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THE STUDY OF THREATENING GLACIERS: *A paper read at the Afternoon Meeting of the Society on 19 November 1934, by*

PROFESSOR KENNETH MASON

THE present paper is the outcome of an intermittent study of the movement of glacier snouts lasting over more than twenty years. It is intended primarily to summarize what we have learnt from the movements of glaciers in the neighbourhood of the Karakoram, and it is hoped that it will lead to a useful discussion by those who have studied glaciers in other parts of the world. I also hope to show how necessary it is to carry out further observations and research before it is possible with any certainty to lay down the laws that govern glacier movement.

It was in 1910, on my first visit to Kashmir, that the late Sir Henry Hayden, then Director of the Geological Survey of India, interested me in glacier movement; and from that year till now I have endeavoured to collect information and reports, tried to interest travellers in Himalayan and Karakoram glaciers, and studied their reports in conjunction with previous accounts.[1] It is not the normal flow of the ice-stream in a glacier that I intend to discuss. It is of course well known that the velocity of the ice-stream is dependent on various topographical factors, such as the general slope of the land surface, and in particular the volume of accumulated ice to be carried away from the feeding ground. Such ice-stream velocities vary from an inch to perhaps (though I doubt it) as much as 60 feet a day, according to text-books, and they are not constant in different parts of the glacier, nor at different seasons. This flow of ice is however a condition of all live glaciers, and it only ceases at the snout, where the supply of ice by flow is balanced by the sum total of destructive agencies, such as melting, evaporation, radiation, etc. It is therefore obvious that if either the volume of ice in the feeding-ground is altered, or if the destructive agencies at the snout are changed, there will be a variation in the snout position. Conversely, it would appear that measurements of snout variation should give some indication of climatic change. This is the theory underlying the projects that have been carried out during the last forty years of glacier snout measurement.

In attempting to investigate the results of measurements we may resolve the total movement of a snout into four possible components: (1) Secular, (2) Periodic, (3) Seasonal, (4) Accidental.

Secular change is the name given to changes distributed over long periods of time, due to world causes which overrule local factors of climate, weather, and topography. The retreat of glaciers since the last ice-age is a secular change.

Periodic change is the name given to changes believed by some to be due to climatic or weather cycles, such as the Brückner cycle, of comparatively short duration, say thirty-five years. To prove it, all glaciers in a given region should have the same period of advance and retreat. I may perhaps say at once that the Karakoram and Himalayan glaciers that have been studied show no

[1] A preliminary study of thirty-four Karakoram glaciers by the author of this paper appeared in the *Records of the Geol. S. of India*, vol. 63, pt. 2, pp. 214–278.

evidence whatever of any regular periodic change common to all that agrees with the periodicity of any supposed weather cycle.

Seasonal change is the name given to the changes between different seasons of the year. This is of considerable importance in India; and failure to appreciate the immense difference between the conditions of winter, when ablation is almost completely absent at the snout, and those of the months July, August, and September, when every factor of ablation is at a high maximum, has led many observers to false conclusions when applying observational tests of snout movement that may be applicable to glaciers in higher latitudes. In the Karakoram and Himalaya, unless a glacier is advancing strongly, we must expect to find some signs of degeneracy of the snout in August, but they do not necessarily denote retreat; and we must expect to find a more upstanding ice-front in winter, though active advance, other than a small seasonal one, is not necessarily indicated.

