VII.

On the Height of the Himálaya Mountains.

By H. T. COLEBROOKE, Esq.

WHEN I presented to the Society the narrative of a journey, performed by Lieutenant WEBB and Captain RAPER, to explore the sources of the Ganges, I had occasion to notice the observations mentioned to have been made for determining geometrically the altitude of remarkable peaks of the snowy mountains, and the inference which appeared to be fairly deducible, that this chain of mountains is among the most elevated in the known world, neither surpassed nor rivalled by any other but the *Cordillera* of the *Andes**. I should have been justified by the premises in saying more: but I thought it right to speak thus guardedly; not having been then enabled to examine the particulars of the altitudes taken, the distances measured, and the calculations founded on them; nor to procure barometrical measurements tending to confirm or to correct conclusions drawn from those grounds. But having been since furnished with further observations taken by Lieutenant WEBB, in prosecution of the same inquiry, and having compared them as well with those before made by him, and by the late Lieutenant-Colonel COLEBROOKE, as with Lieutenant-Colonel CRAWFORD's labours in the pursuit of the same

* As Res. vol. xi, p. 445.

inquiry, I consider the evidence to be now sufficient to authorize an unreserved declaration of the opinion, that the *Himálaya* is the loftiest range of Alpine mountains which has been yet noticed, its most elevated peaks greatly exceeding the highest of the *Andes*.

This had been long suspected, or rather had been very generally believed, in *India*, upon less conclusive evidence than will now be submitted to the public. It was remarked, that this chain of mountains constantly covered with snow is visible from the plains of *Bengal* at the distance of 150 miles * (it might have been said at a still greater distance). This fact demonstrates great elevation. For the peak of *Teyde*, or *Teneriffe*, measuring nearly 12,000 feet †, is discernible in clear weather at a distance of 120 miles, and appears like blue vapour scarcely darker than the sky; and *Chimborazo*, the highest peak of the *Andes*, ascertained to be more than 20,000 feet high ‡, is seen at a distance of little more than 60 leagues, the rest of the *Cordillera* of the *Andes* being then concealed from view: but the *Himálaya* chain of mountains is visible in the horizon, as a continued line extending through more than two points of the compass, at a distance equal to that last mentioned, appearing in clear weather like white cliffs, with a very distinctly defined outline.

To justify the assertion, that the distance, at which the chain of snowy mountains continues to be visible, exceeds 150 miles, it may be sufficient to mention, that it is seen bearing Easterly of North, from *Patna* and from other stations (as *Bhágalpúr*, &c.), on the Southern bank of the Ganges. Now the latitude of *Patna*, by astronomical observation, is 25° 36′ §; and that of *Cat'h-*

* Rennel's Memoir of a Map, p. 302. (2d Edit.)
† 1,904 *French* toises.
‡ 3,220 *French* toises.
§ Reuben Burrow.

mandú, nearly due North of it, is 27° 42′*, the difference being 126 geographic, or about 146 English, miles. But the nearest of the *Himálaya* mountains are yet distant in a horizontal line above 25 miles from the last-mentioned town; more than one valley and intermediate ridge being interposed; some of which, to a distance of ten miles, have been visited by *Europeans*, without approaching within several days' travelling distance of the foot of the *Himálaya* †.

The continuation of the same chain of mountains divides *Bután* from *Tibet*, and is distinctly visible from the plains of *Bengal*. Captain TURNER and Mr. SAUNDERS, on their journey to *Tisholumbo*, after traversing *Bután* and crossing the frontier of *Tibet*, found themselves near a range of mountains covered with everlasting snow, which seemed to be but two miles distant from their route. Captain T. particularly noticed a conspicuous peak held in high veneration by the *Hindus*, and named *Chamalári*. Both the travellers were satisfied, the one from the remarkable form of the peak, the other from the height and bearings of the range, that the mountains which they then viewed are the same which are seen from *Purnea*, *Rajmahl*, and other places in *Bengal* ‡. Now, according to the survey of Captain Turner's route, *Chamalári* is placed in Lat. 28° 5′ Long. 89° 18′; a position no less than 165 geographic miles from *Purnea*, and 200 from *Rajmahl*, which is situated in Lat. 25° 3′ and Long. 87° 44′ by observation §. From a commanding eminence, on the frontier of *Tibet*, the travellers had an extensive view of the mountains of *Bután*, covered with verdure to the very tops; and it appears, from what is said by them, that *Bután* contains no mountains on which snow con-

* Lt.-Col. CRAWFORD.

† General KIRKPATRICK's Account of the Kingdom of *Nepal*.

‡ Capt. TURNER's Narrative, p. 203 (2d Edit.), Phil. Trans. vol. 79.

§ REUBEN BURROW.

tinues during all seasons of the year, and few on which it remains until the middle of summer. These circumstances seem to establish, beyond question, the fact, that the snowy range, of which *Chamalári* is a part, is that which is seen from stations in *Bengal*, distant 165 and even 200 geographic miles, answering to 191 and 232 *British* miles. Now it requires an elevation exceeding 28,000 feet to be barely discernible in the mean state of the atmosphere at so great a distance as that last mentioned; though a much less elevation, it must be acknowledged, may suffice under circumstances of extraordinary refraction.

The presumption, which was however raised on these grounds, was to my apprehension corroborated by observations, which I had myself the opportunity of making twenty years ago; and which gave, according to the note I have preserved of them, 1° 1′ for the usual altitude of a conspicuous peak of the *Himálaya* viewed from a station in *Bengal*, which, according to the construction of RENNEL's map, was not less distant than 150 English, or about 130 geographic, miles. If this distance might be relied on, the height to be inferred from that observation of altitude, after a due allowance for terrestrial refraction, would considerably exceed that of *Chimborazo*, being not less than 26,000 feet above the level of the plains of North *Bengal*. But, as the distance was not ascertained with sufficient accuracy for the purpose of confidently grounding on it a calculation of this nicety, I proposed to determine it by observations of the bearings of the same peak, from two places distant enough to afford an adequate base, the length of which might be found by correct survey. Not having had the means of completing the inquiry upon the principle here explained, I recommended it to the attention of the late Lieutenant-Colonel COLEBROOKE, by whom it was prosecuted during his survey of *Rohilkhand;* and it has been further pursued to a satisfactory result by his assistant, Lieutenant

WEBB, during his journey towards the sources of the Ganges, and finally during a survey of the province of *Górakhpúr*.

Colonel COLEBROOKE's notice was also drawn to the subject by the communications of Dr. FRANCIS BUCHANAN and Lieutenant-Colonel CRAWFORD, who both visited *Nepal* in 1802, and who were convinced by the information they received there, from intelligent persons, that the sources of the Ganges are on the southern face of the *Himálaya*, and that these mountains are of vast height. He had likewise a knowledge of a survey by Lieutenant-Colonel CRAWFORD, executed in 1805, along the northern frontier from *Behar* to *Róhilkhand*, in which bearings were taken of every remarkable peak of the snowy range, which could be seen from more than one station; and consequently the distance of those peaks from the places of observation, and their geographical positions relatively to the plains of *Hindustán*, were determined by the intersection of the bearings and by calculation. Colonel CRAWFORD had also taken altitudes, from which the height of the mountains might be computed, and which gave, after due allowance for refraction, the elevation of conspicuous peaks, at least equal to that above mentioned. But the drawings and journal of this survey have been unfortunately lost.

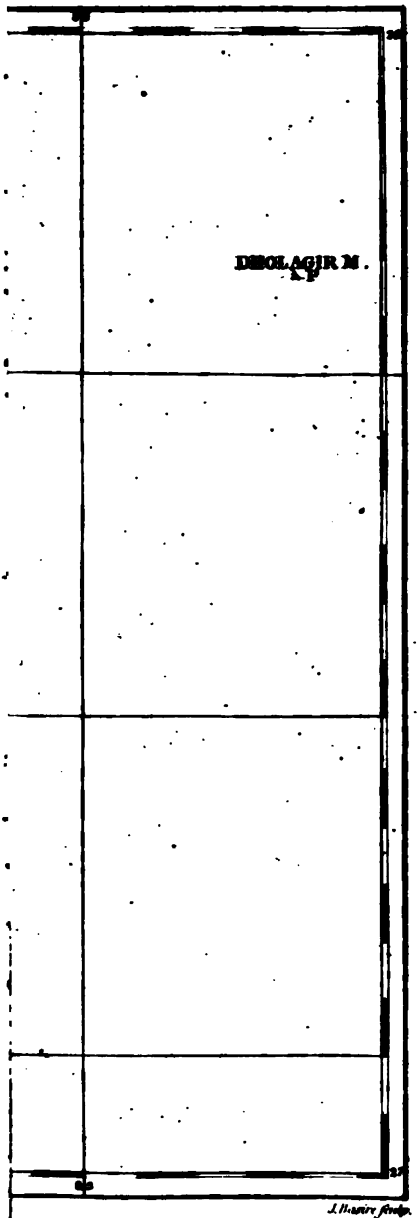
The observations instituted and completed by Lieutenant-Colonel COLEBROOKE, while in *Róhilkhand*, were two; one taken at *Pilibhít*, where the elevation of a peak distant 114 English miles, according to bearings from two stations, the distance between which was measured, was found to be 1° 27′; the other at *Jét'hpúr*, where the elevation of the same peak, distant 90 English miles, was observed to be 2° 8′. I find among his papers numerous other observations of the bearings and appearance of the chain of snowy mountains, as seen from

