Several were brought in to Candahar, which had been found sitting on the rocks far from any water, and from their offering no resistance to their captors, they had evidently alighted from fatigue, and would probably have perished in a few hours. When approached, if unable to escape, they open wide the beak and strike at the intruder, making a loud snapping noise as they strike the mandibles together. I had two of these birds alive in a small tank, and have often seen them catch and swallow whole a fish of seven and eight inches in length. It is first caught within the pouch, and then thrown up into the air and caught again so as to bring the head foremost into the pouch and thus swallowed; the fins of the fish in this case are prevented from offering any impediment to its passage down the throat. They often dip the beak into the water as they sail along, and suffer the pouch to become filled with water; they then close it, and press the pouch against the breast, by which means the water is gradually expelled at the edges of the closed mandibles, and the water insects, small fish or other prey, are retained and swallowed.

It is not to be supposed that these are nearly *all* the birds of the Southern parts of Afghanistan; but my arduous duties in the Pay and Commissariat Department of Shah Soojah's force prevented my doing more than is above recorded, and you must overlook many omissions as well as scantiness of information, when I assure you that I was generally at the desk from sun-rise to sun-set!

A Description of the Glaciers of the Pindur and Kuphinee Rivers in the Kumaon Himálaya.—By Lieut. R. Strachey, *Bengal Engineers.*

The existence of Glaciers* in the Himalayas, being apparently still considered a matter of doubt by the Natural Philosophers of Europe, I have thought that some account of two most decided Glaciers, which I have just visited (May 1847) in these mountains, in about Lat. 30° 20′, may not be uninteresting.

* For the benefit of those persons, who now read of a Glacier for the first time, I have in an appendix given a short account of their chief peculiarities, which I should recommend them to look at first.

As there is probably nothing specially worthy of note in these individual Glaciers, I wish to explain, that my object being to show that these phenomena exist in the Himalaya, under forms apparently identical with those observed in the Alps, it has been necessary that I should enter into details, which under other circumstances would have been superfluous. As these are the first Glaciers that I have ever seen, it is right to add, that I am only acquainted with those of the Alps, through the medium of Professor Forbes's accounts, and that as I lay no claim to originality, I have not scrupled to adopt freely the ideas, and perhaps expressions, of a person so infinitely better acquainted with these phenomena than I can be. To guard against mistakes I would also mention, that these Glaciers were selected for examination only on account of their accessibility, and that consequently no inferences should be drawn from them, of the general extent of Glaciers in the Himalaya.

The Pindur river (vide accompanying map,) is the most easterly tributary of the Bhagiruttee, or that stream of the Ganges that issues into the plains of India at Hurdwar. It rises from the south side of one of the great snowy ranges of the Himalaya, which contains the cluster of Peaks, (No. 10 to 15 of the Indian Atlas, sheet No. 66,) of which Nunda Devee* is the centre. At the head of the Pindur is one of the Glaciers I am about to describe; the other gives rise to the Kuphinee, the first considerable affluent of the Pindur.

The Pindur and Kuphinee, rising on opposite sides of the Peak called Nunda Kot, unite about 7 miles south of it. A small tolerably level space between them close to their confluence, is called Diwálee. The lower end of the Glacier of the Pindur is about 8 miles, and that of the Glacier of the Kuphinee about 6 miles above this place.

* The heights of these peaks are as follows:

No. 10	15805	English feet.	
11	20758	,,	Vide Asiatic Researches, Vol. XIII. p. 306.
12	23531	,,	
13	22385	,,	
14	25741	,,	
15	22491	,,	

No. 14, which I call "*Nunda Devee*," is the "*Jowahir*" of the Maps. "*Jowahir*" or more correctly "*Jwar*" or "*Joohar*," is the name of a district (Purgunnah) which consists of the upper part of the valley of the Goree River. Nunda Devee is on the boundary of this district, and has been erroneously named after it in many maps, the word "*Joohar*" being never applied to designate this *particular peak*, though the portion of the range in which it is, has undoubtedly been called *the mountains of Joohar*.

The valley of the Pindur, at the termination of the Glacier, is about a mile across between the precipitous mountains that bound it. From the foot of the rocks on either side, its bottom slopes inwards with a moderate inclination, leaving in the middle a hollow about 300 yards wide and 250 feet deep, with very steep banks, at the bottom of which flows the river. This comparatively level space, between the central hollow in which the river runs and the precipitous sides of the valley, its surface running nearly parallel with the present bed of the river, but from 200 to 300 feet above it, can be distinctly seen for a mile or more below the end of the Glacier. The plateau itself, as well as the steep banks between it and the bed of the river, are considerably cut up by water courses running across them from the sides of the valley, but every where they have an almost perfectly rounded outline.