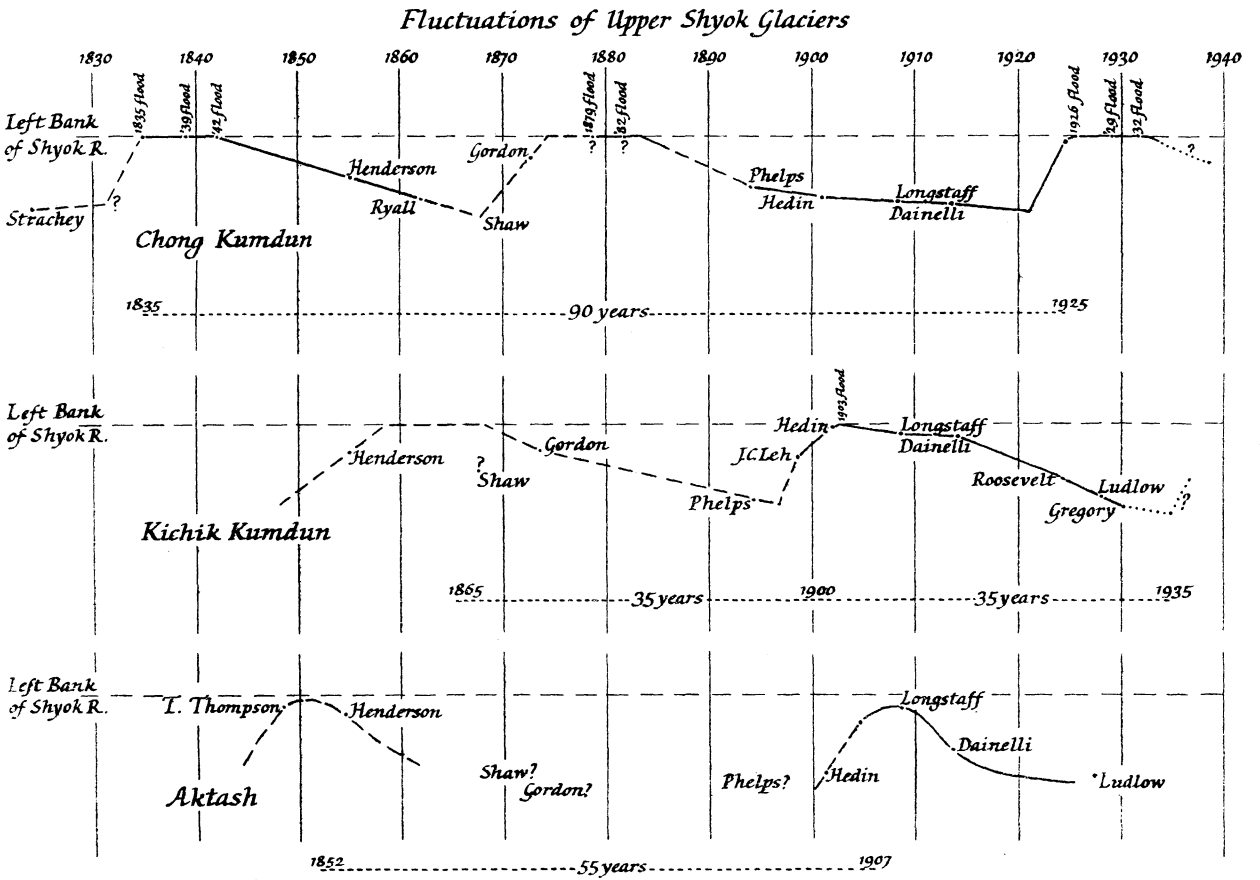
Accidental change in a glacier snout is the component of movement under which we group all other movements that cannot be resolved into either secular, periodic, or seasonal. It is this component that I now intend to discuss. Generally speaking I do not think that any other of the movements that I have mentioned are responsible for any of the major blocks of river valleys that have occurred in the past; such movements are slow, and rivers can be expected to keep a clear channel. With "accidental" movements, the advance of the snout is often extremely rapid, so rapid that a large valley becomes completely blocked, a great lake several miles long is impounded, and a great flood may occur when the waters are let loose.

I propose first to give a brief history of the movements of the following glacier-snouts, pointing out any special peculiarities possessed by each: the Chong Kumdun and the Kichik Kumdun glaciers of the upper Shyok; the Hasanabad, the Minapin, and the Yengutz Har of Hunza and Nagar; and the Karambar glacier of the Ashkuman district of the Gilgit Agency. I may also refer, if I have time, to evidence exhibited by other glaciers, such as the Kyagar and the Lungmo-che glaciers, which I have studied but the history of whose movement is not known.

The Upper Shyok glaciers

In an appendix to his paper read before this Society in 1910, Dr. Longstaff called attention to the positions and movements of the glaciers of the upper Shyok.[1] I found Dr. Longstaff's researches of very great value, and using them as a basis to work upon, carried them further. The collection and study of the history of these glaciers was a fascinating occupation. In the old volumes of the *Journal* of the Asiatic Society of Bengal I found the controversies that raged round the causes of the great Indus floods of 1841 and 1858, when so little was known of the detailed geography of the Gilgit district or of the mountain neighbourhood of the upper Shyok. It was absorbing to sift the evidence collected by men like Vigne, Alexander Cunningham, Henry Strachey, Becher, Falconer, Drew, Abbott, Henderson, Montgomerie, and Godwin-Austen, some of them ranged on one side of a controversy, some on the other. There were reports of floods in the Indus valley in the years 1826,

[1] *Geogr. J.*, vol. 35, p. 641 (1910).


Fluctuations of Upper Shyok Glaciers
1830
1840
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1835 flood
39 flood
42 flood
1879 flood
82 flood
1916 flood
29 flood
32 flood
Left Bank of Shyok R.
Strachey
Chong Kumdun
Henderson
Ryall
Gordon
Shaw
Phelps
Hedin
Longstaff
Dainelli
1835
90 years
1925
Left Bank of Shyok R.
Kichik Kumdun
Henderson
Shaw
Gordon
Phelps
Hedin
1903 flood
J.C.Leh.
Longstaff
Dainelli
Roosevelt
Ludlow
Gregory
1865
35 years
1900
35 years
1935
Left Bank of Shyok R.
Aktash
T. Thompson
Henderson
Shaw?
Gordon?
Phelps?
Hedin
Longstaff
Dainelli
Ludlow
1852
55 years
1907

