts. The yaks and donkies carried a good supply of ordinary necessaries, such as grain, barley-meal, tea, butter, &c., and sheep and goats were generally procurable at the halting places. A never failing supply of fuel, though not of the pleasantest kind, was generally forthcoming from the argols or dried dung of the baggage animals, each camp being supposed to leave behind at least as many argols as it burns. At most of the halting places there is generally a very large accumulation.

Between the Mansarowar and Sarkájong nothing in the shape of spirits was to be had, but to the eastward of the latter place a liquor made from barley could generally be got in every village. This liquor, called chung, varies in strength, according to the season of the year, being in summer something like sour beer, and in the winter approximating closely in taste and strength to the strongest of smoked whiskey. The good-natured Tibetans are constantly brewing chung, and they never begrudge anyone a drink. Thirsty travellers, on reaching a village, soon find out where a fresh brew has been made; their drinking cups are always handy in their belts, and they seldom fail to get them filled at least once. The Pundit stoutly denied that this custom tended to drunkenness among his Tibetan friends; and it must be allowed that in Ladák,

where the same custom prevails, the people never appeared to be much the worse for it; guides had however to be rather closely watched, if the march took them through many villages, as they seldom failed to pull out their cup at each one.

A good deal of fruit is said to be produced on the banks of the Brahmaputra, between Shigátze and Chushul. The Pundit only saw it in a dried state.

When marching along the great road, the Pundit and his companions rose very early; before starting they sometimes made a brew* of tea, and another brew was always made about the middle of the march, or a mess of stirabout (suttoo)† was made in their cups, with barley-meal and water. On arriving at the end of a march they generally had some more tea at once, to stave off the cravings of hunger, until something more substantial was got ready, in the shape of cakes and meat, if the latter was available. Their marches generally occupied them from dawn till 2 or 3 P.M., but sometimes they did not reach their camping ground till quite late in the evening. On the march they were often passed and met by special messengers, riding along as hard as they could go. The Pundit said these men always looked haggard and worn. They have to ride the whole distance continuously, without stopping either by night or day, except to eat food and change horses. In order to make sure that they never take off their clothes, the breast fastening of their over-coat is sealed, and no one is allowed to break the seal, except the official to whom the messenger is sent. The Pundit says he saw several of the messengers arrive at the end of their 800 miles ride. Their faces were cracked, their eyes blood-shot and sunken, and their bodies eaten by lice into large raws, the latter they attributed to not being allowed to take off their clothes.

It is difficult to imagine why the Lhasa authorities are so very particular as to the rapid transmission of official messages, but it seems to be a principle that is acted on throughout the Chinese empire, as one of the means of Government. Ordinary letters have a feather attached to them, and this simple addition is sufficient to carry a letter from Lhasa to Gartokh, 800 miles, in little over thirty days. A messenger arriving at a village with such a letter is at once relieved by another, who takes it on to the next village. This system was frequently made use of by the Surveyors in Ladák and Little Tibet, and it generally answered well.

If any very special message is in preparation, and if time permits, an ordinary messenger is sent ahead to give notice. Food is then kept ready, and the special messenger only remains at each staging-house long enough to eat his food, and then starts again on a fresh horse. He rides on, day and night, as fast as the horses can carry him. The road throughout can be ridden over at night, if there is no moon the bright starlight‡ of Tibet gives sufficient light. Tibet is rarely troubled by dark nights; but, in case it should be cloudy, or that a horse should break down, two mounted men always accompany the messenger. These men are changed at every stage, and are thoroughly acquainted with their own piece of road. Each of these two men has, at least, two spare horses attached behind the horse he is mounted. If any horse gets tired it is changed at once, and left on the road, to be picked up on the return of the men to their own homes. By this means the messenger makes great progress where the road is good, and is never stopped altogether, even in the rougher portion. A special messenger does the 800 miles in twenty-two days on the average, occasionally in two or three days less, but only on very urgent occasions. The Pundit made fifty-one marches between Lhasa and the Mansarowar lake, and his brother makes out the remaining distance to Gartokh seven marches more, or, in all, fifty-eight marches. The Pundit found very few of the marches short, while a great many were very long and tedious.

Little idea of the general aspect of the country which the road traversed could be given by the Pundit.

From the Mansarowar lake to Tadúm (140 miles) glaciers seem always to have been visible to the south, but nothing very high was seen to the north; for the next 70 miles the

---

* The Tibetans stew their tea with water, meal, and butter; the tea leaves are always eaten.

† A Tibetan always carries meal with him, and makes suttoo whenever he feels hungry.

‡ The starlight in Tibet, as in all very elevated regions, is particularly bright.

mountains north and south seem to have been lower, but further eastward a very high snowy range was visible to the north*, running for 120 miles parallel to the Raka Sangpo river. From Janglache to Gyangze the Pundit seems to have seen nothing high, but he notices a very large glacier between the Penanang valley and the Yamdokcho lake.

From the lofty Khamba-la pass the Pundit got a capital view. Looking south he could see over the island in the Yamdokcho lake, and made out a very high range to the south of the lake; the mountains to the east of the lake did not appear to be quite so high. Looking north the Pundit had a clear view over the Brahmaputra, but all the mountains in that direction were, comparatively speaking, low, and in no way remarkable.

About Lhasa no very high mountains were seen, and those visible appeared to be all about the same altitude. Hardly any snow was visible from the city, even in winter. From the Mansarowar to Ralung, 400 miles, there were no villages, and no cultivation of any kind. The mountains had a very desolate appearance, but still numerous large camps of black tents, and thousands of sheep, goats, and yaks were seen. The fact being that the mountain sides, though looking so arid and brown, do produce a very nourishing coarse grass.

To the eastward of Ralung, cultivation and trees were seen every day near the villages. Near the Yamdokcho lake the lower mountains seem to have had a better covering of grass. The Pundit mentions the island in the Yamdokcho as being very well grassed up to the summit, which must be 16 or 17,000 feet above the sea. This extra amount of grass may be due to a larger fall of rain, as the Pundit was informed that the rains were heavy during July and August.

As a rule, the Pundit's view from the road does not seem to have been very extensive, for although the mountains on either side were comparatively low, they generally hid the distant ranges.

The only geological fact elicited is that the low range to the east of the Lhasa river was composed of sandstone. According to the Pundit, this sandstone was very like that of the Siwálik range at the southern foot of the Himalayas.

The probability of this is perhaps increased by the fact that fossil bones are plentiful in the Lhasa district. They are supposed to possess great healing properties when applied to wounds, &c., in a powdered state. The Pundit saw quantities of fossils exposed for sale in the Lhasa bazar. The people there call them Dúg-rúpa, or lightning bones. One fossil particularly struck the Pundit, it consisted of a skull which was about 2½ feet long, and 1½ feet broad. The jaws were elongated, but the points had been broken off. The mountains crossed were generally rounded with easy slopes. The roundness of those on the Yamdokcho island seems to have been very remarkable; this general roundness and easiness of slope probably points to former glacier or ice action.

Besides the Yamdokcho, a good many smaller lakes were seen, and two much larger ones were heard of. Those seen by the Pundit were all at about 14,000 feet above the sea. There are hardly any lakes in the lower Himalayas; the few that exist being all at, or below, 6,000 feet, but from about 14,000 to 15,000 feet lakes and tarns are particularly numerous†. This may be another evidence of former ice action.

Whilst the Pundit was at Shigátze and Lhasa, he took a series of thermometer observations to determine the temperature of the air. During November, at Shigátze, the thermometer always fell during the night below the freezing point, even inside a house. The lowest temperature recorded was 25°, and during the day the temperature hardly ever rose to 50°. At Lhasa, in February, the thermometer generally fell below 32° during the night, and the lowest observed

---

* With a very high peak at its western extremity, called Harkiang. A very high peak was also noticed to the south between the Raka and Brahmaputra valleys.

† There are no lakes known in the Himalayas higher than 16,000 feet, but possibly one of those heard of by the Pundit may turn out to be a little higher.

temperature was* 26°; during the day it seldom rose to 45°. During the whole time the Pundit was in the Lhasa territory, from September to the end of June, it never rained, and snow only fell once whilst he was on the march, and twice whilst in Lhasa.

The snow fall at Shigátze was said to be never more than 12 inches; but the cold in the open air must have been intense, as the water of running streams freezes if the current is not very strong. A good deal of rain falls during July and August about Shigátze, and there is said to be a little lightning and thunder, but the Pundit does not recollect seeing the one or hearing the other whilst he was in the Lhasa territory. The wind throughout Tibet is generally very strong on the table-lands, but at Shigátze and Lhasa it does not seem to have been in any way remarkable. The sky during the winter seems to have been generally clear.

The Pundit's heights were all determined thermometrically, that is, by observing the temperature of boiling water. The height of Kathmandû, thus determined, agrees very closely with that deduced from other sources; the thermometer used there, and at Muktináth, returned in safety, and was afterwards boiled at a trigonometrical station. It was found to agree with the observations taken before the Pundit went to Kathmandû. This thermometer was handed over to the Pundit's brother.

The Pundit took another thermometer with him to Lhasa, and, with it, all his higher points were determined. This latter was unfortunately broken near the end of the Pundit's march. There has, consequently, been no means of finding out whether it had altered in any way during the journey, nor any opportunity of testing it at known altitudes. If it had come back safely, there would have been no difficulty in having it boiled at trigonometrical stations of all heights, up to the highest visited by the Pundit. This thermometer was boiled at Almorah before the Pundit started, and with that observation as a zero, the heights of Lhasa, &c., have been computed out.

The height of Darchan, a little above the Mansarowar lake, computed out in this way is found to be 14,489 feet above the sea. The Mansarowar lake, as derived from Captain H. Strachey's thermometrical observations, is 14,877† feet, or taking a mean between his height of the Mansarowar and Rakas Tâl lakes it is about 15,000 feet. A result 4 or 500 feet higher than the Pundit's height. It may consequently be concluded that the Pundit's heights are not in excess.

With reference to the spelling of the name of the capital of Tibet, Lhasa has been adopted as that agrees best with the Pundit's pronunciation of the word. He says the word, means God's abode, from Lha a God, and Sa, a place.

It may be remarked that more bearings to distant peaks would have been a great addition to the Pundit's route-survey, but the recognizing of distant peaks from different points of view is a difficult matter, and only to be accomplished after much practice. The Pundit's next survey will, no doubt, be much improved in this respect. On the whole, the work now reported on has been well done, and the results are highly creditable to the Pundit.

---

* Inside a house.

† Mansarowar, 175 feet above lake, air 46°·0 boiling point 186·0
Rakas Tâl, " " 54°·0 " " 186·0
Petoragurh, 5,500 above sea, " 64°·0 " " 202·5.

EXTRACTS FROM A DIARY KEPT BY PUNDIT *————————, DURING HIS JOURNEY FROM NEPAL TO LHASA, AND FROM LHASA THROUGH THE UPPER VALLEY OF THE BRAHMAPUTRA TO THE SOURCE OF THAT RIVER NEAR THE MANSAROWAR LAKE.

Having made our preliminary arrangements, I started from Nepal on the 20th March 1865, accompanied by my brother and four private servants. We arrived at night-fall at Azidpur village, on the Lhásá road.

March 21*st*.—Crossed over the Nilkánt hills, and arrived at Sûndriphedi.

22*nd*.—After travelling all day, I arrived in the evening on the bank of the Bitráwăti stream.

23*rd*.—I arrived at Ramchá village, and took observations for latitude, and thermometrical observations.

24*th*.—Arrived at Náklang halting place.

25*th*.—Arrived at Shábro village, situated near the junction of the streams Gandak and Lendichû, and took observations for latitude. This is a customs' post, where all goods are taxed, and travellers have to pay a toll of 4 annas each; we paid Rs. 1-8 for our party.

26*th*.—Arrived at Medongpodo village, where we altered our mode of dress, adopting a mode familiar to the inhabitants of Lhásá, in order to preclude any suspicion as to the object of our visit.

27*th*.—Arrived about noon at Temuriá Bhansár (a Nepalese thannah and customs' post), where the officials forced us to undergo a strict examination. Our boxes and baggage were closely searched, but they failed to discover our instruments, which were hid in a secret compartment of a box; they, however, compelled us to pay a toll of Rs. 4, after examining our purwanahs. We then proceeded on our way, and by night-fall arrived at Raswágarhi, a fort built by Jung Bahadoor in 1855, during a war between him and the Lhásá rajah. This fort is situated near the junction of the Gandak and Lendichû streams, the latter forming the boundary between the Nepal and Lhásá territories. A stone bears a Chinese inscription mentioning this fact. I here took observations for latitude, and thermometrical observations.

28*th*.—I arrived at noon on the left bank of the Gandak at Pemánesá halting place, near a thannah of the Kirong district. We were here stopped, and interrogated as to who we were, and as to the object of our visit. Our answer was that we were Bisahiris*, and the objects of our visit was to purchase horses, and also to pay our homage at the shrine of the Lhásá divinity. On hearing this, they told us that we must be detained till the Kirong governor gave us his sanction to pass; and, acting up to their decision, they sent word to Kirong, meanwhile searching our boxes, &c.; but the same good fortune attending us, they failed to discover the secret recesses where our instruments were hidden; they, however, made us pay a toll of Rs. 5 for myself and party. After detaining us the whole of the next day, the 29th, and a portion of the 30th, the expected answer from the Kirong governor arrived, and was read to us. It stated that we were forbidden to continue our route by Kirong, because this was not the ordinary route from Káthmándû to Lhásá, the proper route being *viâ* Nílam or Kúti, and, had we been Bisahiris, the route we should have taken was *viâ* Mansarowar, and not this. Seeing such a decided prohibition set against our continuing our onward march by Kirong, I demanded back the toll which had been imposed on us, but a portion only of the Rs. 5 was returned. With heavy hearts and gloomy forebodings as to the ultimate success of our enterprise, we made a detour to Răswágárhi.

31*st*.—We left Răswágárhi fort early this morning, and arrived at night-fall at Shábro. Here I was again questioned why I had returned, when I had told them on leaving the place on the first occasion that I was going on to Lhásá. I told them how it was that, after travelling up to Pemánesá unmolested, our further march was prohibited by the police at that thannah. They suggested to me that if I laid my complaint before another official, who lived some miles away, and who was in favor with the Potolah rajah (the Lhásá Lama's diwan), I might perhaps get a passport to Lhásá through his intercession.

* Inhabitants of the country north-east of Simla, who possess the privilege of travelling through the Lhásá territory without question.

Acting up to this suggestion, I proceeded early the following morning to visit this official, and told him all that I had mentioned to the police at Pemánesá, and also exhibited to him the passports that I had in my possession. He listened to me with great attention, and evidently believed my statements. After a long pause he wrote a letter to the Kirong governor (Jongpon), stating that I was no impostor, but that my real object in wishing to visit Lhásá was for the purpose of purchasing horses, to visit the shrine of the Lhásá divinity, and to recover certain sums of money due me by some of the Lhásá residents. I succeeded completely in imposing upon this official, and elicited from him a promise that no one should now impede me. After making him a present of a few trifles, such as a pair of spectacles, a box of matches, &c., I withdrew to Shábro village, intending to start the following morning towards Kirong, armed with the letter.

APRIL *2nd.*—Starting early from Shábro, we arrived at noon at a serai called Dongkhang; here we were accidentally informed by some travellers that the Kirong governor (Jongpon) was the individual who had in previous years been the governor of Purang Taglá Kote, and the chief official at one time of Gartokh. This deprived us of all hope of being able to proceed onwards, for this chief of Kirong was personally well-acquainted with my brother, and had we proceeded, even with such influential support as the letter mentioned above was likely to give, yet the recognition of my brother by the Kirong governor (which was certain to happen) would have prevented him from having any confidence in us, and would thus have thwarted our enterprise at the outset. My brother had very frequently (only a few years previous) been brought in close and friendly contact with the governor, and he well knew that we were no Bisahiris. I then planned that my brother and three servants should return and stay at Nepal, till such time as the melting of the snow would render the road to Lhásá, *viâ* Nílam or Kúti, practicable for travellers, while I, with one servant, should proceed by Kirong; but, after mature consideration, we abandoned this plan, because, with but one servant, I might have fallen an easy prey to thieves. Accordingly we retraced our steps, and on the 7th April arrived at Khinchat bazar, situated on the bank of the Tirsuli river. Here, thinking that our number (six) might create suspicion, I discharged two of our servants who knew but little of the Tibetan language. I made over to them the papers and work already finished, with instructions to deposit them in a safe place till my return. We ourselves marching back, arrived at the Batar bazar by night-fall. Resuming our march the next morning, we arrived at Káthmándû on April 10th, 1865.

I was already acquainted with a resident of Káthmándû, and with his aid I took up my residence there, waiting till such time as the melting of the snow might render the road to Lhásá, *via* Nílam or Kúti, practicable to travellers. Meanwhile I made the acquaintance of all who I thought might enable me to compass my object, collecting as much information as to the road to Lhásá, the state of the country, &c., as I could, without creating suspicion. My friend promised to accompany me to Lhásá as my servant, on a pay of Rupees 25 per month. I thought he would be useful, as he had travelled the road, and was well-known all along it, but when the time came, he failed me.

Another resident of Káthmándû told me that it was fruitless to imagine that I could ever reach Lhásá, for although I had tried only one of the two roads, *i.e.*, the one by Kirong, and had to return, yet there was less chance of success in reaching my destination by the other, viz., by Nílam or Kúti, for the authorities on this road were much stricter than those I had met with on the Kirong road. He informed me that if I was not personally known to the (Jongpon) chief official at Nílam, he would on no account give me permission to travel to Lhásá, as he was forced to give security for the good conduct of those he passes. With the best intentions, he advised me to give up all thought of seeing Lhásá, telling me that even if I should be fortunate enough to pass through Nílam, yet a higher and stricter official residing at Dhingri Ghangá (Tingri Maidan)* would require better and stronger reasons before allowing me to go to Lhásá. Suffering from anxiety, and losing nearly all hope of ever accomplishing my design, I determined to overcome my despondence, and make one effort more. With this view I daily went about the city questioning all who were going to Lhásá, but none would allow me to accompany them. At last I met with an apparently rich man on the eve of travelling to Lhásá, and did all I could in my power to gain his confidence. When I thought I had partially succeeded, I asked him if he would allow me to accompany him, and he said he would have no objection. I then made him take an oath not to desert me on the road. I advised him not to travel by Kirong. He, however, told me that he was well-known by the authorities on the Kirong road, and that his house was not far from Kirong, so that there was no cause of fear. Thinking that this man, Dawá Nangal, was really as honest and honorable as he appeared to be, I lent him

* The Ghoorkhas suffered their first defeat at the hands of the Tibetans on the Tingri Maidan in 1792. Kúti and several other frontier posts of Nepal were taken from the Ghoorkhas in consequence, and the Lhásá boundary was carried considerably to the south.

Rs. 100, a sum which he promised faithfully to return on our arrival at Lhásá. At that time I heard that Jung Bahadoor intended to send another vakeel to Lhásá in place of the one already there, and I was told that this would be the best opportunity afforded of getting to Lhásá. We then decided that my brother, who was likely to be recognised by the Kirong official, had better accompany this vakeel, who was about to proceed by the Nílam road, while I was to travel by the Kirong road with the Bhotiya, Dawá Nangal. Thinking that, if I was unfortunate enough not to reach Lhásá, my brother might be more successful, and *vice versâ*.

We consequently divided the money in my possession, and I made over a few of the instruments to him, retaining the better servant of the two for myself. I then removed to the dwelling of Dawá Nangal, and, preparatory to starting, altered my dress to one adopted by the Ladákis, and added a tail of hair to the back of my head. All my arrangements being completed, I requested Dawá Nangal to delay no longer. Whereupon he advised me to start, in the company of one of his men, and promised to join me, either on the road, or at Shábro village, as work was likely to detain him for four or five days at Káthmándû. We started from Káthmándû on the night of the 3rd June 1865, and arrived, after travelling for four miles, at a village named Dharamtalli.

Resuming our march the following morning, we arrived at Basuata Páwá. On the 5th we arrived at Sundriphedi. On the 6th we halted at Tirsuli bridge. On the 7th arrived on the bank of the Bitrawati stream. On the 8th at Dhebung Páwá. On the 9th we continued our stay at Dhebung Páwá, in consequence of rain. On the 10th we arrived at Bekuti village. On the 11th we halted. From this village, all the way to Raswágarhi, the inhabitants of the country are Bhotiyas. On the 12th we arrived at Garrang village. 13th at Dañglang, where I fell ill with fever, and continued there in that state for six days. On the 20th, after my recovery, we marched to Shábro village. Here the servant of Dawá Nangal, who accompanied me thus far, mentioned to Dawá Nangal's family that I was a friend of Dawá's, and that it was the request of the latter that they should shew me kindness. I was hospitably received and lodged, but after some days I began to feel uneasy at Dawá Nangal's long delay. I mentioned my anxiety to his family, and, in compliance with my request, they sent a messenger, asking the cause of the delay. Dawá's answer was that press of work would keep him still longer at Káthmándû, but that he might be expected at Shábro within ten or twelve days. I now concluded that Dawá intended to play me some trick, and this suspicion gave me great anxiety, and induced me to visit Dawá's uncle; he was the chief person of Shábro village, and possessed great influence. I asked his advice as to what was to be done in my perplexity, for to return to Káthmándû was not my intention, and to proceed onward to Lhásá was not in my power, in consequence of the prohibition of the road officials. He said he felt for me, and would give me a passport to Kirong, as also a letter to Dawá Nangal's brother, who had just returned from Lhásá to Kirong, and who being a just and good man, would return me the money lent to his brother, and also arrange for my safe journey to Lhásá. Acting up to his promise, he gave me a passport to Kirong, and the letter to Dawá's brother. He stated in his letter that I was an honest man, going to Lhásá on commission for the purchase of horses, and that my claim of Rs. 100 against his brother was just, also mentioning that he would stand security for my good conduct to Lhásá, and requesting him to arrange for my journey to that place, and if the Kirong officials required it, even to stand security for me.

Starting on the 6th July, accompanied by a relative of the Shábro official, I reach Temuria. On the 7th I arrived at Pemanesá, where, as on the first occasion, the officials attempted to stop me, but the person who accompanied me from Shábro opened the way, and in the evening of this same day we arrived at Kirong.

Kirong is a small town, possessing from fifteen to twenty shops (some kept by Nepalese and some by Bhotiyas, who sell a variety of articles). Kirong has a fort and a good sized temple. Its population is estimated at from 3 to 4,000 souls. Rice is imported, and salt exported. Three crops are raised annually. Wheat and barley are sown in October, and ripen in June. Another description of barley, called Ne, is sown in July, and ripens in October, and two other grains (called in these parts Phápar and Sarso) are sown in May, and ripen in September. A number of edible herbs are cultivated. On arriving at Kirong, I lost no time in seeing Dawá Nangal's brother, by name Chûng Chû, and after offering a few trifling presents, explained my business with him. He promised me that all in his power would be done to enable me to travel onwards to Lhásá, but, as regarded the money, he could not refund it, as his brother was a bad man, and it was not his intention to pay his debts. For four days after this interview, the chief official (Jongpon) was busy, and could not attend to my affairs, but on the fifth day I obtained a hearing from him, and urged my request to be permitted to travel on. He told me, with all my strong recommendations, he would not wait a moment longer to grant me leave to travel, had there not been a

higher official than him at Dhingri Ghangá who might object, but that he would send word to the chief official at that place (eight days' journey distant), and if he granted my request, no further obstacle would present itself to my travelling to Lhásá. He also mentioned that the only thing he found not right was, that no Bisahiri travelled by this road at this time of the year, and this might be one of the reasons which might induce the chief official at Dhingri Ghangá to negative my request. A messenger was sent bearing a letter from the Kirong to the Dhingri Ghangá official, and after fifteen or sixteen days, on the 26th July, the answer was received. The Kirong official was ordered to send me back to Nepal, and on no account to allow me to travel on towards Lhásá, for had I been going to Lhásá for horses I would not have taken this route, and, had I been a Bisahiri, the route to Lhásá I should have adopted was by Mansárowar, and not this. On hearing the decision of the Dhingri Ghangá chief, I implored the Kirong chief to permit me to travel to Pati Nubri, to see my countrymen *viâ* Lá-Jok Tûmbá mountain and Kadáng-Chûm, but he hesitated, and said that should he permit me to go there, and should I thence proceed on to Lhásá, and the news of my arrival at the latter place reach the ears of the Dhingri Ghangá chief, then he would forfeit his all, and perhaps be murdered, for disobeying orders; he, however, sent a man with a letter, urging this fresh request of mine, to the Dhingri Ghangá chief. The messenger was dispatched on the 29th of July, and returned on August 10th, bearing the order from the Dhingri Ghangá chief to make me give security for my good conduct, before I was permitted to travel to Pati Nubri. On learning this, I returned to Shábro village, and with a great deal of persuasion and many entreaties induced the chief of the village, Chûng Chû, to enter into security for me. The wording and sense of the security was, that should I, on being permitted to travel to Pati Nubri, break through my promise not to visit Lhásá within this year, then he, Chûng Chû, would submit to the heaviest penalty which the Potolah rajah might think fit to impose on him. Chûng Chû, after doing this much for me, made me give him a declaration to the effect that, should I be found in Lhásá within this year, then it would be at the penalty of the loss of my life. This declaration was written out by the Kirong official, and I subscribed my name and seal to the document. This did not appear entirely to allay the suspicion of the Kirong official, and to guard against any wrong-doing on my part, he directed that I should be accompanied by his men from stage to stage, and they were ordered to bring back a letter from me on my arrival at Pati Nubri.

August 13*th*.—I left Kirong, and arrived at Rákmá village. 14*th*.—Arrived at Thotang village, and halted there the following day. 16*th*.—Arrived at Nûn village. 17*th*.—Crossed Lá-Jok Tumbá, and arrived at Kolûng Chuksâ. 18*th*.—Arrived at Joñká-hil village. 19*th*.—Arrived at Chartan-Phuk-khar village. 20*th*.—Arrived half way up Lá-Chumu-phur-phur mountain. 21*st*.—Arrived at a halting place; the road to this place from the last was very bad. Tradition has it that a priest rose to heaven on wings from the top of this mountain, hence its name. 22*nd*.—Arrived at Namdûl village, where I met Chûmik Dûrji, the brother of the man who I said lived at Pati Nubri, and to whom I told the Kirong chief I intended going. 23*rd*.—At Lue village.