The whole of the bottom of the valley is covered with grass, or those species of plants that grow in these elevated regions, excepting where beds of snow, rocks, or the debris of the mountains interrupt the vegetation.

The Glacier (Fig. 2,) occupies about $\frac{3}{4}$ of the whole breadth of the head of this valley, leaving between itself and the cliffs on the east, an open grassy slope, which extends along the foot of the moraine for upwards of a mile and a half above the source of the river, and which seems to be a continuation of the plateau I before mentioned.

The first appearance is remarkable; it seems to be a vast rounded mass of rocks and ground, utterly devoid of any sign of vegetation, standing up out of a grassy valley. From the foot of its nearer extremity the river, even here unfordable, rushes in a turbid torrent out of a sort of cave, the top of which when I saw it was but a few feet above the surface of the water. The end immediately over the source of the river is very steep and of a dull black color. It is considerably fissured; the rents appearing to arise from the lower parts tearing themselves from the upper by their own weight. On a closer examination, this abrupt end proves to be a surface of ice, covered with sand and gravel, and curiously striped by the channel made by the water that runs down it as it melts. Behind this the glacier rises less steeply, like a bare gravel hill to its full height, which is probably about 500 feet above the water of the river, when it leaves the cave; in some places however are seen great fissures both vertical and horizontal, the

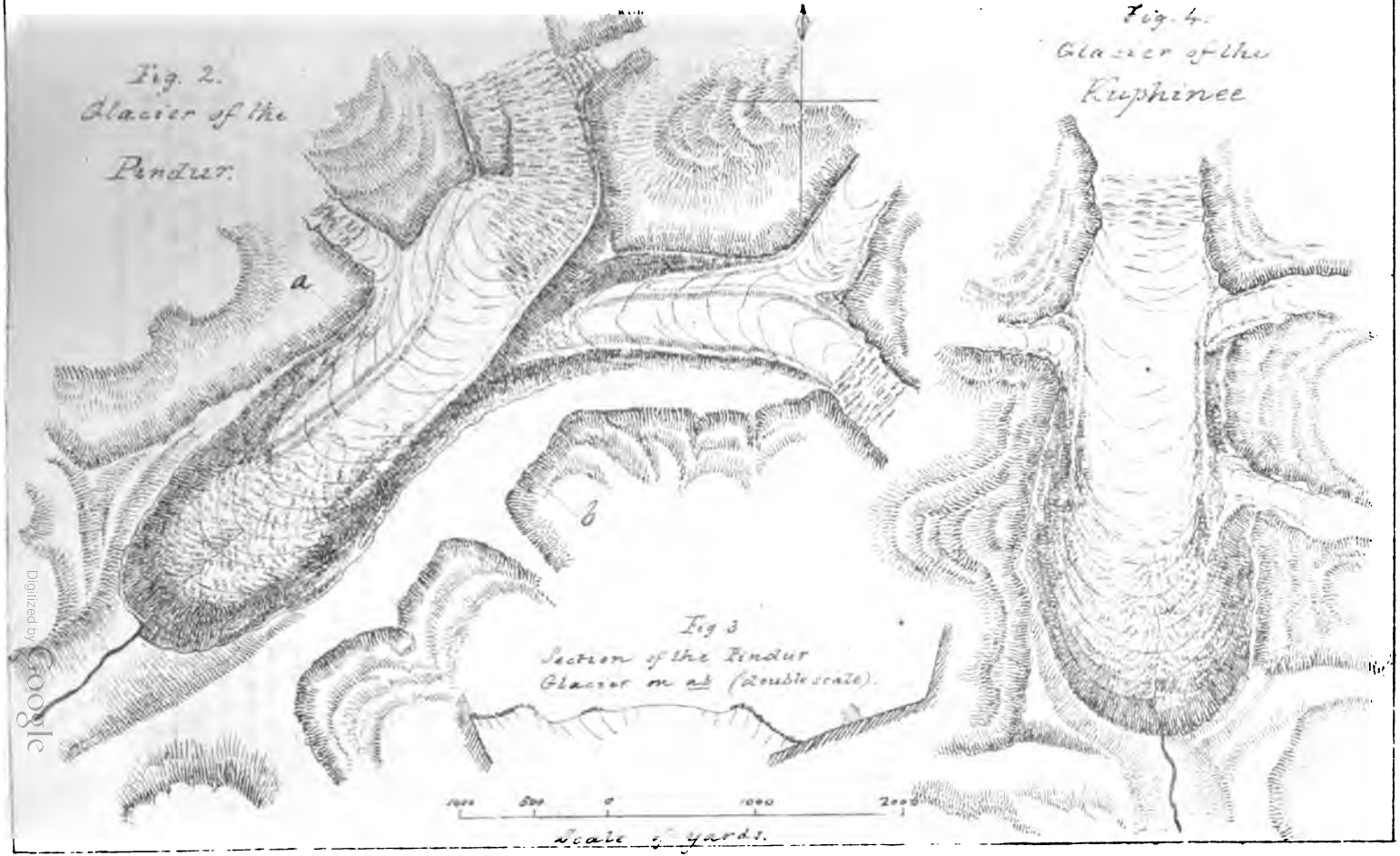


Fig 3
Section of the Pendur
Glacier on ab (double scale).

latter evidently made by the separation of regularly stratified layers. The last thing that might be expected of such a dismal-colored and monotonously rounded hill, is that it should be composed within of the purest ice.