1833, 1835, 1839, 1841, 1842, 1844, 1855, 1858, and 1865, almost all attributed by one writer or another to the bursting of the Shyok glaciers. In investigating the reports of these ten floods, I came to the conclusion that two were due to errors in date and are identical with others, two were due to blocks formed by landslides and not by ice, two were due to glacier blocks in the Gilgit Agency, and one to a small glacier block or landslide, probably the latter, near Gol on the Indus. Three floods only can be identified as definitely due to the upper Shyok glaciers, namely that in 1835, which was catastrophic, that of 1839, "of much less extent" according to Sir Henry Strachey, and that of 1842, which was small.[1] In recent years we have been able to investigate the upper Shyok glaciers in considerable detail. Dr. Longstaff and Major D. G. Oliver took a series of photographs of the Aktash, Kichik Kumdun, and Chong Kumdun glaciers in 1909; and another valuable series was taken by Professor Giotto Dainelli in 1914. In the winter of 1924–25 the Chong Kumdun glacier formed a complete block across the Shyok and impounded a lake upstream of it; this lake was released in October 1926 with catastrophic effects. The following winter the dam reformed and impounded another lake; this was released on 15 August 1929. Again the glacier healed its wounds during the next winter to impound a third lake. This lake was discharged on 10 July 1932, after considerable percolation during the preceding day. Besides Dr. Longstaff's and Professor Dainelli's photographs we have about forty photographs taken in 1928, 1929, 1931, and 1932 by Messrs. Ludlow, Gunn, Captain Gregory, and Mr. Durgi. The receipt of these during the course of investigation combined with our previous knowledge of the glacier's behaviour enabled us to forecast the future with very considerable accuracy. There is no doubt in my mind that in 1909 the Chong Kumdun glacier was in a fairly advanced condition of degeneracy, and that in 1914 it was more so. This state is shown by the comparatively low surface of the glacier, by the hummocky, black appearance of the surface, and by the fact that the glacier failed to reach even the right bank of the Shyok at any point. Dr. Longstaff's and Professor Dainelli's photographs show the Kichik Kumdun very different from the Chong Kumdun. From both downstream and upstream the extremity shows a broad high wall of ice stretching across the river-bed, under which the Shyok river escaped by means of a tunnel. The surface was much broken up by pinnacles. We know that throughout the nineties of last century this glacier was well clear of the river and that it advanced to the river-bed in 1899, finally blocking the river in the winter of 1902–03 and causing a minor flood the following summer.

In 1925, when the Chong Kumdun glacier had advanced to block the Shyok, the Kichik Kumdun was found to be greatly degenerate, and offered no obstacle to movement. Mr. Ludlow's photographs of 1928 and 1929 show comparatively low, detached ice-pinnacles at the snout and long bands of surface moraine covering the greater part of the last 2 miles of the glacier surface, a very different state of affairs from that of 1909 or 1914. On the other hand the Chong Kumdun showed every sign of active rejuvenation, and not

[1] I must refer those interested in the evidence and description of these floods and the location of the blocks that caused them to my paper in the *Himalayan Journal*, vol. i, p. 13, where I have given references.

till I received the photographs of 1929 could I detect any sign of incipient degeneration. Degeneration on the Chung Kumdun is more marked in the photographs of 1931, though it is still in its early stages, and I believe that it is now sufficiently degenerate to cause no further anxiety for some time to come.

Before leaving these two glaciers I must call attention to the close similarity of the three floods in 1926, 1929, and 1932 to those of 1835, 1839, and 1842, both as regards date and nature. Though I realized the possible repetition of the early events in 1928 and called attention to this likelihood before the flood in 1929, I tried to keep my examination of the data free from any bias. I also had the records of river-levels at Attock searched for other evidences of floods, with most interesting results. In August 1879, and on 29 July 1882 the river at Attock showed abnormal rises above normal summer flood-level: 28·72 on the first occasion, 33·82 on the second. The height for the Shyok flood of August 1929 is 28·75. From 1873 to 1889 I can find no record of any traveller having used the valley route of the upper Shyok. It may of course be coincidence that these two flood rises of 1879 and 1882 are so similar to those of recent years, that they occurred at a period when the Shyok was probably blocked, and that this period is almost exactly halfway between the periods 1835–42 and 1926–32. On the other hand there does seem to be some justification for supposing that the Chong Kumdun for some reason advances and blocks the Shyok valley at periods approximately forty-five years apart and remains a danger for the next eight or nine years.

The Kichik Kumdun also seems to fluctuate in a similar manner, but at present we cannot indicate a regular interval between the advances with any certainty. We have some important evidence in 1869 and 1873, but it is not enough, even if we could be absolutely certain that the Kichik Kumdun is the glacier referred to. In July 1869 Mr. R. B. Shaw found that the glacier pressed up against the great cliffs on the left bank, while one of his guides had passed the snout by the river-bed in April. In 1873 Colonel Gordon and other members of the Forsyth Mission found "a perfect wall of ice rising from the water about 120 feet and showing a surface covered with countless pinnacles and points." I believe these both refer to the Kichik Kumdun and that some time between 1862 and 1869 the glacier advanced to the river-bed; in this case the interval between the two advances is about thirty-five years, and if it is to be repeated another advance is already due or overdue. It is therefore most important that the Kichik Kumdun should be visited next year.