24*th*.—At Bâbuk village, where I saw Thele, from whom the messengers carried back the letter as ordered by the Kirong official. At this place a plant called Nirbisi, or Jadwar, grows wild very abundantly; its root is held in very great esteem throughout India, as possessing great healing power when applied to cuts, scars, bites of venomous serpents and insects. Bâbuk is a large mart for the exchange of goods; Bhotiyas from all parts frequent it. Salt, wool, felt, and borax are brought here from Tibet, prior to being carried into Nepal and adjacent territories, while tobacco, rice, grain, cloth, copper plates, &c., are brought from Nepal, prior to being carried into Tibet to Tadúm, Nikú, Hâpchân, Labrang, and all other large places. From Káthmándû to Lue village jungle and forest was generally abundant, but at this place there was none visible, and hence to Lhásá the mountain sides were very bare and rocky. I learnt that, on the 25th August, Báro Thele Durcha, with a large party, and a great number of yaks (about 200) laden with goods, intended to start from this place towards Tadúm. Having told these people that I was a Bisahiri (a countryman of theirs), I was held in great favor with all, and consequently received no opposition to my wish to accompany them; we accordingly started, and arrived in the evening at Galá Sátang camp.

26*th*.—We crossed the Galá mountain, which forms the boundary between the Lhásá and Gurkha territories, where I took thermometrical observations, and after passing Sang-jomba village, we arrived by evening at Somnuth camp.

27*th*.—Crossed Gñolá mountain, and arrived at Báro Dhuksum camp. 28*th*.—Halted at Báro Dhuksum. 29*th*.—Arrived at Zángra grazing ground, at that time covered with herds tended by men. 30*th*.—Arrived at Talla Labrang. 31*st*.—Halted at Talla Labrang.

September 1*st*.—Arrived at Yákâû. 2*nd*.—Arrived on right bank of Brahmaputra river, at

Relá monastery. 3*rd.*—Arrived at Muna Ghát on bank of river, where boats formed of a framework of wood, covered with leather, convey people and goods across; on this occasion the boat was lost with three people in my presence, and so I returned to Káu. 4*th.*—Arrived at Jangtha grazing-ground. 5*th.*—Arrived on right bank of Brahmaputra at Likche monastery, situated on a low hill. 6*th.*—Crossed the river by ferry at Likche, and arrived at Tadúm monastery.

I was frequently asked who I was by the inhabitants, and I always said that I was a Bisahiri merchant, called Khûmû in these parts, and had purchased a quantity of Nirbisi* root at Pati Nubri and Muktinâth, which I had sent on to Mansarowar by another route, and had come here merely to worship. The inhabitants told me that the road from hence to Lhásá was infested by thieves and dacoits, and that a journey by a small party was attended with great danger.

The Maharajah of Kashmir sends a merchant with a great quantity of goods to Lhásá once in two years. Hearing that he was to be sent this year, it occurred to me that I had better try to accompany his party. The merchant sent is called Lopchak, and, by the orders of the Lhásá rajah, is shown great attention, and treated with great distinction, as he passes along the road. The rajah of Lhásá sends a merchant, called Jang Chongpon, into Ladák once a year.

On the 8th of September a traveller came into Ladák from Gartokh, and on questioning him I was delighted to hear that the merchant (Lopchak) would be here within thirty days. I accordingly rented a house, and made up my mind to wait, and to avoid suspicion pretended that illness prevented me from joining the party on their way to Mansarowar. Grain and food generally, being imported, are very dear. Grain is not raised at all at this place. Tadúm possesses a large monastery, surrounded by eight or nine post-houses (Tarjams). At this place there are very extensive plains, stretching to the east seven miles, and in width about four, to the west fifteen miles, by about fifteen in breadth.

October 2*nd.*—The merchant's head man, named Chiring Nurpal, accompanied by about twelve men and seventy laden yaks, came into Tadúm this day. On his arrival I sent for him, and made friends with him. I told him what I had already told all at this place, and asked him to let me accompany him to Lhásá, as the season had advanced, and to return to Mansarowar was nearly impossible. He, without hesitation, acceded to my request, and so we started the following day. 3*rd.*—Arrived at Thuku camp.

4*th.*—Arrived at Siri Kárpo camp. 5*th.*—Arrived at Niku Tarjam, where Chiring Nurpal dismissed the coolies from Tadúm, and engaged fresh men. 6*th.*—Arrived at Jagûng camp. 7*th.*—After crossing a large river called Chartá Sángpo, we arrived at Jalûng camp.

8*th.*—Marching along the bank of the Cháká Chû river, we arrived at Sarká-jong town. This place is presided over by two officials (Jongpons) residing at Sar-jong and Nub-jong, who questioned Chiring Nurpal as to who I and my servants were. He told them that we were his countrymen and servants. Nothing more was said by them on hearing this, but I was very much troubled in mind, thinking that, should I be discovered at Lhásá, I would to a certainty forfeit my life; and another subject was a source of great uneasiness to me, viz., that I was fast exhausting my funds; I, however, determined to accomplish my design of seeing Lhásá. I continued my route-survey, and took observations for latitude at favorable moments, wherever I could. Grain is not raised at Sarká-jong, but is brought here all the way from Kirong and Jonká-jong. Chiring Nurpal was very kind to me, and I, in return, told him that when we got back to Mansarowar, he need only ask me for whatever he wished to have it granted. Coolies were changed at Sarka-jong. 9*th.*—Arrived at Nágûling camp. 10*th.*—Arrived at Chomûkulá Tarjam; coolies and yaks were changed. Halted on 11th. 12*th.*—Arrived at Tarchunk camp. 13*th.*—Arrived at Nangbá Yako camp. 14*th.*—Arrived at Rûin camp. 15*th.*—Arrived at Sang-Sang Gyádo Tarjam, a mud house, where coolies and yaks were changed. 16*th.*—Arrived at Ge camp. 17*th.*—Arrived at Sang-Sang Kau Tarjam, a mud house, there is, besides the above, one other house of mud belonging to a jemadar; coolies and yaks were changed. 18*th.*—Arrived at Kûkap camp. 19*th.*—Arrived at Rálung camp. Cultivation is seen from this place onwards, and willow trees make their appearance here also; from Tadúm to this place there are no signs of cultivation, and the population is very scanty.

20*th.*—Arrived at Nábring Kháká Tarjam, to the N.W. of which place lies a lake eight miles long and three miles in breadth. On the bank of the lake, and N.E. of this village, is situated Nábring village, ruled by a Jongpon (an official). The yaks between Nábring and Lhásá are very small, and the goods (which from Tadúm had been carried on large yaks) were at Nábring transferred to asses.

---

* Zedoary, a spicy plant somewhat like ginger in its leaves, but of a sweet scent.

21*st*.—After passing a small lake called Láng-cho-Gonok, we arrived at Barkhá village. The water of this lake is very salt, and is reported to be 162 feet in depth. The length of this lake is four miles, and breadth two miles.

22*nd*.—After crossing the Brahmaputra by ferry, we arrived at Jangláche town, which has a very fine monastery, and a strongly built fort, situated on the top of a small hill. They call a fort in these parts khar.

A number of shops are kept by Nepalese. I was informed that the Kirong and Dhingri Ghangá road passes through this place. We halted here on the 23rd, when we were joined by a second portion of the Ladák merchant's men and yaks (105) conveying goods.

24*th*.—Continued our stay at Jangláche town. From this town to Shigátze city goods and men are frequently transported by boats covered with leather, the river being wide and navigable, but we preferred going overland, and so continued our journey.

25*th*.—Arrived at Táshiling village. 26*th*.—Arrived at Phuncholing village, which is ruled by a Jongpon. There is a very well-built monastery in this village. At this village the river is spanned by a bridge, formed of iron chain and rope, called chakoam.

27*th*.—Arrived at Jilong village. 28*th*.—Arrived at Chakri village.

29*th*.—Arrived at Digarcha, or Shigátze, city. We took up our quarters at a serai (called Kunkhang in these parts), built by the government. At N.W. end of the city, on a low hill, stands a strong fort, called Gang Már Jong, which, as tradition has it, was built by a Deo. To the south-west of the city stands a very well-built monastery, called Tashilumbo, surrounded by a wall about one mile in circumference. Numerous houses and temples rise within this enclosure; four of the larger temples among these are superior to the rest, and have gilded spires.

The idols in these temples are studded with precious stones, gold, and silver. There are 3,300 priests in this monastery, the chief being the Great Lámá, called Panjan Ringbo-Che, considered throughout Tibet as an incarnation of the Deity, who can read the thoughts of men, and who is supposed never to die.

We formed a small party, and on the 1st of November went to do homage to Panjan Ringbo-Che, and were conducted into the presence of a boy eleven years old, seated on a high throne covered with rich silks. He was surrounded by a number of priests, standing in reverential attitudes, and bearing the insignia of their calling. We uncovered our heads, and made a low obeisance, and then presented an offering of pieces of silk. Panjan Ringbo-Che then placed his hands on each of our heads, and beckoned to his priest to have us seated. Up to this time he had preserved a profound silence, but on seeing that we were seated, put us only three questions (as he is wont to do to every worshipper), viz.: 'Is your king well?' 'Is your country prospering?' and 'Are you in good health?' The priest then placed a small strip of silk round each of our necks, and from a silver kettle poured a little tea into our cups, and then dismissed us.

The city of Digarcha is three-quarters of a mile in length, and half a mile in breadth. North-east of the city, distant three-quarters of a mile, situated on the left bank of the Penánangchú stream stands a monastery, called Kongkuling, in the centre of a garden. A market (bazar) is daily held on the space called Thom, between the city and the Tashilumbo monastery, where every saleable article is exposed throughout the day, the vendors retiring to their homes in the evening.

The population of the city is estimated at 9,000 souls, exclusive of the 3,300 priests. The earth here is rich, and yields fine crops of grain. The city is ruled by two Depons, one residing at Khárak village, and the other at Rimu village, but two Jongpons (inferior officers) are obliged to take up quarters in the city.

A force, consisting of 100 Chinese and 400 Bhotiya soldiers, is quartered here. To the south of the city, and distant about fifteen miles, is situated a hill called Mao-mi, where gold is said to be found, but a strict order prohibits the people from working it.

NOVEMBER 16*th*.—The Kashmir Maharajah's merchant*, for whom we were waiting, came in on

* Officially called Lopchak, his own name in this case being Chyanggonboo.

this day, and I waited on him with a few presents, requesting to be permitted to accompany his men, as I had done from Tadúm. I told him the story of my illness, and how it was that I came with his servants. He saw no objection to my continuing with his men, and promised to assist me at Lhásá. I took star observations for latitude at this place as often as I could.

28*th*.—The Nepalese agent (vakeel) at Lhásá, who was recalled by Jung Bahadoor, arrived at Digarchá city on this day, and I was sorry not to discover my brother among his followers.

DECEMBER 22*nd*.—Left Digarchá city, and marched to Giáng village. 23*rd*.—Arrived at Penájong town, governed by a Jongpon, who resides in the fort. 24*th*.—Arrived at Tákche village. 25*th*.—We arrived at Gyangze city, which is about the size of Digarchá, and has a fort on a low hill in the heart of the city, and also a large gilded temple. The city is ruled by a Depon, assisted by two Jongpons.

A force, consisting of 50 Chinese and 200 Bhotiya soldiers, is quartered here. The boundary between the Lhásá and Loh (Bhootan) territories is three days journey from Gyangze. Rice and tobacco are imported from Bhootan, while wheat, flour, barley, oil, radish, pease, ghee, produced in the place, are sold very cheap. Very fine crops are raised here, although it appeared to me to be higher above the sea level than either Digarchá or Lhásá. The following are the names of three different descriptions of woollen cloth manufactured in this city, for which it is famous, viz., gethá, nambu, chuktu, purik nambu, this last being very superior. It is also the seat of the manufacture of a kind of small bell, called yárká, with which they adorn their horses. To the south-west, north-west, and south-east of the city are plains stretching from six to ten miles, through which the Penánangchú stream flows. At this time of the year the river becomes frozen, and men pass over on foot. We started from hence on the 28th. 28*th*.—Arrived at Gobzi village. 29*th*.—Arrived at Rálung village. 30*th*.—After crossing Kharolá mountain, we arrived at Zárá halting place. 31*st*.—Arrived at Nanganche-jong, a village on the Yamdokcho lake, with a fort on a small hill.

JANUARY 1*st*, 1866.—Arrived at Piáhtejong, on the bank of the Yamdokcho lake. Its small fort is situated so close to the lake that the water washes its walls.

2*nd*.—Marching along the bank of Yamdokcho lake, we came upon a band of robbers. One of them took hold of my horse's bridle, and told me to dismount. Through fear, I was on the point of resigning my horse to him, when a Mahommedan who accompanied me, raised his whip; whereupon the robber drew a long sabre, and rushed on the Mahommedan. Taking advantage of this favorable moment, I whipped my own horse forward, and as the robbers could not catch us, they fired on us, but without effect, and we arrived at Demálung village all safe.

The Yamdokcho lake from this point stretches to south-east about twenty miles, and then turns west. The breadth of this lake varies from two to three miles, and it is said to be very deep. In the centre of the lake stands a hill, at the foot of which are situated a number of villages. The circumference of the lake is about forty-five miles; it is crossed in wicker boats covered with leather. We halted at Demálung this day, the 3rd, to procure yaks and coolies.

4*th*.—After crossing Khambálá mountain, we arrived at Khambá-Bárchi village, situated on the right bank of the Brahmaputra river, and taking boat from hence, we were rowed down the stream to Chusul village, passing Chaksam Chori village, which is situated on the right bank of the river, at foot of hill, and alongside an old bridge (formed of iron chain and rope), which owing to its insecurity, is seldom or never used, the ferries being preferable.

The Khambálá mountain forms the boundary between the two districts Oo and Chang, from Khambálá west to Kálá mountain being the Chang, and from Khambálá east to Chari being the Oo district. Chusul Jong is ruled by a Jongpon. On the bank of the river, situated on a low hill, stands a fort. We stayed here three days.

8*th*.—Arrived at Chábonang village.

9*th*.—Marching along the right bank of the Kichu Sangpo river, we arrived at Netang village. The Kichu Sangpo river comes from the direction of Lhásá, and falls into the Brahmaputra at Chusul village. The Brahmaputra from thence flows east.

10*th*.—We arrived this day at Lhásá, and, soon after my arrival, I engaged two rooms in a building called Dhiki Rabdan Tashilumbo-gi-Khan Sumbá. One of the rooms was well adapted for taking my star observations from within. I had been here some ten days, when the Lopchak's men, my late companions,

told me they were going to visit the Goldan monastery, and asked me to go with them. I accordingly left Lhásá in their company on the 21st, and arrived at Sárá monastery, distant some three miles only from Lhásá, at the foot of the Tatiphû mountain. The circumference of this mountain is little more than one mile. Numerous temples, with gilded spires, and of all sizes, are seen in the inclosure. The idols within are studded with gold, silver and precious stones. They differ in size and hideousness, some having horns, but the limbs and lower portion of the figures are generally those of men. I was informed that there were 5,500 priests in this monastery.

22*nd*.—Starting this morning from Sárá, we arrived late in the evening at Dák Yárpá monastery, situated half way up a hill. Many temples are to be seen here also, although the number of priests is not more than a dozen.

23*rd*.—Arrived at Bumtod.

24*th*.—After crossing the Kichu stream, we arrived at Goldan monastery, situated on the summit of a low hill. The circumference of this monastery is about three-quarters of a mile. There are numerous well-built temples, with idols much the same as those at Sárá. It is reported to be a very wealthy monastery, and is occupied by 3,300 priests.

25*th*.—Returning to Lhásá, we arrived at Nángrá village.

26*th*.—Reached Lhásá. It was my wish now to follow the course of the Brahmaputra river, but I was informed that, unless I went with a well-armed party of at least a dozen, it would be dangerous to proceed.

The city of Lhásá is circular, with a circumference of two and a-half miles. In the centre of the city stands a very large temple, called by three different names, viz., Máchindránáth, Jo, and Phokpochengrá. The idols in it are richly inlaid with gold and precious stones. This temple is surrounded by bazars and shops, kept by Lhásá, Kashmiri, Ladáki, Azimabad, and Nepalese merchants, a number of whom are Mahommedans. Chinese tradesmen are numerous here also.

The city stands in a tolerably level plain surrounded by mountains, the level or open ground extending about six miles on the east, seven on the west, four on the south, and three on the north. At the northern end of the city there are two monasteries, called Mûrû and Rámoche. At the north-west corner stands the Chumuling monastery. At the west end the Tankyáling monastery. The monastery called Kontyaling is about one mile west of the city, at the foot of a low isolated hill called Chápochi, which has a house on its summit. About three-quarters of a mile west of the Rámoche monastery there is, on a low hill, a large and strong fort called Potoláh, which is the residence of the Lámá Gûrû, who is also called Gewáring-bo-che, his head minister being generally called rajah. The fort is one and a-half miles in circumference, and 300 feet above the surrounding level; steps lead up to the fort on every side. The village Jol lies under the fort. Four miles west of the city stands the Debang monastery, at the foot of a hill; it is occupied by 7,700 priests, who are held in great veneration by all classes of the Lhásá people. South of the city, and distant three miles (beyond the Kichu Sangpo river), is situated the Chochuling monastery. I accompanied the Ladák merchant, called Lopchak, on the 7th of February, to pay homage to the Gewáring-boche (the Great Lámá of Tibet) in the fort, ascending by the southern steps. A priest came out to receive us, and we were conducted into the presence of the Gewáring-bo-che, a fair and handsome boy of about thirteen years, seated on a throne six feet high, attended by two of the highest priests, each holding a bundle of peacock feathers. To the right of this boy, and seated on a throne three feet high, was the rajah Gyálbo-Khuro-Gyágo, his minister. Numbers of priests in reverential attitudes were standing at a respectful distance from them. We were ordered to be seated, and after making offerings of silks, sweets and money, the Lámá Gûrû put us three questions, placing his hand on each of our heads: 'Is your king well?' 'Does your country prosper?' and 'Are you in good health?' We were then served with tea, which some drank, and others poured on their heads, and after having a strip of silk, with a knot in it, placed by the priests round each of our necks, we were dismissed, but many were invited to inspect the curiosities that were to be seen in the fort. The walls and ceilings of all the chief houses in the fort, and all the temples that contained images of gold, were covered with rich silks.

The Lámá Gûrû is the chief of all Tibet, but he does not interfere with state business. He is looked upon as the guardian divinity, and is supposed never to die, but transmigrates into any body he pleases. The dead body from which the Lámá Gûrû's soul has departed is placed in a gold coffin studded with the finest gems, and kept in the temple with the greatest care. The belief of the people is that the

soul of one Lámá Gûrû is privileged to transmigrate thirteen times. The present Lámá Gûrû is now in his thirteenth transmigration. Churtans are placed over the coffins containing the Lámás' bodies, and it is said that these dead bodies diminish in size, while the hair and nails grow.

The rajah, or gyalbo, is next to the Lámá Gûrû in rank, below him there are four ministers, called kaskak, who conduct all state business, under his orders. The Chinese vakeel at Lhásá, who is called ambán, has the power of reporting against either the rajah or the four ministers to the king of China, and, if necessary, can have them removed from office.

The general belief of all the Tibetans is, that no sooner is the Lámá Gûrû born, than he speaks, and all withered plants and trees about his birthplace at once begin to bear green leaves. The moment news gets to the Lhásá court of such an occurrence, then the four ministers repair to the house, in order to ascertain the truth by the following method:—Articles of all descriptions are placed before the child, and he is requested to tell which belonged to the late Lámá Gûrû, and which did not. Should he be able to select from the articles put before him such of those that belonged to the Lámá Gûrû, then he is pronounced to be no impostor, and is forthwith carried away to the fort of Potoláh, and placed upon the throne as Lámá Gûrû.

The Mahommedans of Lhásá gave me the following account as to the selection of the future Lámá Gûrû:—From the day of the death of a Lámá Gûrû, all male births are recorded by the Lámás about the city, and the ministers are secretly informed of them. Names are given to the children, and on the thirtieth day after the decease of a Lámá Gûrû, slips of paper, each bearing the name of a child born within the month, are placed in a vessel; the chief of the four ministers then draws out one of the slips with a pair of pincers, and which ever child's name that bears, he is pronounced to be the future Lámá Gûrû. He is then taught all that is required of him by the priests, and when they think he has come to years of discretion, the previously narrated ceremony of the choosing of articles is conducted. The people of Lhásá are kept in the dark as to this method of adopting a Lámá Gûrû. The Lhásá people are, by strangers, supposed to adopt a Lámá Gûrû, in order to prevent the Government of the country from falling entirely into the hands of the Chinese.

Of all the monasteries in these parts, the largest, apparently, are Sárá, Debang, Goldan, &c., and occupied likewise by the largest number of priests, but in former days the monasteries held in greatest esteem were Kontyaling, Tankyáling, Chumuling, and Chochuling; and on the death of the Potoláh rajah the successor was chosen from one of these four monasteries, while now he is chosen from the Debang monastery only. The reason that the Potoláh rajah is not selected from one of the four monasteries, but only from Debang, is because, not very long ago, Sátá Safáde, allied with the Debang priests (7,700), and also with the people, and aided by the Chinese vakeel, managed to remove the then reigning rajah Gyalbo Riting, from the throne, and drove him to Pekin, where he died shortly after. Sátá Safáde then assumed the position of rajah, and ever since the recognised heir to the Potoláh throne has been the head Lámá of the Debang monastery.

Three days journey (thirty-six miles) east of Lhásá, situated on the left bank of the Brahmaputra river, stands a monastery called Sáme, the seat of the Jam Rajah, who is believed to possess the power and authority to punish or reward the souls of departed men. The state treasury of Lhásá is also at this place, Sáme, and, on the occasion of a war, the four ministers repair thither, and after a little ceremony, receive the amount they solicit, with an injunction to return the same within a certain period. Within forty miles east of Sáme monastery, and on the right bank of the Brahmaputra, is situated Chotang city, rivalling in size the city of Digarcha. The Brahmaputra river flows from hence in an easterly direction for a distance of one hundred and twenty miles, and then flows due south.

I observed that there was but little order and justice to be seen in Lhásá.

The new year of this people commences with the new moon appearing on or about the 15th of February; they call it Lohsar. On New Years' Eve an order from the court goes round to have every house in the city cleaned; the houses are swept and whitewashed, and the streets are cleaned. On the day following each household displays as many flags, &c., from the house-top as it can afford. Throughout the day and night singing, dancing, and drinking are kept up. On the second day of their new year all the people of the city assemble before the Potoláh fort, to witness the following feat, performed generally by two men:—A strong rope is fastened from the fort walls to strong rivets in the ground, 100 yards distant from the base of the fort. The two unfortunate men then have to slide down this rope, which very often proves fatal to them; should they, however, survive, they are rewarded by the court. The Lámá Gûrû is always a witness of the performance from the fort.

From the commencement of the new year, whoever pays the highest sum is considered the judge of the rajah's court, and for twenty-three days he exercises his authority in the most arbitrary manner possible, for his own benefit, as all fines, &c., are his by the purchase. The purchaser of such authority must be one of the 7,700 priests attached to the Debang monastery; the successful priest is called Jalno, and announces the fact through the streets of Lhásá in person, bearing a silver stick.

The priests attached to all the temples and monasteries in the neighbourhood assemble in the fort, and offer homage. This assembling of the priests is called Molum Chumbo, and the holidays go by the same name. The Jalno's men are now seen to go about the streets and places, in order to discover any conduct in the inhabitants that may be found fault with. Every house is taxed in Lhásá at this period, and the slightest fault is punished with the greatest severity by fines. This severity of the Jalno drives all the working classes out of the city, till the twenty-three days are over. The profit gained by the Jalno is about ten times the purchase-money. During the twenty-three days all the priests of the neighbourhood congregate at the Máchindránáth temple, and perform religious ceremonies. On the fifteenth day of the new year all the priests, assembling about Máchindránáth temple, display hundreds of idols in form of men, animals, trees, &c., and throughout the night burn torches, which illuminate the city to a great distance. The day on which the authority of the Jalno ceases, the rajah's troops parade through the streets, and proclaim that the power of the rajah has again been assumed by him. Twenty-four days after the Jalno ceases to have authority, he again assumes it, and acts in the same arbitrary manner as on the first occasion, for ten days, after which authority is once more assumed by the rajah. These ten days are called Chokchut Molam.

On the first day the Lámás all assemble, as before, at Máchindránáth temple, and after a religious ceremony, invoke the assistance of their deities, to prevent sickness, &c., among the people, and, as a peace-offering, sacrifice one man. This man is not killed purposely, but the ceremony he undergoes often proves fatal. Grain is thrown against his head, and his face is painted half white, half black.

On the tenth day of this vacation, all the troops quartered at Lhásá march to the temple, and form line before it. The victim, who has his face painted, is then brought forth from the temple, and receives small donations from all the populace assembled. He then throws the dice with the Jalno, and if the latter loses, it is said to forebode great evil, and if not, and the Jalno wins, then it is believed that the victim, who is to bear the sins of all the inhabitants of Lhásá, has been permitted by the gods to do so. He is then marched to the walls of the city, followed by the whole populace, and troops hooting and shouting, and discharging volleys after him. When he is driven outside the city, then people return, and the victim is carried to the Sáme monastery. Should he die shortly after this, the people say it is an auspicious sign, and if not, he is kept a prisoner at Sámo monastery for the term of a whole year, after which he is released, and is allowed to return to Lhásá.

The day following the banishment of the man to Sáme, all the state jewels, gold and silver plate, &c., are brought out from the fort, and carried through the streets of Lhásá, protected by the troops armed, and followed by thousands of spectators. Towards evening everything is taken back to the fort, and kept as before. The day following, immense images of the gods (formed of variegated paper, on wooden frame-work) are dragged by men through the city, protected by armed troops. About noon the whole populace, great and small, assemble on the plain north of the city, and publicly carouse, race, and practice with the gun at targets. I was informed that the Molam Chambo and Chokchut Molam vacations, with all the religious ceremonies and observances, were instituted from time immemorial, but that the business of putting to the highest bid the powers of sole and chief magistrate, dates from the tenth transmigration of the soul of the present Lámá Gûrû.