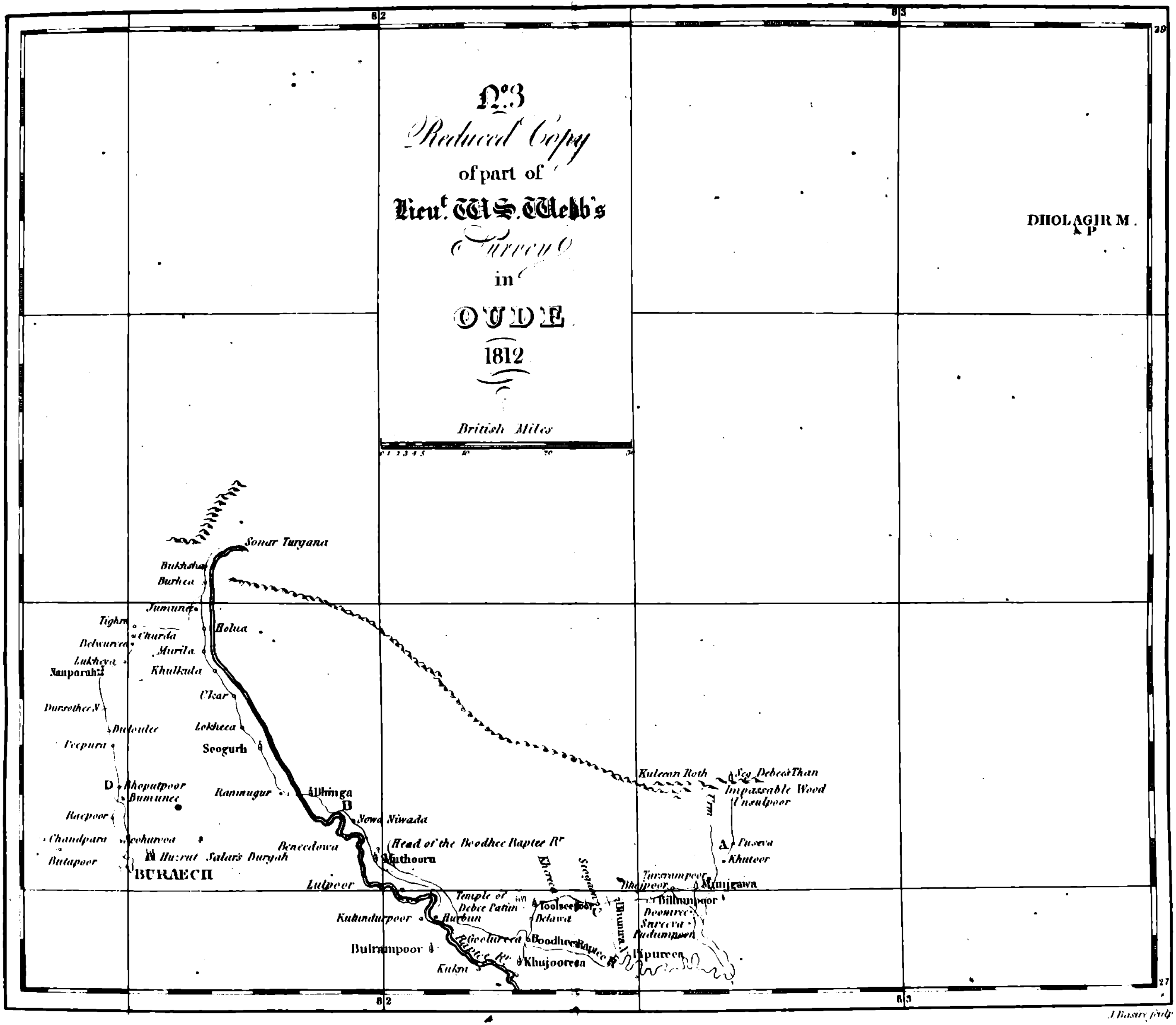
many successive stations. But the only altitudes which have been preserved are those above mentioned.

In calculating from these observations of altitude, allowance was first made for refraction at the same rate as for celestial objects of the same apparent altitude: and, from the observed elevation so corrected, was deduced a height of 20,019 feet for the mountain as viewed from *Pilibhít*, and 20,598 for the same as seen from *Jét'hpúr*, or 20,308½ feet on a medium of both observations. But the allowance for refraction being much too great, amounting to $\frac{2}{9}$ths of the contained arc in one instance and $\frac{3}{13}$ths in the other, the computation was again made, allowing $\frac{1}{8}$th of the intercepted arc for terrestial refraction, and the result showed a height approaching to 22,000 feet above the level of the plains of *Róhilkhand*.

However, this allowance of an eighth part of the contained arc still exceeds the mean of terrestrial refraction, as appears from the trials conducted by General Roy, and Colonels Williams and Mudge*, and especially from those of the last-mentioned observer. They found terrestrial refraction subject to great variation, amounting to no less than ½d of the contained arc in some instances, and so small as $\frac{1}{85}$th of the intercepted arc, and even less, or absolutely 0, in others. But, in the numerous observations of those gentlemen, the extreme instances are few; and the range of variableness is commonly within narrower limits, from $\frac{1}{7}$th to $\frac{1}{15}$th, being on a mean either $\frac{1}{11}$th or $\frac{1}{12}$th part. The trials most to be depended on, being those which were conducted by means of correspondent and contemporary observations, give a mean of $\frac{1}{11}$th. It appears, also, that the refraction is least variable where the ray passes through the air at a considerable distance from the surface of the earth, for the greatest part of its course: which is eminently the

* Phil. Trans. vol. 80, 85, and 87.

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in
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1812
British Miles
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Nanparah
Khulkula
Ukar
Dursothee N.
Dulouler
Lokheea
Seogurh
Peepura
Dhoputpoor
Bumunee
Ramnugur
Dhinga
Nowa Niwada
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Chandpara
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Dutapoor
Huzrut Salars Durgah
Muthoora
BURAECH
Lulpoor
Kuleean Roth
Seo Debee Than
Impassable Wood
Unsulpoor
Puseva
Khutoor
Munjgawa
Temple of Debee Patin
Toolseepoor
Delawa
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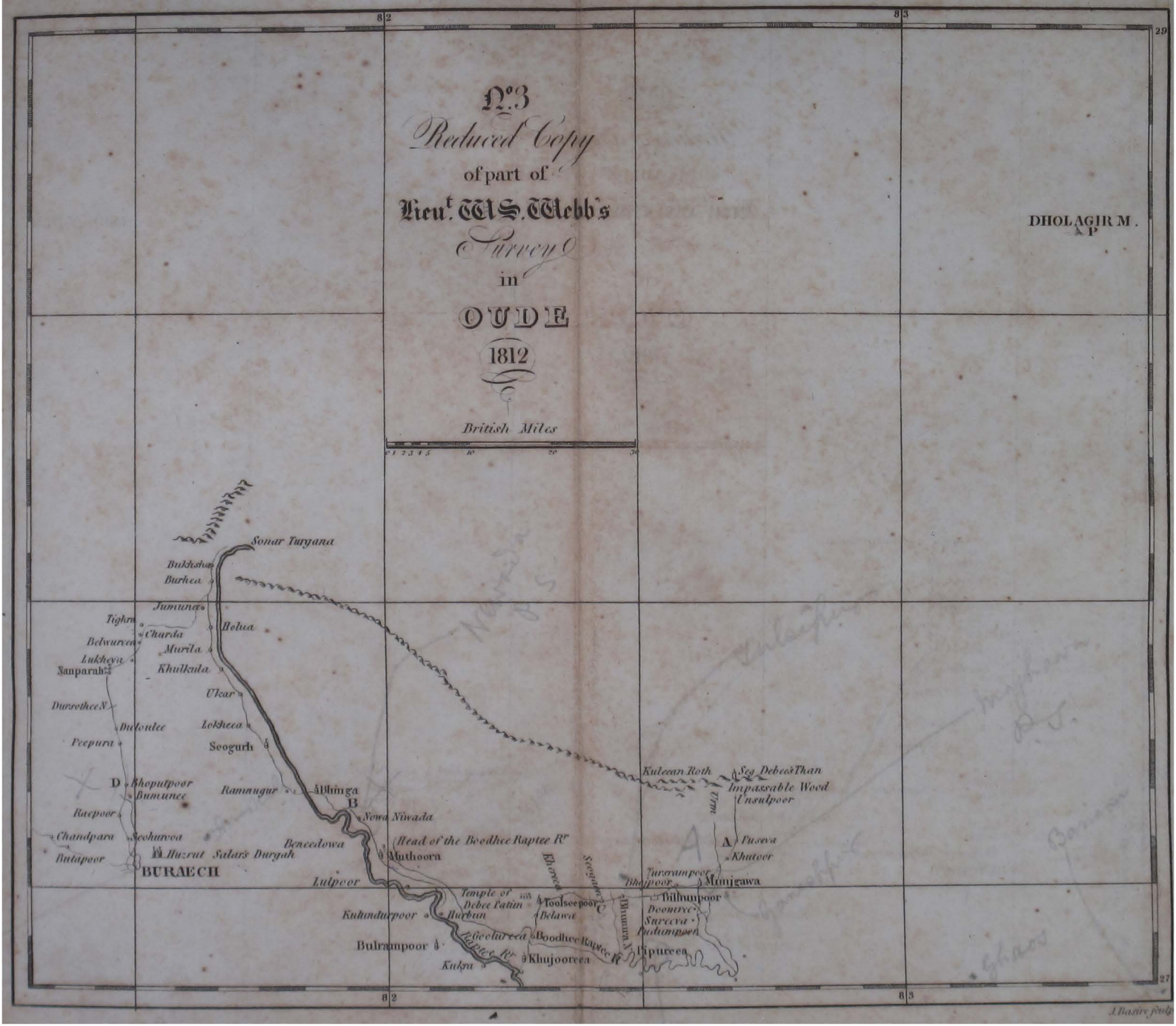
No 3
Reduced Copy
of part of
Lieut. W.S. Webb's
Survey
in
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Huzrut Salar's Durgah
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Tursrampoor
Bhuipoor
Munjgawa
Bilhunpoor
Doomree
Sarreeva
Padumpoor
Pipurrea