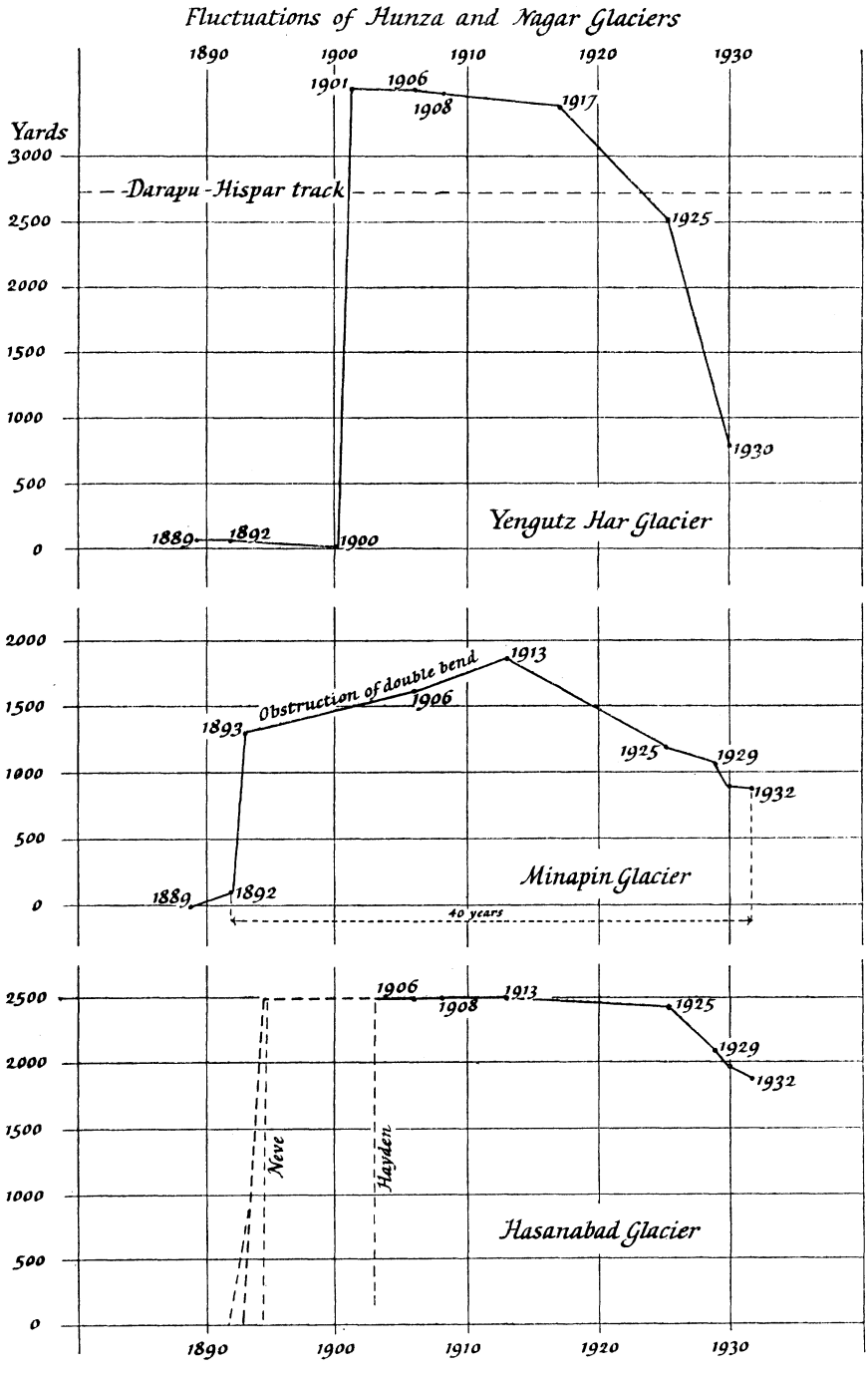
I should perhaps stress the fact that when the Chong Kumdun is advancing, its neighbour the Kichik Kumdun is degenerate and *vice versa*. The movements therefore must be, in my opinion, independent of local climatic causes, or at any rate, mainly due to properties possessed by each individual glacier. These two glaciers are in uninhabited regions, and no one has seen them actually moving forward. Slow movement forward between April and July has been recorded at the extremity of the Kichik Kumdun after both its advances, but it appears that the major part of the advance of the ice had already taken place and that the final movement was in the nature of settlement and spread of the snout.