One crop only is raised here in the year. Seed is sown in April, and the crop cut in September. The grains raised are Sua, Ne, Do, Doo Sanma, Youkar (barley, another description of barley, wheat, another kind of wheat, peas, and mustard). Radish, carrots, onions, potatoes, beans, garlic, and various other edibles are cultivated. There are two kinds of trees, called Changma and Jawar, but they are not indigenous, and are only to be seen in gardens. There is no jungle hereabouts, and excepting one thorny bush, called Sia, the hills are absolutely barren.

A very few of the rich men's houses are built of brick and stone, all others are of mud. Some few are built of sun-dried bricks. The manufactures of Lhásá are woollen cloths, felt, &c. The cattle of Lhásá are cows, sheep, goats, yaks, horses, asses, &c.; pigs and dogs are also reared, the latter being a very big animal; there are quantities of domestic cats, mostly black, and a few white and red. Fowls, pigeons, kites, crows, ducks, and pheasants, together with a variety of small birds, are very numerous. Snakes, reptiles, scorpions, &c., are not known.

The water supply of Lhásá is from wells, and a tax of two annas on every house is imposed monthly on the inhabitants for the use of the wells.

During the month of December, merchants from all parts bring their merchandise here (from China, Tartary, Darchando, Chando, Kham, Tawang, Bhotan, Sikkim, Nepal, Darjiling, Azimabad and Ladák). From China, silks of all varieties, carpets and Chinaware. From Jiling, in Tartary, is brought gold-lace, silks, precious gems, carpets of a superior manufacture, horse-saddles, and a very large kind of Dumba sheep, also valuable horses. From Darchando immense quantities of tea—(Darchando is said to be situated north-east of Lhásá, and to be distant two months' journey). From Chando city, in the Kham territory, an enormous quantity of the musk perfume is brought, which eventually finds its way to Europe, through Nepal. Rice, and other grain that is foreign to Lhásá, is brought from Tawang, in Bhotan. From Sikkim, rice and tobacco; and from Nepal, Darjiling and Azimabad, broad-cloth, silks, satins, saddles, precious stones, coral, pearls, sugar, spices, and a variety of Indian commodities. Charas and saffron (késar) come from Ladák and Kashmir. The merchants who come here in December, leave in March, before the setting in of the rains render the rivers impassable. The inhabitants use ornaments of coral, pearls, and precious stones, and occasionally of gold and silver, which are more especially worn by women on their heads. Coats lined with the skins of sheep are generally worn.

During the month of December, at nights and early in the mornings, the mercury in the thermometers sank below 32°, and during the days never rose over 40° to 45°. The river Kichu was frozen at that time of the year, and water kept in the warmest parts of a house, froze, and burst the vessels holding it.

The chief divinity worshipped in this part is Budh.

The food of the inhabitants consists chiefly of salted butter, tea, mutton, beef, pork, and fowls. Rice is not much eaten, owing to its high price, and because it is considered a fruitful source of disease. Other edibles, such as wheat, barley, and kitchen produce, &c., are cheap.

The current coin of the country is a silver piece called Naktang, two and a-half of which pieces being the equivalent of one rupee. The silver pieces are cut into either halves, or into three pieces, the half pieces are called Chikyah, and one-third of the Naktang is called Karma, and two-thirds of the Naktang piece, called Shokang or Miscal. There is also a large lump of silver, bearing the seal of the Chinese Emperor, the value of which is equal to 333 Naktangs, called Dojah or Kurus.

To the north-east of Lhásá, distant about one months' journey, there is a country called Kham or Nyahrong. Thousands of the inhabitants of this country annually pay Lhasa a visit, some under the plea of wishing to worship, while others come with the ostensible reason of trading, but all really come with the object of robbing and stealing whatever they can. These people are held in terror by all the peaceable inhabitants of the Lhásá territory, who have named them Golok Khamba. Highway robbery and murder are perpetrated by them without compunction. They appear to be exempt from the wrath or punishment of the Lhásá chiefs. The Lhásá government never takes notice of any complaints brought against this marauding tribe, and the reason I heard for this silence was that the Lhásá vakeel with government merchandize, on his annual journey to Pekin, has to pass through the territory appertaining to this tribe, and to insure a safe journey for these, the government connives at the mischief done by them in the Lhásá territory. Another reason I heard was, that, in case of a war, this Khamba tribe would render good service.

North of Lhásá, and four miles distant, is situated a long hill, stretching from east to west, reported to contain immense quantities of silver; but a government order prohibits anyone from working the metal. The government itself refuses to work the metal, for the general belief is, that the country will be impoverished, and the men will degenerate, should the metal be worked.

A Chinaman, not many years ago, worked a large quantity of silver here, but intimation was given to the government of the fact, and the man was seized, and sent to Pekin, where his hands were cut off. The name given to this hill is Toti-phu. On the summit of this hill is a spring, and a large flat slab of stone called Darga, the seat of the Mahommedan Pír. Another large slab of stone close to this is called Ja Nawaj; it bears the impression of a large hand, said to be the hand of a Mahomedan Pír, who lived here in former days. The Mahomedans of Lhásá resort to this place to worship. It is also reported and believed that gold exists in the Toti-phu hill, and near the monasteries Debang and Ramoche, but it is not worked. Gold is however worked to a very slight extent near the monasteries by the priests, but should they, in their search, discover a nugget of large size, it is immediately replaced in the earth, under the impression that the large nuggets have life, and germinate in time, producing the small lumps, which they are privileged to search for.

To the north-east of Lhásá, and one and a-half months' journey from it, at Sarka or Thok, gold is extracted in large quantities, there being no prohibition as to working it. This gold is carried to Lhásá, Gartokh and Digarcha. In this country no grain is raised near Sarka, the gold-diggers barter the metal for grain, &c., brought by merchants.

The strength of the standing force in Lhásá is 1,000 Bhotiya and 500 Chinese soldiers, armed with long flint guns, and of late seven small pieces of ordnance have been introduced. During the war between the Goorkhas and the Lhásá government, in 1854, an order was given for a census of the inhabitants, and, exclusive of the military and priests, Lhásá was found to contain 9,000 women and 6,000 men. The reason of this preponderance of females over the males is easily accounted for, in consequence of the large number of males who become priests, who are compelled to vow celibacy.

The Nepalese residents of Lhásá, though believing in the same divinity, Budh, as the Lhásá people, yet differ from them in many minor points. Another reason of the scanty population of Lhásá is traced to the custom of one family, consisting say of four or five males, who cohabit with one woman.

Regarding the disposal of their dead, the Lhásá people of the poorer classes bind the corpses tightly with rope, and place them erect against the inner walls of their houses for two or three days, while the richer and well-to-do classes detain the corpses in their houses for a length of fourteen days; after which time priests are invited, who pretend to read from their ritual the manner in which these corpses are predestined to be disposed. Sometimes their decision is to cut the corpse into pieces, and scatter the fragments to the birds and beasts of prey, and sometimes to bury them. The reason assigned by them for detaining the bodies springs from the belief that they may become demons if disposed of without the blessings of the priests.

The inhabitants of Lhásá report that the ready cash possessed by the government of Lhásá, and deposited in the Potoláh fort, equals, if not exceeds, the wealth of the whole world, but I was of a contrary opinion, as I learnt that, during the war between Lhásá and the Goorkhas, in 1854, the Lhásá government had to bring two lacs of rupees from Sáme monastery, to conduct the war.

Having made such a long stay in Lhásá, I had completely exhausted my funds, and was driven to teach some Nepalese merchants a little Hindee calculation, for my support, since I could get no credit in the place, and no opportunity to return to Nepal offered itself. I was one day questioned as to who I was by two Mahommedan merchants of Lhásá, who appeared to be of a better class than the generality of the people. I told them (as I had told every one who asked me the same question) that I was a Bisahiri, but they contradicted me familiarly, and said that I, they were convinced, was no Bisahiri, and at last they forced me to confess the truth, but solemnly swore to secrecy. By this confession of mine I was enabled to borrow of them a sum of money, on pledging my watch, and after borrowing another small sum, I made up my mind to start from Lhásá by the first opportunity that presented itself.

I was at about this time very much alarmed, by seeing the Kirong Jongpon in the streets of Lhásá one day; and I was still more alarmed on seeing the summary manner in which treachery in these parts was dealt with, in the person of a Chinaman, who had seditiously raised a quarrel between the priests of the Sara and Debang monasteries. He was (on the receipt of an order from Pekin to kill him) brought out before whole of the people, and beheaded with very little hesitation. Owing to my alarm, I changed my residence, and seldom appeared in public again.

At this time I learnt that the Ladák merchant, with whose servants I had travelled hither, was sending his party back to Ladák with large quantities of tea, &c., that he had purchased. Hearing this, I went to see him, and after making a few presents, preferred my request to be allowed to return to my own country along with his party. He assented, and ordered that I should be well provided for, giving his servants injunctions to receive from me all that I might owe him on our arrival at Mansarowar.

April 21*st*.—Left Lhásá early this morning, and arrived at eve at Netang village. 22*nd*.—Arrived at Chusul. 23*rd*.—Arrived at Kamba Barchi village. 24*th*.—Crossed Khambálá mountain, and arrived at Piate Jong village. 25*th*.—Arrived at Nangancho village. 26*th*.—Crossed Kharola mountain, and arrived at Ralung village. 27*th*.—Arrived at Gyangze city; halted here the 28th. 29*th*.—Arrived at Takche village. 30*th*.—Arrived at Pena Jong village.

May 1*st*.—Arrived at Shigátze city; made a stay of six days here, while collecting provisions for the road. 8*th*.—Left Digarcha in the morning, and arrived at Natang village. 9*th*.—Arrived at

Sabgeding village. 10*th.*—Arrived at Silka village. 11*th.*—Arrived at Tamcheding village. 12*th.*—Arrived at Phuncholing village. 13*th.*—Arrived at Chakdong village. 14*th.*—Arrived at Janglâche town; halted here one day, seeking provisions for the road as far as Mansarowar. 16*th.*—Crossed the Brahmaputra river, and arrived at Singilung village. 17*th.*—Arrived at Lharcha village. 18*th.*—Arrived at Gnabring Thaka Tarjam. 19*th.*—Arrived at foot of Rigu Tapjang monastery, situated on a hill. 20*th.*—Arrived at Sang-Sang-Kao Tarjam; halted here one day. 22*nd.*—Arrived at Ge camp. 23*rd.*—Arrived at Sang-Sang-Giado Tarjam. 24*th.*—Arrived at Gñangba-Yako camp. 25*th.*—Arrived at Rakha Thazang Tarjam. 26*th.*—Arrived at Chomukula Tarjam. 27*th.*—Arrived at camp near Gyacho Jheel. 28*th.*—Arrived at Sarka Jong. 29*th.*—Arrived at Tagung camp. 30*th.*—Arrived at Srikarpo camp, after passing Niku Tarjam. 31*st.*—Arrived at Thuku camp.

JUNE 1*st.*—Arrived at Tadúm monastery. 2*nd.*—Left Tadúm, and after crossing Chachu stream, arrived at Birmalung camp, on the left bank of the Brahmaputra. The Brahmaputra river is called by the people in these parts by three names, Tamjan Khamba, Machang, and Gnarichu Sangpo. 3*rd.*—Arrived at Tulu camp. 4*th.*—Arrived at Dhuksum Tarjam; sheep, goats, yaks and horses are seen in large numbers here; salt, which is got from Chaba, is bartered here for grain, brought from Muktinath and Jumla, this place producing no grain. 5*th.*—Arrived at Demar camp. 6*th.*—Arrived at Lahro camp. 7*th.*—Arrived at Thamzang Tarjam; sheep, goats, yaks, &c., are seen here in large numbers, and salt is bartered for grain brought from Jumla; halted here one day. 9*th.*—Arrived at Tha Khabjor; my servant here fell ill, and I was compelled to ask the assistance of my Ladáki companions for the prosecution of my work. 10*th.*—Arrived at Gyamzar camp; halted here one day. 12*th.*—Crossed Marium La mountain, and arrived at Ugro Tarjam, situated near Gunkyud-cho lake; this lake is about ten miles in length, and two miles in breadth. 13*th.*—Arrived at Nukche camp. 14*th.*—Arrived at Thokchan Tarjam, on right bank of Some Chu stream; halted here one day. 16*th.*—Arrived at Sarnia Unia camp, distant half a mile from bank of Mansarowar lake. 17*th.*—Left Sarnia Unia camp this morning, and travelling fast arrived at Darchan, a large village. Here I met Supia Shopol, an inhabitant of the Kumaon district, through whose assistance I was enabled to discharge my debts, which had been accumulating since I left Lhásá. The party whom I had accompanied hither went on to Gartokh, while I, in company with two of Supia's sons, started for Kumaon. I left my servant, who was ailing, at Darchan, as a security for the fulfilment of my promise to return and pay Supia all he had lent me. The watch I, however, could not redeem, but told the men who had possession of it to leave it at Gartokh, and that I would send the money to redeem it. 20*th.*—Left Darchan this morning, and arrived at a camp, name not ascertained. 21*st.*—Arrived at Gyanima camp. During the rains Darchan and this place are resorted to by many traders, who come here to dispose of their merchandize. 22*nd.*—Arrived on right bank of Chu Nago stream. 23*rd.*—Arrived at Thazang camp, and was surprised to see the low hills in the vicinity covered with snow in a way I had never seen before. The road over Kongribingri mountain was covered with snow, and rendered quite impracticable, this caused me to journey on to Niti, but even this road was so much covered with snow, that, on crossing over a hill, I accidentally slipped, and the thermometer I was carrying fell and broke. I left Thazang this same day, and arrived at Ship camp. 24*th.*—Arrived at Nukchang camp, on bank of Sákchu stream. 25*th.*—The Sakchu stream was not fordable, so I travelled alongside it till we arrived at Dongpu village; there I was asked who I was; I answered that I was a Bhotiya, like themselves, but they refused to let me pass, unless I showed them my authority for travelling thither. They told me if I had come from Tagla-Kote, as I said, to produce the passport of the Jongpon residing there. I told them I was on my way to Niti, but this did not satisfy them, and so they told me I must be detained till they had reported, and got back word from the Daba Jongpon. I was told that whenever the passes were opened, news of the fact was sent officially to every village, and that none of the passes were yet open, hence their suspicion of me. On seeing their determination to stop my further progress, I told them that I had a passport from the Jongpon of Tagla-Kote, but had forgotten, and left it at Darchan, and if they would not let me pass on, I would return to Darchan. They then informed me that they would allow me to return to Darchan, but could, on no account, let me pass for Niti, and with this, I returned three miles by the Darchan road, and struck out by a jungle path over hills, &c., and arrived at night at Lamlung camp. From Dongpu to this place I was unable to continue my route-survey.

26*th.*—Arrived at Lapthal camp. Here I saw four Bhotiya soldiers, who were sent here to stop the progress of Major Brereton. They questioned me as to who I was, where I had come from, and whither I was going; my answer to them was that I had come from Niti, knowing this would not excite suspicion. This village is on the extreme border of the Lhásá territory. 27*th*—Arrived at Khingur camp, where I met Major Brereton's camp. I halted here a portion of the next day, and was very kindly treated by Major Brereton. 28*th.*—Arrived at Topi Dhunga camp, where I left my servants,

in consequence of one of them having been taken suddenly ill. 29*th*.—Crossed Utdhura or Untadhura pass, and thence made my way, through Kumaon and Gurhwal, to Masuri. My servant Chumbal, whom I had left at Darchan, rejoined me on the road, having quite recovered from his illness.

My brother, who had returned to the British territory some time before me, had been instructed to cross the passes, in order to assist me. I gave him my sextant, and told him to carry a route-survey back to Dongpu (where I was forced to leave off), and thence to carry on the route-survey to Gartokh, in order to fix that place, and at the same time to redeem my watch, which the Ladákis had left there for me. My brother was successful in both these objects.

Route-Survey from Nepal to Lhasa.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
168	360 0*	...	...	...	In Kathmandû city, near the left bank of the Bishnomati river. This stream, after flowing 1,000 paces, joins the Bagmati river, which comes from the east. Thápáthalí, the house of Jung Bahadur, is on the right bank of the Bagmati, at 1,000 paces from the junction. Patan city, opposite to Thápáthalí, is on the left bank of the same stream. The temple of Pashopati Nath is 10,000 paces east of the station.
			3,000	...	To station 169. At the north end of the Kathmandû bazar.
169	331 30	...	1,000	...	To 170. On bridge on the left bank of the Bishnomati stream.
170	343 0	1,100	...	...	Balaji bazar.
		1,000	2,100	...	To Páwá resting place, on right bank of the Bishnomati stream.
171	360 0	1,700	...	...	To a small nala from the N.E., joins the Bishnomati.
		1,500	...	...	To Dharamthali village.
		600	3,800	...	To station 172.
172	326 0	...	1,900	...	To Jitpur village.
173	286 30	...	1,400	...	
174	337 30	...	500	...	To a small nala which flows westward.
175	258 30	...	1,100	...	To Páwá, or halting place, on the right of the road.
176	360 0	...	1,000	...	To station 177.
177	292 30	2,800	...	...	To Kaharia Páwá, a house.
		1,300	4,100	...	To station 178.
178	337 30	800	...	...	To Jaiphal Páwá.
		1,700	2,500	...	To station 179.
179	315 0	700	...	D†	To Rani Páwá.
		3,000	...	D	To Birahmanadi village.
		1,000	...	D	To Chowtaria Páwá.
		2,400	...	...	To Sundariphedi, at the base of the hill. Here a nala from the east, and another from 151° join, and flow towards 315° for 900 paces.

* 0° or 360° = North, 90° = East, 180° = South, and 270 = West.

† A—Ascending. D—Descending.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
179	315 0	900	8,000	...	To station 180.
180	270 0	3,500	...	...	At this point the Tari nadi from the N.E. joins the nala from Sundariphedi; at the junction is Malkote village. On the right bank of the Tari nadi is a building for the court of the raja of Nakote.
		2,000	5,500	...	To Batar bazar, on the left bank of the Gandak.
181	360 0	...	2,400	...	Near Trisuli bridge, on the left bank of the Gandak. On the right bank of the river is Kinchut bazar. A road from Trisuli bridge runs in a westerly direction to Pokra and Silgurhi, two places of some importance.
182	28 0	...	8,000	...	To station 183.
183	45 0	2,000	...	...	To Deobung (Páwá).
	45 0	4,000	6,000	A	Helango, a small Bhotiya village. The road runs about half way up the slope of the hill, which appears very high. Hence the people along the road are all Bhotiyas.
184	348 30	1,000	...	Level	Bekûti village.
		700	1,700	Do.	
185	33 30	...	1,400	Do.	
186	348 30	...	3,000	Do.	Ramcha village. To the west of Ramcha village is seen a very high snowy range, running in a northerly direction.
187	33 30	...	2,500	Do.	Here a small stream runs by from the east, and two miles lower falls into the Gandak, near the place where another small stream empties itself. From this point the Gandak is distant about two miles.
188	343 0	400	...	Do.	Garang village. This village, and all others on the road from hence, are roofed with wood only.
		1,400	1,800	Do.	
189	50 30	3,400	...	Do.	Tangû, a small village.
		200	3,600	Do.	
190	78 30	2,000	...	Do.	Boldong, a small village.
		1,600	3,600	Do.	Naklánphû a resting place for travellers.
191	28 0	2,000	...	Do.	Láncháchimbo, a small village.
		500	2,500	Do.	A pyramidal pile of stones at which the villagers worship (Chortún).
192	67 30	1,200	1,200	Do.	Dûnglang, a very large village.
193	45 0	1,100	1,100	D	Tinghori, a small stream, flows from the south, and falls into the Gandak river at about ¾ of a mile from hence. This stream has its origin in a large sheet of water, named Goosái, well-known as a place of annual resort by the inhabitants, for the purpose of worship.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
194	360 0	1,700	1,700	Slight A	
195	56 0	800	800	Level	Bhárkû.
196	16 30	1,000	1,000	Do.	
197	39 0	500	...	D	Along the left bank of the Gandak river.
		3,600	4,100	Level	Shabrû village, at the junction of the Gandak and Langdong (Khola), a small stream from the N.E. The Langdong Khol is bridged, and a toll is levied on all goods and men passing over.
198	360 0	1,800	...	Do.	Ungal village (small).
		600	2,400	Do.	Opposite this point a small stream from the W. falls into the Gandak, and about four miles up the stream the village of Gúljun is visible.
199	16 30	1,400	...	Do.	Here the Gandak is bridged, and on the opposite (R) bank of the river is situated the village of Medongpodo.
		700	...	Do.	Here a small stream from the E. falls into the Gandak.
		2,000	...	Do.	Biting village.
		1,800	5,900	Do.	Here a small stream from the E. falls into the Gandak.
200	360 0	1,800	1,800	Do.	Here the Gandak is bridged.
201	33 30	1,500	...	Do.	Temuria Bansár or Satang, a large village where tolls are levied.
		200	1,700	Do.	
202	45 0	1,500	1,500	Do.	A corn-mill. Here a small stream from the E. falls into the Gandak.
203	11 0	1,500	...	Do.	A fort called Raswagarhi, built by Jung Bahadoor, stands here. A good-sized stream, named the Lendichú, coming from the N.E., falls into the Gandak. This stream forms the boundary between the Lhásá and the Gûrkha territories. A stone 4½ feet high and 3 feet in breadth has been erected here as a boundary pillar; it bears an inscription in Chinese characters.
		300	1,800	Do.	Dongkhang (Dhramsala).
204	292 30	2,900	2,900	Do.	Along the left bank of the Gandak river.
205	348 30	1,000	1,000	Do.	Do. do.
206	343 0	300	...	Do.	Opposite this point a stream from the W. falls into the Gandak.
		300	600	Do.	Paimánesa, a Police post Travellers are examined here.
1	343 0	3,400	3,400	Do.	Along the Gandak. This (station) is identical with No. 206 above.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
2	16 30	15,200	15,200	Slight A	Thunsiá village.
3	320 30	3,000	...	Do.	A small stream from N.E. by N. flows from hence parallel to the Gandak, and falls into it about one mile below Thunsiá.
		2,800	5,800	Ascent	
4	298 0	1,300	...	Slight D	Kiroñg, a small town, with a large temple dedicated to the Saint Phákpáchengrá, which stands at the N. end of the town. A fort called Sharbá (jong) lies to the east, and a place called Nûb (jong) to the west. A house at the N.W. end, the residence of a Labrong, was the place from which observations for latitude were taken.
		500	...	Do.	A corn-mill, on the left bank of a small stream from the west.
		1,300	...	Level	A bridge across the last mentioned stream. From this two monasteries (Gûnpá) are seen at about four and five miles.
		600	...	Do.	Opposite on the right bank of the Gandak is the village of Dûlbo.
		1,500	...	Do.	Chougdiá village. Opposite which a small stream falls into the Gandak.
		2,600	...	Do.	Jamding village.
		400	...	Do.	Pañg Sing village.
		2,000	...	Do.	Opposite this on the other bank of the Gandak stands the Garú monastery (Gûnpá).
		2,900	...	Do.	On the right bank of the Gandak river, which was crossed by a bridge.
		700	...	Do.	Mágal village.
		2,500	16,300	Do.	Half mile from the Gandak river. A good-sized stream comes from the W., and passing this place, falls into the Gandak.
5	343 0	1,300	...	Do.	Rakmá village.
		800	...	Do.	On the left bank of the Gandak river, which was again crossed by a bridge called Rakmá Yársam. Tolls are levied here during the months of September and October on all goods taken across.
		3,200	...	Do.	Tildi-fû, an immense fragment of rock to the right of the road, bearing inscriptions in Chinese and Lhásá characters.
		1,300	...	Do.	On the left bank of the Gandak. On the other bank, and about ¼ mile from it, is a Gúnpá (monastery) half way up the hill side. A small stream from the E. falls into the Gandak at this point.
		1,400	...	Do.	Thotang. The houses of this village are on both banks of the Gandak. A small stream from E. here falls into the Gandak.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
5	343 0	1,700	...	Level	On the opposite bank a glacier is visible, from beneath which a small stream flows into the Gandak.
		700	...	Do.	A small stream from N.E. falls into the Gandak.
		200	...	Do.	On the right bank of the Gandak, which is bridged.
		1,500	...	Do.	A small stream from the N.W. falls into the Gandak.
		100	12,200	A	The ruins of Linde Fort.
6	33 30	1,000	...	Level	On the left bank of the Gandak, which is here bridged.
		500	...	Do.	On the right bank of the Gandak, which is here bridged.
		500	...	Do.	On the left bank of the Gandak, which is here bridged.
		1,400	...	Do.	A small stream from the S.E. falls into the Gandak. This stream is the boundary between the two districts Kiroñg and Joñkájoñg.
		2,500	...	Do.	A stream from glacier on the east falls into the Gandak.
		1,000	...	Do.	On the right bank of the Gandak, which is bridged.
		2,100	...	Do.	Sangdá village, a stream flowing from W. falls into the Gandak.
		500	9,500	Do.	A small stream from W. falls into the Gandak. The road to Joñkájoñg and Lhásá follows a northerly direction from this; Joñkájoñg is about 24 miles from hence. Followed the course of this small stream.
7	298 0	4,200	...	Slight A	At Mûn village.
		7,600	...	Great A	*On the top of Lájúk Thûmbá mountain. Thermometrical observations taken here.
		8,700	20,500	Steep D	A grazing-ground (chûksa). Along the bank of a stream called Bûriá Gandak.
8	236 0	400	...	Slight D	At this point a good-size stream coming from N.W. falls into Bûriá Gandak.
		3,300	3,700	Do.	Kolung (chûksa) grazing-ground. A stream called Chike (Chú), from the N.W., falls into the Bûriá Gandak. From hence a large road crossing a high mountain, distant about 16 miles, leads to Tibet.
9	180 0	4,600	...	Do.	Chûrtan (temple). A small stream from E. falls into the Bûriá Gandak.
		1,200	...	Do.	A small stream from W. falls into the Bûriá Gandak.
		1,900	...	Level	On the left bank of the Bûriá Gandak, which is bridged.