The cliffs that form the immediate bounds of the valley where the Glacier lies, are of no great height; but the mountains of which they are the foot, rise many thousand feet above them, though with much monotony of appearance. Many grassy slopes are still seen considerably above the Glacier; but bare rock and snow much predominate, and are soon left in sole possession of these inhospitable regions. Two peaks* which rise, one to the N. East and the other to the N. West of the valley, probably to a height of 20,000 feet above the sea, are fine objects in themselves, and the frozen snow on their summits shines gloriously in the sun: but they are not sufficient to prevent the general impression from the scene being one of disagreeable monotony, and of desolation complete indeed, but without sublimity.

The Glacier is formed by the meeting of two ice streams, from gorges, one coming from the north-west and the other nearly from the east, which meet about 2 miles above the source of the river.

The feeder from the north-west is larger than that from the east, and its surface is at a considerably higher level, for some hundred yards below their first junction.—It descends with a great inclination, entirely filling the gorge down which it comes, in what Professor Forbes aptly terms a cascade of ice. It assumes the general appearance of a confused mass of irregular steps, which are again broken up transversely into peaks of every shape. The west side of this cascade continues nearly in its original direction, after having passed the point A, (see the sketch) below which the Glacier bends sharply to the S. W., and in this way completely crosses the Glacier. The steps in which it falls however also gradually change their direction, so as to

* The peak on the N. West is the most easterly of the three smaller peaks, which are seen from Almorah below Nunda Devee. That on the N. East, is the point at the end of the range that descends from Nundakot to the North, and appears on its left from Almorah. Between these peaks is the pass called after Mr. Trail, over which he went into Joohar, or the valley of the Goree. It is perhaps rather gratuitous to call this passage a pass, as no one has gone over it since, and certainly never will go unless from curiosity. To the right of the N. E. peak is another depression in the range, over which, I was told Mr. Trail attempted to go but failed.

remain nearly perpendicular to the general current of ice. The transition to the regular level ice is very sudden, and begins much higher up on the west, than on the east side; the sudden change of direction in the Glacier round the point, A, evidently producing much the same sort of effect in breaking the current of ice and giving it a smooth surface, as would have been observed under similar circumstances in running water. Near the foot of this ice fall, (beyond which I did not ascend the Glacier,) the steps were observed to be in the form given in Fig. 5, having their tops considerably overhanging. A small tributary, also descending in cliffs of ice, joins the main Glacier from a ravine on its east side not far above the point A. Beyond it I was unable to see owing to the sudden bend in the glacier's direction.

The feeder from the east is formed by the union of two smaller Glaciers, one coming down from the N. E. the other from the S. E.; the latter is the larger of the two, and descends in ice cliffs to some little distance below the rocky point which intercepted my view of its upper parts. The N. E. tributary is not so steep, its surface as far as I could see being continuous, excepting immediately at its union with the other, where it seems to be a good deal broken up. I did not go on to any of these Glaciers, and describe them as they appeared from the upper parts of the united Glacier.

Another small tributary Glacier also falls into the main one from the N. W., a short distance below the point A. Its inclination is very great, but it perfectly maintains its continuity of structure to the bottom.

The lateral moraine of the west side of the northern branch of the glacier is first seen as it turns the point A, where it shows itself as a black band along the edge of the ice, which in other parts of the fall is quite white. The moraine is small between the points A and the tributary glacier below it; but from this it very rapidly increases, and in its lower parts is a chaos of desolation such as I never saw before. This great addition to the size of the moraine is owing to the quantity of debris brought down by the small glacier, over the lower parts of which stones were constantly rolling on to the upper end of the moraine during the whole time we were near it. We were thus here enabled to see the actual formation of a moraine. The ice below

the junction of this tributary with the main glacier being much broken up by crevasses; rocks and gravel from the moraines on the two sides of the tributary are scattered over the space between them, and the moraines at first sight appear to lose their distinct form; but although there is no clear ice between the moraine that originates on the east of the tributary, and the west side of the glacier, the identity of that moraine is sufficiently marked by its color, and by the regular rise above the general surface of the glacier, of its top, which remains tolerably even for some way down, being beyond the limit of the disturbance caused by the crevasses along the edge of the glacier; about half way down to the lower end of the glacier however, the full action of these crevasses reaches the whole of the moraine, and it is scattered or lost sight of in the general confusion of surface.