case in the instance under consideration; and especially in some which will be subsequently noticed, where the altitude of the mountains was taken from elevated spots: and, in all, the ray must pass for a great part of its course through a stratum of the atmosphere of much less density than in the experiments of General ROY and Colonel MUDGE, to which reference has been made.

It follows, from these considerations, that the mean terrestrial refraction should not be taken at more than $\frac{1}{11}$th of the arc contained between the object and station. This allowance agrees with that which DELAMBRE directs to be made: it exceeds what was found by LEGENDRE, (viz. $\frac{1}{14}$th); and it approaches very near to MASKELYNE's estimate of $\frac{1}{10}$th. But from Major LAMBTON's observations, in the peninsula of *India*, terrestrial refraction was found to vary from $\frac{1}{4}$th to $\frac{1}{18}$th*, or on a medium $\frac{1}{8}$th of the contained arc. As this mean refraction may be thought more applicable to the north of *India* than that deduced from the trials made in the climate of *Great Britain*, I shall compute from altitudes reduced by this as well as the preceding correction for refraction, and contrast the results with similar calculations, in which the refraction shall be taken at the utmost quantity which any past experience could justify, viz. $\frac{1}{3}$d of the arc.

To compute from the data, we have, in an oblique plane triangle, the angle (B) at the base of the mountain, which exceeds a right angle by half the contained arc; or (which is the same thing) by half the angle at the earth's centre subtended by that arc; the angle (S) at the station of observation, which is the sum of the observed altitude (corrected for refraction) and half the contained arc; and one side (A), which is the chord of the contained arc, or distance between the

* Page 100 of this Volume.

base of the mountain and station of observation, differing but a few feet, in the cases before us, from the circular arc itself. The angles and one side of the triangle being thus known, the other two sides may be found; one of which, subtending the angle S, is the height of the mountain, or perpendicular from its summit to the middle of its base. The observations at *Pilibhít* and *Jét'hpúr*, calculated upon this principle, and with an allowance of $\frac{1}{11}$th for refraction, give 22436 and 22146 for the elevation of the peak observed from those stations; or on a mean 22291 feet above the level of the plains of *Rohilkhand*; or about 22800 feet above the level of the sea.

In the same manner may be calculated the height of the peak, situated, according to the information of the mountaineers, near the source of the *Jamuná*, and measured from the summit of *Nágún-ghátí*, near *Lálúrí*, under an angle of 3° 17′, and, from that of *Chandra-badaní*, under one of 2° 50′. The position of the mountain, deduced from horizontal angles taken at both stations, is settled by Mr. Webb in lat. 31° 23′, long. 78° 31′*. The latitude of the stations, determined by astronomical observations made at the next places of encampment †, is 30° 32′ and 30° 20′; and the distances, taking the longitudes as inferred from survey, are 54′.2 and 63′.2 geographic miles respectively. Whence, allowing $\frac{1}{11}$th for refraction, we have 20895 and 21855 feet; or, with an allowance of $\frac{1}{6}$, 20503 and 21320 feet; for the elevation of the mountain above those stations. Their respective heights are yet unascertained: but *Chandra-badaní* was, by Mr. Webb, thought the highest, contrary however to what the result of the present calculation indicates. The height of *Nágún-ghátí* was estimated by him at 5000 feet; and this guess is

* *Asiatick* Researches, vol. 11, p. 442.
† MS. Journal.

corroborated by a trigonometrical measurement of a mountain called the *Khanjar* near *Bhuwan-dévi* *, seen the preceding day, and found to be 3297 feet above the valley. It is distantly supported by barometrical measures of mountains in a different part of the same chain, as will be noticed further on.

The elevation of the *Jamunávatári* appears then to be not less than 25000 feet above the valley. It is however right to observe, that this measurement of the height of that mountain above the summit of the passes from which the angles were observed is not entirely to be relied on; as the distances are not determined with sufficient precision, being dependent on the relative position of the stations in longitude, concluded from a survey performed by means of a route measured by time in a very uneven country.

It might be expected that use should be made of numerous other observations, which were taken from various elevated situations among the lower mountains, especially those which exhibited much larger angles; on the presumable ground, that the height of any selected point among the numberless snowy peaks of the *Himálaya* would be best ascertained by angles taken at the nearest positions approaching it. No doubt such would be the case, could a survey be leisurely performed in the mountains, choosing the fittest stations upon a previous view of the country, and satisfactorily identifying the point to be observed. But a hasty journey (more was not in this instance practicable) among mountains nearer to the object affords less means of an accurate measurement than a survey carefully conducted at a remoter distance in the champaign country. Instead of keeping in view, from day to day, during the progress of survey, the same se-

* It is to be regretted that more frequent opportunities did not occur for similar measurements.

lected point, and being fully assured of its identity by the uniformity, or at least the very gradual alteration of its appearance, the traveller through the mountainous skirts of the *Indian* Alps loses sight of those objects for successive days as he proceeds along the valleys, and finds it impracticable, when he emerges to higher ground, his route leading him over some mountain, to discern from its summit the loftiest peak, now perhaps intercepted from his view by one nearer, though of less elevation; or to discriminate and recognise among innumerable glaciers, which have varied their aspect with his change of place, the particular snowy peak before contemplated by him from another side, in a different point of view, and with another aspect.

On these considerations, and after carefully inspecting Mr. WEBB's journal, in which I find observations of unnamed snowy peaks seen from the stations of *Rét'hal** and *Bahmencót'hí* † under angles of nine and ten degrees; with others, from more distant stations, of mountains supposed to be known, as the peak near *Gangávatárí* seen from *Nágún-ghâtí* and *Chandra-badaní* ‡, and *Cédár-nát'h* from the last mentioned station §; I do not deem any of these points to be so verified as to be made the certain grounds of a correct measurement of altitude. The horizontal distance of the near glaciers appeared to the travellers, in more than one instance, to be only ten miles ‖; but this, being a mere guess, cannot serve for the basis of correct calculation. Employed as a conjectural measure, it gives 9000 feet for the height of the objects above the lofty spot whence they were viewed.

* 10° 18′. 9° 55′. 9° 42′. 9° 19′. 8° 19′ bearing respectively N. 62° 49′. E. N. 59° 04′ E. N. 54° 56′ E. N. 49° 42′. N. 45° 28′ E. and further diminishing as the bearings grew more Northerly.

† 9° 55′. 9° 14′. 8° 17′ bearing N. 43° 35′ E. N. 39° 12′ E. N. 28° 17′ E. respectively.

‡ 3° 1′ and 2° 50′.

§ 2° 34′.

‖ *Asiatick* Researches, 11, p. 515 and 552.

The position of *Cédár-nát'h* is not confidently stated *, the materials for determining it being insufficient. Supposing however that of *Gangávatárí* to be more nearly correct, the pyramidical peak in the vicinity of that celebrated place, if indeed the same which was seen and measured from *Nágún-ghát'i*, is 17784 feet above the summit of that pass, esteemed to be 5000 feet high.

But, leaving these conjectures and doubts, let us pass to more certain observations and more exact measurements. To Colonel CRAWFORD I am indebted for the communication of observations made by him at *Cat'hmándu*. Another set, much more numerous, was taken by him during an extensive survey along the frontier, but it is not at present within his reach. If not actually lost, as was believed when a preceding paragraph of this essay was written, the journal of his observations is probably in *England*, and, when there found, will confirm what is here stated upon other grounds.

At present what we possess of that laborious survey is the protraction of it, showing the positions of the mountains as they were determined by cross bearings taken from a great number of stations between *Púrnea* in *Bengal*, and *Balrámpúr* in *Ayudh*. This document, however, is invaluable for the purpose of the present inquiry.