* This forms the boundary between the Lhásá and Gûrkhá territories.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
9	180 0	600	...	Level	On the opposite bank a stream from N.W. falls into the Bûriá Gandak.
		2,600	...	Do.	Opposite, on the right bank of the stream, stands the village of Chûm, also called Nilûe; this is a very large village.
		500	11,400	Do.	At the village called Chûlûe a small stream from the E. falls into the Bûriá Gandak.
10	225 0	1,200	...	Do.	A very large temple (Chortún.)
		1,200	...	Do.	A village called Páñgdûn.
		1,000	...	Do.	A village called Phûrûe; the stream is bridged at this village.
		300	...	Do.	On the right bank of the stream. A small stream from S.E. falls into the Bûriá Gandak on the opposite side.
		700	...	Do.	On the other bank the village of Láhar. A small stream from N.W. falls into the Bûriá Gandak.
		2,200	...	Do.	A village called Ñah (small).
		1,500	...	Do.	A large village called Ñahkû. A stream from the N.W. into the Bûriá Gandak, and a second from the S.E. falls in on the opposite side.
		800	8,900	Do.	A (Gúnpá) monastery. The country from hence is covered with jungle.
11	247 30	1,300	...	Do.	A good-sized village, called Jonghíl.
		1,000	...	Do.	A small village, called Páldoñ.
		500	...	Do.	A small village, called Chokáñg. The road from hence is very bad.
		4,400	...	Up & Down	A large stream, called the Khímúlúng (Chú), from the north falls into the Bûriá Gandak.
		600	...	Slight A	A small village called Lohong; opposite stands the village of Go.
		600	8,400	Level	The small village of Pangu. A small stream from the S.E. falls into the Bûriá Gandak. From this point, for about four miles, the Bûriá Gandak assumes a south-westerly course, and then changes to a southerly one. Two villages are visible, distant about four miles, viz., Shipche village on the left, and Chûmúling on the right bank.
12	286 30	6,000	6,000	A	Chûrtan-Phuk-kúr. This village lies between two small streams, which coming from the north, and joining near the village, fall into the Bûriá Gandak about one mile lower.
13	236 0	2,000	...	Level	The village of Chumzchil.
		1,000	...	Do.	A pile of stones (Lapchá).

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
13	236 0	1,400	...	D	A small stream from N.W. falls into the Bûriá Gandak one and a-half miles below. A corn-mill stands here.
		3,500	...	Great A	On the top of the Lhá Chûmû-phûr-phûr mountain near a pile of stones (Lapchá). Thermometrical observations taken here.
		600	...	Up & Down	Pile of stones (Lapchá).
		1,100	9,600	D	From this the junction of the Nûbri (chú) and the Bûriá Gandak is visible, the joint stream flows south. Near the junction is a large village called Niá, one mile lower the village called Báñgsing, and a mile below the latter Tara village.
14	286 30	4,800	...	D	On a small stream which falls into the Nûbri lower down.
		1,200	6,000	Level	On the left bank of the Nûbri (chú) river; a small stream falls into the Nûbri opposite this point.
15	360 0	1,500	...	Do.	Ráná village; here the stream is bridged, and a road *viâ* Niá and Báñgsing leads to Nepál.
		900	...	Do.	A small stream from the E. falls into the Nûbri.
		300	...	Do.	Another stream from E. falls into the Nûbri.
		700	3,400	Do.	On the left bank of the Nûbri.
16	315 0	1,000	...	Do.	At Bigá village.
		600	...	Do.	A small stream from the N.E. falls into the Nûbri.
		1,500	...	Do.	Lûñg village.
		1,900	5,000	Do.	A stream from north falls into the Nûbri.
17	181 0	1,500	...	Do.	On the right bank of Nûbri, which is bridged.
		600	...	Do.	Kap village; opposite, on the right bank of the river, distant about half a mile, are the villages of Chak and Gopá.
		1,800	...	Do.	At this point a large stream, called the Gnola-chú, from the N. falls into the Nûbri.
		2,000	5,900	Do.	A stream from the S.W. falls into the Nûbri.
18	303 30	3,200	...	Do.	Namdûl village, on right bank of Nûbri (chú).
		300	...	Do.*	Here a small stream from the W. falls into the Nûbri.
		3,500	7,000	Do.	Lûiláká village.
19	281 0	1,000	...	Do.	The Haman stream from W. falls into the Nûbri (chú), over it is a bridge called Haman (Sambá).

* Thermometrical observations were taken here.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
19	281 0	1,200	...	Level	Shao village; (small). Immediately opposite, on the other bank of the Nûbri (chú), stands the village of Niñg.
		3,400	...	Do.	Lûe, a large village.
		1,200	6,800	Do.	A small stream from W. falls into the Nûbri river.
20	275 30	4,000	...	Do.	A stream from S.W. falls into the Nûbri river.
		3,000	7,000	Do.	Rûe village; (very large).
21	348 30	600	...	Do.	To the left of this point, distant quarter of a mile, stands a monastery (Gûnpá).
		1,500	...	Do.	Here a stream flowing from W., and coming from under a large glacier, falls into the Nûbri.
		5,700	...	Do.	On the left bank of the Nûbri (chú) stream, which is bridged. A small stream, coming from a glacier distant about quarter of a mile, falls into the Nûbri here.
		2,100	10,200	Do.	At Bábûk (chûksa) grazing-ground, which is at the junction of the Nûbri (chú) and another large stream coming from an immense glacier, three-fourths of a mile distant, lying west of this point. From this place a road runs in a westerly direction to an important place called Muktinath, distant five days journey. Bábûk (chûksa) is on the right bank of the Nûbri (chú) stream, which is bridged.
22	11 0	4,000	4,000	Slight A	Here the stream is crossed by a bridge called Diluñg (Sambá). This point is on the left bank of the Nûbri (chú). On the other bank of the stream, in a N.W. direction, lies an immense glacier about four miles in length, from which a small stream falls into the Nûbri (chú).
23	315 0	2,800	...	Level	Gyá-lá Sáláng, at the foot of a high mountain.
		3,500	6,300	Great A	On the top of Gyalá mountain. This forms the boundary between the Lhásá and Gûrkhá territories. Thermometrical observations were taken here.
24	33 30	2,600	...	D	A small stream from a glacier on the W. flows past this point, and falls into another stream one mile distant. This latter stream, after flowing a long distance in an easterly direction, falls into the Nûbri (chú) near the village called Kap.
		2,300	...	A	Near a pile of stones (Lapchá).
		2,300	7,200	D	At a village named Sañgjúmbá, on the right bank of a stream.
25	343 0	3,400	3,400	Level	Somnath camp*, at the junction of two streams, viz., one mentioned above, and a second coming from the W.

* Thermometrical observations were taken here.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
26	28 0	4,000	...	Slight A	On the left bank of the stream mentioned above, which is here joined by a stream from the N.W.
		2,000	...	Do.	A small stream from the E. falls into this stream.
		4,900	10,900	Great A	On the top of Gñolá mountain. Thermometrical observations were taken at this point.
27	22 30	9,500	...	D	At a halting place for travellers called Bárûdhuksam, on the left bank of a stream called Shûrtá Sáñgpo.
		3,000	12,500	Level	
28	343 0	4,000	...	Do.	Opposite this point a large stream from S.E. falls into the Shûrtá Sáñgpo.
		4,900	...	Do.	A small stream from the W. falls into the Shûrtá Sáñgpo (river).
		5,200	...	Do.	Zángrá Dûñg or Rebo (camp).
		10,500	24,600	Do.	On the left bank of the Shûrtá Sáñgpo.
29	326 0	4,000	4,000	Do.	Opposite this point, on the other bank, stands an isolated hill called Tházam (well-known).
30	309 0	6,000	6,000	Do.	At this point the Shûrtá Sáñgpo river follows a north-easterly course for about three miles, and then taking an easterly course for about four miles, falls into the Tamjan Khambá or Brahmaputra.
31	286 30	10,200	10,200	Do.	Gangab-phû (Gûnpá). At this point a stream from S. flows past, and falls into the Brahmaputra three miles ahead.
32	320 30	2,500	...	Do.	At Tallá Labrong (camp). Observations for latitude were taken here, also thermometrical observations.
		4,400	...	Do.	A stream called Hûmûlûng (chú) coming from W. flows past this point and falls into the Brahmaputra.
		1,600	...	Do.	At Yák Kíû or Malá Labrong (a large camp). The Brahmaputra river is distant about one and a-half miles N.E.
		2,600	...	Do.	One branch of the Hûmûlûng (chú) flows past this point, and falls into the Brahmaputra river one mile above.
		8,500	19,600	Do.	At Chabdan (Gûnpá), an old monastery about one mile from the Brahmaputra river.
33	337 30	4,500	...	Do.	On right bank of the Brahmaputra. To the left of the road is a small tarn.
		2,000	6,500	Do.	Small isolated hills on both sides of road.
34	11 0	3,000	...	Do.	Relá Gûnpá, a large monastery.
		4,000	7,000	Do.	On the right bank of the Brahmaputra.
35	348 30	2,000	...	Do.	Do. do.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
35	348 30	2,000	...	A	On the right bank of the Brahmaputra.
		1,000	...	D	Do. do.
		700	5,700	Level	At Kiûdoñg.
36	45 0	5,000	5,000	Do.	On right bank of the Brahmaputra.
37	22 30	4,000	4,000	Do.	Mûná-dûgá or Ghát.
1	286 30	5,000	...	Do.	(Station 1). This station is identical with No. 36.
		1,700	6,700	A	On the top of Tákoláh mountain.
2	292 30	2,000	...	D	Sateáh-doñg (camp).
		3,600	5,600	Level	
3	337 30	3,000	3,000	Do.	Jáñg-thák-doñg (camp).
4	303 30	2,000	...	Do.	A small stream from S.E. flows past, and falls into the Brahmaputra two miles ahead.
		2,000	4,000	Do.	
5	286 30	2,800	...	Do.	At Gárbá-doñg, to the right of the road is an isolated hill.
		1,000	...	Do.	On right side of the road a tarn called Sañgi-gám.
		1,000	...	Do.	Do. do.
		800	...	Do.	Do. do.
		19,000	24,600	Do.	At Likche Gûnpá, on right bank of the Brahmaputra. South of this point, distant about one mile, lies a lake one mile long by one mile in breadth. The Brahmaputra at this point is crossed in boats formed by a frame-work of wood covered with leather.
6	354 0	5,000	5,000	Do.	In the vicinity of numerous little patches of water.
7	22 30	7,400	7,400	Do.	Tádúm (Gûnpá) monastery, and tarjum, or halting place, situated on a hillock. Numerous patches of water all round.
8	101 0	13,000	...	Do.	
		2,500	15,500	Slight A	
9	78 30	1,000	...	D	In the vicinity of this point are numerous patches of water.
		3,000	4,000	Level	Thûkû camp.
10	95 30	2,500	...	Do.	
		3,200	5,700	Slight A	
11	106 30	2,000	...	D	
		6,200	8,200	Level	Lakchan camp.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
12	140 30	1,000	...	Level	A tarn.
		5,000	6,000	Do.	Phûchûngmá camp.
13	129 0	4,000	...	Do.	On the left bank of a small branch of the Brahmaputra river.
		6,000	10,000	Do.	At Shricárpo, on the right bank of the Minchû Sáñgpo, which comes from the E., and falls into the Brahmaputra one mile distant.
14	78 30	7,000	7,000	Do.	On right bank of Minchû Sáñgpo.
15	39 0	5,500	...	Do.	From this point the Minchû Sáñgpo is seen to come from the N.E.
		1,200	...	Do.	Nikû tarjum, or halting place.
		2,000	8,700	Do.	
16	95 30	9,300	...	Do.	On road to this point crossed a branch of the Minchû Sáñgpo; a stream coming from the S. flows past and falls into the Minchû Sáñgpo four miles to the north.
		3,500	12,800	Slight A	
17	112 30	2,000	...	Level	At this point a small stream coming from S.W. flows past, and taking a north-easterly course, falls into the Minchû Sáñgpo three miles ahead.
		4,000	...	Do.	At this point a stream from S.W. flows past and falls into the Minchû Sáñgpo.
		1,400	...	Do.	Jagúñg camp.
		6,700	...	Slight A	On top of Lálúnglá mountain. A small stream, rising at the foot of this mountain, falls into the Minchû Sáñgpo. A large road leads from hence to Joñg-ká-joñg.
		400	14,500	D	
18	84 0	5,000	5,000	D	A village in ruins.
19	56 0	4,000	4,000	Level	On the right bank of the Chartá (Sáñgpo) river. At this point the Chartá-Sáñgpo changes its course from a southerly to a south-easterly direction. The ruins of an old fort are seen near, called Gyáh-khar-jáh-khar.
20	112 30	2,500	...	Do.	On the left bank of the Chartá Sáñgpo.
		700	...	Do.	At this point the Chartá Sáñgpo flows in a southerly direction, and empties itself into the Brahmaputra six or seven miles below. To the north of this point, distant about one mile, stands a monastery (Gûnpá) called Darkiáling.
		3,100	6,300	Do.	On the right of a stream called Chá-ká-chú which comes from E. and falls into the Chartá (Sáñgpo) river three miles below.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
21	84 0	8,000	...	Level	Jhálúñg camping place, on the right bank of the Chá-ká-chú.
		1,000	9,000	Do.	
22	78 30	5,000	5,000	Do.	Sar-ká, a large village, situated one mile north of the Chá-ká-chú stream. A fort called Sarkájong stands at the east end of the village.
23	118 0	3,400	...	Do.	A small stream from N.W. flows past and falls into the Chá-ká-chú stream quarter of a mile below.
		12,900	...	Do.	On the left bank of the Chá-ká-chú, which stream from this point appears to come from N.E., flowing past the foot of a very snowy and high mountain called Hurkiang, distant about three miles.
		1,100	17,400	Do.	Nágúling camping place. A road from this point running S.E. leads to Joñk-ká-joñg.
24	112 30	4,000	...	Do.	Lárchá; (foot of hill).
		1,000	...	A	
		1,000	...	Level	On top of Gyálá mountain; pile of stones (Lapchá).
		2,300	8,300	Do.	From this point the Brahmaputra river is visible three miles to the south.
25	140 30	2,000	...	D	
		2,000	4,000	Level	A ruined village.
62	106 30	2,000	...	Do.	
		1,000	. .	A	To the right of the road a long tank called Gahlchu.
		1,500	4,500	Slight A	Pile of stones (Lapchá). The tank mentioned above ends at this point.
27	67 30	1,600	1,600	D	Upshi village. Grain is raised at this village.
28	129 0	2,800	2,800	Level	The Brahmaputra is two miles south.
29	95 30	8,000	8,000	Do.	Road runs between hills along a small stream.
30	33 30	5,200	...	Do.	At Chomûkûlá Tarjum. Observations for latitude were taken here.
		2,800	...	Do.	A very small stream from the left.
		1,200	9,200	Do.	
31	50 30	3,700	3,700	Do.	About three miles from this point is a high snowy mountain.
32	73 0	5,200	5,200	Do.	
33	22 30	2,700	2,700	A	On top of Gûrlá mountain. From this point is distinctly visible a high snowy range fifteen miles distant, stretching about forty miles E. to W. The Ráká (Sáñgpo) river has its source at the foot of this mountain.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
34	67 30	6,200	6,200	Level	To the right of the road stands a range of hills stretching in an easterly direction.
35	90 0	6,000	...	Do.	At this point a stream from south falls into the Ráká Sáñgpo.
		2,500	8,500	Do.	At Tarchung camp; a small stream from south falls into the Ráká.
36	95 30	8,000	...	Do.	On the opposite bank of the Ráká is a grazing-ground called Ahle.
		8,000	...	Do.	At Ráká-Tházang-Tarjam, or halting-house.
		4,500	20,500	Do.	At this point the Ráká Sáñgpo flows in an N.N.E. direction for about four miles, and then due E.
37	67 30	2,000	...	Do.	At Máne; a platform covered with engraved stones.
		1,700	...	Slight A	
		1,200	...	D	A stream from S.E. flows past, and falls into the Ráká one mile N.
		1,600	6,500	Level	Gñáñg-bi-áko camping-ground.
38	73 0	5,500	5,500	Slight A	Gñáñg-la mountain. To the right of the road a very lofty snowy peak.
39	78 30	2,500	...	Level	Lapchá; pile of stones.
		3,200	5,700	D	On the right bank of the stream mentioned on road from station 37 to 38.
40	101 0	2,200	2,200	Level	
41	73 0	8,400	8,400	Slight A	Sáñg-bi-(la) Lapchá.
42	67 30	600	...	Level	Lapchá; pile of stones. From this point, distant about fifteen miles, is seen a very high snowy range stretching from N.E. to S.W. The Brahmaputra flows behind this range.
		1,800	...	D	At Rûan; camping place foot of hill.
		7,000	9,400	Level	On left bank of a stream which from this point flows to the right of the road, and falls into an immense lake four miles in length called Kyongdam cho.
43	61 30	8,000	...	Do.	The lake called Kyongdam extends to this point.
		3,500	...	Do.	At Sáñg-Sáñg-giah-do Tarjam. Observations for latitude were taken here, also thermometrical observations.
		1,200	12,700	Do.	Alongside lake.
44	33 30	2,000	2,000	Do.	Alongside lake. This lake is three-cornered. The Ráká Sáñgpo river supplies it with water.
45	106 30	1,000	1,000	Do.	On the right bank of the Ráká Sáñgpo.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
46	180 0	900	...	Level	From this point the Ráká Sáñgpo continues an easterly course, and a large road runs alongside the river leading to Lhásá. At this point a stream coming from S. falls into the Ráká Sáñgpo.
		2,800	3,700	Do.	On the left bank of the stream mentioned above.
47	140 30	4,000	4,000	A	On top of Kichelá mountain.
48	67 30	4,000	4,000	D	On left bank of a stream which rises at the foot of Kichelá mountain.
49	39 0	1,400	...	Level	A small stream from S.E.
		300	...	Do.	On right bank of stream.
		1,500	3,200	Do.	At this point the stream follows a northerly course, and falls into the Ráká Sáñgpo one mile distant.
50	84 0	5,500	...	Slight A	On top of Ge-la mountain; (Lapchá) pile of stones.
		700	6,200	D	
51	56 0	3,500	3,500	Level	Ge camp, on bank of a small stream which rises at foot of the Ge-la, and falls into the Ráká Sáñgpo river.
52	112 30	1,600	1,600	A	Lapchá; pile of stones.
53	90 0	2,600	2,600	Slight D	From this point the Ráká Sáñgpo river is seen three-quarters of a mile distant north, and about one mile beyond the stream is the Gniaring Gûnpá monastery.
54	106 30	1,500	...	Level	A small stream from S. flows into the Ráká Sáñgpo half a mile north.
		4,000	5,500	Do.	
55	135 0	2,000	2,000	Do.	
56	106 30	3,000	...	Do.	A stream coming from S.W. flows past into the Ráká Sáñgpo.
		3,800	6,800	Do.	Lapchá; pile of stones.
57	112 30	4,000	...	Do.	A large stream from S. flows past into the Ráká Sáñgpo one and a-half miles north.
		2,800	6,800	Do.	Máne; platform covered with engraved stones.
58	135 0	2,200	2,200	Do.	Lapchá; pile of stones.
59	95 30	7,200	7,200	Do.	A small stream from S.W. flows past, and falls into the Ráká Sáñgpo three miles north.
60	73 0	5,000	5,000	Do.	At this point* a stream coming from E. flows past into the Ráká Sáñgpo. North of this point 1,000 paces stands Sang-Sang-Kau Tarjam, where latitude and thermometrical observations were taken.

* Thermometrical observations were taken here.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
61	135 0	2,000	2,000	Level	Máne; a platform covered with engraved stones.
62	101 0	1,500	...	Do.	Due north of this point about four miles the Ráká Sáñgpo is seen flowing in a north-easterly direction.
		2,900	...	Do.	On right bank of stream mentioned on road from station 60 to 61, which comes from the S.E.
		800	5,200	Do.	Lapchá; pile of stones.
63	90 0	4,600	...	Slight A	On summit of Kálhá mountain, which forms the boundary between the districts of Bót or Chang and Dókthál.
		1,800	6,400	D	
64	106 30	1,800	1,800	Level	
65	78 30	2,000	...	Do.	Máne; a platform covered with engraved stones. A small stream from S.
		1,000	...	Do.	On right bank of stream.
		800	3,800	Do.	
66	140 30	1,100	...	Do.	A small stream from S.E. flows past in a N.W. direction.
		1,800	...	...	At Kûkáp camp.
		1,000	3,900	Do.	
67	123 30	2,500	...	Do.	Lache, foot of hill.
		1,300	...	A	On summit of Tháñglá hill.
		1,500	...	D	
		2,000	...	...	On left bank of a stream from S.W. and flows in a north-easterly direction. About one mile to the north of this point is situated a very large monastery (Gûnpá) called Rigû-Tábzáng.
		2,800	10,100	Level	On right bank of the stream.
68	90 0	600	...	Do.	Here another stream comes in.
		2,000	...	Do.	Alongside stream which takes hence a northerly course, and falls into the Ráká Sáñgpo some distance away.
		1,600	4,200	Do.	Máne; a platform covered with engraved stones.
69	112 30	800	...	Do.	A stream from S. flows past.
		1,200	2,000		
70	95 30	1,600	...	Slight A	On top of hill at a small tarn.
		200	1,800	Level	

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
71	78 30	7,500	7,500	D	On right bank of the Chirkû stream, which flows hence N.E. by N., and falls into the Rák i Sáñgpo.
72	101 0	1,200	1,200	Level	Rálûng, a large village; observations for latitude were taken here. East of this all villages on the road raise their own grain.
73	90 0	1,500	1,500	Slight D	At the N.W. end of a large lake called Gñábring Kimcho, about five and a-half miles long and three miles broad.
74	123 30	500	...	Level	A Gûnpá monastery lies to the north, the lake being about quarter mile distant.
		5,000	...	Do.	To the left of the road another monastery (Gûnpá).
		1,000	6,500	Do.	Máne; a platform covered with engraved stones.
75	135 0	3,600	3,660	Do.	Gñábring Kháká village and Tarjam; latitude observations taken here. About three miles, 60° east of north, is a very large village and fort called Gñábring joñg. From this point a snowy range is seen about fifteen miles north.
76	157 30	3,100	3,100	Do.	A stream coming from S. flows past into the Gñábring Kimcho.
77	106 30	1,900	1,900	A	On summit of a low hill.
78	123 30	300	...	Level	At a small tank.
		300	...	Do.	
		2,900	3,500	Slight D	On left bank of a stream.
79	106 30	2,400	...	Level	Chaulûng, a small village on bank of stream.
		2,500	...	Do.	At Chitûng, a small village on bank of stream.
		2,200	7,100	Do.	A large stream from 78° east of north flows past, and falls into the Brahmaputra to the south.
80	78 30	2,200	...	Do.	Damálûng village, on right bank of above stream.
		3,200	...	Do.	500 paces to north stands the village of Lárchá-hil, the large stream comes from the north to this point.
		300	5,700	Do.	
81	84 0	2,500	...	Do.	300 paces S.W. is the village called Namá.
		600	...	Do.	At S.W. end of a large lake called Láñgcho Gonák.
		300	3,400	Do.	On bank of lake.
82	61 30	2,600	...	Do.	At a (Gûnpá) monastery, on bank of lake. To the left of the road stands a second Gûnpá half way up the slope of a low hill.
		600	3,200	Do.	A large monastery (Gûnpá) on bank of lake.
83	95 30	2,500	2,500	Do.	On bank of lake.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
84	90 0	200	...	Level	At this point the lake becomes very narrow.
		1,200	...	Do.	To the left of the road the Lalung monastery (Gûnpá).
		2,600	4,000	Do.	Extreme E. end of lake.
85	73 0	2,100	2,100	Do.	To the N.E. quarter of a mile the village of Bárkhá, and to the north a very lofty snowy peak.
86	129 0	4,000	...	Do.	At Kharû village.
		3,800	...	Do.	A large Máne; platform covered with engraved stones.
		400	8,200	Do.	Singilûng village.
87	157 30	3,800	3,800	Do.	Napsi village, on left bank of stream, which flows south into the Brahmaputra one mile distant.
88	78 30	6,000	...	Do.	Gádûc village, to right of road.
		600	...	Do.	Degûñg (Gûnpá) monastery to left of road.
		4,500	11,100	Do.	On left bank of the Brahmaputra, which on the opposite bank receives a stream from the south.
89	90 0	3,000	3,000	Do.	Chûnká village, on left bank of the river.
90	50 30	4,000	4,000	Do.	Jangláche city with a fort, both on the right bank of the Brahmaputra, which was crossed in boats. Latitude and thermometer observations were taken in the city.
91	326 0	3,200	...	Do.	The Brahmaputra is here spanned by an iron chain suspension bridge called Chaksam. Opposite this point on the left bank is the Debung (Gûnpá) monastery.
		500	3,700	Do.	
92	45 0	3,700	...	Do.	To left of road stands a Gûnpá and a corn-mill.
		1,000	...	Do.	Opposite, on the left bank, is the Dele village.
		3,000	...	Do.	To right of road the Shekcha village.
		1,800	...	Do.	To right of road the Shekcha Okmi village.
		1,200	10,700	Do.	A village is seen on opposite bank, name not ascertained.
93	360 0	3,800	3,800	Do.	The Cholá village.
94	16 30	2,500	2,500	Do.	Two villages (names not ascertained).
95	84 0	2,400	2,400	Do.	Chakdang village. The Brahmaputra is half a mile from this point.
96	28 0	4,600	4,600	Do.	On right bank of Brahmaputra river. Opposite a village, name not known.
97	73 0	2,000	2,000	Do.	Nesá village.
98	56 0	2,000	...	Do.	Diñg village, on right bank of river.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
	56 0	2,000	...	Level	Pháñgzi village, on right bank of river.
98		2,400	6,400	Do.	On right bank of the Brahmaputra.
99	90 0	3,000	...	Do.	At Táshi joñg village.
		2,000	5,000	Do.	On right bank of river.
100	45 0	1,000	...	Do.	At this point a stream from S.E. falls into the Brahmaputra. A village called Thásiling lies 1,000 paces south-east, on the left bank of stream; observations were taken here.
		7,000	8,000	Do.	Thañg; (road precipitous here). At this point the Ráká Sáñgpo river falls into the Brahmaputra, it comes from (252°) 72° west of south.
101	129 0	3,500	3,500	Do.	Phûn-cho-ling village and (Gúnpá) monastery, on right bank of river; the river is here spanned by an iron suspension bridge called Chaksam.
102	84 0	5,500	...	Do.	Thang; (precipitous road). On the other bank of the river is the Chehil village.
		3,000	...	Do.	Opposite, on the other bank of the river, the Púsúm village.
		400	...	Do.	Páñgdá village, on right bank of river.
		2,000	10,900	Do.	On right bank of Brahmaputra river.
103	90 0	2,500	2,500	Do.	Do. do.
104	157 30	1,200	...	Do.	At this point the river is spanned by an iron suspension bridge called Chaksam. A road leading over the bridge and running N.E. goes to Jisáñg Lûngbá.
		3,200	4,400	Do.	From this point the Brahmaputra flows 112° bearing.
105	180 0	2,500	2,500	Do.	Dhûn-dup-diñg village.
106	157 30	3,200	...	Do.	Táshi Kang, a very large village.
		2,000	...	...	A small stream from the south flows past into the Brahmaputra three miles north.
		1,000	6,200	Do.	
107	112 30	4,000	...	Slight A	(Lapchá) a pile of stones.
		2,000	6,000	Slight D	
108	151 30	3,800	3,800	Do.	Road runs between hills.
109	95 30	4,400	4,400	Level	Jilûng, a very large village; observations for latitude were taken here.
110	106 30	6,700	...	Do.	Near Shilkár village.
		800	7,500	Do.	Near Shilkár Bárki villages; thermometrical observations taken here.
111	45 0	2,000	2,000	Slight D	Regained the high road, which was left at station 110.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
112	67 30	500	...	Level	One mile south the village of Shilkár Okni.
		3,500	4,000	Do.	
113	101 0	500	...	Do.	A very large village called Sabgeding.
		1,000	...	Do.	A stream from S.E. flows past, and after pursuing a north-westerly course for one mile turns to E., and falls into the Brahmaputra three or four miles distant.
		500	2,000	Do.	
114	135 0	1,700	...	Do.	A village (name not ascertained).
		1,200	...	Do.	Thoŭktá village.
		900	3,800	Do.	
115	112 30	4,500	4,500	Do.	Gñe village.
116	101 0	2,000	...	Do.	To right of road a (Gûnpá) monastery.
		1,500	3,500	Do.	
117	90 0	4,500	...	Do.	Hamánang-jolá village.
		6,400	...	Do.	Shegûe village.
		2,000	...	Do.	Singmá village.
		600	...	Do.	North three quarter mile a large (Gûnpá) monastery called Ganjian.
		4,800	18,300	Slight A	On summit of a low hill.
118	106 30	1,200	1,200	Level	Lapchá (pile of stones). Near this point a stream rises, known as the Zourák-chû lower down.
119	90 0	5,000	5,000	Slight D	At Chakri village.
120	67 30	8,000	8,000	Level	To the south one mile is a village (name not ascertained).
121	45 0	5,000	5,000	Do.	Nátáng village, and Gûnpá (monastery).
122	73 0	3 700	3,700	Do.	To the south about one mile flows the Zourák-chû stream, which from thence an easterly course.
123	360 0	1,900	1,900	Do.	To the north about half a mile the Shabro village.
124	45 0	2,500	...	Slight A	Lapchá (pile of stones). To the north one and a quarter miles Sundûphûk village.
		6,500	...	Level	Dhejánphûk village.
		1,200	...	Do.	Táshilûmbo monastery (Gûnpá), one mile in circumference*.