An epoch of peculiar destructiveness to the mountains passed by the glacier is marked in one part of this moraine, by an accumulation of huge masses of rock from 20 to 30 feet square, and as much as 15 feet high, and the stones found on it, are generally larger than those on any of the other moraines; the true west lateral moraine below the tributary glacier is not very large, nor is its top much elevated above the bottom of the valley, excepting quite at its end. This is probably owing to the level of the valley on this side being higher, (vide fig. 3,) rather than to the top of the glacier being lower. The bottom of the valley slopes from the cliffs at its sides, inwards. On the east, the edge of the glacier is at some distance from the cliff and the bottom of the valley has dipped considerably where it meets. The foot of the moraine, the summit of which on that side, is high above the valley. On the west side the glacier edge is close to the cliff; the bottom of the valley will therefore be higher. I did not notice any difference of level in the two sides of the valley.

The lateral moraine of the S. E. side of the glacier is very large. Its top rises, on an average, probably 250 feet above the bottom of the valley. Along its foot runs a stream gradually increasing in size, that collects the drainage of the open part of the valley, and of the outer slopes of the moraine. The lower part of this slope is a mass of loose stones and earthy gravel, which rolls down from above, as the face of the ice, which is visible in the upper 50 or 60 feet of the slope, melts and recedes; this process is seen constantly going on. On the

inner side, the top of the moraine is 30 or 40 feet above the level of the clear ice of the glacier.

The upper part of this moraine comes down nearly straight from the point B. The north branch glacier being, as was before noticed, considerably higher than the eastern, the moraine slopes down from the level of the former to that of the latter, forming a deep angular depression under the point B, (when it meets the foot of the north moraine of the east glacier;) that gradually diminishes in depth up to the top of this glacier, which is here entirely covered with debris, the moraines of its two sides being scattered all over it, for some distance above its union with the north or main branch. The appearance produced by this is that the northern branch runs over the eastern, or that the latter runs into the side of the former and is absorbed by it.

The eastern tributary brings down with it moraines which require no particular remark, beyond that already made, viz. that they spread over the whole of its breadth at its extremity.

Besides these lateral moraines, is a medial one, which, similar to several described by Professor Forbes, is first seen as a dirty stripe among the white ice cliffs of the fall at the head of the north glacier. As it comes down the level ice it gradually begins to assume the decided appearance of a moraine, and increasing by degrees at last becomes very large. It continues in a well defined form for some short distance beyond where the western moraine is dispersed; but there it also is scattered over the ice, and the two become blended together and ultimately extend to meet the debris which is similarly dispersed by the eastern moraine from the opposite side of the glacier.

The whole of the moraines in the middle of the length of the glacier, where it is most regular, are very considerably raised above the general surface of the ice, which in some parts is, I should think, as much as 100 feet below the tops of the western and medial moraines. It is not to be supposed that this great elevation is caused to any considerable extent by the mere mass of rocks and rubbish collected in the moraine; it results from the ice below the mass being protected by it from external melting influences, which constantly depress the level of the clear ice beyond the moraine. On the very tops of the moraines pure ice was often seen hardly covered by the stones.

The protection given to the ice by the great lateral moraines, raises

the sides of the glacier so much that a very considerable hollow is caused in its middle, which is a striking feature in the first appearance of its lower extremity.

The ice of which the glacier is composed agrees most exactly in its nature with the Alpine Glacier ice as described by Professor Forbes. It is perfectly pure and clear, but where seen in considerable masses stripes of a darker and lighter bluish green are distinctly visible. It is composed of bands of ice containing small air bubbles, alternating with others quite free from them. In many places the surface presents a striated appearance, arising from the different degrees of compactness of these differently colored bands, and their consequently different rates of melting.

The direction of these colored veins as seen in crevasses, or in the striated surfaces of the ice, follow laws exactly similar to those observed in the Alps. The dip was most distinctly inwards, i. e. towards the longitudinal axis, and upwards, i. e. towards the origin of the glacier, in every part; the stratification being more perpendicular near the head, and more nearly horizontal in the lower parts. The direction of the strata in plan, was also very clearly marked in many parts of the ice, and was plainly in curves, having their branches nearly parallel to the sides of the glacier, and their apices directed downwards; the curvature in the centre not being at all sudden. I no where could perceive "dirt bands."