The Hunza and Nagar glaciers

I am now going to discuss the movements of three most interesting glaciers in Hunza and Nagar, the Minapin, the Hasanabad, and the Yengutz Har. The Minapin glacier has been known to us for forty-five years, if we can believe the small reconnaissance map of Surveyor Ahmad Ali Khan dated August–September 1889. I see no reason why it should not be substantially correct. We then have Lord Conway's map of 1892 and Surveyor Khan Sahib Abdul Gaffar's in 1893. Hayden marked the position of the snout in 1906 and photographed it. I did the same in 1913, Visser in 1925, and officers of the Gilgit garrison, Mr. H. Todd and Captain Wooldridge, have visited it in 1929, 1930, and 1932.[1] The observations prior to 1906 must be accepted with reserve, but they seem to indicate either a slight advance or a position of stability between 1889 and 1892, when a rapid advance of about 1200 yards seems to have taken place. In 1906 the snout was apparently 300 yards in advance of its position of 1892, giving an annual average between 1893 and 1906 of 23 yards. Exact measurement in 1913 showed the snout a further 700 feet advanced since 1906, giving an annual average of about 33 yards. Unfortunately we do not know the year or position of its maximum advance. In 1925 the Vissers found it about 650 yards farther back than I marked it in 1913, in a position intermediate between its 1892 and its 1893 positions. Instead of the active end that I saw, the Vissers record "an insignificant narrow strip of ice, buried beneath rubbish" with the characteristic U-shaped trough valley deeply cut, with polished walls below the decrepit snout. In 1930 Todd recorded that the snout was still more attenuated and some 300 yards farther back from the position recorded by the Vissers; while Wooldridge in 1932 recorded still further degeneration, with the miserable tongue almost severed from the trunk still higher up. There are topographical features of its lower valley, particularly a great double bend with a protruding rock buttress, which may have checked the first rapid advance. But forty-two years have now passed since this glacier last began to come forward. It is of the utmost importance that it should be examined yearly now that it is so decadent.

The Hasanabad glacier is often quoted, though sometimes rather sceptically, as one which has advanced a great distance within a short time. There is no reason to doubt the rapidity, though the date is uncertain. In 1889 Ahmad Ali Khan showed the snout of this glacier about 6 miles back from the road crossing of the Hasanabad ravine. Lord Conway's map of 1892 shows the Hasanabad nala dotted, so presumably he did not survey it, though he shows the glacier about 8 miles from the crossing. Abdul Gaffar's plane-table shows the glacier in 1893 only 2 miles from the crossing. In 1895 Dr. Arthur Neve learned from native sources that the ice had advanced 2 miles that year and from 4 to 5 miles the preceding year. In 1906 Hayden was told that the glacier had advanced a distance variously estimated from 6 miles to a day's march in 1903. It is difficult to get at the truth, but some facts stand proved. All accounts, in 1895, 1906, and 1913, agree that advance was as much as about 6 miles in one winter and spring, that irrigation channels taking water from far up the glacier were thrown out of action by the advance, and that fields were left barren. I believe

[1] Details are given in the *Himalayan Journals*.


Fluctuations of Hunza and Nagar Glaciers
Yards
3000
2500
2000
1500
1000
500
0
1890
1900
1910
1920
1930
Darapu-Hispar track
1889
1892
1900
1901
1906
1908
1917
1925
1930
Yengutz Har Glacier
2000
1500
1000
500
0
1889
1892
1893
Obstruction of double bend
1906
1913
1925
1929
1932
40 years
Minapin Glacier
2500
2000
1500
1000
500
0
1906
1908
1913
1925
1929
1932
Neve
Hayden
Hasanabad Glacier
1890
1900
1910
1920
1930

Phot. Giotto Dainelli

1. Degenerate Chong Kumdun Glacier in 1914, showing free passage of river past snout and active condition of tributary glacier

Phot. Capt. C. E. C. Gregory

2. Chong Kumdun dam from above the lake, 15 July 1931; old lake levels in right foreground

3. Snout of the Juncal–Plomo Glacier, January 1910 (compare Plate 3 in Mr. King's paper, vol. 84, October 1934)

Phots. Dr. Reichert

4. Nevado del Plomo and Cerro I, January 1910 (compare Plate 1 in Mr. King's paper)

myself, though without definite proof, that the advance recorded by Hayden refers to the same advance recorded by Neve, and that it occurred in the winter of 1892–93, for the position marked by him is roughly 7 miles in advance of Lord Conway's position in 1892 and almost exactly 1 mile (1750 yards) from the position shown on Abdul Gaffar's map of 1893. In 1908 the Workmans reported no change from the 1906 position; and in 1913 my photograph, taken from the same spot marked by Hayden, showed no appreciable change. We know quite definitely that since that date the ice has very gradually degenerated and that the end is now about 600 yards farther back from its most advanced position. Forty-two years have passed since this glacier last started to advance. Is it a coincidence that it began its advance during the same year as the Minapin? If so, why was the Minapin's advance so protracted and that of the Hasanabad so sudden? And why has the Minapin become such a miserable specimen of a glacier while the Hasanabad is still far from miserable, though now deteriorating fast? It seems to me that only local topography can account for these differences of movement.