* Thermometrical observations were taken here.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station	Slope of road.	REMARKS.
	° ′				
124	45 0	1,000	11,200	Level	In the caravanserai or konkhan north-east end of the city of Shigátze or Digarcha. N.W. of this point about 500 paces, on the summit of a low hill, stands a fort called Giáng Márjoñg. South about three-quarters of a mile lies a village called Táshikanchá; three-quarters of a mile distant, north-east of the city, is the Konkaling monastery (Gúnpá), on the left bank of the Penánáng chu river, which, flowing north for three miles, falls into the Brahmaputra. To the south of the city about nine miles is a range of mountains called Máori, where gold is said to be found. The city of Digarcha is one mile long and three-quarters broad. Observations for latitude and thermometrical observations were taken in the konkhan or caravanserai.
125	140 30	4,800	...	Do.	Khárak village; the residence of a high military official called Depung.
		1,100	...	Do.	On the left bank of a stream coming from 151° which falls into the Penánáng chu river three-quarters of a mile distant.
		2,500	...	Do.	Chamchû village.
		3,500	...	Do.	Giádûe village.
		2,500	14,400	Do.	Lálûng village.
126	123 30	4,900	4,900	Do.	Chongdûi village, on the bank of a small stream from south, which falls into the Penánáng chu half a mile distant.
127	78 30	8,000	...	Do.	Giang village.
		2,000	...	Do.	Jûge village.
		2,200	...	Do.	Dûe village.
		6,000	...	Do.	15° east of north two miles distant stands the Kátong monastery.
		2,000	...	Do.	Pházang village.
		2,800	23,000	Do.	Pená Jong village, situated on the right bank of the Penánáng chu river, which is bridged. Observations for latitude were taken at this village in konkhan or caravanserai.
128	112 30	5,800	5,800	Do.	On the right bank of the Penánáng chu. To left and right of road are hills.
129	146 0	6,000	...	Do.	Shobo village.
		1,200	7,200	Do.	On right bank of stream.
130	123 30	2,600	2,600	Do.	Do.
131	101 0	2,600	2,600	Do.	Do.
132	90 0	2,000	...	Do.	Tashiphû village.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
132	90 0	2,000	...	Level	Yái village.
		9,800	13,800	Do.	Túksc village; a small stream from 56° east of north falls into the Penánáng chu here.
133	101 0	2,000	2,000	Do.	A solitary hut on the right bank of the Penánáng chu river.
134	163 0	2,700	2,700	Do.	On the right bank of the Penánáng chu, to the left of the road.
135	140 30	2,000	2,000	Do.	Due west three-quarters of a mile is situated Roñgche Gûnpá.
136	129 0	2,300	...	Do.	Thákchá village.
		6,400	...	Do.	Chanka-Kesû village.
		8,500	...	Do.	Cheko village, on right bank of stream. Due west one mile stands Chichi Gûnpá monastery.
		3,800	21,000	Do.	At konkhan or caravanserai in the city of Gyangze. A fort commands the city called Gyangze Jong. Observations for latitude, &c., were taken here.
137	123 30	8,000	...	Do.	Two miles due south of this point a stream from S.E. falls into the Penánáng chu stream*.
		1,000	9,000	Do.	
138	118 0	3,800	...	Do.	Thagni village.
		4,000	7,800	Do.	On right bank of Penánáng chu.
139	101 0	3,800	...	Do.	At Kotang village, on right bank of stream. The road from the city of Shigátze to this point is very good.
		800	4,600	Do.	
140	90 0	3,800	3,800	Do.	On right bank of stream. To the left of road are hills.
141	22 30	1,700	1,700	Do.	A small village (name not ascertained).
142	84 0	1,100	...	Do.	On left bank of the river, which is bridged.
		3,000	...	Do.	Málang village, on left bank of stream.
		400	4,500	Do.	
143	157 30	1,600	...	Do.	Gobji village, on left bank of river. Observations for latitude and height were taken here.
		500	2,100	Do.	At this point a stream from S.W. flows past into the Penánáng chu near Gobji village. A road from this point runs alongside the stream, coming from S.W. above mentioned, leading to Loh†.

* This is Turner's river.

† Loh or Bhootan.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
144	67 30	400	...	Level	On right bank of stream.
		1,400	...	Do.	Sákiá monastery.
		2,600	...	Do.	Gorch village, on right bank of stream.
		6,700	...	Do.	Shetot village, on right bank of stream.
		600	11,700	Do.	A stream from north falls into the Penánáng chu near the village of Tashikekañg.
145	135 0	1,000	...	Do.	Lûñgmá village; a stream from N.E. falls into the Penánáng chu.
		6,000	7,000	Do.	On right bank of Penánáng chu stream.
146	84 0	6,500	6,500	Do.	Gahkhan (Palace), on left bank of stream, which is bridged. Here a stream coming from east falls into the Penánáng chu. Opposite, on the left bank of the former stream, is situated a village called Rálûng. Thermometrical observations were taken at Gahkhan.
147	11 0	5,200	5,200	Do.	On left bank of Penánáng chu stream.
148	33 30	7,500	7,500	...	Opposite, on the other bank of the stream, stands the village called Gomtañg, at the foot of a very lofty snowy mountain called Kharolà.
149	90 0	7,400	...	Slight A	Lapchá*; a pile of stones on summit of hill. Alongside this point lies an immense glacier. Here the Penánáng chu stream has its source.
		2,500	9,900	D	
150	61 30	4,500	4,500	D	On left bank of a small stream rising at foot of Kharolà mountain.
151	101 0	400	...	D	Zárá, a Chinese post-stage.
		2,200	2,600	...	On left bank of stream.
152	73 0	2,400	...	Level	A stream from north.
		3,000	5,400	Do.	On left bank of stream.
153	84 0	2,200	2,200	Do.	Do.
154	129 0	2,600	2,600	Do.	Do.
155	45 0	2,400	...	Do.	Rigro village.
		3,900	6,300	Do.	On left bank of stream, which flows north-east, and feeds the Yamdok-cho lake two miles distant.
156	28 0	5,000	5,000	Do.	
157	16 30	5,000	5,100	Do.	Nangáñche village, with a fort called Nangáñche Jong.
158	355 0	2,000	...	Do.	On west side of the Yamdok-cho lake at a village (name not ascertained).

* Thermometrical observations were taken here.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
158	355 0	6,000	...	Level	On west side of the Yamdok-cho lake.
		4,400	...	Do.	From the foregoing point to this the lake bends in considerably.
		2,600	15,000	Do.	On west bank of Yamdok-cho lake.
159	309 0	7,500	7,500	Do.	On bank of lake, at Yárchi village.
160	118 0	6,500	6,500	Do.	On bank of lake.
161	45 0	6,800	6,800	Do.	On bank of lake, at Pyáhtejong village and fort. Observations for latitude and thermometrical observations were taken at this place.
162	56 0	8,000	...	Do.	On bank of Yamdok-cho lake. At this point the lake widens somewhat.
		12,000	20,000	Do.	On bank of do.
163	95 30	2,500	2,500	Do.	On bank of Yamdok-cho lake, at Demálúng village. From this point the Yamdok-cho lake bears 120° east of north, stretching in that direction for twenty miles. The Yamdok-cho lake, as far as seen, varied in breadth from one and a-half to three and a-half miles, it is said to encircle a very large island about fifteen miles in diameter. This island rises into low rounded hills, at the foot of which several villages were visible. The villagers keep up their communication with the main land by means of boats.
164	360 0	1,500	1,500	Great A	At Kla-mbálá (Lapchá); pile of stones. This mountain forms the boundary between the two provinces Ou and Cháng. These latter names are derived from the mode of head-dress which their respective inhabitants adopt, the former circular, and the latter conical.
165	11 0	7,400	...	D	At Khambá-báche village.
		800	8,200	Level	On right bank of the Brahmaputra, which appears to be coming from the W.
166	40 0	10,000	10,000	Do.	At Chaksam-chori village, on right bank of the Brahmaputra river. The river is bridged at this point. The bridge is formed of iron chain and rope. The river is also crossed by ferry at this point.
167	50 0	6,700	6,700	Do.	On left bank of the river, at a large village called Chúshûl Joug. From this point the Brahmaputra river flows S.E., and at the distance of two miles receives the water of the Lhásá Kichû Gonbo river (also called Lhásá Kichû Sáñgpo), and from thence flows east.
168	67 30	1,000	...	Do.	At this point a stream from N.W. flows past, and at a distance of two miles S.E. falls into the Lhásá Kichû (Sáñgpo) river.
		3,200	...	Do.	On the right bank of the Lhásá Kichû (Sáñgpo) river.
		7,900	12,100	Do.	Cháboñáñg village.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
169	84 0	4,000	4,000	Level	On right bank of the river, which bends in between the foregoing and this point.
170	50 30	1,500	1,500	Do.	On right bank of river.
171	45 0	3,600	3,600	Do.	Záme village, on right bank of river.
172	22 30	2,000	...	Do.	Jañglot village.
		3,000	5,000	Do.	Thang; precipitous road overhanging the river.
173	5 30	9,000	9,000	Do.	Do., do.
174	45 0	2,000	...	Do.	Gákhan (or serai), in Netang village.
		6,000	8,000	Do.	On right bank of the Kichû (Sángpo) river.
175	360 0	7,000	...	Do.	At Gañg village, on right bank of river.
		2,400	9,400	Do.	Tilung village, on the left bank of the Tilung chú, which stream is here spanned by a stone bridge of two arches, called the Tilung Sumbá. The Tilung chú comes from the north, but for five miles above Tilung the bearing of its course is 293°; it continues to flow in the same direction for two miles below Tilung, and then falls into the Kichû Sángpo.
176	45 0	4,500	4,500	Do.	Singdoñkhar village, on right bank of the Lhásá or Kichû (Sángpo) river.
177	61 30	2,600	...	Do.	North of this point quarter mile stands Debûng monastery (Gûnpá); 7,700 priests (Lámás) are said to live in this monastery. The temples belonging to this monastery are gilded.
		1,000	3,600	Do.	
178	95 30	2,000	...	Do.	Two and a-half miles, 51° N.E., stands a large monastery on the banks of a stream, which coming from N.W. flows past into the Lhásá Kichû Sángpo river half a mile south.
		4,000	6,000	Do.	Near a Chûrtan. To the north of this point, on a low hill, stands the fort called Potoláh, the residence of the rajah and the high priest of the Lámás. To the south of this point lies a high isolated hill, called Chákpori, surmounted by a solitary hut. At the foot of this hill stands the Koñtáling monastery.
179	90 0	1,800	1,800	Do.	At Chûrtan, in the heart of the city of Lhásá. 300 paces from this point to the south stands a very large temple, called by three different names, viz., Jûring-bo-chá, Phákpáchengrá, and Máchindránáth; it is surrounded by shops and bazars. West of this temple stands a monastery called Tánkáling. Two monasteries respectively named Mûrû and Rámûchiá are situated the one E., and the other N.W. of this Chûrtan, while a third monastery, called Chumoling, stands west of Rámûchiá. South of the river Kichû Sángpo (which flows half a mile south of the city), and distant two and a-half miles, is situated the monastery called Chochûling. The four monasteries Kontáling (No. 178), Tánkáling,

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
179	(*Continued.*)	...	...	...	Chumoling, and Chochûling, were held in great repute in former days, the chief Lámás of these monasteries succeeding to the throne of the Potoláh rajah on its becoming vacant; but now their right of succession has been abolished, the Debúng head Lámá possessing the sole right. To the east of Lhásá, and within three days journey (about thirty-six miles), on the left bank of the Brahmaputra river, is situated a large monastery and city called Sáme. Thousands of pilgrims resort annually to worship at this shrine. The government treasury is said to be at Sáme. Forty miles east of the city Sáme, and on the right bank of the Brahmaputra river, is situated the large city of Chotang, and 120 miles east of Chotang is situated the city called Churri, forming the extreme east boundary of the Lhásá territory. The Brahmaputra river is said to flow south from this city. To the north of Lhásá, and distant about four miles, is seen a range of hills, called Totiphû, stretching from east to west, among which gold and silver are found. Latitude observations were taken in the city of Lhásá, as also thermometrical observations at a house named Dhiki Rábdán Tashilûmbogi Kháñg Sombá, twenty paces east of the Jûring-bo-chá temple.
180	360 0	5,500	5,500	Level	Near the Sárá monastery, at foot of Totiphû range of hills; 5,500 priests are said to live in this monastery, which is very large.
181	129 0	4,300	4,300	Do.	A small village (name not ascertained), at foot of Totiphû range of hills.
182	118 0	2,000	2,000	Do.	At foot of Totiphû hills.
183	95 30	4,000	4,000	Do.	At Chaksam village, on right bank of the Kichû (Sángpo) river. This village is on the high road to China.
184	67 30	6,000	...	Do.	On right bank of Kichû Sángpo, at Garbá village.
		1,200	7,200	Do.	The high road to Galdan bears 75° from this point.
185	33 30	1,000	...	A	
		1,800	2,800	D	Dási village.
186	348 30	5,500	...	Slight A	A small village (name not ascertained).
		1,400	6,900	Great A	Dákyárpá monastery, half way up the hill.
1	112 30	2,900	2,900	Level	On high road to Galdan, alongside Kichû Sángpo river.
2	78 30	1,200	...	Do.	Nañgrá village, on right bank of Kichû Sángpo.
		3,500	...	Do.	A quarter of a mile from this point, and about S.E., is situated a fort called Dhejáu Joñg, on a low isolated hill.
		5,000	9,700	Do.	Bûmtat village.
3	45 0	2,400	2,400	Do.	On right bank of Kichû Sángpo river.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
4	22 30	1,800	1,800	Level	On right bank of the Kichû Sángpo river.
5	360 0	3,700	...	Do.	Khire village No. 1, on bank of river.
		1,000	4,700	Do.	Khire village No. 2, do.
6	73 0	800	...	Do.	At this point a stream coming from west, but changing its course to south within two miles of this place, falls into the Kichû Sángpo.
		500	...	Do.	On left bank of river.
		3,000	...	Do.	At foot of hill.
		3,100	7,400	A	Galdan monastery; this monastery is said to contain 3,300 priests. About three and a-half miles distant, on the other side of the river, with a bearing of 16°, lies the village called Tákche.

Route-Survey from Tadúm to Mansarowar and Dongpû (in Nari-Khorsum).

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
1	315 0	7,200	...	Level	To the left of the road at this point lies a patch of water.
		1,400	8,600	Do.	A stream from 33° east of north passes, and flowing south two miles, falls into the Brahmaputra river.
2	281 0	7,500	...	Do.	On left bank of the Chá-chu Sángpo (river), which comes from the north, but changes its course to south-east at the distance of about three miles above this point, and four miles below empties itself into the Brahmaputra river.
		10,400	17,900	Do.	Tháng-ring-bo, on the left bank of the Brahmaputra. The valley hereabouts is very open.
3	298 0	4,000	...	Do.	A stream from N.E. falls into the Brahmaputra at this point.
		5,000	...	Do.	Barhmálûng camp, on left bank of Brahmaputra.
		6,000	15,000	Do.	On the left bank of the Brahmaputra, which appears to be flowing from the westward.
4	315 0	9,000	...	Do.	A stream from north flows past, and falls into the Brahmaputra one mile south of this place.
		2,000	11,000	Do.	At this point there are hills on either side.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
5	292 30	4,500	4,500	Gentle A	(Lapchá); pile of stones on summit of low hill.
6	275 37	6,600	...	D	Totû camp.
		400	7,000	Level	
7	309 22	14,800	14,800	Do.	Lapchá; pile of stones. The road gently ascends for about 1,000 paces.
8	286 52	4,000	...	Slight D	
		2,000	...	Level	From this point distant two miles, bearing 257° 30′, stands Gyáze monastery.
		3,500	9,500	Do.	
9	315 0	10,000	10,000	Do.	To the right of the road is a low range of hills, while to the left lies a dangerous quagmire.
10	275 37	2,000	2,000	Do.	On either side of the road there is a conical isolated hill.
11	292 30	3,000	...	Do.	Dûksûm Tarjam (Gûrsá) camp.
		13,000	...	Do.	The Chû Nágû stream, coming from 345°, flows past this point, and falls into the Brahmaputra river five miles below.
		12,000	28,000	Do.	Demár camp. On either side of the road there is a small lake, and to the north one mile is a range of low hills stretching from east to west, this range has a very red appearance, giving rise to its name Dák Máru (red stone).
12	281 0	14,000	14,000	Do.	At foot of low range of hills, which look very black, giving rise to its name Dák Nagû (black stone).
13	292 30	14,000	14,000	Do.	On left bank of Brahmaputra river, and at foot of Dák Máru hill.
14	315 0	7,000	...	Do.	On left bank of a small stream from north, which falls into the Brahmaputra one mile to the south.
		1,800	...	Do.	On the left bank of a branch of the stream mentioned above.
		2,500	...	Do.	On the left bank of a third branch of the stream mentioned above. This stream is called Roñg chû. Between the second and third branches of the Roñg chû stream are three low conical isolated hills called Pûnsûn.
		7,000	...	Do.	At this point a stream called Láro chû from north flows past, and falls into the Brahmaputra one mile distant.
		1,400	19,700	Do.	At foot of a low hill, which is situated on the left bank of the Brahmaputra river.
15	309 0	10,500	...	Do.	On left bank of Brahmaputra river at Tamjan Tarjam. The river appears to be coming from the west at this point. To the south and south-west of this point, distant about twelve miles, are seen very high snowy peaks.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
15	309 0	9,500	...	Level	On left bank of a stream from the W., which changes its course at this point to S.E., and falls into the Brahmaputra near Tamjan Tarjam.
		6,000	...	Do.	Thá Khábjor camp, near foot of a low hill.
		1,000	2,700	Do.	
16	331 52	2,000	2,000	Do.	Between low hills.
17	287 0	4,000	4,000	Gentle A	At Lapchá; pile of stones.
18	292 30	14,000	14,000	Level	At the junction of two streams, one coming from north, and the other from N.W.
19	326 0	5,300	5,300	Do.	Between the two streams.
20	303 45	3,400	...	Do.	Gyamzár camp, on bank of stream.
		3,500	6,900	Do.	
21	320 37	4,000	...	Do.	At the junction of two streams, one from 22° E. of N., and the other from W.
		1,500	5,500	Do.	
22	286 52	7,700	...	Do.	
		4,000	11,700	A	On summit of a hill at a Lapchá, or pile of stones, called Mariam Lá. Thermometrical observations were recorded at this place. This forms the boundary between the districts Nari-Khorsum and Dokhthol. South of this point, and distant about eight miles, is seen a very high snowy range, between which and this point the Brahmaputra flows.
23	298 0	4,000	4,000	D	
24	247 30	7,000	7,000	Gentle D	Between two small ranges of hills.
25	286 52	4,500	...	Level	A stream coming from 22° flows on for one mile and then turns west, and empties itself into the Gûngyud lake.
		10,000	...	Do.	Ugro Tarjam which is one mile north of the extreme east end of the Gûngyud lake.
		800	...	Do.	A stream flows past this point, coming from 24°, and falls into the Gûngyud lake half a mile from hence.
		14,000	...	Do.	Rebo camp. From this point the Gûngyud lake lies half a mile south.
		7,000	...	Do.	A stream coming from north flows past, and empties itself into the Gûngyud lake half a mile from hence.
		1,000	...	Do.	At this point the extreme west end of the lake is distant about quarter of a mile. The breadth of this lake varies from one and a-half to two miles. To the south of Gûngyud lake are seen two snowy ranges, one very close, and the other about four miles distant. These ranges stretch from E. to W.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
25	286 52	2,500	...	Slight A	Lapchá; pile of stones.
		300	40,100	Level	
26	258 45	2,700	...	D	Nókche camp. A stream from north flows past in a south-westerly course.
		2,000	4,700	Gentle A	On summit of a low hill.
27	275 37	2,000	...	D	At foot of low hill.
		14,000	16,000	Level	On right bank of the Some (chû) stream.
28	230 37	3,200	...	Do.	On right bank of Some chû stream. At this point the Pamburgi chu stream from north falls into the Some chû.
		1,000	4,200	Do.	
29	286 52	5,200	...	Do.	A stream from north flows past into the Some chû one and a-half miles below.
		1,500	6,700	Gentle A	On summit of a low hill.
30	258 45	4,000	4,000	Gentle D	Thokchan Tarjam (Yársá), on left bank of the Some chû. This stream bends in south considerably between No. 29 and this station. South of this point is visible a high snowy range, distant about six miles; between this range and this point the Brahmaputra flows.
31	298 0	8,000	8,000	Level	On right bank of Some chû stream, which runs between two low ranges of hills.
32	257 37	2,000	...	Do.	On right bank of Some chû stream, which from this point flows 257°, and empties itself into the Mánsarowar lake.
		3,100	5,100	Do.	
33	315 0	300	...	Do.	A stream from 15° E. of N. flows past, and falls into the Some chû about half a mile below.
		5,000	...	Do.	From this point the Káilás mountain is north-west, and is distant about twenty-four miles. Another very high peak, 215° bearing, is distant about twenty miles, called Gûrlá.
		1,000	6,300	Do.	A stream from north-east flows past into the Mánsarowar lake two miles from hence.
34	303 45	900	...	Do.	Sarniah-Uniah camp.
		1,400	...	Do.	A stream from 32° E. of N. flows past into the Mánsarowar lake one and a-half miles from hence.
		1,100	...	Do.	Close to a small lake called Gorgel cho a small stream issues from this patch of water, and falls into the last stream mentioned.
		3,500	...	Do.	At the south-west end of the Gorgel cho lake.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	REMARKS.
	° ′				
34	303 45	3,100	...	Level	About four miles south-west, situated at the foot of a low hill, stands the Láng-bo-ná monastery, on the banks of the Mánsarowar lake.
		13,500	23,500	Do.	A stream from N.E. flows south for some distance, and then changing its course to W., falls into the Láng-cho lake.
35	298 0	21,000	...	Do.	The Joñg-chû stream from 32° flows past into the Láng-cho lake some distance south.
		4,600	25,600	Do.	Darchan. A stream coming from north flows past into the Joñg-chû stream. Darchan is situated at the foot of the Kailás mountain; it boasts of a large official residence. Six miles from Darchan, and 172° bearing, is situated the Barkhá Tarjam; three miles from this latter point lies the extreme east end of the Láng-cho lake. The distance between the two lakes Mánsarowar and Láng-cho is two and a-half miles. Láng-cho lake is the source of the Sutlej river, called in these parts Láng-jan Khámbá. The point where the Joñg-chû stream enters the Láng-cho lake bears from this point 207°, and is distant about six miles. Observations for latitude and thermometrical observations were taken at Darchan.
36	230 37	3,000	...	Do.	On the left bank of the Sársû-chû, which comes from the north, and falls into the Joñg-chû.
		6,800	...	Do.	On bank of Kalap-chû stream, which flows from the north, and falls into the Joñg-chû two miles south-east of this point.
		6,000	...	Do.	Loñg-goñg camp.
		800	...	Do.	At the source of the Sutlej river, N.E. end of the Láng-cho lake, which is also called the Rákus-Tál.
		12,000	...	A	
		2,000	30,600	Great A	On summit of high hill. This hill runs south-east for four miles, and terminates near the Láng-cho lake.
37	247 30	2,000	...	Gentle D	At the source of a small stream, which flows S.E. for four miles, and then falls into the Láng-cho.
		2,300	4,300	...	A camping place (name not ascertained). The road ascends at the commencement, and then descends.
38	303 45	3,500	3,500	Level	
39	219 0	4,000	...	A	On a small hill.
		3,000	7,000	D	At foot of hill.
40	247 30	13,000	13,000	Level	At a distance of two to three miles from this point on either side of the road are hills. The high road from Darchan *viâ* Chûmûrshala comes from 35°.
41	213 45	3,800	3,800	Do.	
42	241 53	4,000	4,000	Do.	At foot of a low hill.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
43	247 30	7,000	7,000	Level	Four miles from this point, and bearing 341°, stands a ruined fort, called Gyánimá Khar.
44	326 0	4,200	...	Do.	A stream issuing from a small lake four miles south flows past in a north-westerly direction. This lake is called the Tárá cho.
		4,800	9,000	Do.	Gyánimá Mandi-(Haut), at foot of small hill, is a great mart during the rainy season. Observations for latitude and thermometrical observations were taken here.
45	253 0	11,300	11,300	Do.	South of this point about ten miles is seen a very high snowy range of mountains bounding the plain which is very open. To the north, and very close, is a low hill stretching N.E. for about three miles.
46	270 0	3,400	...	Do.	At northern foot of Dák Kárpo hill. Distant from this point one and a-half miles, and bearing 62°, stands a very high and remarkable conical hill.
		600	4,000	Do.	At foot of Dák Kárpo hill.
47	230 37	3,500	3,500	Do.	The Darmiyanti-chû (from a high snowy range ten miles south) flows past this point, and, following a northerly course for twenty-four miles, falls into the Sutlej. Bearing 67° E. of N., and distant three-quarters of a mile, stands a high conical hill. During the rainy season the inhabitants bring to this place salt, borax, and wool, and barter them for grain, sugar, and cloth.
48	253 0	6,000	...	Do.	On right bank of the Gûniangti-chû from the south, which flowing past in a N.E. direction, joins the Chû-Nágo six miles from hence. The Chû-Nágo flows one mile N.E., after receiving the water of the Gûniangti-chû, then falls into the Dármiyanti-chû. At the junction of the Gûniangti-chû with the Dármiyanti-chû stands a conical isolated hill called Jiná Khar.
		4,000	10,000	Do.	At foot of Thamba Dhár hill.
49	286 52	3,400	3,400	Gentle A	Thamba Dhár, pile of stones on summit of hill. This hill stretches four miles north and five miles south, meeting a spur of the snowy range. Distant seven miles, and bearing 10° from hence, is Gombá Chen Dang, a grazing-ground. A high snowy range is seen from here, distant about thirty miles N.E.
50	236 0	2,400	2,400	D	At foot of hill.
51	258 45	4,500	4,500	Level	On right bank of Chû Nágo stream, which comes from south.
52	275 37	4,400	...	Do.	A stream passes this point coming from 200°, and flows north-east, then falls into the Máne Manthangá lake six miles from hence.
		1,500	5,900	Do.	On either side of the road at this point are hills.
53	247 30	2,000	2,000	Do.	At Thájañg (Lam); a bazar during the rainy season. The high road from Johárgáti (south) joins at this point.