The crevasses (perhaps owing to my visit having been made somewhat early in the summer) were much less numerous and terrific than I had expected. Although considerable detours were at times necessary in crossing them, I remember no place that I thought dangerous or difficult to pass. They are developed across the direction of the glacier's length along both of its sides, commencing from the small tributary on the west side, and from the union of the eastern glacier on the other;—and continuing almost to the end, those on the west being, I think the largest. They are generally wider towards the edges of the glacier, closing up as they approach the centre. They are nearly vertical, and are directed from the sides upwards, or towards the head of the glacier, those on the west bearing nearly E. and W., those on the east bearing nearly N. and S., thus forming angles of about 45° with the axis of the glacier.

Many pools of water (the Baignoirs of the Alps) were seen on the surface of the ice; some of the largest were said by our guides, who are in the habit of visiting the glacier, to be found in the same place every year. The clear surface of the ice everywhere assumes a more or less undulating form, from the action of the water that drains from it as it melts; and the small streams, into which the drainage collects, end, as in the glacier of the Alps, by falling into some of the crevasses. The remains of the last winter's snow was hardly perceptible on any part of the glacier.

The occurrence of stones standing upon bases of ice (Glacier Tables) above the general surface of the glacier, is common, but all that I saw were small. I also observed what appeared to be imperfect glacier cones, or the remains of them, but these also were small.

The ice of the glacier coming into direct contact with the cliff below the point A, I was enabled to examine the effect produced upon the rocks; I found it covered with grooves or scratches, sloping in about the same direction as the surface of the ice at the spot. These grooves extend to 20 or 30 feet above the present level of the glacier. I also observed, that almost everywhere a space was left between the rock and ice, the latter appearing to shrink from contact with the former. This was of course the effect of the heat of the rock melting the ice. I regret that an attempt that I made to measure the actual motion of this glacier proved ineffectual, owing to circumstances which it is not necessary to detail.

The valley of the Kuphinee, for a mile or two below the end of the glacier, has much the same general character as that of the Pindur, but is more rugged and desolate in appearace. A fine peak of pure snow (probably Nunda Kot, or No.15) is seen from below the glacier, but is lost sight of behind an intermediate point, on a nearer approach.

The direction of the glacier (fig. 4) is almost due N. and South, and the whole breadth of the valley, in its upper part, about $\frac{3}{4}$ mile, is occupied by it. It commences about 2 miles above the river source, in a very precipitous fall of ice. We went up about 200 feet of the lower part of this, much beyond which it would probably have been impossible to ascend owing to the excessive steepness alone. A cliff of ice about 60 feet or 70 feet high rose immediately above the point which we reached. The ice was perfect, with the ribbon structure quite visible; the bands

were very highly inclined, and I think farther apart than in the lower parts of the glacier. The direction of the structural lines was in no degree parallel to the sides of the glacier, but much more nearly perpendicular to them. The precise contrary of this was observed by Professor Forbes under apparently similar circumstances, in the glacier du Taléfre in the Alps.

From the foot of the fall, the surface of the glacier was on the whole very even, though its slope downwards was very considerable. It still had remaining on its upper half a good deal of unmelted snow, which was disagreeable to walk over, as it was seldom strong enough to make us indifferent to what was under it.

The main glacier is joined by two small tributaries on the east, and by one on the west; all are highly inclined and bring down considerable quantities of debris. The moraines are altogether confined to the sides of the glacier, though many small stones are scattered over every part of the ice. Here, as in the glacier of the Pindur, the protection given by the moraines to the ice on the sides raises them greatly, and leaves a deep hollow in the middle of the glacier at its end. The crevasses here also are most strongly marked near the sides, and are inclined at an angle of about 45° from the longitudinal axis, downwards. The structure of the ice is in all respects precisely as was seen in the Pindur Glacier. I am unable to offer any decided opinion as to whether these glaciers have ever varied considerably from their present limits. During the very short period of my visit to these regions, I saw no direct evidence of it. The shepherds who take their flocks to the pastures in the valleys near the glaciers during the summer months, (for there are no fixed habitations within 14 or 15 miles of them,) have no idea of any motion in the glacier, but say that they suppose the ends of them to be gradually receding. Their statements are however of a very vague nature, and as far as I could judge, are founded on their views of what ought to be rather than of what really is. Some very decided change in the state of things is however certainly indicated by the long plateaus, which I before mentioned, running for a mile or two below the present terminations of both glaciers, nearly parallel to the rivers, but several hundred feet above them. I consider it to be impossible, that these level banks above the rivers have been caused by deposits from the ravines in the sides of the

valleys, for such deposits would have had very irregular surfaces; and indeed their present effect in *destroying* the regularity of the plateaus is every where visible. Had the same appearance been noticed in any other part of the river's course, it would at once have been attributed to the action of the water at some former period; and it would have been supposed, that the bed had afterwards been excavated to its present depth. If this was the case, the glaciers while the plateau was forming, must either have terminated considerably higher up the valleys, or have stood altogether at a much higher level; in either of these ways the water could have been delivered at a level sufficiently high to form the plateau. But it may admit of doubt, whether the quantity of water in the rivers, as they are at present, is sufficient to account for such an extent of level deposit, or for such a depth of erosion of their beds; for at this great elevation they are not subject to those violent floods that occur lower down; for nearly half the year too they must be almost inert.