Colonel CRAWFORD, during a long sojourn at *Cat'hmándú* in 1802, took the angles of several selected points, of which he determined the distances by trigonometrical measurement, having taken the bearings from various stations in the valley of *Népál*, the relative situations of which were ascertained by a trigonometrical survey proceeding from a base of 852¾ feet, carefully measured four times, and verified by another base of 1582 feet,

* *Asiatick* Researches, 11, p. 442.

measured twice. The positions of the same mountains were also settled by observations of them made from the plains of *Behar* in the progress of the great survey which has been mentioned.

The angles of elevation of the mountains above the stations of *Sambhú* and the queen's garden near *Cat'hmándu* were taken with an astronomical sextant and an artificial horizon. Among the most remarkable is an observation of a mountain pointed out as mount *Dhaibun*. It was seen under an angle of 5° 4′ 21″, and ascertained to be distant 35⅔ g. m. The elevation calculated from this measure is 20140 feet above the station from which the altitude was taken, and which is itself more than 4500 feet above the level of the sea, as concluded from barometrical observations to be subsequently mentioned. Another seen under a similar angle, 5° 3′ 58″, but less distant by four miles, exceeds the elevation of the station by 17819 feet. Both these mountains are but little to the eastward of north from *Cat'hmándu*. The following are as little north of east; viz. one nearly in the position of the *Cála-bhairava**, distant 59 g. m., with an altitude of 2° 48′ 6″, and consequently 20025 feet high; another in its vicinity, with an angle of 3° 23′ 6″, distant 48 g. m. and elevated 18452 feet; and a third, as much more remote, being 68 g. m. with an altitude of 2° 7′ 21″, and a consequent elevation of 18662 feet above *Cat'hmándu*.

All those mountains are perceivable from *Patna*: the first or the supposed *Dhaibún*, at a distance of 162 g. m., and *Cála-bhairava*, or the mountains in its vicinity, at that of 153, 150, and 145 g. m. These are the nearest of the *Himálaya* which are visible from that city. The most remote are seen in the N. E. quarter, at the prodi-

* General KIRKPATRICK's Account of *Nepál*.

gious distance of 195 g. m., ascertained by their position, which is determined by bearings taken by Colonel CRAWFORD from stations approaching within a hundred miles of their site.

Mount *Dhaibún*, or at least the peak which was indicated to Colonel CRAWFORD under that name, and which is not surpassed by any of the points measured from *Cat'hmándu*, was viewed by General KIRKPATRICK, if indeed it be the same mountain, from a position ten miles nearer to it on mount *Bhírbandí* *, and his animated description of the sublime prospect contains presumptive evidence that the remoter glaciers of the *Himálaya* are still more elevated; for he speaks of a neighbouring mountain not less stupendous, yet surpassed by one of the pyramidical peaks of the snowy chain seen peeping over its towering summit. It may readily be credited that the more accessible mountains which approach *Cat'hmándu*, as *Jibjibia*, *Dhaibún*, and *Dhúnchá*, may be inferior in height to the abrupter peaks in the chain of the *Himálaya*.

Among the loftiest in that chain is one distinguished by the name of *Dhawala-giri*, or the white mountain, situated, as is understood †, near the source of the *Gandhac* river, called in its early course *Sálagrámí*, from the schistous stones, containing remains or traces of ammonites, found there in the bed of the river, and thence carried to all parts of India, where they are worshipped under the name of *Sálagráma*; the spiral retreats of

* Account of *Nepál*, p. 138. It is right to observe that the map annexed to that publication places *Dhaibún* and other mountains, as *Dhúncha* and *Ghírkhá*, much nearer to *Cat'hmándu* than they are by Colonel CRAWFORD's survey. The latter is however most to be depended on.

† KIRKPATRICK: *Nepál*. *Sálagráma* stones are found in great abundance near *Muctinát'h*, and more sparingly at *Dúm dher cúnd* still nearer to the source of the *Gandhac*. Colonel CRAWFORD's MS.

antediluvian molluscas being taken by the superstitious *Hindu* for visible traces of VISHNU.

A high peak, among the most conspicuous of those which are seen from the plains of *Górakhpúr*, and on that account selected by Mr. WEBB for a measurement, conducted by means of observations taken at different stations in that province, was pointed out to him as recognised by the mountaineers to be *Dholagir (Dhawalagíri)*. Mr. WEBB took the bearings from four stations, and altitudes from three; and the particulars of his observations are as follow:—

At station A, situated near *Khatúr*, bearing of the snowy peak P, corrected for magnetic variation and error of adjustment by an azimuth observed at the time	N. 30° 12′ E.	
Altitude.....	2° 48′	
At station B, *Nowá newádá* on the *Rapti*. Bearing of P.....	N. 49° 30′ E.	
At station C, two furlongs W. of *Sétígaon*. Bearing of P.....	N. 35° 49′ E.	
Altitude.....	2° 19′	
At station D, two furlongs W. of *Bhópetpúr*. Bearing of P,.....	N. 60° 1′ E.	
Altitude.....	1° 22′	
B bears from A by the survey, W. 2° 5′ N. distant, ...		43,4 B. M.
D bears from A, W. 7° 5′ N.....		73,5 B. M.
The bearing of C from A is not used, the side A C measuring only 16,3 B. M.		
C to B W. 13° 54′ N. distant		29,4 B. M.
C to D W. 15° N.		60 B. M.
B to D W. 14° 3° N.		30,5 B. M.

From these data Mr. WEBB computes the distance of

the peak (P) from the stations A, C and D*, at the numbers under mentioned: viz. From the station A, by the triangle A P B, 89,6, and by the triangle A P D 89,1; mean of both computations 89,35 miles, or 471768 feet. From the station D, by the last triangle, 135,9, and by C P D 136,8; mean of both, 136,35 miles, or 719928 feet. From C, by the last of these triangles, 103,4, and by C P B 102,3; mean of both 102,85 miles, or 543048 feet. He remarks that several other bearings of the same peak were taken from different stations; and that, by laying off the rhumb-lines of bearing on the map, they intersect at very inconsiderable distances from the position of the peak, as deduced from those which were selected for calculation.

Let us proceed to compute the height of *Dhawalagiri* (vulg. *Dhólágir*) with the foregoing measures of distance and the observed altitudes.

At the station A we have the distance 471768 feet, 77,85 geographic miles†, or in parts of a circle 1° 17′ 51″; the chord of which in feet is 471758. The altitude observed being 2° 48′, and the refraction being taken at $\frac{1}{12}$th of the intercepted arc, the angles are S 3° 20′ 26″ 15‴ and P 86° 0′ 38″ 15‴, with the side S B 471758; whence we have the side B P, or height of the mountain, 27558 feet.

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* See the annexed map.

† The geographic mile, or sixtieth part of a degree of a great circle, is here taken at 6060 feet. The length of the meridional degree in different latitudes, according to the latest measurements, being 60995 fathoms in latitude 66° 20′, 60820 in latitude 52° 2′, 60783 in latitude 46° 12′, and 60487 in latitude 11° 6′; whence may be concluded 60600 nearly between the latitudes 27° and 31°; and this measure is employed without correction or modification, though the position of the arcs be at acute angles to the line of the meridian; greater precision in reducing the distances to parts of a great circle appearing to be unnecessary, as the utmost accuracy would make little difference in the computed height of a mountain.

By a similar calculation of the altitude of the same mountain observed from the stations C and D; viz. 2° 19′ and 1° 22′, or corrected for refraction 2° 11′ 32″ and 1° 12′ 6″, with the distances above found, which in parts of a circle are 1° 29′ 36″ 36‴ and 1° 58′ 48″, and, reduced to the chords of the arcs in feet, 543031 and 719893, the height comes out 27900 and 27573; or, on a mean of the three, 27677 feet above the plains of *Gorak'hpúr;* and reckoning these to be 400 feet above the mouth of the *Ganges*, as inferrible from the descent of the stream of rivers, the whole height is more than twenty-eight thousand feet above the level of the sea.

The following table exhibits a comparison of this result, with other computations made on different rates of refraction:—

Station.	Distance in miles.	Interc. arc in deg.	Alt. by obs.	Height, allowing for refraction. $\frac{1}{5}$	$\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{11}$	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{15}$
A	89$\frac{14}{100}$	1° 17′ 51″	2° 48′	24875	26663	27110	27476	27558	27626	27855
C	102$\frac{11}{100}$	1° 29′ 36″.6	2° 19′	24348	26716	27308	27792	27900	27991	28294
D	136$\frac{18}{100}$	1° 58′ 48″	1° 22′	21338	25494	26554	27384	27573	27773	28286
			Mean	23520	26091	26784	27551	27677	27797	28145
			Extreme difference	3537	1922	774	408	342	365	439

It is apparent, from inspection, that the observations at the stations A and D agree best; and if that computation be nearest the truth, wherein the extreme differences are least, the conclusion will be, that the height is about 27550 feet; such being the elevation deduced from the mean of observations calculated according to middle refraction.

The limit of error arising from refraction must be taken at less than 850 feet, as the observations at A and C coincide for the height of 26690 feet, $\frac{1}{8}$th of the contained arc being allowed for refraction; and those at C and D for an elevation of 28290 feet, $\frac{1}{18}$th being allowed; while those at A and D do so for the mean altitude of 27565

feet, refraction being taken at the middle rate of $\frac{1}{15}$th; and a larger allowance than $\frac{1}{7}$th of the intercepted arc, which would exceed mean celestial refraction for like altitudes, cannot be requisite, without very wide disagreement in observations made on different days, which would mark extraordinary refraction; but that is not the case with those in question.