Station No.	Bearings of forward station.	Distances in paces from point to point.	Distances in paces to forward station.	Slope of road.	Remarks.
	° ′				
54	337 30	4,500	...	A	On summit of hill, which stretches from north to south. At foot of this hill, to the east, is situated Hûniá Thajañ.
		2,900	7,400	Gentle D	
55	360 0	4,700	4,700	Level	At northern end of hill. Distant five miles from hence, bearing 40°, is situated a high hill.
56	343 0	14,000	14,000	Do.	On left bank of Tokpû stream, at Ship Chalam camp. The Tokpû comes from the south, and flowing north for a distance of six miles, joins the Sutlej river.
57	303 45	1,000	...	Do.	A stream from 200° flows past to the N.E., and falls into the Tokpû stream three and a-half miles from hence.
		8,800	...	Do.	
		27,300	37,100	Do.	On right bank of Nûkchán (chû) stream, which comes from 206°, and flows north-east. To S.W., and distant eight miles, in seen a snowy range of mountains.
58	45 0	6,500	6,500	Do.	At Doñgpû village, on right bank of Nûkchánchû stream. The Nûkchánchû stream falls into the Sutlej river two and a-half miles to the N.E.
					Note.—Owing to the interference of the Bhotiyas the Route-Survey was not carried beyond this last point. This point was however connected with Kumaon subsequently by another Route-Survey which was carried up to Gartokh.

Observations for Latitude taken in Nepal, Tibet, &c., with an Elliott 6-inch Radius Sextant, No. 44.

No. of Observations.	Astronomical Date.		Watch Time.	Station.	Object on Meridian.	Upper or Lower Transit.	Double Altitude.	Single.	Index Error.	Deduced Latitudes.	Mean Latitudes.	Remarks.
	1865.		*h m s*				° ′ ″			° ′ ″	° ′ ″	
1	Jan.	13	10 5 0	Morádábád city, Atái mohalla, on the house of Janki.	*α* C. Maj. (*Sirius*)	Upper	89 18 0		+ 30″	28 49 27	28 50 18	This latitude station is about 1½′ S. of the kutcherry and 1′ 20″ E. of the said kutcherry, and according to G. T. Survey the kutcherry is in lat. 28°51′1″, long. 78° 48′ 36″.
2	,,	,,	11 40 0	Do.	*α* C. Mino. (*Procyon*)	...	133 25 50		...	28 51 8		
3	,,	23	8 32 50	Bareilly city, on the western part in serai.	*β* Orionis. (*Rigel*)	...	106 32 0		...	28 22 36	28 22 3	This latitude station is about 20″ S. of Bahadur Singh's house, and nearly in the same longitude. By G. T. Survey, Bahadur Singh's house is in lat. 28° 22′ 9″, long. 79° 26′ 38″.
4	,,	,,	16 34 50	Do.	Polaris.	Lower	53 57 10		...	28 21 17		
5	,,	24	10 48 52	Do.	*α* C. Mino. (*Procyon*)	Upper	134 23 30		...	28 22 16		
6	,,	28	8 2 3	Sháhjahánpur city, on the eastern part, in a garden.	*β* Orionis. (*Rigel*)	Upper	107 34 10		...	27 51 29	27 51 33	This point is much the same as the G. T. Survey point in latitude, and about 1′ E. of the said G.T.S. point. The G. T. Survey point in Sháhjahánpur being lat. 27° 52′ 55″, long. 79° 57′ 16″, but the point itself cannot be exactly identified. The latitude given by the Pundit agrees with some of the G. T. Survey values.
7	,,	,,	9 35 5	Do.	*α* C. Maj. (*Sirius*)	...	91 13 30		...	27 51 37		
8	March	7	13 18 0	Khatmandû city, on left bank of Bishnomati nadi, near lower bridge, in serai.	Polaris.	Lower	52 36 30		...	27 41 11	27 41 28	This point is rather more than a mile S. of the British Residency.
9	,,	18	12 51 0	Do.	...	...	52 37 30		...	27 41 44		

10	„	23	6 32 32	Ramchá village, on the road.	α C. Mino. (*Procyon*)	Upper	135 5 50	...	28 1 1	28 1 33		
11	„	„	8 17 42	Do.	α Hydræ.	...	107 46 50	...	28 2 4			
12	„	25	8 10 12	Shabrú, outside the village, on the bank of a small nadi.	...	...	107 32 10	...	28 9 24	28 9 24		
13	„	27	6 9 38	Raswágarhí, on the right bank of the Lendichú, on the boundary line between Nepal and Tibet territories.	α C. Mino. (*Procyon*)	...	134 34 40	...	28 16 36	28 16 32		
14	„	„	8 0 31	Do.	α Hydræ.	...	107 18 0	...	28 16 28			
	July	30	14 0 0	Kiroñg city, on Chang-chú's house.	α Pis. Aus. (*Fomalhaut*)	...	62 2 80	...	28 27 5			
15	„	31	8 20 0	Do.	Jupiter.	...	87 44 10					
16	August	31	12 45 0	Tallá Lhábrong, near Doñg.	α Pis. Aus. (*Fomalhaut*)	...	60 53 30	...	29 14 8	29 13 21		
17	„	„	15 10 30	Do.	Polaris.	...	61 15 40	...	29 12 34			
18	Sept.	9	0 41 0	Tadumgunpá, near the monastery.	Sun. (*Upper limb*)	...	131 50 10	...	29 39 30			
19	„	11	0 48 30	Do.	...	...	130 17 40	...	29 40 15			Watch moved back 48m. 30s. after the observation.
20	„	13	11 44 0	Do.	α Pis. Aus. (*Fomalhaut*)	...	60 3 0	...	29 39 26			
21	„	21	0 15 0	Do.	Sun.	...	122 35 20	...	29 39 56			
22	„	„	13 30 0	Do.	Polaris.	...	62 7 20	...	29 38 29			
23	„	22	13 20 0	Do.	...	...	62 7 10	...	29 38 25			
24	„	24	0 0 0	Do.	Sun.	...	120 16 0	...	29 39 26	29 39 21		Watch was all right.

Observations for Latitude taken in Nepal, Tibet, &c.—(Continued.)

No. of Observations.	Astronomical Date.		Watch Time.	Station.	Object on Meridian.	Upper or Lower Transit.	Double Altitude.	Single.	Index Error.	Deduced Latitudes.	Mean Latitudes.	Remarks.
	1865.		*h m s*				° ′ ″					
25	Sept.	25	0 0 0	Tadumgunpá, near the monastery.	Sun.	Upper	119 29 10		+ 30″	29 39 27		
26	,,	27	16 36 0	Do.	β Orionis (*Rigel*)	...	103 58 30		...	29 39 25		
27	,,	29	12 35 0	Do.	Polaris.	...	62 8 0		...	29 38 52		
28	,,	30	23 40 0	Do.	Sun.	...	115 35 10		...	29 39 31		
29	October	2	23 41 0	Do.	...	...	114 2 10		...	29 39 28		
30	,,	10	11 0 0	Chomûkûla Tarjum, Post Office.	Polaris.	...	61 32 40		...	29 21 17	29 21 17	
31	,,	15	9 10 0	Sang-sang-giádo Tarjum.	α Pis. Aus. (*Fomalhaut*)	...	60 19 40		...	29 30 59	29 30 59	
32	,,	17	15 45 0	Sang-Sang-Kau Tarjum.	β Orionis. (*Rigel*)	...	104 26 0		...	29 25 39	29 25 39	
33	,,	19	11 15 0	Ralung village, in the house of Gáñbo.	Polaris.	...	61 28 20		...	29 19 10	29 19 10	
34	,,	20	15 40 0	Nabring-Khá-Khá Tarjum.	β Orionis. (*Rigel*)	...	104 45 30		...	29 15 55	29 15 55	
35	,,	22	9 20 0	Janglache city, in the Giá Khang (building for the accommodation of Chinese officials).	α Pis. Aus. (*Fomalhaut*)	...	61 3 30		...	29 8 59	29 8 59	

36	„	25	15 44 0	Tashílingh village, in the house of Gáñbo.	β Orionis. (*Rigel*)	....	104 36 10	...	29 20 34	29 20 34		
37	„	27	11 55 0	Jilungh vil., in the Giá Khang.	Polaris.	...	61 14 40	...	29 12 20	29 12 20		
38	„	29	15 50 0	Shigátze, or Digarcha, city, in the Kun Khang (building for the accommodation of Chinese officials).	β Orionis. (*Rigel*)	...	104 45 20	...	29 16 1			
39	„	31	17 25 30	Do.	α C. Maj. (*Sirius*)	...	88 23 40	...	29 16 32			
40	Nov.	3	15 5 0	Do.	β Orionis. (*Rigel*)	...	104 44 10	...	16 36			
41	„	4	0 24 0	Do.	Sun.	...	91 11 30	...	16 40			
42	„	5	0 30 0	Do.	...	...	90 34 30	...	16 49			
43	„	11	11 10 0	Do.	Polaris.	...	61 22 40	...	16 20	29 16 32	Watch was 35m. fast.	
44	„	14	0 0 0	Do.	Sun.	...	85 28 30	...	16 60	...	Observation doubtful. Watch stopped on 13th, and was regulated and made to run on 14th, 12 P.M.	
45	„	„	13 46 0	Do.	β Orionis. (*Rigel*)	...	104 44 10	...	16 34			
46	„	16	10 0 0	Do.	Polaris.	...	61 22 40	...	16 22	...	Observation taken very correctly.	
47	„	17	0 5 0	Do.	Sun.	...	83 58 0	...	16 49			
48	„	„	9 48 0	Do.	Polaris.	...	61 22 30	...	16 17	...	Watch kept correct time.	
49	„	18	9 40 0	Do.	...	...	61 22 40	...	16 22			
50	„	21	15 0 0	Do.	α C. Maj. (*Sirius*)	...	88 23 30	...	16 33			
51	Dec.	23	12 30 0	Penájong, in the Giá Khang.	...	...	88 35 10	...	29 10 37	29 10 37		
52	„	27	12 25 0	Gyañgze city, near the fort, in the Kon Khan.	...	...	89 5 0	...	28 55 37	28 55 37		

Observations for Latitude taken in Nepal, Tibet, &c.—(Continued).

No. of Observations.	Astronomical Date.		Watch Time.	Station.	Object on Meridian.	Upper or Lower Transit.	Double Altitude.	Single.	Index Error.	Deduced Latitudes.	Mean Latitudes.	Remarks.
	1865.		*h m s*				° ′ ″					
53	Dec.	29	10 45 0	Gobjí village, in the Kun Kháng.	β Orionis. (*Rigel*)	Upper	105 36 30		+ 30″	28 50 17	28 50 17	
	1866.											
54	Jan.	1	10 35 0	Pyatejong village, near the fort, on the bank of a small lake named Yamdok-cho.	...	...	105 4 50		...	29 6 4	29 6 4	
55	„	12	17 30 0	Lhásá city, near the temple of Jú or Machandranáth, in Dhiki Rabdan Tashi-lumbo-gí-Kháng-Sombá, (new house called Dhiki Rabdan, the property of Tashilumbo temple).	Polaris.	Lower	56 31 30		...	29 38 44		
56	„	13	17 20 0	Do.	...	...	56 31 20		...	29 38 39		
57	„	14	9 27 0	Do.	β Orionis. (*Rigel*)	Upper	103 59 10		...	38 55		
58	„	15	9 25 0	Do.	...	...	103 58 30		...	39 14		
59	„	16	9 20 0	Do.	...	...	103 59 0		...	29 38 59		
60	„	17	0 12 0	Do.	Sun.	...	79 41 50		...	39 21	...	Observation taken very correctly.
61	„	„	9 25 0	Do.	β Orionis. (*Rigel*)	...	103 53 40		...	39 9	...	Do.
62	„	19	9 15 0	Do.	...	...	103 58 30		...	39 14	...	Do.
63	„	20	0 10 0	Do.	Sun.	...	80 56 0		...	39 23	...	Observation taken correctly.

64	„	26	16 55 0	Do.	Polaris.	Lower	56 32 10	...	39 4			
65	„	27	0 8 0	Do.	Sun.	Upper	84 15 10	...	39 21	29 39 17		Do.
66	„	28	0 8 0	Do.	...	...	84 46 40	...	39 10	...		Altitude doubtful.
67	„	29	0 5 0	Do.	...	...	85 18 0	...	39 27	...		No doubt, and taken correctly.
68	„	31	0 10 0	Do.	...	...	86 23 20	...	39 35	...		Seen on meridian, but doubtful.
69	Feb.	6	8 30 0	Do.	β Orionis. (*Rigel*)	...	103 85 30	...	39 12	...		Watch stopped, time was taken by supposition.
70	„	9	0 0 0	Do.	Sun.	...	91 47 50	...	39 29	...		Watch was set at 12 o'clock noon, observation taken correctly.
71	„	10	0 0 0	Do.	...	...	92 26 20	...	39 34	...		Observation taken correctly.
72	„	13	9 0 0	Do.	α C. Maj. (*Sirius*)	...	87 36 20	...	39 51			
73	„	26	8 10 0	Do.	...	...	87 36 30	...	39 44			
74	March	3	8 0 0	Do.	...	...	87 36 30	...	39 43	...		No watch, time taken by supposition.
75	June	17	10 0 0	Darchan village, at the base of the Kailas Peak, on Dung Khang (serai).	α Scorpii. (*Antares*)	...	65 44 30	...	31 0 28	31 0 28		Do.
76	„	21	7 15 0	Gyánimá Mandí.	Polaris.	Lower	58 51 0	...	30 49 14	30 49 14		Do.
77	Sept.	23	11 0 0	Sankú Dhúrá.	α Pis. Aus. (*Fomalhaut*)	Upper	59 20 50	$-7'$ 10″	30 4 56	...		Do.
78	„	24	0 0 0	Do.	Sun.	...	119 42 20	...	30 5 41	30 5 19		Do.
79	„	30	17 45 0	Kap kot village, near a bungalow.	β Orionis. (*Rigel*)	...	103 31 10	...	29 57 11	29 57 11		Do.
80	1866. October	1	10 0 0	Bágéshwar, near the bridge.	α Pis. Aus. (*Fomalhaut*)	...	59 48 40	...	29 51 8	...		Do.

Observations for Latitude taken in Nepal, Tibet, &c.—(Continued.)

No. of Observations.	Astronomical Date.		Watch Time.	Station.	Object on Meridian.	Upper or Lower Transit.	Double Altitude.	Single.	Index Error.	Deduced Latitudes.	Mean Latitudes.	Remarks.
	1866.		*h m s*				° ′ ″					
81	October	4	10 0 0	Almorah city, near the walls of Narain Tewari and the temple, in serai.	α Pis. Aus. (*Fomalhaut*)	Upper	60 15 40		− 7′ 10″	29 37 32	...	No watch, time taken by supposition.
											29 37 32	
82	„	5	...	Do.	...	...	...		...	29 37 32	...	Do.
83	„	9	0 0 0	Bogoálipokhar, in the school.	Sun.	...	108 46 50		...	29 44 54	...	Do.
84	„	„	10 0 0	Do.	α Pis. Aus. (*Fomalhaut*)	...	61 1 50		...	29 14 28	...	Do.
85	„	10	9 45 0	Doráhát, ...	...	...	59 56 0		...	29 47 21	29 47 21	Do.
86	„	13	9 30 0	Thángáoñ, ...	...	...	59 31 20		...	29 59 43	29 59 43	Do.
87	„	14	...	Kanûrgáoñ, near the bungalow.	...	...	59 27 40		...	30 1 29	30 1 29	Do.
88	„	15	9 0 0	Chiphalghát village, near the bungalow.	...	...	59 15 10		...	30 7 53	30 7 53	Do.
89	„	16	...	Paori village, in the yard of Lachman Sing, patwarí.	...	...	59 11 40		...	30 9 31	30 9 31	Do.
90	„	17	0 0 0	Sri-nagar city, ...	Sun.	...	101 49 30		...	30 13 52	...	Do.
91	„	„	11 0 0	Do.	Polaris.	...	63 21 40		...	11 51	...	Do.
92	„	18	8 45 0	Do.	α Pis. Aus. (*Fomalhaut*)	...	59 4 20		...	13 17	30 13 10	Do.
93	„	19	0 0 0	Do.	Sun.	...	100 22 30		...	13 38	...	Do.

94	„	23	8 45 0	Jolingh village, in the yard of Kalmu, zamíndar.	α Pis. Aus. (*Fomalhaut*)	...	58 41 30	...	30 24 38	30 24 38	Do.
95	„	25	8 45 0	Dhanoltí, near the bungalow.	...	...	58 39 0	...	30 25 49	30 25 49	Do.
96	Sept.	5	11 0 0	Gartokh, on parade ground.	...	...	55 57 10	− 2′ 30″	31 44 14	31 44 14	Do.
97	„	6	...	Namáchia, ...	...	...	56 11 30	...	31 37 5	31 37 5	Do.
98	„	10	...	Dongpú village, in the house of Chikpûá Darkia.	...	...	57 9 10	...	31 8 12	31 8 12	Do.
99	„	11	...	Nagbo village, ...	...	...	57 11 0	...	31 7 17	31 7 17	Do.

No. of Station.	Astronomical Date.		Watch Time.	Station.	Thermometer.		Thermometer.		Deduced height above Sea.	Remarks.
					No.	Boiling Point.	No.	In Air.		
	1867. June	3	h m 3 0	Mussoorie G. T. S. Office, ...	22	201·18	...	81· 0	...	Height determined trigonometricly. 6923·2.
	1865. April	14	0 35	Almorah, ...	7	203·25	...	64· 0	...	Do. do. 5400·0
		18	20 28							
1	March	10	0 45	Khatmandû city, on left bank of Bishnomati river near lower bridge, in serai.	22	206·00	10	67·50	4,044·5	Clear sky; gentle south wind blowing. This point is about 200 feet below the Residency, which, according to these observations, would be 4,244 feet.
2	,,	16	20 18	Do.	,,	206·25	,,	54·75	...	Clear sky; no wind blowing.
3	,,	23	18 7	Ramcha village, on the road, ...	,,	203·00	,,	53·00	5,874·9	Gentle east wind blowing.
4	,,	27	16 58	Raswágarhí, on the right bank of Lendíchú nadi, on the boundary line between Nepal and Tibet.	,,	202·95	,,	55·50	5,901·0	N.E. wind blowing; sky somewhat cloudy.
5	April	5	22 24	Deobung, on the serai, ...	,,	207·70	,,	70·00	3,144·0	South wind blowing; sky cloudy near the horizon only.
6	July	21	20 41	Kiroñg town, on Chang Chu's house,	7	196·80	6	64·50	9,074·6	S.E. wind blowing; sky cloudy on all sides.
7	,,	31	1 50	Do.	,,	197·00	,,	71·50	...	South wind blowing; sky cloudy near the horizon; bright sunshine.
8	August	14	1 49	Thotang village, ...	,,	194·20	,,	58·50	10,619·1	Strong S. wind blowing; rain falling.
9	,,	16	23 35	Lajûk Thumbá, top of pass, ...	,,	186·00	,,	47·50	15,391·8	Strong W. wind blowing; slight rain falling.

10	„	17	19 53	Kolung chûksá, ...	„	191·80	„	51·25	11,984·4	No wind; cloudy sky
11	„	19	6 55	Junka village, ...	„	195·20	„	60·00	10,035·6	Do.
12	„	20	22 57	Lachûmûphûrphûr, top of pass, ...	„	192·60	„	63·25	11,590·3	South wind; bright sunshine.
13	„	25	22 29	Gyálá, hill top, ...	„	183·80	„	45·00	16,679·3	Gentle west wind; cloudy sky.
14	„	26	5 18	Súmnath, ...	„	188·40	„	57·75	14,043·2	Do.
15	„	27	0 17	Gno-lá, crest of pass, ...	„	184·00	„	51·25	16,622·9	Slight N.W. wind; clear.
16	„	31	4 58	Tallalabrong, near Dong, ...	„	187·40	„	55·00	14,617·0	No wind; rather cloudy sky.
17	Sept.	7	22 0	Tadumgunpá, near the temple, ...	„	188·00	„	48·75	14,187·4	Gentle north wind; clear sky.
18	„	25	21 46	Do.	„	188·10	„	47·50	...	No wind; clear sky.
19	„	26	4 0	Do.	„	188·00	„	52·00	...	Do.
20	October	25	6 30	Tashiling village, in the house of Gañbo.	„	188·80	„	53·50	13,774·1	North wind; clear sky.
21	Nov.	3	19 26	Shigátze, or Digarcha, city, in the Kon Khan (building for the accommodation of the public).	„	192·00	„	38·25	...	Do.
22	„	14	4 0	Do.	„	191·95	„	49·75	...	West wind; clear sky.
23	„	„	10 0	Do.	„	192·00	„	47·25	11,822·4 ...	Slight north wind; clear sky.
24	„	„	16 0	Do.	„	192·00	„	32·50	...	Do.
25	„	„	22 0	Do.	„	191·90	„	36·50	...	No wind; clear sky.
26	Dec.	28	20 0	Gobji village, Kon Khan, ...	„	188·60	„	40·00	13,779·8	South-east wind; clear sky.
27	1866. January	12	4 0	Lhásá city, near the temple of Jû or Machandranáth, in Dhiki-Rabdan-Tashilumbo-gi-Khang-somba.	„	192·20	„	36·25	...	No wind; sky very cloudy.

Observations of the Boiling Point in Nepal, Tibet, &c.—(Continued.)