Of all the glaciers in this region perhaps the most exciting is the Yengutz Har. In 1889 a reconnaissance sketch by Ahmad Ali Khan showed the track between the villages Darapu and Hispar as crossing the gorge of the Yengutz over $1\frac{1}{2}$ miles north of the glacier snout. Three years later it was roughly at the same point, and Lord Conway, in 1892, wrote: "A deep nala . . . divides Darapu and Hispar. In its bowels some half a dozen mills find a footing. The path goes round by these and mounts to the fair fields of Hispar." In 1906 Hayden called attention to an advance: "Now the path," he wrote, "instead of descending, climbs arduously over a steep mass of black and slippery ice, the mills are gone, and their ruins hidden under the snout of the advancing glacier." The Vissers made no mention of this interesting glacier in 1925, but when I examined Khan Sahib Afraz Gul's survey made that year I noticed that the path was again shown as crossing the gorge some distance north of the snout. The glacier had therefore degenerated considerably. In November 1930 Captain Berkeley, of the Gilgit garrison, visited the glacier, whose snout he found after "an arduous climb of at least two miles" at about 13,000 feet, 2000 feet higher than its position in 1906. Berkeley recorded that the ice showed great deterioration and was difficult to identify, and he added these significant words: "Judging from the enormous amount of ice clinging to the almost perpendicular mountains which hem this glacier in, I should think that it is subject to frequent ice-avalanches." Is it possible that *frequent* is hardly the correct word, and that the surrounding mountains are preparing a bombardment of the valley below and so may create the conditions in the névé region for another onrush to the fair fields of Hispar? I think that there is every prospect of this and that the danger is not far distant, if it has not already occurred. As regards the rapidity of the last advance about 1903, I cannot resist quoting the circumstantial account of it given to Berkeley in 1930 by an old villager:

"The glacier was above where the present snout is. One day when the crops were about a hand's breadth high [*i.e.* May] we noticed that the water in the irrigation channels was very muddy and was coming down in greater quantity than usual. We went up the nullah to see what had happened and saw the

glacier advancing. It came down, like a snake, quite steadily: we could see it moving. There was no noise. At the same time water and mud gushed out from the ice while it was still advancing and flooded our polo ground and some fields. When an obstruction got in the way the ice went round it at first and then overwhelmed it. The ice was not clear, but contained earth and stones. All our mills and water-channels were destroyed. The ice continued to move for eight days and eight nights and came to a stop about forty yards from the Hispar river. As soon as the ice stopped, the mud and water, which had been coming out higher up, stopped too. The ice remained down for fifteen years, during which time one man to each house remained in the village. All our cultivation was spoilt and we could not bring another water-channel to our fields while the glacier was below them. The Mir fed us. Twelve years ago [1918] the ice began to go back. Each day a length of about fifteen yards would break off from the main ice and was washed away by the water. And once again water commenced to flow out of the glacier above the village, and we were able to make another water-channel. The ice continued to go back until about three years ago [1927] when it stopped where it is now."

Fantastic as it may seem, I believe that this report is substantially true, allowing for a certain descriptive licence natural to a completely uneducated villager speaking from memory. Hayden was there in 1906 and recorded the recent advance. He noted the desolation and hazarded a guess that the advance had occurred in 1901. After twenty-seven years or more a villager gives the date of the occurrence as 1903. I believe also that the rapidity of advance is also substantially correct, though perhaps not all the picturesque details. If so, this glacier must have come forward something in the nature of 3 miles in eight days, and I believe that nothing will stop it from doing the same again. There are many stories of rapid advance of glaciers in the Himalaya, where the snouts come down low enough to reach ground that is inhabited all the year round, as is the case with these glaciers in Hunza. The Minapin and the Hasanabad snouts, when advanced, descend as low as 7050 and 7290 feet respectively. One need not credit all the lurid details, such as those given of the Garumbar, which is said to have overwhelmed two old ladies fleeing before it; but I am convinced that there is plenty of evidence in support of extremely rapid advance where local topography permits it, and I believe that such rapid advance generally occurs during the late winter or early spring, owing to the accumulation of unstable ice unfettered by ablation during the preceding months, and to the rise in temperature assisting melting along shear planes roughly parallel to the bed.

These three glaciers are not dangerous to the inhabitants farther down the great valleys they serve, as is the Shyok, because even during their most extended advance they do not reach the main valleys, but the study of them can throw considerable light on the sudden movements of glaciers that are dangerous.

The Karambar glacier

I am only going to mention one other of these threatening glaciers, and that briefly. This is the Karambar glacier of the Ashkuman district in the Gilgit Agency. The details are not very certain because there are apparently two

glaciers that may project into the valley and the names used by travellers are not consistent. It is however significant that the native name of the one that causes most of the trouble is *Chhatiboi*, which, in Khowar, means *There will be a lake*. Colonel Lewis records that in Chitral there is another glacier also called *Chhatiboi*, and that this also blocks the valley below it. We owe our first information regarding blocks in the Ashkuman district to Drew. Hayward also stated that this region was the source of flood trouble, while records kept at Gilgit since the establishment of the Agency locate the origin of certain floods in the Ashkuman valley. My later information is from Mr. Todd, the late Political Agent at Gilgit, and from Dr. Longstaff, who was up the valley in 1916. Recent block dates for this valley are probably 1891–92, 1904–05, and 1929–30, giving intervals of approximately thirteen and twenty-five years. Dr. Longstaff supplied the information that he found the Karambar at its maximum advance in 1916 also. Taking into account a flood attributed by Drew to this same cause in 1865 and Dr. Longstaff's observations, we get intervals of 26, 13, 12, 13. It is, I am afraid, too much to hope for any evidence for the years about 1878, since the British Agency was not established at that date. But how comforting it would be to know that there was also a block in that year, so that we could establish the intervals 13, 13, 13, 12, 13!