The limits of error in respect of the observations themselves, whether for the distance or for the altitude, are more confined, since the uncertainty in the distance, amounting to a quarter of a mile in one instance, and half a mile in the rest, induces uncertainty in the computed elevation to no greater extent than 76 or 99 feet for the nearer stations, and 180 for the most remote. An error of a whole minute in an observation of altitude affects the consequent calculation of height in the proportion of about 200 feet for the more distant station, and 130 to 150 for the nearer. But the instrument which was used should, with due care, give angles true within that quantity; and the observer was enjoined to take the angles to the nearest minute *.

It would be an extreme supposition that the errors have in every instance been the highest possible, and on the side of excess. Assuming, however, that they are so, the elevation, as observed from the two nearest stations, is not reduced below 26457 and 26467, or, on the mean of both, 26462 above the plains of *Górak'hpúr*.

We may safely then pronounce that the elevation of *Dhawalagiri*, the white mountain of the *Indian* Alps †,

* Instructions, quoted in *Asiatick* Researches, vol. 11, p. 448. The writer of these was acquainted with the instrument, and knew the degree of precision which it comports.

† *Sans. Dhawala*, white; *Giri*, mountain. Vulg. *Dhoulagir*, the white mountain. KIRKPATRICK's *Nepal*, p. 287. It is the *Mont-blanc* of the *Himálaya*.

exceeds 26862 feet above the level of the sea; and this determination of its height, taken on the lowest computation of a geometrical measurement, is powerfully corroborated by the measure of an inferior, though yet very lofty mountain, observed from stations in *Rohilkhand*.

It may be satisfactory to bring this measurement to the test of comparison with the calculation of heights from like observations of small angles at great distances in a case where the elevation is otherwise known or more precisely determined. This we are enabled to do in the very instance most to be desired, that of *Mont-blanc*, heretofore considered to be the loftiest mountain of the old continent. Its altitude, as seen from *Pregny*, a station half a league from *Geneva*, near the lake, exhibits an angle of 3° 14′, according to an observation by DE LUC *. The distance is stated by him in round numbers, 227000 *French* feet; but appears from Sir G. SHUCKBURGH's series of triangles † to be over-rated, the distance of *Geneva*, a little more remote, being no more than 225098 *English* feet. Calculating from this side, and the angle observed by DE LUC, with an allowance of $\frac{1}{11}$th of the arc for refraction, the height is found 13713 feet above *Pregny*, or 15122 feet above the level of the sea. DE LUC himself computed it from the same observation, differently employed in a manner which is little affected by uncertainty in the refraction or the distance, though subject to other error, at 2391 *French* toises equal to 15289 *English* feet: and Sir GEORGE SHUCKBURGH, by a trigonometrical measurement, in which he uses from one station a side of a triangle 206879 feet, and from another one of 142362 feet, and corrects the observed angles by an allowance for refraction equal to $\frac{1}{10}$th of the contained arc, makes the elevation of *Mont-blanc* 14411

* Modifications de l'Atmosphere, § 763.

† Philosoph. Trans. vol. 67. The distance is not there stated, but is easily calculated from the angles and distances exhibited.

and 14453, or, on a mean of the two, 14432 feet above the lake of *Geneva*, and 15662 above the sea.

These instances may authorize an inference, that, in similar measurements of *Dhawalagiri*, *Dhaibún*, and other mountains of the *Himálaya*, from stations some as near, others twice or thrice as distant, the uncertainty respecting the accuracy of the result is not so much greater as to render that result vague and dubious.

Barometrical measurements, though less to be depended upon than a geometric one, would have been desirable, as showing that no very material error has by any oversight crept into it. In the absence of any observations of the barometer on the nearest accessible heights, we are in possession of some made on summits of mountains belonging to the intermediate chain. For instance, at *Chisápání* fort, on the route from North *Bihár* towards *Cat'hmándú* in *Népál*, the barometer was noted on two days at an interval of more than a month (23d February and 28th March 1793), and both observations gave the same length of the column of mercury 24.63. On one of those days the barometer was observed at a spot a little more elevated, near the cold spring which gives name to the place*, 24.43: and the temperature shown by the thermometer is also given, 65° FAHRENHEIT's scale at 9 o' clock, and 67° at 11 in the forenoon†. A meteorological journal was kept by Dr. F. BUCHANAN at *Cat'hmándú*, for nearly ten months (April 1802 to February 1803‡), and the mean height of the barometer in that period is 25.22. The greatest height being (in May) 25.62; and the least (in August) 24.83§. On a

* *Népal; Chisó* cold, *Páni* water. *Sans. Sí'ira-pániya.*

† KIRKPATRICK. *Népál*, p. 52 and 331.

‡ MS.

§ The barometer, by which the journal was kept, gave less length to the column of mercury, than another, with which it was occasionally

minute inspection of it, the changes, though observations were made at four different hours of each day, are small, seldom amounting to the tenth of an inch within the day, and by no means corresponding to the changes of temperature shown by the thermometer.

To compute the elevation of the stations at *Chisápání* and *Cat'hmándú*, under the want of corresponding observations of the thermometer and barometer at the foot of the mountains, we must either seek in some journal, which may have been preserved, a contemporary observation at a station (a very distant one) in *Bengal*, or else be content to take the mean height of the barometer in *Bengal*, where it is very stationary, and seemingly unaffected by changes of temperature.

For here, as in most countries near the tropicks, the barometer has a very confined range, and does not vary with the fluctuations of the temperature, owing to contrary but equal variations of density and elasticity of the air, or other countervailing causes not investigated. The column of mercury stands within a few tenths of an inch of the same height at all seasons of the year *; and exhibits, but within narrower limits, the phænomenon of diurnal tides, which also do not correspond with the rise and fall of the thermometer †. Towards the end of February, the season when the mountains of *Népál* were visited by General KIRKPATRICK, the barometer does not vary in *Bengal* so much as the tenth of an inch above and below 30 inches, while the thermometer in the shade ranges 10°, (from 70° to 80° on a medium,) and much more in an

compared, and which was constantly higher by a quarter of an inch. The latter agrees more nearly with General KIRKPATRICK's barometer, which in March exhibited 25,87 for the length of the column of mercury at *Cat'hmándú*. The measure of it must be therefore taken as doubtful to one quarter of an inch.

* *Asiatick* Researches, vol. 2, p. 471.

† Ibid. vol. 4, p. 202.

open exposure, between morning and noon. In the months of December and January, the season when the column of mercury is at its maximum*, the mean elevation of the barometer is 30.07, while that of the thermometer is 68°. At *Cat'hmándú*, during the same season of the year, the mean height of the barometer is 25.28, while the thermometer is 52°: seldom altering so much as the tenth of an inch, and never more than 1½ tenths, in the compass of one day, nor during the whole season so much as two tenths for the same hour of the day.

The last of the two methods proposed seems therefore preferable, as the barometer is shown by the journal kept at *Cat'hmándú* to be as little variable in *Népál* as it is in the plains of *India*; and contemporary observations at places very remote (no other could be found) would produce no greater degree of accuracy, since a like state of the atmosphere in respect of elasticity, or in regard to humidity and other circumstances affecting its density exclusive of temperature, is hardly to be presumed to prevail through an expanse of many hundred miles between places so differently situated; the one on the open plain within the reach of influence of the sea, the other in the midst of mountains at the foot of the loftiest Alps. I shall therefore take the mean height of the barometer in *Bengal*, towards the end of February, or 30 inches, and the observed height at the spring of *Chísápání* at the same season of the year 24.43: and in like manner the mean length of the column of mercury for both *Calcutta* and *Cat'hmándú*, in the winter season, when the mean temperature at the one place as much exceeds the zero of the scale adapted to the measurements of heights, as it is short of it at the other. This appears to be 68° at *Calcutta* and 52° at *Cat'hmándú*: the mean

* *Asiatick* Researches, vol. 2, p. 470.

of both, or 60°, differing by less than $1\frac{1}{2}$° from the zero of the scale. The corresponding lengths of the column of mercury are 30.07 and 25.28 respectively.

Proceeding on these grounds to calculate the heights of the places, we find from the difference of logarithms *, $753\frac{1}{2}$ *French* toises or 803 *English* fathoms in one instance, and 892 *French* toises or $950\frac{3}{4}$ *English* fathoms on the other: needing little correction for the difference of temperature, the thermometer being near the zero of the scale†. The elevation thus found, corrected, however‡, for expansion of mercury and variation of the density of the air, as indicated by the thermometer, is 5818 *English* feet or $969\frac{3}{4}$ fathoms for *Chisápání*, and 4784 feet or $797\frac{1}{3}$ fathoms for *Cat'hmándú*§, above the plains of *Bengal*. Hence may be inferred the following approximated measures of other stations where barometrical observations were also made, unaccompanied, however, by observations of the thermometer.

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* De Luc, Mod. de l'Atmosphere, § 576 and 631.