No. of Station.	Astronomical Date.		Watch Time.	Station.	Thermometer.		Thermometer.		Deduced height above Sea.	Remarks.
					No.	Boiling Point.	No.	In Air.		
	1866.		*h* *m*							
28	Feb.	9	1 0	Lhásá city, near temple of Jhû or Machindranáth, in Dhiki-Rabdan-Tashilumbo-gi-Khang-Sumba.	7	191·90	6	43·50	...	West wind; clouds here and there in the sky.
29	„	„	4 0	Do.	„	192·10	„	40·50	...	Do.; cloudy sky.
30	„	„	10 0	Do.	„	192·20	„	33·50	...	Gentle south-west wind; sky cloudy near horizon only
31	„	„	16 0	Do.	„	192·20	„	32·50	...	Very faint west wind; clear sky.
32	„	„	22 0	Do.	„	192·20	„	32·00	11,699·1	No wind; clear sky.
33	April	22	7 0	Chúshúl jong, on left bank of the Brahmaputra river.	„	192·90	„	50·00	11,334·3	From this date time taken by supposition. East wind blowing violently; cloudy sky.
34	„	24	...	Piáhte jong village, near the fort, on the bank of a lake named Yamdok-cho.	„	188·80	„	40·00	13,663·1	Light north-east wind; clear sky.
35	„	26	1 30	Kháro-lá, crest of pass, ...	„	183·80	„	48·00	16,711·7	Gentle west wind; clear sky.
36	„	„	5 30	Ralung village, Giakhang,... ...	„	188·20	„	38·00	13,996·6	Strong south wind; cloudy sky.
37	„	27	20 30	Giangze city, near the fort Kun Khang.	„	190·30	„	55·00	12,895·2	Gentle east wind; sky somewhat cloudy near the horizon.
38	May	9	23 30	Silkar village, in house of Ganbo,	„	190·40	„	52·00	...	North wind blowing strongly; clear sky.
39	„	14	3 30	Jangláche city, in Giakhang (building for the accommodation of Chinese officials).	„	189·40	„	74·00	13,579·8	West wind; clear sky.

40	„	17	22	30	Nabring Khá Khá Tarjum, ...	„	189·30	„	54·50	13,486·1	North wind; clear sky.
41	„	20	1	0	Sang-sang Kau Tarjum, ...	„	188·20	„	61·50	14,203·1	Strong north wind; sky cloudy.
42	June	11	20	0	Mariam-lá, crest of pass, on the boundary line between Nari-Khorsum and Dokhtal.	„	185·80	„	43·00	15,462·3	Gentle east wind; clear sky.
43	„	17	6	0	Darchan vil., at base of the Kailás mountain, on Dung Khang (serai).	„	187·60	„	53·50	14,489·0	N.E. wind; clear sky.
44	„	21	6	30	Gianima-mandi, ...	„	188·60	„	49·75	13,860·2	South wind blowing violently; clear sky.
1	1865. July	22	9	0	Trisûli hathi, ...	22	210· 0	10	84·25	1,760·6	
2	August	5	Noon		Muktináth, at Rani-ka-páwá, ...	„	190·80	„	61·25	13,086·0	
3	„	7	3	0	Denjiá-lá, ...	„	183·80	„	55· 0	17,310·9	
4	Sept.	15	6	0	Jumla, at Tattapani village, . .	„	199·80	„	69· 0	7,734·1	
5	October	2	6	0	Bharat village, ...	„	202·50	„	59· 0	6,158·2	
6	„	5	6	0	Do.	„	202·50	„	57·50	6,158·9	
7	„	5	2	0	Do.	„	202·50	„	75·50	6,145·4	
8	„	8	7	0	Bank of Karnáli river, ...	„	209·25	„	64·50	2,280·5	
9	„	15	6	0	Shilgarhi, at Painkhán, ...	„	204·50	„	75·50	4,978·2	
10	„	16	6	0	Do.	„	204·50	„	65·25	4,999·5	
11	„	20	7	0	Seti-ghát, on bank of the Seti river.	„	211· 0	„	60· 0	1,311·5	
12	„	24	2	0	Ganghushia, ...	„	200·20	„	56·25	7,491·3	
13	„	29	6	0	Jhulghát, on bank of the Káli river.	„	210·40	„	50·75	1,694·6	
14	„	„	1	0	Do.	„	210·40	„	64·75	1,626·2	

Observations of the Boiling Point in Nepal, Tibet, &c.—(Continued).

No. of Station.	Astronomical Date.		Watch Time.	Station.	Thermometer.		Thermometer.		Deduced height above Sea.	Remarks.
					No.	Boiling Point.	No.	In Air.		
	1865.		*h m*							
15	Oct.	29	6 0	Jhulghát, on bank of the Kali river.	22	210·40	10	59·50	1,650·6	
16	Nov.	11	6 30	Petoragarh, near bangla of khazanchi.	„	203·40	„	46·25	5,642·9	
17	„	13	7 0	Do.	„	203·40	„	46·75	...	
18	„	15	7 0	Do.	„	203·40	„	47·75	...	
19	„	20	6 0	Do.	„	203·50	„	44·25	...	
20	„	28	1 30	Bank of Sarjû river, near bridge, ...	„	208·50	„	60· 0	2,727·4	
21	„	29	0 30	Burjageshur, at temple on the hill.	„	200·40	„	55·75	7,374·7	

Observations of the Temperature of the Air at Shigátze, or Digarcha, a large town in Great Tibet, 11,800 *feet above the sea.*

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
14th November, 1865.	1	6	41·50	Very slight wind from S.W.; clear sky.
„	2	...	43·25	Wind lulled. ... do.
„	3	...	44·25	Slight wind from W.; do.
„	4	...	49·75	Do. W.; do.
„	5	...	49·50	Do. W.; do.
„	6	...	50· 0	Do. W.; do.
„	7	...	50·50	Do. W.; do.
„	8	...	49· 0	Strong wind from W.; do.
„	9	...	48· 0	Do. W.; do.
„	10	...	47·25	Slight wind from N.; do.
„	11	...	44·50	Do. S.E.; do.
„	12	...	43· 0	Do. S.E.; do.
„	13	...	40·25	Do. S.; do.
„	14	...	38· 0	Do. E.; do.
„	15	...	34·25	Do. W.; do.
„	16	...	32·50	Do. N.; do.
„	17	...	31·75	Very slight wind from N.E.; do.
„	18	...	30·25	Do. N.E.; do.
„	19	...	33·50	Do. N.E.; do.
„	20	...	34·50	Do. N.E.; do.
„	21	...	34·25	Wind lulled. ... do.
„	22	...	36·50	Do. ... do.
„	23	...	38·75	Do. ... do.
„	24	...	41· 0	Do. ... do.
15th „	1	...	43·50	Do. ... do.
„	2	...	45·25	Do. ... do.
„	3	...	45·75	Do. ... do.
„	4	...	46·25	Do. ... do.
„	5	...	44·50	Do. ... do.
„	6	...	43·50	Do. ... do.
„	7	...	47· 0	Do. ... do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
15th November, 1865.	8	6	45·50	Wind lulled. ... clear sky.
,,	19	...	32·25	Do. ... do.
,,	20	...	32·50	Do. ... do.
,,	21	...	32·50	Do. ... do.
,,	22	...	33·50	Do. ... do.
,,	23	...	34·75	Do. ... do.
,,	24	...	36· 0	Do. ... do.
16th ,,	1	...	38·75	Wind slight from N.E.; do.
,,	2	...	39·25	Wind lulled. ... do.
,,	3	...	41·50	Do. ... do.
,,	4	...	42·50	Do. ... do.
,,	5	...	41·25	Do. ... do.
,,	6	...	42·25	Wind slight from N.; do.
,,	7	...	44·25	Wind lulled. ... do.
,,	8	...	41·25	Wind slight from W.; do.
,,	9	...	39·25	Do. S.; do.
,,	10	...	39· 0	Do. S.; do.
,,	19	...	30·75	Do. S.; do.
,,	20	...	30·75	Do. S.; do.
,,	21	...	30·75	Do. S.; do.
,,	22	...	32·75	Wind slight from S.; do.
,,	23	...	35· 0	Wind lulled. ... do.
,,	24	...	37·50	Do. ... do.
17th ,,	1	...	39·50	Slight wind from S.; do.
,,	2	...	42·75	Wind lulled. ... do.
,,	3	...	43·50	Slight wind from W.; do.
,,	4	...	49·50	Hurricane from W.; do.
,,	5	...	46·75	Do. W.; do.
,,	6	...	47· 0	Very slight wind from W.; do.
,,	7	...	48· 0	Strong wind from W.; do.
,,	8	...	46·50	Do. W.; do.
,,	9	...	45· 0	Slight wind from N.W.; do.
,,	10	...	43·25	Strong wind from S.; do.
,,	19	...	29·25	Slight wind from W.; do.
,,	20	...	32·50	Do. E.; do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
17th November, 1865.	21	6	33·25	Slight wind from E.; clear sky.
„	22	...	34·25	Do. S.E.; do.
„	23	...	39·50	Strong wind from S.; do.
„	24	...	40·25	Do. S.; do.
18th „	1	...	43· 0	Do. S.W.; do.
„	2	...	45· 0	Do. S.W.; do.
„	3	...	44·25	Slight wind from W.; do.
„	4	...	44·50	Do. W.; do.
„	5	...	43·25	Do. W.; do
„	6	...	41·50	Do. W.; do.
„	7	...	42·25	Do. W.; do.
„	8	...	41· 0	Do. W.; do.
„	9	...	37·25	Do. N.; do.
„	10	...	36·75	Do. N.; do.
„	19	...	24·25	Do. N.W.; do.
„	20	...	26· 0	Do. N.W.; do.
„	21	...	27· 0	Do. S.; do.
„	22	...	28·50	Do. S.; do.
„	23	...	30· 0	Do. S.; do.
„	24	...	31·75	Do. S.; do.
19th „	1	...	34·25	Do. S.; do.
„	2	...	36·50	Wind lulled. ... do.
„	3	...	35·75	Slight wind from W.; do.
„	4	...	36·50	Wind lulled. ... do.
„	5	...	36· 0	Slight wind from W.; do.
„	6	...	36·25	Do. W.; do.
„	7	...	42· 0	Do. W.; do.
„	8	...	40· 0	Do. W.; do.
„	9	...	37· 0	Do. W.; do.
„	10	...	36·50	Do. W.; do.
„	19	...	24·75	Do. N.; fleecy clouds.
„	20	...	26·50	Do. E.; do.
„	21	...	26· 0	Strong wind from N.; do.
„	22	...	28·25	Slight wind from N.; light clouds only to south.
„	23	...	29·50	Very slight wind from N.; clear sky.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
19th November, 1865.	24	6	32·50	Very slight wind from N.; sky clear.
20th „	1	...	33·75	Do. W.; do.
„	2	...	35· 0	Slight wind from W.; do.
„	3	...	36·50	Wind lulled. ... light clouds.
„	4	...	36·50	Slight wind from W.; do.
„	5	...	36· 0	Wind lulled. ... rather heavy clouds all over.
„	6	...	35·50	Do. ... do.
„	7	...	39·50	Slight wind from W.; sky clear.
„	8	...	37·75	Do. N.W.; clouds to E.
„	9	...	40· 0	Very heavy wind from W.; sky clear.
„	10	...	39·25	Strong wind from W; sky cloudy to W.
„	19	...	30· 0	Do. N.W.; sky very clear.
„	20	...	30· 0	Do. N.W.; do.
„	21	...	32·50	Do. N.W.; do.
„	22	...	34·50	Slight wind from W.; do.
„	23	...	35·75	Do. W.; here and there light clouds.
„	24	...	38· 0	Strong wind from N.; sky obscured by light clouds.

Observations of the Temperature of the Air at Lhásá, the capital of Great Tibet, 11,700 *feet above the sea.*

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
9th February, 1863.	1	6	43·50	Strong wind from W.; here and there clouds.
„	2	...	41·75	Do. W.; do.
„	3	...	40·50	Do. W.; do.
„	4	...	40·50	Slight wind from W; clouds all over.
„	5	...	39·25	Do. S.; do.
„	6	...	38·50	Do. S.; do.
„	7	...	36· 0	Do. N.; clouds near horizon.
„	8	...	35· 0	Do. E.; do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.		
9th February, 1866.	9	...	34·50	Slight wind from	S.;	clouds near horizon.
„	10	...	33·50	Do.	S.W.;	do.
„	11	...	36· 0	Do.	W.;	sky clear.
„	12	...	36·50	Do.	W.;	do.
„	13	...	34· 0	Strong wind from	W.;	do.
„	14	...	33·75	Do.	W.;	do.
„	15	...	33·25	Do.	W.;	do.
„	16	...	32·50	Slight wind from	W.;	do.
„	17	...	30·50	Do.	E.;	do.
„	18	...	28·75	Do.	E.;	do.
„	19	...	29· 0	Do.	E.;	do.
„	20	...	29·75	Do.	S.;	do.
„	21	...	30· 0	Wind lulled.	...	do.
„	22	...	32· 0	Do.	S.;	do.
„	23	...	33·25	Slight wind from	W.;	do.
„	24	...	35· 0	Do.	N.W.;	light fleecy clouds all over.
10th „	1	...	37·50	Very strong wind from	W.;	light clouds all over.
„	2	...	39·50	Do.	W.;	do.
„	3	...	39·00	Do.	W.;	do.
„	4	...	39· 0	Very slight wind from	N.;	clouds all over.
„	5	...	37·50	Do.	N.;	do.
„	6	...	38· 0	Do.	N.;	do.
„	7	...	37· 0	Do.	S.;	clouds near horizon.
„	8	...	37· 0	Wind lulled.	...	very cloudy.
„	9	...	37· 0	Do.	...	do.
„	10	...	37·75	Slight wind from	N.;	do.
„	19	...	34· 0	Do.	S.;	do.
„	20	...	34· 0	Do.	E.;	do.
„	21	...	35·50	Do.	E.;	do.
„	22	...	38· 0	Do.	E.;	do.
„	23	...	37·50	Do.	E.;	do.
„	24	...	38·50	Do.	E.;	do.
11th „	1	...	40·50	Strong wind from	W.;	very cloudy all over.
„	2	...	42· 0	Hurricane from	W.;	do.
„	3	...	44·25	Do.	W.;	do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.		
11th February, 1866.	4	6	43· 0	Hurricane from	S.;	very cloudy all over.
,,	5	...	42· 0	Do.	S.;	do.
,,	6	...	40·50	Slight wind from	W.;	at this hour it snowed on all the hills around, and slightly in Lhásá.
,,	7	...	40·25	Do.	W.;	
,,	8	...	39·75	Do.	W.;	
,,	9	...	40· 0	Do.	W.;	
,,	10	...	40·25	Do.	W.;	
,,	19	...	38· 0	Do.	W.;	
,,	20	...	39· 0	Do.	W.;	
,,	21	...	38· 0	Do.	W.;	snowed rather more in Lhásá, but did not collect on the ground.
,,	22	...	37· 0	Do.	W.;	do.
,,	23	...	37·50	Do.	E.;	cloudy towards horizon only, zenith clear.
,,	24	...	39·50	Do.	E.;	do.
12th ,,	1	...	40· 0	Very strong wind from	W.;	sky obscured by clouds.
,,	2	...	40· 0	Do.	S.;	cloudy.
,,	3	...	40· 0	Do.	E.;	do.
,,	4	...	40· 0	Do.	S.;	do.
,,	5	...	39·50	Do.	S.;	do.
,,	6	...	39·50	Do.	S.;	do.
,,	7	...	37·75	Slight wind from	S.;	snowed slightly.
,,	8	...	35· 0	Do.	W.;	do.
,,	9	...	34·50	Do.	W.;	do.
,,	10	...	35·50	Do.	W.;	do.
,,	19	...	29·75	Do.	N.;	horizon cloudy; awoke, and saw ½ inch of snow on the ground, which had fallen overnight.
,,	20	...	32· 0	Do.	N.;	
,,	21	...	33· 0	Wind lulled.	...	cloudy, towards horizon sunny.
,,	22	...	33·50	Do.	...	do.
,,	23	...	35· 0	Do.	...	do.
,,	24	...	36·50	Slight wind from	W.;	sky completely obscured by clouds.
13th ,,	1	...	37· 0	Do.	N.W.;	sky very cloudy.
,,	2	...	35· 0	Hurricane	N.;	do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
13th February, 1866.	3	6	34·75	Hurricane N.; sky very cloudy.
„	4	...	33·50	Do. N.; do.
„	5	...	33·50	Do. N.; do.
„	6	...	33·50	Slight wind from N.; sky clear overhead only.
„	7	...	33· 0	Do. W.; sky clear.
„	8	...	32·50	Do. N.; do.
„	9	...	32· 0	Do. N.; do.
„	10	...	31· 0	Do. E.; do.
„	19	...	26· 0	Do. E.; do.
„	20	...	26·75	Do. E.; do.
„	21	...	28· 0	Do. E.; do.
„	22	...	30· 0	Do. E.; do.
„	23	...	31· 0	Very slight wind from E.; do.
„	24	...	33· 0	Noon, Do. E.; do.
14th „	1	...	34·75	Very slight wind from N.; here and there clouds.
„	2	...	36·50	Do. N.; do.
„	3	...	36·50	Do. N.; do.
„	4	...	37·50	Do. N.E.; sky very cloudy.
„	5	...	37·50	Do. N.E.; do.
„	6	...	35·50	Wind lulled. ... thin clouds all over.
„	7	...	36·75	Very slight wind from W.; do.
„	8	...	36· 0	Wind lulled. ... sky clear.
„	9	...	35· 0	Do. ... do.
„	10	...	33·75	Do. ... do.
„	19	...	27· 0	7 A.M., wind slight from E.; do.
„	20	...	28·50	Do. E.; do.
„	21	...	30·50	Do. E.; do.
„	22	...	32· 0	Do. E.; do.
„	23	...	33· 0	Do. E.; do.
„	24	...	35· 0	Wind lulled. ... do.
15th „	1	...	37· 0	Very slight wind from N.W.; white clouds towards horizon.
„	2	...	38·75	Do. N.W.; do.
„	3	...	43·50	Do. N.W.; do.
„	4	...	43·50	Do. N.W.; do.
„	5	...	43·75	Strong wind from W.; here and there only clouds.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
15th February, 1866.	6	6	40·50	Wind lulled. ... sky clear.
„	7	...	39·75	Do. ... do.
„	8	...	39· 0	Do. ... do.
„	9	...	37·75	Do. ... do.
„	10	...	37· 0	Do. ... do.
„	19	...	29·50	7 A.M., strong wind from E.; do.
„	20	...	32· 0	Do. E.; do.
„	21	...	33·50	Do. E.; do.
„	22	...	35·25	Wind lulled. ... do.
„	23	...	37· 0	Do. ... do.
„	24	...	40· 0	Do. ... do.
16th „	1	...	40·25	Do. ... do.
„	2	...	41· 0	Do. ... do.
„	3	...	41· 0	Strong wind from W.; clouds to N.
„	4	...	43· 0	Do. W.; do.
„	5	...	44· 0	Do. W.; do.
„	6	...	40·50	Wind lulled. ... sky clear.
„	7	...	40·50	Slight wind from E.; do.
„	8	...	40· 0	Do. E.; do.
„	9	...	38· 0	Do. E.; do.
„	10	...	37· 0	Do. E.; do.
„	19	...	31· 0	7 A.M., Do. E.; do.
„	20	...	31·50	Do. E.; do.
„	21	...	33· 0	Do. E.; do.
„	22	...	35· 0	Wind lulled. ... do.
„	23	...	36·25	Slight wind from W.; do.
„	24	...	37·50	Strong wind from S.; here and there white clouds; bright sun.
17th „	1	...	39·75	Slight wind from W.; here and there light clouds.
„	2	...	39·75	Do. W.; do.
„	3	...	40· 0	Do. W.; do.
„	4	...	40·50	Do. W.; do.
„	5	...	40·50	Very slight wind from W.; a few cirrus clouds.
„	6	...	39·75	Do. W.; do.
„	7	...	39·50	Very strong wind from S.; sky clear.
„	8	...	38·50	Wind lulled. ... do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
17th February, 1866.	9	6	36·75	Wind lulled. ... sky clear.
„	10	...	36· 0	Do. ... do.
„	19	...	32· 0	Very slight wind from E.; heavy dark clouds.
„	20	...	32·50	Do. E.; do.
„	21	...	34·50	Do. E.; do.
„	22	...	35·50	Wind lulled. ... do.
„	23	...	36·50	Slight wind from E.; here and there clouds.
„	24	...	37·50	Do. W.; do.
18th „	1	...	39·75	Do. W.; do.
„	2	...	40· 0	Do. W.; light clouds obscuring sky.
„	3	...	40·50	Do. W.; do.
„	4	...	40·50	Do. W.; do.
„	5	...	40· 0	Do. W.; do.
„	6	...	40· 0	Do. W.; clouds to north of horizon.
„	7	...	39·75	Do. W.; do.
„	8	...	39·50	Do. W.; do.
„	9	...	39·50	Do. W.; do.
„	10	...	39· 0	Do. W.; light clouds obscuring sky.
„	19	...	34·50	Do. W.; sky clear.
„	20	...	34·75	Do. W.; do.
„	21	...	35·50	Do. W.; do.
„	22	...	37· 0	Do. W.; do.
„	23	...	37·75	Do. N.W.; here and there white clouds.
„	24	...	39·50	Do. N.; white & light clouds obscuring sky.
19th „	1	...	41·25	Strong wind from W.; here and there light clouds.
„	2	...	42· 0	Do. W.; do.
„	3	...	42· 0	Slight wind from N.W.; do.
„	4	...	41· 0	
„	5	...	41· 0	Very slight wind from W.; heavy clouds obscuring sky.
„	6	...	41· 0	Do. W.; do.
„	7	...	42· 0	Strong wind from S.; clouds to north.
„	8	...	41·50	Do. S.; do.
„	9	...	40·25	Slight wind from S.; do.
„	10	...	40· 0	Do. W.; do.
„	19	...	33· 0	Do. E.; sky clear.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
19th February, 1866.	20	6	33·25	Wind lulled. ... sky clear.
„	21	...	35· 0	Slight wind from W.; do.
„	22	...	35·50	Do. N.; here & there clouds, sun shining.
„	23	...	37·25	Do. W.; do.
„	24	...	38·75	Noon, Do. W.; do.
20th „	1	...	39·50	Do. W.; here and there fleecy clouds.
„	2	...	40·75	Do. W.; do.
„	3	...	41· 0	Do. W.; do.
„	4	...	41·50	Strong wind from W.; do.
„	5	...	40·50	Do. W.; do.
„	6	...	39·50	Very strong wind from N.; do.
„	7	...	38· 0	Do. N.; do.
„	8	...	37· 0	Do. N.; do.
„	9	...	36· 0	Wind rather strong from N.; do.
„	10	...	35·50	Do. N.; do.
„	19	...	30· 0	Slight wind from E.; sky clear.
„	20	...	31·50	Do. E.; do.
„	21	...	33· 0	Do. E.; do.
„	22	...	34· 0	Wind lulled. ... do.
„	23	...	35· 0	Do. ... do.
„	24	...	36·50	Very gentle wind from W.; do.
21st „	1	...	38· 0	Very slight wind from W.; do.
„	2	...	39· 0	Do. N.; do.
„	3	...	39·50	Do. N.; do.
„	4	...	41· 0	Do. N.; here and there clouds.
„	5	...	40·25	Do. N.; do.
„	6	...	39·25	Do. E.; sky clear.
„	7	...	39· 0	Do. E.; do.
„	8	...	38· 0	Do. E.; do.
„	9	...	36·75	Do. W.; do.
„	10	...	36·26	Do. W.; do.
„	19	...	36·50	7 A.M., Do. S.; do.
„	20	...	37· 0	Do. S.; do.
„	21	...	39·50	Wind lulled. ... do.
„	22	...	42· 0	Very strong wind from W.; do.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
21st February, 1866.	23	6	43· 0	Very strong wind from W.; sky clear.
„	24	...	43· 0	Do. W.; do.
22nd „	1	...	45·50	Do. W.; do.
„	2	...	45·75	Do. W.; do.
„	3	...	45· 0	Do. W.; do.
„	4	...	44·75	Slight wind from W.; light clouds obscuring sky.
„	5	...	44·75	Do. W.; do.
„	6	...	43· 0	Do. N.; do.
„	7	...	42·50	Do. N.; do.
„	8	...	40·50	Do. N.; do.
„	9	...	40·50	Do. N.; do.
„	10	...	37·50	Do. N.; do.
„	19	...	32· 0	7 A.M., Do. E.; sky clear.
„	20	...	32·50	Do. E.; do.
„	21	...	34·50	Do. E.; do.
„	22	...	36· 0	Do. E.; do.
„	23	...	37· 0	Wind lulled. ... do.
„	24	...	40· 0	Do. ... do.
23rd „	19	...	36· 0	Slight wind from E.; do.
24th „	6	...	45·75	Do. W.; heavy clouds obscuring sky.
„	19	...	35· 0	Do. E.; sky clear.
25th „	6	...	45·75	Wind lulled. ... heavy clouds all over.
„	19	...	33·50	Slight wind from E.; sky clear.
26th „	6	...	45·75	Do. W.; clouds obscuring sky.
„	19	...	33·50	Strong wind from E.; sky clear.
27th „	6	...	45·75	Wind lulled. ... clouds obscuring sky.
„	19	...	34· 0	Slight wind from E.; sky clear.
28th „	6	...	45·50	Very slight wind from W.; clouds all over.
„	19	...	33·50	Do. E.; here and there clouds.
1st March, 1866.	6	...	43·50	Do. E.; clouds all over.
„	19	...	35·50	Do. E.; sky clear.
2nd „	6	...	43·50	Do. E.; clouds all over.
„	19	...	36·25	Do. E.; sky clear.
3rd „	6	...	47·25	Do. W.; clouds near horizon.
„	19	...	36·50	Do. E.; sky clear.

Date.	Hour.	No. Thermometer.	Thermometer.	Remarks.
4th March, 1866.	6	6	48·25	Slight wind from N.W.; clouds near horizon.
„	19	...	37· 0	Do. E.; sky clear.
5th „	6	...	48·50	Do. W.; here and there clouds.
„	19	...	37·50	Do. E.; do.
6th „	6	...	50· 0	Do. W.; do.
„	19	...	42· 0	Do. E.; sky clear.
7th „	6	...	49·75	Do. N.; cloudy.
„	19	...	41·50	Do. E.; sky clear.
8th „	6	...	48·75	Wind lulled. ... cloudy.
„	19	...	38·50	Slight wind from E.; here and there clouds.
9th „	6	...	48·50	Wind lulled. ... clouds near horizon.
„	19	...	44·75	Slight wind from W.; cloudy.