I have drawn the following conclusions from a study of these and other glaciers: (1) Substantial advance follows an interval of considerable degeneration. (2) The rate of advance is governed by topography and not by climate. Advance is likely to be very rapid and long in steep, narrow, smooth-walled valleys, but the rate may be quickly checked by obstructions, and advance may then proceed more slowly. (3) After advance, the ice takes some time to settle, and if unenclosed the extremity of the glacier tends to spread. Glaciers tributary to a main valley, which have advanced across the main valley, as in the upper Shyok, therefore retain some forward activity for a considerable time, possibly for a few years, before they begin to deteriorate. This property accounts for the winter healing after an initial block and flood, and for subsequent blocks and floods. (4) The time taken up by deterioration or degeneration of the snout (ill-named "retreat of the snout") is considerably longer than that of the advance. (5) The interval between successive advances varies with each glacier; the date of advance varies with each glacier. Advance therefore cannot be due to climatic or weather cycles, and must, it seems, be due to local topographical factors. (6) There is some probability of fairly regular intervals between successive advances of the same glacier, but further evidence is necessary before any such regularity is proved. It seems however that a glacier which has once made a rapid advance is extremely likely to repeat the performance after some interval of time.

Can we yet say what is the reason of these advances? Perhaps we have not yet enough evidence. My own conclusions, arrived at gradually during this investigation, are that on certain glaciers the accumulation of ice in the feeding area is augmented in some way, either by ice-avalanches, or by the rapid advance of tributary glaciers, or maybe merely by annual snowfall, to an extent greater than can be carried away by the normal flow of the main ice-stream. It may be that the accumulation is quite slow and that during

the period of degeneration, the flow becomes obstructed, possibly by the accumulation of englacial moraine or for some other reason. Eventually the accumulation of obstructed ice becomes irresistible and it overcomes the obstruction. From the appearance of degenerate tongues it seems that the massed ice-pinnacles that are present on certain glaciers are features of glaciers that have recently advanced; it is impossible to believe that the great pinnacles of the Karakoram glaciers move forward with any great rapidity and maintain their equilibrium while doing so. My own belief is that they are formed soon after advance has taken place. The shear planes shown in the pinnacles themselves, probably caused during the advance, can be traced in adjacent pinnacles. On this point however further research is most necessary. From a study of the photographs of the upper Shyok glacier pinnacles, it seems to me that they grow in apparent size during the first years after advance, mainly through the melting of the glacier surface between them. Near the extremity of the glacier these pinnacles gradually range themselves in line with the crevasses; farther up the glacier they tend to align themselves with the direction of the ice-flow. I have measured some of the pinnacles on the Kyagar glacier and found them as much as 300 feet above the moraine surface. In the later stages of degeneration the pinnacles also lose height by evaporation and radiation from the increasing surface of exposed moraine, till they become detached at the snout or disappear on the body of the glacier. Examination of the height, alignment, and condition of the pinnacles therefore gives us an indication of the state of degeneration of the glacier.

The Nevado Glacier

It is most interesting to compare the Karakoram movements with those that have recently taken place in the Rio Plomo in the Andes. I do not think that Mr. King (*Geogr. J.*, vol. 84, p. 321) is correct in describing the advance of the Nevado glacier as due to an avalanche, certainly not in the accepted meaning of the word. The Nevado block bears an extraordinary resemblance to those of the Chong Kumdun and the Kichik Kumdun; and there is every reason why it should. The Nevado glacier is in latitude 33° S., the Chong Kumdun in 35° N. The aspects, bed-slopes, and local topography are not dissimilar, and the rugged, pinnacled surface of the extended Nevado bears a striking likeness to the Chong Kumdun block, though on a smaller scale. We do not know the date of the Nevado advance. Mr. King states that the last movement was probably in October 1933, in the southern spring. It burst in January 1934, the month in the southern hemisphere that corresponds with July in the northern, when ablation is severe. With the Chong Kumdun the interval between advance and flood is two or three years, possibly owing to the greater scale of the topography. But there is another point of similarity that is interesting. The Juncal and the Plomo glaciers have deteriorated considerably from their positions of 1909–11, just as the Aktash and Kichik Kumdun have done, while the Nevado has advanced similarly to the Chong Kumdun. The comparison must not be pushed too far however, for local factors of topography must influence the movements.

[*Professor Mason here gave a brief account of Dr. Helbling's views on the Rio*

Plomo ice-dam, a more extended summary of which by Mr. K. A. Goudge is printed immediately after the present paper.]

The whole of Dr. Helbling's report is of very great interest, and accords generally with what must happen in similar advances in the Karakoram. I do not believe myself that tributary glaciers entering below the neve line affect the movement. I do not think that dead ice-covers stranded on the grey trunk of a Karakoram glacier slide forward and cause blocks. But I agree most certainly that the movement starts in the uppermost névé; that after the creation of crevasses in an overloaded névé, "cover-ice" is formed to relieve the obstructed flow; and that this begins the movement by sliding. I feel convinced that Dr. Helbling is correct in stating that in the later stages, when the advancing ice has passed the degenerate snout, the movement is one of successive ice waves moving forward on successive shear planes roughly parallel to the bed; and that this was the movement so graphically described by the old villager of Hispar.