The only other way that occurs to me of accounting for the appearance, is that it has been occasioned by an *extension* of the glacier, and that the level top of the plateau shows the limit to which the tops of the moraines reached, as the glacier gradually receded. From the very cursory nature of my examination of the matter however I am unable to do more than point out the fact, and what possibly may have caused it.

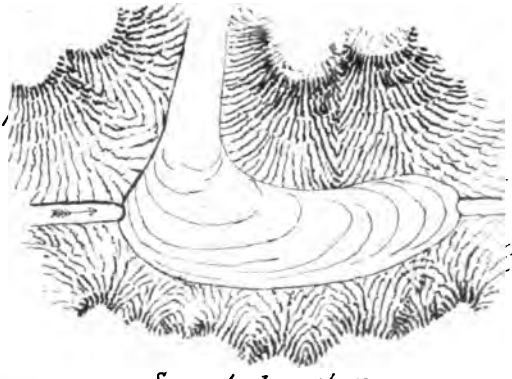
There is another circumstance relating to these rivers which is also worthy of notice, namely, that in the upper 2 or 3 miles of their course their fall is considerably less than in the 2 or 3 miles immediately succeeding those. Thus in the Kuphinee, the average fall in the first 3 miles is about 400 feet, in the next 4 miles about 650 feet per mile; but as the average is only about 160 feet for the next 8 miles, it is highly probable that the fall in the 4th and 5th miles will be considerably greater than in the 6th and 7th. I therefore infer that it is quite possible that the fall in the 4th and 5th miles may be as much as 800 feet per mile, or even more; which the appearance of the rivers would fully justify.

Smaller extensions of the glacier of the Pindur were visible in many places. They were marked by mounds of a rounded form, covered with grass, projecting from the modern moraines in a curved direction concave to the glacier. I did not remark them at the Kuphinee.

fig 5

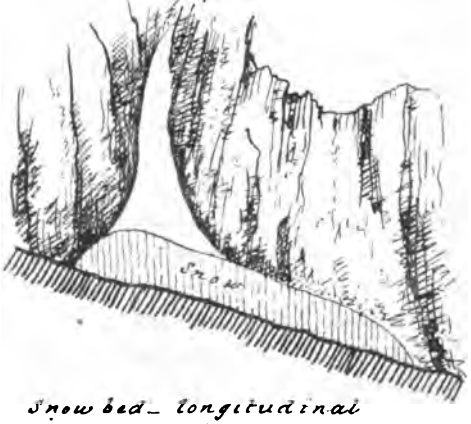
Section of ice-cliffs at head of Pindur Glacier

fig 6



Snow bed – plan

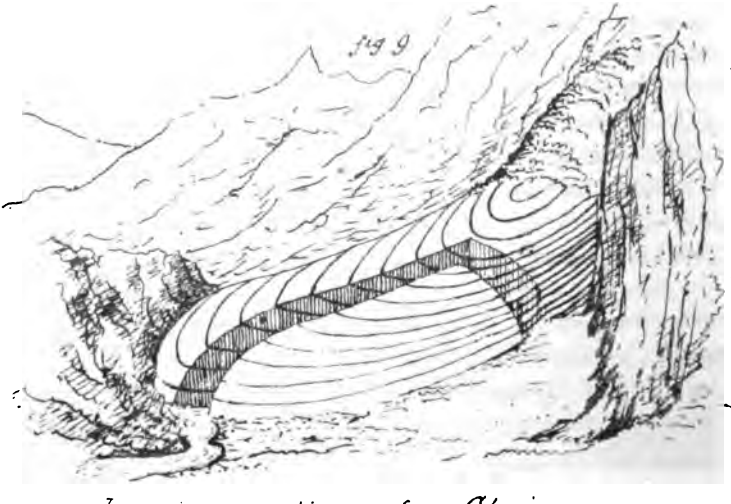
fig 7



Snow bed – longitudinal section.

fig 8

Snow bed – transverse section



Imaginary sections of a Glacier.