† Zero of De Luc's scale, 16.75 of Reaumur's, answering on Fahrenheit's scale to 69.32
General Roy's (Philos. Trans. vol. 67, p. 740), adapted to *French* toises 61.4
Thermometer at *Chisápání*, 65°, that at *Calcutta* being 75°; the mean is 70
Thermometer at *Cat'hmándú* 52
At *Calcutta* 68

Mean of both 60

‡ According to the mean of the rules proposed by General Roy and Sir George Shuckburgh; and nearly in conformity to De Luc's, excepting the reduction of 8° in his scale: the numbers being 0.454 for the multiplication of the difference of thermometers, and 0.00244 for that of the mean of both thermometers above 32° Fahrenheit.

§ By another barometer which stood a quarter of an inch higher, the elevation of *Cat'hmándú* above *Calcutta* is 4510 feet; or 4600, nearly, above the sea.

		Feet.
Chandragiri, M	(22.5*)	7989†
Tambékhán, M	(23.75‡)	6488
Chisápáni. M	(23.8§)	6453
Cumhara, M	(24.22*)	5943†
Bhírbandi, M	(24.28‖)	5875
Sibudhol valley	(24.48¶)	5711

Also, as before,

Cold spring *Chisápáni*	5818
City of *Cat'hmándú*	4784
And (by a trigonometrical measurement of mountains encompassing the valley of *Népál***, selecting from it mountains south of *Cat'hmándú*) *Chandragiri* M. above *Cat'hmándú* 3682 feet, and above the sea††	8466
Palchu M. (above *Cat'hmándú* 4210 feet,)	8994

It does not seem, then, that the elevation of the pass of *Nágun-ghátí*, whence the mountain near *Jamunáwatárí* was observed, need be thought overrated at so little as the lowest of these heights, which command a similar extensive view of the *Himálaya*.

To recapitulate the result of this minute examination of measurements of the *Indian* Alps, the following are stated as differences of elevation which may be received as near approaches to a correct determination of the

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* Estimated, KIRKPATRICK, *Népal*, p. 331 and 332.

† Doubtful.

‡ KIRKPATRICK, *Népál*, p. 70.

§ Ibid. p. 57.

‖ Much beneath the summit of the mountain: ibid. p. 139 and 333.

¶ Ibid p. 334.

** Colonel CRAWFORD, MSS.

†† This mountain, by General KIRKPATRICK's doubtful observation of the barometer (22.5), is 7989 feet above the plains of *Bengal*.

height, and as fully substantiating the position which was advanced at the beginning of this paper.

Dhawalagiri or *Dhólágír*; above *Gorakhpur*, which is estimated to be 400 feet above the sea;

On a mean of two nearest observations, and at the lowest computation ..... English feet 26462

On a mean of three observations with middle refraction 27677

Above the sea, at the lowest computation 26862

Yamunávatárí, or *Jamautrí*; above the summit of *Nágúngháti*, which is estimated to be 5000 feet higher than the sea 20895

Above the sea 25500

A mountain supposed to be *Dhaibun*; above *Cat'hmándú*, which appears by a barometrical measurement to be at least 4600 feet higher than the sea 20140

Above the sea 24740

A mountain not named, observed from *Pilibhít* and *Jét'hpúr*; above *Rohilkhand*, which is estimated at 500 feet above the sea:

On a mean of observations at both stations, 22291, or, more exactly 22268

Above the sea 22768

A mountain not named, observed from *Cat'hmándú*, and situated in the direction of *Cálabhairavi*; above the valley of *Népál*, 4600 feet higher than the sea 20025

Above the sea 24625

Another near it; above the valley of *Népál*.. 18662

Above the sea 23262

A third in its vicinity; above the valley of *Népál* 18452

Above the sea 23052

I take this opportunity of adding to the former communication of Captain RAPER's account of the journey

to *Bhadrináth* and to *Rétal*, and *Bêt'hári* on the route towards *Gangáwatári*, the narrative of the prosecution of the journey towards the source of the *Bhágirat'hi* by the *Múnshí*, who was sent from the last-mentioned station to explore that source, and who actually penetrated several miles beyond *Gangáwatári*. It is taken from the field-book which was kept by him, and of which the original has been delivered to me by Lieutenant WEBB. The route is laid down from this journal in Lieutenant WEBB's map of a survey of the Ganges within the mountains, inserted in the last volume of the *Asiatick* Researches *.

It will be observed that the *Múnshí* crossed the Ganges several times on *Sangas*, or bridges consisting of one or two fir-trees laid across from bank to bank. The breadth of the river, or, which is the same thing, the length of the bridge, was, in the first such instance which occurred, 56 paces. At the second bridge the breadth of the river crossed was 46 paces; half of which consisted of rocks in the middle of the river, and the other half only appears to have been the breadth of the stream. In the third instance the distance from bank to bank was 51 paces; but one-third of this was rock, leaving two-thirds only, or 35 paces, for the width of the stream. The fourth bridge was 45 paces long; but the fifth 28 only: and the sixth appears to have been no more than 25 paces. This was below the confluence of the *Bhágirat'hí* with a rival stream named *Kédárgangá*, and considerably short of the termination of the *Múnshí's* journey. He has not specified the breadth of the river where last seen by him: but, at *Gangáwatári*, an expansion of the stream is described by him to be 40 cubits wide and two deep, with scarcely any current. The river was traced 3 miles further amidst the snow.

* Vol. 11, p. 447.

Sunday, 1st May, 1808, set off from Bet'hári, Pergh Taknúr in Garhwál.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Road level. Ganges distant 200 paces. Name of the place *Bet'hárîban.*		622	Across the Ganges, the river *Idrar* in sight; distant ½ coss. Name of the place *Sálkában.*
Mauza *Kiárkhí* in sight; distant ½ coss. A small stream from the mountain flows towards the Ganges. The river 100 paces distant. Road over rocks; difficult.		320	
Road level over rocks. Ganges very near.		800	R. *Jamca;* distant ½ coss.
Ascent. Ganges 400 or 500 paces distant.		150	
Descent. Ganges 250 paces off.		128	
Over rocks near the river; extremely difficult.		192	
A small stream from the mountain falls into the Ganges.		11	
A grotto resembling a veranda, near the road.		56	
Torrents, fifty or sixty paces wide, running with great violence towards the river, 200 paces off.		857	
A grotto capable of containing ten or fifteen persons; river as before.		135	
Ascent.		80	
Level road on the high ground. Ganges 400 paces distant. A village in sight, ¼ coss off.			
Ascent. Ganges ¼ coss off.		540	
Level. River as before.		200	

Left hand.	Bearings by Compass.	Paces.	Right hand.
Over rocks; very difficult.		320	
A grotto capable of containing 25 persons.		240	
Road level. River still as before.		408	
Descent: to the bank of R. Soar.		309	
Cross R. Soar, by a *Sanga*. The water touched the bridge and flowed with rapidity. Ganges ½ coss distant. Ma. Murar in sight on an eminence.		14	
Ascent.		32	
Road along the side of the mountain.		1208	A large village, *Sálang*, and river of the same name; distant ½ coss.
Descent*.		320	
Road along the side of the mountain.		174	
Descent to the bank of the *Cúchián* N.		560	
Ford of the *Cúchián* N.†.		5	
Ascent of mount *K'hontá*‡.	N. 3 points E.	848	
Road descends.		704	
Ascends again.		128	
Descends.		205	
Ford of the *Taur* N§.		2	
Road along the side of the mountain‖.		997	
Level.	N.2 points E.	59	

* Ganges 500 paces off.

† Ganges ½ coss off. The village of *Cúchián* in sight on the height.

‡ Name of the place *Agrákhá*. Ganges ½ coss distant.

§ This stream comes from North 7 points West. Ganges still ½ coss distant. Rained at noon. We ate bread on the bank of the stream.

‖ Lower down, a grotto capable of holding 25 persons.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Ascent of mount *Tuwárá* *.		2264	
Descent.	N. 4 points E.	176	
Ascent. A large grotto seen.		168	
Descent along the side of the mountain to the banks of the *Tiar* R. Ganges ½ coss off.		1392	
Ford the *Tiar* †.	N. 5 points E.	18	
Road level; a little undulating ‡.		1283	
	Total	16865	paces.

Monday, 2d May, proceeded.

Road leads over rocks of the Ganges. Stream distant 500 paces.	N. 3 points E.	283	River *Datai* in sight, ½ coss distant. It comes from mount *Kailás*. N. 6 points E.
Ascent of Mount *Capar Khola*. Ganges ½ coss distant.		1248	Flows with great rapidity.
Road level. A small grotto. Ganges ½ coss distant.	N. 1 point E.	464	
Road undulating to the banks of the *Khótmári*. Ganges ½ coss distant.		496	
Ford the stream §.		3	
Ascent.	N. 2 points E.	112	
Road level on the high ground.		208	Water of the Ganges appeared like mud.
Along the side of the mountain. Ganges ½ to ¾ coss distant.		960	

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* Village of *Tuwárá* in sight. A small grotto. Ganges ½ coss distant.

† The stream comes from N. 2 points E.

‡ Ganges 500 or 600 paces distant. Stopped for the night in a large grotto or place sheltered by rocks. Rained the whole night.