Remarks as to the Weather, &c., in the Lhásá Territory.

During my stay at Lhásá, Shigátze, and in the Lhásá territory, I do not recollect either having seen lightning or heard thunder, and, on making enquiries, I was informed that during the winter season there is neither one nor the other, though there is a little during the rains. Lightning is never known to kill the inhabitants, or to strike houses, &c. The rains (during the season) are very heavy at Shigátze, especially during the months of July and August. The snow fall at Shigátze, and on the country around, never exceeds one foot, although the water of running streams freezes if the current is not very rapid. During my journey in Tibet, from October to June, it never rained, and on only a single occasion did I observe a fall of snow of about three inches, when on my way to Penajong from the Takche village.

The inhabitants regard snow as an evil, and attribute the slight fall during the winter to the goodness of their chief divinities and head Lamas. Should the fall ever exceed a foot, it is looked on as an evil sign, expressing the displeasure of their gods, and to propitiate them large sums of money are expended on the priests, &c. They call snow "khá," after the word khá, meaning nothing.

I was informed that earthquakes are unknown in the Lhásá territory proper, though slight earthquakes are said to occur in Nari-Khorsum.

Strong and high winds are very prevalent throughout the Lhásá territory.

No rain fell during my three months' residence in Lhásá. Snow fell twice in the city, but only to the amount of about three inches on each occasion. The fall on the surrounding hills was somewhat heavier.

High winds were prevalent during March and April.

Note.—The thermometer observations at Shigátze were taken in a small room off the large one the Pundit had hired for himself in the Kunkung, or serai. There were forty to fifty people in the serai, mostly his Ladáki friends. The small room was entirely open upon one side, the thermometer hanging in the middle; the open side looked to the south.

The walls of the room were of sun-dried bricks, and the roof of wood covered with earth, so that the sun's heat did not penetrate.

At Lhásá the thermometer observations were taken in a house with a roof and walls quite as thick as those in the serai at Shigátze.

Memorandum on the Great Tibetan Road from Lhasa to Gartokh.

The Great Tibetan road between Lhasa to Gartokh is divided into twenty-two stages, of from twenty to sixty miles in length, varying according to the nature of the country.

At the end of each of these stages there is a halting place, called a Tarjum, where shelter is provided for all Tibetan officials travelling along the road.

These halting places, or Tarjums, generally consist of one large house, or of several small houses, with a number of tents, sufficient together to supply shelter to at least 200 men, with their baggage and merchandize. The houses have generally walls of sun dried-bricks, and a wooden roof covered with earth.

The Tibetan officials get a change of cattle at each Tarjum. The Tarjums are in charge of a man called Tarjumpá, or Jalno. He is bound to have coolies, horses, yaks, and donkeys in attendance, whenever he receives notice of the approach of a Lhasa official. The Tarjumpás are supported by the State, and they give the order to the heads* of camps and villages near these Tarjums as to supplying cattle, &c.

From ten to fifteen men, and as many horses, are always in attendance at the Tarjums.

The horses that are kept in constant readiness form what is called a Taol.

A high official, called Shipchat, is sent every third year from Lhasa to Gartokh, in order to see how matters have been carried on.

The Shipchat, and all high officials, receive every attention on the road, and, when travelling on the public service, they and their retinue are supplied with horses, baggage animals, food, and fuel free of all charge. Their goods sometimes take as many as a thousand yaks, besides men, &c.

A caravan of yaks, &c., is called a Dûe. The supply of cattle, &c., forms a kind of tax on the inhabitants, called Changshul and Thoptang.

Although the nomadic tribes and villagers receive nothing for the above, they are nevertheless held strictly responsible for the safe transit of all goods, and are made to pay twice the value of anything lost or damaged.

The higher officials generally trade on their own account, and this adds very much to the tax upon the inhabitants, who, in addition, are often forced to buy the goods at very much over their proper value.

The inhabitants appear to have no remedy, as the Shipchat, or inspector of the road seems to trade just as much as the other officials.

---

* The heads of villages are called Gámbos.

A List of the twenty-two Tarjums, or Halting Places, between Gartokh and Lhasa, with the distances between each.

No.	Names of Tarjums, or halting places, were cattle are changed.	Estimated distances in miles.	Remarks.
	Gartokh to		
1	Naku Tarjum, ...	6	No houses, only tents.
2	Mesir Tarjum, ...	37	The Tarjum consists of a house and tents.
3	Barkha Tarjum, ...	40	The Tarjum consists of a house and tents, and is situated in a very cold place near the Mansarowar Lake.
4	Thokchan Tarjum, ...	34	On right bank of Some stream, only tents, no houses.
5	Tamjan Tarjum, ...	77	On left bank of Bramaputra river, only tents, no houses.
6	Dûksûm Tarjum, ...	41	Only tents, no house.
7	Tadum Tarjum, ...	52	Four or five small houses about the monastery form the Tarjum.
8	Niku Tarjum, ...	31	On the bank of the Minchu stream. Tents only, no house.
9	Sarká Jong Tarjum, ...	29	Sarka is a large village containing numerous houses built of sun-dried bricks. It is ruled by a Jongpon. The Tarjum is a house built with sun-dried bricks.
10	Chomokula Tarjum, ...	26	Only tents.
11	Raka Thazang Tarjum, ...	23	Only tents, a very cold place.
12	Sang Sang Giado Tarjum, ...	27	The Tarjum is built of sun-dried bricks.
13	Sang Sang Kau Tarjum, ...	34	The Tarjum is of a good size, and built of sun-dried bricks. There are many tents, but only two houses besides the Tarjum.
14	Nabring Khaka Tarjum, ...	31	This is the first place east of Gartokh where the people were seen to cultivate the ground; from hence on to Lhasa the villagers cultivate. The Tarjum consists of a house.
15	Jang Lache Tarjum, ...	33	A house in town of same name. Travellers from Lhasa provide themselves with provisions at this place for the entire journey to Gartokh.
16	Phuncholing Tarjum, ...	26	The Tarjum is a house in the large village of the same name.
17	Shigatze Tarjum, ...	61	The Tarjum is a large building in the city.
18	Pena Jong Tarjum, ...	19	The Tarjum is a house in the town.
19	Gyangze Tarjum, ...	29	The Tarjum is a house in the city.
20	Nanganche Jong Tarjum, ...	57	The Tarjum is a house built of sun-dried bricks.
21	Pyahtejong Tarjum, ...	18	On border of the Lake Yamdok chu. The Tarjum is a house built of sun-dried bricks.
22	Chushul Tarjum, ...	25	On right bank of Bramaputra river. House same as last.
	Lhasa, ...	34	
	Total miles, ...	790	

List of Ordinary Marches between Gartokh and Lhasa.

No. of Tarjum.	Names of the daily halting places for ordinary marches.	Estimated No. of miles from stage to stage.	Under the authority of whom.	REMARKS.
	Gartokh, ...	...	Chief Garpon of Gartokh.	Two Garpons and a Shipchat reside here.
1	Naku Tarjum,.. ...	6	Do.	
	Langbochia, ...	10	Do.	No accommodation for travellers here.
	Nigri camp, ...	12	Do.	Tents.
2	Mesir Tarjum,.. ...	15	Do.	
	Dokpachu, ...	5	Do.	No accommodation for travellers here.
	Ramothal, ...	20	Jongpon of Barkha.	Do.
3	Barkha Tarjum, ...	15	Do.	The Jongpon resides here.
	Langbona camp, ...	9	Do.	Near a monastery.
	Sariniah Uniah camp, ...	15	Do.	Tents. This is a large camp.
4	Thokchan Tarjum, ...	10	Purang Jongpon.	
	Nokche, ...	17	Do.	No accommodation here.
	Ugro (old tarjum in ruins),	14	Do.	Do.
	Giamzar camp, ...	23	Dhuksum Jongpon.	The Jongpon is called Bongpua-Chigap.
	Thakhabjor, ...	15	Do.	No accommodation here.
5	Tamjan Tarjum, ...	8	Do.	
	Laro, ...	6	Do.	No accommodation here.
	Demár camp, ...	23	Do.	Tents.
6	Dûksûm Tarjum, ...	12	Do.	The Jongpon of Dhûksûm resides here.
	Totu camp, ...	20	Do.	
	Barhmalung, ...	14	Do.	No accommodation here.
7	Tadum Tarjum, ...	18	Jongpon of Sarka.	
	Thuku camp, ...	9	Do.	Tents.
	Shrikarpo camp, ...	16	Do.	Tents.
8	Niku Tarjum,... ...	6	Do.	
	Jagúng, ...	10	Do.	No accommodation here.
	Jhalung, ...	16	Do.	
9	Sarkajong Tarjum, ...	3	Do.	The Jongpon resides here.
	Upshi village, ...	18	Do.	Mud houses.
10	Chomokula Tarjum, ...	8	Do.	
11	Raka Thazang Tarjum,...	23	Do.	
	Gñang-biako, ...	6	Do.	
12	Sang Sang Giado Tarjum,	21	Do.	
	Ge, ...	15	Do.	Camp.

List of Ordinary Marches between Gartokh and Lhasa.—(Continued.)

No. of Tarjum.	Names of the daily halting places for ordinary marches.	Estimated No. of miles from stage to stage.	Under the authority of whom.	Remarks.
13	Sang Sang Kau Tarjum, .	19	Jongpon of Sarka.	
	Kukap camp, ...	11	Nabring Jongpon.	
	Ralung village, ...	14	Do.	
14	Nabring Khaka Tarjum, .	6	Do.	
	Larcha Nil village, ...	11	Do.	
	Singilung village, ...	11	Jang Lache Jongpon.	
15	Jang Lache Tarjum, ...	11	Do.	The Jongpon resides here.
	Chakdong village, ...	11	Do.	
16	Phuncholing Tarjum, ...	15	Phuncholing Jongpon.	A very large village. The Jongpon resides here.
	Chamcheding village, ...	10	Do.	
	Shilkar village, ...	14	Jongpon of Shigatze.	
	Chakri village, ...	22	Do.	
17	Shigatze Tarjum, ...	15	Do.	The Jongpon resides here.
18	Penajong Tarjum, ...	19	Jongpon of Penajong.	The Jongpon resides here.
	Thakcha village, ...	15	Do.	
19	Gyangze Tarjum, ...	14	Jongpon of Gyangze.	The Jongpon resides here.
	Gobzi village, ...	16	Do.	
	Ralung village, ...	13	Do.	
	Zara village, ...	14	Nanganche Jongpon.	A Chinese post-stage.
20	Nanganchejong Tarjum, ..	14	Do.	The Jongpon resides here.
21	Pyahtejong Tarjum, ...	18	Jongpon of Pyahte.	The Jongpon resides here.
	Demalung village, ...	12	Do.	
22	Chûshûl Tarjum, ...	13	Jongpon of Chûshûl.	The Jongpon resides here.
	Netang village, ...	18	Jongpon of Lhásá.	
	Lhásá city, ...	16		
	Total miles, ...	790		

Note.—The tents in Tibet are made from the coarser hair of the yak, and are generally of a black color.

No. ..... OF 1867.

Mussoorie, 30th July 1867.

Memorandum on 600 *miles of the Brahmaputra River, from its source near the Mansarowar Lake, in latitude* 30½° *and longitude* 82°, *to the junction of the Lhasa River, in latitude* 29° 22′ *and longitude* 90° 40′.

When sending the Pundits to explore the country from Mansarowar to Lhasa, they were directed to make every enquiry as to the great river which was known to flow from near the Mansarowar lake to Lhasa. Care was taken not to give the river any name, it was simply called the great river, and the explorers were told to find out its name.

The Pundit on his return said that the river is called by the Nari and Ladak people the Tamjan Khamba (the horse's mouth) from its source to the junction of the Charta Sangpo, from the latter to Janglache it is called Machang Sangpo by the Dokthal people, and from Janglache to Lhasa it is called the Narichu Sangpo by the Lhasa people, the latter name being given to it because the river runs from near Nari, the country about Mansarowar, &c.

The Nepalese, the Newars from Nepal, and the Kashmiri Mahomedans who were in Lhasa all told the Pundit that this great river was the Brahmaputra. All the Lhasa people who were questioned were unanimous in saying that, after going east for a considerable distance, it flowed down into Hindostan.

For this reason, and others to be given hereafter, the river throughout this paper will be referred to as the Brahmaputra.

The river Brahmaputra was ascertained to rise in about north latitude 30½°, and east longitude 82°.

The great road along which the route-survey was carried does not follow the course of the river for the first fifty miles, but the road was probably never much more than ten miles north of the river.

The general direction of the river's course during the first fifty miles was, however, quite unmistakable, owing to the gigantic range visible to the south of it, the large glaciers which filled every ravine of that range evidently forming the sources of the river.

The Tamjan Tarjum, in latitude 30° 21′, longitude 82° 51′, was the first point of the road actually on the river. The staging-house is called Tamjan, from the Tibetan name of the river which is Tamjan Khamba (horse's mouth). From Tamjan there was a good view up the river for a considerable distance. The Tibetans all agreed in saying that it was the main branch of the river.

At Tamjan, on the 7th of June, the river was much swollen, its current rapid, and water turbid. About forty miles south-east of Tamjan the first large tributary (the Chu-Nago) falls in from the north, intermediately only two small tributaries were noticed. From the junction of the Chu-Nago the great river flows south-east, and about fifty miles lower down received a still larger river, called the Chachu Sangpo, coming from the north; this tributary was about 200 paces wide, and not very much inferior to the Brahmaputra itself. The junction is near the Tadum monastery, a well-known halting place on the great road.

90 miles from source.

140 miles from source.

From the junction with the Chachu the river runs four to five miles due south, and

then continues as before in a south-easterly direction for nearly thirty miles, below which it
170 miles from source. makes a great bend, and flowing southward for twenty-five miles, receives a large tributary from the south called the Shorta Sangpo, and then flowing north-east for twenty-five miles more, receives another great tributary from the north called the
195 miles from source. Charta Sangpo. The Charta Sangpo was in October about 250 paces in width, and its tributary, the Chaka Chu, which joins it a few miles below the point where the road crosses, was 150 paces in width. The combined stream forms one of the largest tributaries, if not the largest, that was seen to join the Brahmaputra. In May the Charta Sangpo and its tributary were very slightly swollen; ice was still clinging to their edges.

From the junction of the Charta Sangpo the great river was observed to flow for about
260 miles from source. forty miles in a direction a little south of east. At this last point, near Upshi, the main road separated from the river, and the latter was not seen again till it had reached a point 100 miles further east, above the village of Napsi. Of this 100 miles of the river's course nothing positive is known; according to the natives of the country, it had no good road along it. The Pundit conjectured that the river flows (somewhat as shown in the map by dotted lines) south of a great peak which he observed from the road.

From Nupsi the river flows east by north for twenty-five miles, and then turning sharp
385 miles from source. to the north, flows past the large town of Janglache, taking thence a north-east course for twenty-five miles more, where it is joined by a very large river, called the Raka Sangpo. The course of this tributary was followed by the Pundit from the
410 miles from source. Gurla pass, near Upshi, where the great road leaves the Brahmaputra, to a place called Ralung on the Nabring lake. At this place it was a large river, but when seen again lower down, at its junction with the Brahmaputra, the Raka Sangpo had become very much larger, having evidently received a large addition by one or more tributaries from the north. Just above the junction it was estimated to be about 200 paces in width. From Janglache some of the Pundit's companions took boat, and were paddled down the great
475 miles from source. river to Shigatze, a distance of eighty-five miles below Janglache, and sixty miles below the junction of the Raka Sangpo. The Pundit continued his march by land to Shigatze, crossing a good-sized tributary from the south. The great river was seen occasionally, and was evidently never so much as ten miles from the road. His companions who went by boat said the stream was smooth, and the course direct. From Shigatze the great river is again visible at the point where it receives the Penanangchu river from the south. The Penanangchu was about 150 paces wide in December. From Shigatze to Khamba-
575 miles from source. barche the river was not seen for about 100 miles, the main road diverging considerably to the south of the river. The Tibetans said that this portion was too rapid for boats. At Khambabarche the river, when again seen, was flowing
585 miles from source. in a broad deep stream. The stream flowed so easily that every one of the party went by boat from Khambabarche to Chushul, a distance of about ten miles.

From Chushul the Pundit could see the river flowing eastward for twenty or thirty miles, and
605 miles from source. was informed that it continued to flow in that direction for a great distance.

A mile or two below Chushul the Lhasa river, called the Kichu Sangpo, joins the great river. The Kichu is navigable for small boats for about thirty miles, and in January was about 250 paces wide.

During the first week of June, at about 140 miles from its source, the water of the main branch of the Brahmaputra was very dirty and very cold, again, at the end of August, a little lower down the water was of a dirty whitish color, and very cold.

At Chushul, 585 miles from its source, the water of the Brahmaputra was in January very clear, and again in April at the same point the water was only slightly less clear, though the river had swollen. As to the tributaries, the water of the Charta Sangpo and the Chaka Chu rivers was very clear in October, and in May, after the river had swollen, the water was still only slightly less clear.

The water of the Raka Sangpo river was very clear and cold in October, and in May it was slightly dirty.

The water of the Penanangchu was very clear in December, but dirty in April.

The Kichu Sangpo (or Lassa river) was clear in January, and again at the end of April it was still clear.

Streams from glaciers are always noted for having exceedingly dirty water, from the action of the glaciers on the rocks and earth in contact with them. Those who have travelled in glacier regions are hardly ever mistaken in deciding as to whether a stream comes from a glacier or not.

The Pundit had been acquainted with glaciers all his life. His evidence as to the water, given above, would tend to show that the main branch of the river rose among glaciers, and he says that he saw the glaciers; again, the Shorta Sangpo, from his own observation, was known to rise among glaciers, and so also does the Penanangchu; so that the two southern tributaries would also appear to rise among glaciers, but none of the four northern tributaries appear to rise among glaciers, or, at any rate, if they do, the glaciers must be very remote or very small, as their streams were clear, even in April and May, after the rivers had begun to rise. Summing up, it appears that at Likche, near Tadum, just below the junction of the first great tributary, the Brahmaputra was in September estimated to be at least one-half wider than the Ganges at Hurdwar in December.

Between Likche and Chushul, a distance of about 450 miles, the great river is known to receive

1st—A large tributary, called Shorta Sangpo,
2nd—A very large tributary, called the Charta Sangpo, estimated to be 250 paces wide in October,
3rd—The Chaka Chu tributary of the Charta Sangpo, estimated to be 150 paces wide in October,
4th—A very large tributary, called the Raka Sangpo, estimated to be 200 paces wide in October,
5th—A large tributary, called Penanangchu, estimated to be 150 paces wide in December,
6th—A very large tributary, the Kichu Sangpo, or Lhasa river, estimated to be 250 paces wide in January.

The main river below Tadum is never fordable, even at the broadest part, and each one of the six great tributaries, by which it is subsequently joined, are represented as being rapid, deep streams, that are not fordable during summer, and only one or two can be crossed with difficulty on large horses and yaks when the rivers are low, at other times they are invariably crossed by means of boats.

Supposing the Pundit's estimates given above to be correct, a very fair idea may be formed as to the size of the combined stream near Chushul.

The Pundit is an accurate observer, accustomed to pacing, and to estimating distances in paces, and as far as can be tested by his ideas of the Ganges, and other known streams, he is not given to exaggeration.

His estimate of one of the tributaries, viz., the Penanangchu, can be tested by direct European evidence, as Captain Turner's route along that stream coincided with the Pundit's route for about fifty miles.

Turner says that the Penanangchu stream near its source formed no inconsiderable river in September. Lower down he crossed the river by a rude bridge. At Tchukha he forded the river close to Gyangze (Jhansu Jung), above the point where it is joined by a very large tributary from the east, which the Pundit considered the

Page 214.

main stream. He again crossed it near that town, and sixteen miles lower down, he says, the river ran in a smooth stream, but was no longer fordable; he noticed a boat placed on its end in one of the villages.

At Painom, ten miles lower, Turner found, "over the broadest part of the river, a long bridge upon nine piers of very rude structure, slight beams of timber were laid from pier to pier."

The Pundit seems to have crossed at this very spot on the 23rd December; he notices that the river was bridged.

In all Tibetan bridges that I have seen, the piers are very broad as compared with the spans, and it would be a moderate estimate to take nine piers of twelve feet each, and ten spans at twenty-five feet, in all 358 feet, as the breadth of the river at this point. The Pundit puts it down at 150 paces, which gives 375 feet. The Pundit says that the river had a rapid current. The above shows that as far as the size of this particular tributary is concerned, the Pundit is remarkably accurate, and at any rate has exaggerated very little.

As far as the Brahmaputra itself is concerned, Turner saw it from the rock above Teshoo-loomboo, some two or three miles from the river.

Near Shigatze, he states that "the Brahmaputra flows in a wide extended bed, and as though the soil gave it an unwilling passage, it has forced itself through many channels, and formed a multitude of islands in its way. But though its bed appears so wide extended from hence, I was told that its principal channel is narrow, deep, and never fordable."

An account which would agree very fairly with the Pundit's description of what he saw from the same point, and also with the Pundit's more detailed description of the river at Chaksamchori, 100 miles further down, where the deepest part was spanned by a very fragile chain-bridge. I hoped that this bridge, which I had heard of, would have given conclusive evidence as to the size of the Brahmaputra near Lhasa. The Pundit was requested to note its breadth in paces; unfortunately, he found that the bridge only spanned the deepest portion, and that, in addition, a great deal of water had to be crossed beyond the bridge. The bridge itself moreover was in such a ricketty condition that the Pundit was afraid to cross it, the people of the country themselves invariably preferring boats. Consequently, only a rough guess could be made as to the breadth of the river.

The Pundit could only say that the river was very much larger than the Ganges or the Indus, or any other river he had seen. The depth of the stream impressed him very much. He inferred that it was very deep, because, though the water was very clear, and the surface smooth, the bottom was nowhere visible.

The breadth of the stream had not impressed the Pundit so much as the depth, he did not think the breadth at Chuksamchori much more than half greater than the Ganges, and he made the same estimate of it at Janglache, 200 miles higher up, where the volume of the river must have been much less.

After receiving so many large tributaries, it may be a matter of wonder that the river was not broader, but that it should not be so is quite in accordance with what is known of the upper course of the river Indus, which rises not far from the Mansarowar lake, and flows through the same style of country as the Brahmaputra. The Indus receives the Zanskar, a river nearly as large as itself, at Snimmo below Leh, and yet the increase in the breadth of the main stream is hardly perceptible to an ordinary observer. The same thing happens at its junction with the Dras river, and, again, it is still more remarkable at the point where the Shayok river joins the Indus, both great streams with but little difference in volume, yet the combined stream appeared to me almost narrower than either of them separately. The increased volume of water having simply made the stream deeper.

The Indus at Attok has run a course of about 700 miles, during which it has received the

following six tributaries, viz., the Zanskar, Dras, Saoroo, Shayok, Gilgit, and Caubul rivers, and, judging from my knowledge of these rivers, I should say they were not equal to the six tributaries of the Brahmaputra above Lhasa, as described by the Pundit; but, supposing that they are equal, and that the size of rivers are somewhat in proportion to their length of course, *i.e.*, that they would drain the same area, I conclude that the Brahmaputra below the junction of the Lhasa river is at least equal to the Indus at Attok. The latter probably drains a country which receives very much less moisture than the Lhasa territory, but during the dry season it discharges about 24,000* cubic feet per second.

As compared with the Indus, the Pundit's account shows that the Brahmaputra is a very much larger river. The Indus has a wooden bridge over it near Leh, 250 miles from its source, consisting of one span of about seventy feet, and a smaller of twenty or thirty feet, and it is again spanned at Kulsi, fifty miles lower, by a wooden bridge of one span of eighty feet, though the river intermediately receives the Zanskar, which is nearly as large as the main stream under Leh. Lower, between Kulsi and Skardo, there is another wooden, and several rope or twig suspension-bridges, but boats are not used for ferries anywhere above Skardo, 400 miles from the source, and no portion of the river whilst in the mountains is navigable.

There is not a single wooden bridge over the Brahmaputra, and no twig, rope, or cane bridges. Iron suspension-bridges have been made at Janglache, and in two or three other places, but the river appears to have been too large for the Tibetan workmanship, even in that material. According to the Pundit's account, they are all dangerous to use, the people of the country preferring boats.

The above, added to the facts that the river was not fordable at 140 miles from its source, or at any point lower down, even at the broadest parts, that ferry boats were used on the six great tributaries, as well as on the main stream, and that the main stream itself was navigable continuously for over eighty miles in one place, and again for ten miles in another, are in themselves sufficient to prove that the river at the lowest point was a gigantic stream. The Tibetans all spoke of the Brahmaputra as a very great river. They call all very large rivers Sangpo, and as that term is applied to four of the tributaries enumerated above, it is to be supposed that the conjoint stream is, in their estimation, a very large one indeed.

The navigation at 13,500 feet above the sea, rude though it may be, is an extraordinary fact; navigation of any kind at such an altitude being quite unknown in any part of either the old world or of the new. If the Pundit had any doubt as to the great volume of the river, it was completely removed by a squall which suddenly swept across the broad expanse of water; the wind raising such large waves that the small fleet of boats carrying the Pundit and his companions only escaped swamping by taking to the nearest shore.

Any comparative estimate by eye of such a great river is of course very deceptive, but, as has already been shown in the case of the Penanangchu, a tolerable estimate may be made in that way of a moderate-sized river.

Assuming that the Pundit's other estimates of the main stream and its tributaries were as accurate as that of the Penanangchu, it would follow that in the dry season (December and January) the resulting stream was composed of the stream near Tadum, which was at least one and a-half times as large as the Ganges in September (or say only the same size in December), and of six other streams, each of which on the average was probably larger than the Ganges, or, say in all, of a discharge of water equal to seven times that of the Ganges at Hurdwar in December.

The Ganges at Hurdwar was selected for comparison, as it was well-known to the Pundit, and had lately been re-crossed by him. Its discharge may be taken at about 5,000† cubic feet

---

* 32,000 cubic feet according to Dr. Lord's measurement.
16,000 do. Colonel Cunningham's estimate.

† More correctly 5,500 cubic feet.