I would here observe, that in this climate, where we are subject to periodical rains, persons should be cautious in concluding that piles of rocks in long lines are moraines, even though their edges are in no way water-worn. On both of these rivers I saw many instances of such heaps of rocks, which might very easily have been thought moraines; and though from their immense extent, and the great size of the blocks they contain it is not easy to believe that they have been formed by the action of water, more particularly as the rocks have perfectly sharp edges and as there is often no appearance of water ever having been near them; yet they have certainly been brought down by torrents and may be easily traced up to ravines in the mountains.

The term snow-bed having been hitherto applied by travellers in these mountains, (with one exception†) both to true glaciers, and to mere beds of unaltered snow. I will shortly explain what is meant by it when used in the latter, which is the correct sense. In many parts of the higher valleys, real beds of snow lie far below the limit of perpetual snow for the greater part of the year, and some would probably be permanent at very low elevations were they not destroyed by the rain during the rainy season. These snow beds are formed by avalanches, as is sufficiently proved by their form and position. Figs. 6, 7 and 8, represents one on the Kuphinee river, which occurs at an elevation of about 10,800 feet.

It came down from a ravine, and entirely covered the river which flowed under its whole length. The snow extended but little beyond the upper side of the ravine, but was prolonged far down the river on the lower side. Its surface was marked by curved hills, as is shown in the sketch. This is evidently precisely the form that would be assumed by snow falling down the ravine into the river. The slope of the river bed being great, the avalanche would naturally continue its course down it, after having filled the channel immediately in front of the ravine. The fall of an avalanche in the upper part of this valley gave me an opportunity of seeing the motion of loose snow in large masses; it was very similar to that of a fluid body, the snow appeared rather to flow than to fall. So here, the snow descending through the ravine, gradually filled the river channel; the main supply moving with the greatest

* I allude to Major Madden, who has given a short account of the glacier of the Pindur in a late number (176) of this Journal.

velocity down the middle, but sending off, all along it as it went on, particles to the sides. Its head would therefore advance in a convex curve, as the central particles moving directly forward, would always keep in advance of those that spread out to the sides. The end of the snow bed thus takes the curved form shown in the figure, and a succession of smaller avalanches, would mark its surface with numerous curves of the same sort.

In the last two miles of the approach to the Kuphinee glacier, we crossed two snow-beds, both of which were upwards of ¼ of a mile wide, and extended from the ravines in which they originated, right across the valley from side to side, entirely covering up the river.

The surface of many of the snow-beds has a sort of rippled appearance, caused by the protection given by grass and leaves blown upon the snow to the parts immediately under them. The snow itself is generally firm, and receives but a slight impression from the foot of a man walking over it.

I have estimated the heights of these glaciers from observations of the boiling point of water as follows; the results will certainly be within 500 feet of the truth.

	Ft. above the sea.
Lowest point of the glacier of the Pindur and source of the river	11,300
Surface of the glacier at the commencement of smooth ice...	12,000
Lowest point of the glacier of the Kuphinee and source of the river	12,000
Surface of the glacier at the commencement of smooth ice ...	13,500
Diwalee, union of the Pindur and Kuphinee	8,200

The limit of perpetual snow here being about 15,000 feet above the sea, in the one case the glacier comes down 3700, and in the other 3000 feet below it. At the Kuphinee glacier, a mass of Rhododendron companulatum, a shrub 6 or 8 feet high, was growing within 30 yards of the ice. There were no shrubs of any size at the Pindur glacier, but grass and flowers were at both places flourishing considerably above the level of the ice.

Having now concluded the record of my own observations on the two glaciers seen by myself, I will add two extracts from the Journals of travellers in these mountains, which most clearly prove the existence of two other glaciers, both of great size, one at the source of the Bha-

giruttee or Ganges, the other at that of the Goree, which is one of the main feeders of the Kalee or Gogra. The first extract is from a journal, by Capt. Hodgson, of a visit to the source of the Ganges, in the year 1817. (Asiatic Researches, No. XIV. Qu. pp. 117—128. Capt. Hodgson thus describes the first appearance of the glacier from which the rivers rises.

"The Bhagiruttee or Ganges issues from under a very low arch at the foot of the grand snow-bed,"—"over the debouche the mass of snow is perfectly perpendicular, and from the bed of the stream to the summit we estimate the thickness at little less than 300 feet of solid frozen snow, probably the accumulation of ages;—it is in layers of some feet thick, each seemingly the remains of a fall of a separate year. The height of the arch of snow is only sufficient to let the stream flow under it."

He ascends the glacier—"This vast collection of snow is about 1½ miles in width, filling up the whole space between the feet of the peaks to the right and left; we can see its surface forward to the extent of 4 or 5 miles or more"—"general acclivity 7°, but we pass small hollows in the snow caused by its irregular subsiding; a very dangerous place, the snow stuck full of rubbish and rocks imbedded in it. Many rents in the snow appear to have been recently made, their sides shrinking and falling in." "Ponds of water form in the bottom of these."