§ It comes from N. 1 point W. Falls in a cataract of 20 cubits high.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Crossed the *Réri**;		8	
Descent along the side of the mountain. Ganges 1 coss distant.		1836	
Ascent. Ganges 400 paces off.	N. 6 points E.	355	
Along the side of the mountain †.		1280	
Road level. Ganges 200 paces distant.	N. 2 points W.	1486	R. *Nar* 1 coss distant. Comes from N. 2 points E. A cataract 7 cubits high.
Road level.	N. 3 points E.	193	
Road level. A grotto seen. Ganges 500 paces off.		200	
Road level.		888	R. *Rúnká* 1 coss distant, N. 7 points E. A hot spring from the side of the mountain called *Rársicund*, on the bank of the Ganges.
Road level ‡.		42	
Road level to the banks of the *Calyáni*.		349	
Cross the rivulet. Ganges ½ coss distant.		2	
A *Dhermsala* at *Banghéli*. Some fields of cultivation. Ganges 600 paces off.	N. 7 points E.	214	The *Malicha* falls into the Ganges. It flows from N. 7 points E.
Level. Ganges 500 paces distant.		266	
Ascent along the side of the mountain. Ganges ½ coss distant.	N. 5 points E.	1110	
Descent by a similar path. Ganges 200 paces off.		1154	

* It comes from S. 7 points E. Ganges less than 1 coss distant. Halted at noon to eat bread. It rained.

† The *Réri* falls into the Ganges. This is 50 paces [wide].

‡ A small stream from the mountain's side falls into the Ganges.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Ford of the *Banghéli* N. It flows from N. 2 points W.		11	
Road level *.		280	
Road level to the Ghat.		186	
Crossed the Ganges by a *Sángá*, or spar bridge, 1¼ space wide †.	N. 7 points E.	56	
		128	Ascent. Ganges 200 paces distant.
		320	Road level.
		80	Along the side of the mountain.
		800	Same. A torrent crosses the road.
		249	Level along the edge of the Ganges ‡.
		480	Road level §.
R. *Kanéla* in sight, a coss distant: comes from N. 3 points W.		152	
		800	Road level: a grotto seen. Ganges 200 paces distant.
		1280	Road level ‖.
		120	Road level ¶.
	Total	17609	paces.

Tuesday, 3d May.

	N. 2 points E.	325	Road level to *Déorání*, a rivulet from N. 5 points E.

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* A deserted hut of herdsmen. Ganges 300 paces off.

† The stream was 30 cubits below the bridge. The *Sángá* consisted of two or three spars, with a few pieces of wood tied on them. It was not a safe bridge. Having crossed, have now the Ganges on the left hand.

‡ A fir-tree, which had fallen in, rested against the bank.

§ A grotto seen: might hold 50 people.

‖ A torrent from the mountain passes close to the road.

¶ Stopped for the night at a large grotto, capable of containing 40 persons, 200 paces from the Ganges. Slight rain all night.

Left hand.	Bearings by Compass.	Paces.	Right hand.
		3	Forded the *Déoráni*.
	N. 5 points E.	378	Road to *Déoráni ghát* of the Ganges.
		46	Crossed the Ganges by a *Sángá*, or bridge of spars *.
Ascent.	N. 2 points W.	40	
Level road.		400	
Descent.		40	
Level.		688	
Over the snow.		182	
Road level.	N. 2 points E.	48	
Ascent.		40	
Level. A small grotto seen.		120	
Crossed the Ganges at the *Ghát Lóhárinág* by a *Sángá*, or bridge of spars †.		51	
		358	Road almost level, over rocks.
		59	Road level.
	N. 4 points E.	1095	Road level along the mountain's side. Ganges 100 paces off.
		19	Crossed the *Lótgárh* by a *Sángá*, consisting of 4 timbers ‡.
		480	Over rocks on the edge of the Ganges.
		296	Over snow which had fallen on the bank of the Ganges.
	N. 7 points E.	184	Proceeded over rocks in the Ganges.

* It consisted of three small spars, and was ½ a pace wide; very dangerous and terrifying. Went over it in a sitting posture, sliding along. The wooden part 24 paces, of which 11 very dangerous, and 13 more easy. The rest (22 paces) on rocks in the Ganges. The stream 7 cubits below the bridge.

† Two paces wide, and five cubits above the stream. Wood 25 cubits. Rock 21 cubits. Wood 10. Rocks 5. Ganges again on the left hand.

‡ It was 2 paces wide, and was touched by the water, which flowed with great rapidity. This stream comes from *Himáchal* N. 7 points E.

Left hand.	Bearings by Compass.	Paces.	Right hand.
		464	Ascent of the mountain, which was very steep. Climbed, holding by the grass and small shrubs.
		88	Descent towards the Ganges: went in a sitting posture.
		16	Road level.
		40	Ascent; very steep and difficult.
		104	Level.
		48	Ascent very difficult; overhangs the Ganges.
		112	Level. Ganges 200 paces off.
		131	Ascent; steep and difficult.
		56	Descent; extremely steep.
		462	Ascent. Ganges 250 paces off.
		272	Level. Ganges 150 paces distant.
		64	Over rocks on the edge of the Ganges.
		168	Descent from rocks; very steep.
The *Jeldrí* R. in sight, one coss distant, comes from N. 7 points E. and snowy mountains seen N. 7 points W. distant one coss.		831	Over rocks of the Ganges; but less difficult.
		1544	Road level; over stones in the bed of the Ganges*.
		56	Level.
		192	Ascent.
		232	Descent.
		145	Over the rocks of the Ganges; very rough and difficult.
		192	Ascent.

* A cave or grotto seen, and a small one capable of containing 50 persons.

Left hand.	Bearings by Compass.	Paces.	Right hand.
		320	Level, along the bank of the Ganges.
		96	Ascent.
		200	Descent.
		653	Over rocks of the Ganges; extremely rough and difficult.
	N. 4 points E.	11	Cross the *Bhélá* by a *Sángá* *.
		135	Level.
	N. 7 points E.	54	Cross the Ganges at the *Ghát* of *Súkh*, by a *Sángá* †.
Ascent, along the side of the mountain.	N. 7 points W.	659	
Along the side of the mountain to *Súkhí*. Ganges one coss distant.	N. 7 points E.	1654	
Along the side of the mountain.		840	
Ascent.		552	
Descent. Ford the *Choraki* N. ‡.		1248	
Road level. Ford the *Pakchahár* §.		523	
Road level. Ford the *Gangátrí* N. This flows from N. 7 points W.		117	
Ascent to *Jhálá*; which is 100 paces from the Ganges ‖.		184	

* Five cubits above the water. The stream comes from S. 1 pt. E.

† One pace wide, five cubits above the water. The old one had been broken down, and a new one had been recently erected. The greatest part of the distance in crossing was over rocks. viz. Rock 26. Wood 17. Rock 11.

‡ Comes from N. 7 points W. Ganges 200 paces off.

§ It comes from S. 1 point W. Ganges 100 paces off.

‖ Slight rain. Snowy mountains on all sides, and apparently very near. In the middle of the night much snow fell. In the morning the whole forest, and the surface of the ground and roofs of houses, were covered with snow. Halted till noon of next day.

4th May.—Proceeded at noon, when the snow was a little cleared away.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Road level.	N. 2 points W.	496	
Ford the *Nibàni* N. It comes from S. 7 points E. Ganges 200 paces off.		11	
Along the side of the mountain.	N. 7 points W.	640	
Descent. Ganges 2 to 300 paces off.		699	
Road level.	N. 5 points E.	400	
Cross the *Shinán* by a *Sángá* *.		32	
Road level.		40	
In the shallow bed of the Ganges.		70	
Over stones in the Ganges.		37	
In the shallow water of the river.		59	
Over stones.		35	
In the shallow water.		11	
Over stones along the edge of the river.		562	
In the shallow water †.		48	
Along the banks of the Ganges ‡.	N. 2 points E.	336	
Ascent.		48	
Along the side of the mountain.		528	
Over the rocks of the Ganges, very rough and difficult.		1000	
Cross the *Gongti* by a *Sángá* §.		22	
Road level. Ganges 250 paces off.	N. 7 points E.	531	

* The stream comes from N. 2 points W.

† Two channels of the river here unite.

‡ The melted snows descending from the mountains.

§ The water touched the bridge. Stream comes from N. 5 points E.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Cross the *Harsilá* by a *Sángá* *.		14	
Road level. Village of *Cachórá*.		280	
Ascent of the mountain near *Cachórá*.		160	
Level road.		320	
Continued ascent of the same mountain.		424	
Descent †.		1024	
Road level.		368	
Ascent. Along the side of the mountain.		256	
Descent. Along the side of the mountain. River very near.		533	
Cross by a *Sángá* near *Dheráli* ‡.		14	
Level road over the rocks of the Ganges.		144	
Cross the Ganges by a *Sángá* §.		28	
The deserted village of *Súkhia* in sight across the Ganges.		96	Level road to the temple of *Mahádéva* ‖.
Khera N. descends from *Cailás*.		96	Arrived in the evening at *Dheráli* in Pergunna *Tacnúr* ¶.
	Total	9002	

5th May.—Proceeded from Dheráli.

	S. 5 points E.	160	Ascent.

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* The stream comes from N. 7 points E.

† A stone representing *Mahádéva*, on a mountain said to be *Cailás*, was in sight from *Cachórá*, bearing N. 5 points E.