"It was remarked above, that the snow of the great bed was stuck, as it were, with rock and rubbish, in such a manner, as that the stones and large pieces of rock are supported in the snow and sink as it sinks; as they are at such a distance from the peaks as to preclude the idea that they could have rolled down to their present places, except their sharp points had been covered, it appears most likely" that they came down like snow balls with avalanches. "It is not easy to account for the deep rents which intersect this snow-bed, without supposing it to be full of hollow places." The source of the Ganges is stated by Capt. Hodgson to be 12,914 feet above the sea.

The next is an extract from a journal of Lieut. Weller, printed as a note to a journal of Capt. Manson's, Journal Asiatic Society, No. 132.

"I went to see the source of the Goree river, about a mile N. W. from Milum. The river comes out in a small but impetuous stream, at the foot of apparently a mass of dirt and gravel some 300 feet high,

shaped like a half moon. This is in reality a mass of dark-colored ice (bottle-green color), extending westward to a great distance, and covered with stones and fragments of rock, which in fact form a succession of small hills. I went along this scene of desolation for a long space, but could not nearly reach the end. Here and there where circular and irregularly shaped craters (as it were) from 50 to 500 feet in diameter at top, and some of them 150 feet deep. The ice was frequently visible on the sides, and at the bottom was a dirty sea-green-colored pool of water, apparently very deep. The bases of the hills on either side, and frequently far up their faces, are one succession of landslips; but from their distance, I do not believe it possible that the debris in the centre of the snow-bed valley, can have fallen there from the side hills." Lieut. Weller also says of the same glacier in his journal published in the Journal Asiatic Society, No. 134:—"The mass of desolation, as described at the source of the Goree, continues thus far up—that is about 4 miles, and how much farther no one will or can tell me. The fissures hereabouts are narrow, instead of being crater-like, and the ice when visible is more nearly the color of snow. On the opposite (south) side, huge accumulations of ice and gravel are to be seen in the openings between the hills;—once on either side, I had a view of the old ice high upon the hills; its light sea-green color, with strongly defined and fantastical lines of shape (castles, stairs, &c.) formed a very pleasing and grand appearance." This glacier is known to be 6 or 7 miles long; its lower extremity is at 11,600 feet above the sea.

In the published journals of travellers in the Himalaya, that I have seen, I have not met with any other accounts of glaciers sufficiently distinct to be worth quoting, though we not unfrequently come across a snow-bed that seems suspicious. I am however fully satisfied of the *actual existence* of many other glaciers, both from the verbal accounts of Mr. Batten, who has been a resident in Kumaon for many years, of my brother, Mr. H. Strachey, who visited several of the passes into Tibet last year, and of the Bhotias (the natives of the valleys immediately below the snowy ranges), and from having myself had distant views of several.

From these sources I am able to affirm positively, the existence of glaciers at the heads of the following rivers;—viz., the Vishnoogunga (near Budrinath); the Kylgunga, the Koourgurh, the Soondurdoonga,

all rising from the southern side of Tresool and Nunda Devee; the Ramgunga (that which falls into the Surjoo, not the great river of the same name); the Piltee, an affluent of the Goree; and the Gonka which rises near the Oonta-doora or Joohar pass into Tibet.

I therefore conclude, that in the Himalaya, as in the Alps, almost every valley that descends from the ranges covered with perpetual snow, has at its head a true glacier; and in spite of M. Elie de Beaumont's ingenious fact, that the seasons here "have no considerable variations of temperature," and that "the thaw and frost do not separately penetrate far enough to convert the snow into ice;" I am of opinion, that the very great intensity of all atmospheric influences, including variations of temperature, should render these mountains one of the most favorable fields for the investigation of glacial phenomena.

APPENDIX.

A short account of the principal Phenomena of Glaciers, abstracted from chapters 2, 8 *and* 21 *of Professor Forbes' Travels through the Alps of Savoy, &c.*

Perpetual Snow.—The atmosphere becoming colder as we ascend in it, the tops of mountains that are more than a certain height above the level of the sea, are always covered with snow;—this height is greatest at the equator, where it is about 16,000 feet, and gradually diminishes towards the poles, where the natural covering of the earth is ice and snow.

Snow Line.—The snow line is an imaginary line passing through those places, at which the snow which falls in one complete revolution of the seasons, is just melted in that time, and no more.

Glaciers.—The common form of a glacier is a mass of ice, that extends from the region of perpetual snow, into the lower valleys, which are clothed with vegetation; and that sometimes even reaches to the borders of cultivation. The snow line on the glacier, is somewhat lower than *on* neighboring parts of the mountains; but below it, the snow is melted and disappears from the surface of the ice, as regularly and entirely, as from that of the country into which the glacier descends.