‡ Five cubits above the water.

§ At the *Ghát* of *Dheráli*. The water rises within 5 cubits of the bridge. The Ganges is now on the left hand.

‖ Containing a stone *linga* to represent the deity. It was buried in the sand. The temple said to have been founded by *Sancarácharya*. Other houses to the number of five or six.

¶ Containing near 25 huts, of which only 5 inhabited.

Left hand.	Bearings by Compass.	Paces.	Right hand.
		400	Descent. Ganges 200 paces off.
		416	Level road. A stream from the mountain crosses the road.
		792	Over rocks on the edge of the river.
		14	Crossed the *Gangá-sárti* by a *Sángá* *.
	S. 5 points E.	1000	A stream from the mountain crosses the road. Ganges 250 paces distant.
		320	Road level: but over rocks.
		96	Level: over snow.
		864	Level: over rocks. Ganges 300 paces distant.
		160	Level: over snow.
		480	Level: over rocks. Ganges 200 paces distant.
		80	Level: over snow.
		400	Level: Ganges 200 paces distant.
	N. 5 points E.	480	Ascent.
		320	Level: Ganges 400 paces distant.
		496	Descent: Ganges 300 paces distant.
R. *Gúmgúm* in sight, one coss distant †.		80	Level: A torrent from the mountain S. 1 point E.
		160	Level.
		249	Over snow. A stream from *Changthanga*.
		240	Level: Ganges 300 paces off.

* The stream is very rapid, and comes from Mount *Cailás*, S. 3 points E.

† Comes from N. 2 points. Is crossed by a *Sángá* on the road to *Bhôt (Thibet)*.

Left hand.	Bearings by Compass.	Paces.	Right hand.
	N. 6 points E.	488	Level.
		80	Over snow.
		533	Level. A stream from *Changla* crosses the road.
		445	Level. Ganges 4 or 500 paces distant.
		1064	Along the side of the mountain.
		14	Cross the *Laconga* by a *Sángá* *.
		240	Level.
		240	Ascent of Mt. *Ratúnti*.
		312	Level: over rocks.
		120	Ascent.
		96	Level: over rocks.
		64	Level: over snow.
		160	Level. Ganges 300 paces off.
		64	Ascent.
		560	Along the side of the mountain.
R. *Jáhnŝ-gangá* from the *Himáchal* mountains. Comes from N. 6 points E. Flows with great rapidity; and joins the Ganges. *A Sángá* over it leads towards *Bhót* (Thibet).	N. 5 points E.	1588	Level: over rocks.
		184	Level: over rocks †.
		512	Road undulating. Descent by means of a short ladder.
		16	Level. A stream from the mountain crosses the road.
		25	Cross the Ganges by a *Sángá* at *Bhairógátí* ‡.
A figure of *Bhairólál*.§		168	
Ascent ‖.		144	
	Total	15032	

* It comes from Mount *Cailás* S. 5 points E. Ganges 200 paces off.

† *Cál-bhairó:* a mere heap of stones, with no idol. Walnut-trees. Ganges 500 paces off.

‡ The stream appeared to be 500 cubits below the bridge.

§ Carved in the stony scarp of the mountain. Two idols of stone, daubed with minium. Pilgrims make offerings here, and proceed.

‖ Halted in a grotto which might contain 100 persons.

6th May.—Proceeded on the journey.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Ascent by means of ladders.	N. 7 points E.	299	
Ascent of the mountain*.		400	
Level: over rocks †.		1080	
Level: a plain.		80	
Level: over rocks ‡.		1035	
Level §.		336	
Along the side of the mountain.	N. 6 points E.	840	
Level ‖.		400	
Level. Over rocks. Ganges 400 paces off.		2000	
Level. Over rocks ¶.		752	
Level. A stream from *Teráli* crosses the road.		452	
Level. Halted in the grotto of *Teráli*. Fir-trees. Ganges 400 paces distant.		576	
Level.	N. 7 points E.	40	A stream from the snow on the other side of the river. Distant ½ coss.
Level. Road crossed by a stream from the mountain.		411	
Level: over rocks **.		444	
Level: over rocks ††.		1392	

* A temple of wood, containing an image of *Bhairóldl.*

† A stream from *Banlago* crosses the road in three places, towards the Ganges. Comes from S. 7 points W. Ganges 500 paces off.

‡ A stream from Mount *Matwári* crosses the road.

§ Halted in a grotto of *Matwári*. Ganges 400 paces distant.

‖ A stream near the deserted village of *Himún*, from the mountain, across the road.

¶ A stream near *Bhandrá* (formerly a village), comes from the mountain across the road.

** Grotto of *Otsaro*, capable of containing 20 persons. Ganges 300 paces off.

†† Many torrents from the mountain cross the road and fall into the Ganges. River 250 paces distant.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Level. A stream from *Otsaro* crosses the road.		818	
Level: over rocks *.		1064	
Level: over rocks †.		1120	
Level: over rocks ‡.		3200	
Level: over rocks.		104	R. *Bhój* from S. 2 points E. Distant ½ coss.
Level: over rocks §.		1104	
Level: over rocks ‖.		584	
Level: over rocks. *Téládhóní* ¶.		176	
Level: along the edge of the river **.		1448	
Level. Arrive at *Gangáwatrí* ††.		580	
	Total	20839	

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* A foaming torrent crosses the road called *Megmerá* or *Shtrcai*. Falls into the Ganges.

† A grotto capable of holding 10 persons. Ganges 250 paces off.

‡ A torrent passes near the road. Falls into the Ganges. The river 200 paces distant.

§ *Patágní*, where the *Pándus* are said to have performed a sacrifice. Ganges 200 paces off.

‖ A torrent falls into the Ganges. *Pakora* and *Cachori:* a spot surrounded with red marks, where the *Pandus* are said to have prepared their victuals. River 300 paces distant.

¶ A spot named from salt and oil, which might formerly be perceived, but not so now.

** *Gauricund*, a pool in which the water collects, and whence a stream proceeds. Confluence of *Kédárgangá* from S. 5 points E. with *Bhágirat'hí* or Ganges from N. 7 points E. Hindus shave and bathe here preparatory to visiting *Gangáwatrí*.

†† On the banks of the Ganges. A wooden temple, containing the footstep of *Gangá* on a black stone. *Súryacund*, *Vishnucund*, and *Brahmecund*, within the Ganges, being names assigned to distinct portions of the river, where pilgrims bathe. The last is 40 cubits wide, and 2 deep. It is the pure *Gangá*, unpolluted by water of any other stream. *Bhágirat'hi-síla*, a large rock in the river, on which the king *Bhágirat'ha* worshipped the deity. The river comes from N. 7 points E., and has very little current. Scarcely any trees but the *Bhójpatr* (birch?). On all sides snow. A large temple roofed with wood, containing an image of *Gangá* in red stone, a small female

7th May.—Proceeded onwards.

Left hand.	Bearings by Compass.	Paces.	Right hand.
Road level: over rocks of the Ganges.	N. 7 points E.	1320	
Road level: the river might now and then be perceived amidst the snow.		1416	
Road level: on rocks in the Ganges*.		496	
The Ganges might now and then be perceived under the snow†.		968	
Along the bank of the Ganges: over rocks‡.		760	
Over snow, filling the bed of the Ganges§.		2640	
Over rocks along the banks of the Ganges, which here shewed itself‖.		520	

figure of silver, images of *Mahádéva* and *Párbatí* in red stone represented with the human form, *Bhágirat'ha*, *Annapúrná dévi*, *Vishnu*, *Brahmá*, and *Ganés'a*, in red stone. A *Bráhmen*, who is an inhabitant of *Dherálí*, attends here during three months, *Vaisák'h*, *Jyét'h*, and *Asárh*. Scarcely any but *Bairágis* and *Sannyásis* come here: the road being in the highest degree difficult, and the place amidst snow most inhospitable.

* The breadth still less than at *Gangáwatrí*. On one side the road is practicable. On the other a perpendicular wall of rock. In the bed of the river saw a rock 2 or 3 paces wide and 5 long, bathed by the river on both sides, and overhanging the stream; the depth of water being very small. This rock exhibits a similitude of the body and mouth of a cow. It is called *Gao-múc'h*.

† An image of black stone might be seen in the snow; but could not be approached, for fear of being buried in the snow. The road was over the snow of the Ganges.

‡ A large cavern, quite capable of containing 100 persons: consists of several apartments.

§ The river was not once seen, nor was any sound of its current heard. The snow, being soiled, appeared like the earth of cultivated fields.

‖ In front was a steep mountain like a wall of rock, from an angle

8*th May.*

Set off to return by the same road towards *Dherálí*, there being no other practicable route.

The sequel of the field-book is kept in a similar manner; but it is thought unnecessary to translate it.

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of which the Ganges appeared to come. Beyond the present station was nothing but snow, nor any road but that termination of the valley. From dread, none would venture into the water of the Ganges. The snowy tops of the mountains appeared of various height; and not the least sign of vegetation: nothing but snow, masses of which were falling from the mountains. As the people in company were deterred from advancing, and there appeared no road by which to penetrate, and further progress seemed full of peril and of terror, I was under the necessity of returning to *Gangáwatrí*.