The question is often asked: What can be done to mitigate the effects of such catastrophes? "As regards the removal of the obstacle (when such an accident may occur again) by our scientific efforts," wrote Major Becher in India, as long ago as 1 July 1859, "I think it is impracticable: the labour of removing such vast masses of mountains or of glaciers would be immense." Nor do I believe that it would be effective with such large blocks as we encounter in the Karakoram, owing to the time taken for the fallen ice to settle. It does not seem practicable to me to keep open a channel through nearly 2 miles of ice by explosives even when there is no water held up. A by-pass tunnel would certainly not be justified financially in the Karakoram, and either a by-pass or a syphon would be extremely difficult to keep clear of obstruction.

In the Karakoram during the Chong Kumdun danger the Government placed watchers and beacons to signal to the nearest telegraph line, and there has been very little loss of life. No bridges of vital importance have been destroyed, though the destruction of minor ones has caused inconvenience. The Pertab Pul, near Gilgit, and the great railway bridge at Attock have stood the floods so far, and provided there is no abnormal flood independent of the Shyok bursts, they should be safe in the future; but once an important bridge or railway is destroyed by such a flood, I would certainly consider it most unwise to site a new work in the same spot.

What might be done, and should be done, is the yearly examination of all glaciers that are known to belong to the threatening group, so that the matter may be removed once and for all from the realm of speculation. In the Karakoram within the next few years I believe that we should be able to learn a great deal from the movements of all those glaciers which I have discussed, particularly the Yengutz Har, the Minapin, and the Kichik Kumdun. Fortunately the officers of the Gilgit garrison are keenly interested in the investigation and have during recent years been watching those that lie in that Agency.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: The paper this afternoon is entitled "The Study of Threatening Glaciers." The movement of glaciers is a problem which has had a great deal of attention directed to it of late years, and it is one which exists wherever there are mountain ranges. In our own sphere we are most familiar with the Himalayan glacier which it will be remembered gave such trouble on the Shyok river and resulted in the bursting of a dam. These cataclysmic occurrences naturally give scientists food for thought, and Professor Mason, who as you know is a member of our Council and Professor of Geography at Oxford, is going to put before us the problem from his point of view. We have other Fellows and guests with us who can speak of particular regions, and they will give us the benefit of their comment in due course. I now call upon Professor Mason.

Professor Mason then read the paper printed above, and a discussion followed.

The PRESIDENT: The lecturer mentioned Mr. Goudge, who was associated with the Argentine Transandine Railway. His father is the Chairman of Directors of that Company and Mr. Goudge has personal knowledge of glacial effects in the region which we have seen depicted on the screen. I call upon him to address us.

Mr. K. GOUDGE: I have no personal knowledge of the actual glaciers, having been through the Andes only by rail, but I have studied Dr. Helbling's report. It is an interesting fact that the Nevado glacier after the movement almost exactly covered the old moraine. That is very suggestive, I think, of the catastrophe having occurred before. I am told that no comparable flood has occurred for the last fifty years at least, so that if there was another period it was probably longer ago than that, and that is probably all that one can say. It is interesting to note that conditions in the Andes in these latitudes seem to be very similar to those in the Karakoram, judging by the photographs: the same scree slopes, the same barrenness, and also the same pinnacles on the glaciers. It would be interesting to know if pinnacles form on all snow or ice in the Karakoram that lasts into the summer, as they do in the Andes.

I think there is possibility of another similarly situated glacier in the Aconcagua region, the lower Horcones glacier, causing some slight trouble, but I am glad to say that it could not hold up much water. This glacier snout appears to have advanced perhaps half a mile nearer the river between 1895 and 1924 according to photographs. But I think tourists go up there every summer; consequently there would be plenty of warning if anything were to happen. What we want to know most of all is whether a catastrophe in the Nevado region is likely to happen again and, if so, roughly when; is the glacier going to heal its own wounds? has it already done so, perhaps? and is it going to form another lake, only to let it burst again?

The PRESIDENT: I was hoping that Dr. Lauge Koch would have been with us this afternoon, but he is not able to come. Dr. Longstaff, will you come and offer some comments?

Dr. T. G. LONGSTAFF: I believe that Professor Mason's paper is a valuable contribution to glaciology. Had he wished to be controversial rather than constructive he could have drawn attention to several theories which have been advanced without any observational evidence to support them.

The secular sequence of glacial and interglacial episodes, or epochs, if you prefer it, is one of slow and gradual change. There are probably also climatic cycles of shorter period of which we know nothing at present. But the mere fact that these catastrophic outbursts of energy are out of phase with one another,

and only affect certain glaciers, indicates that the cause must be some inherent peculiarity of these particular glaciers.

I visited the Kumdun[1] glaciers in 1909 and the Karambar[2] group in the course of duty in 1916. I have more acquaintance with glaciers than with the literature of glaciology, and this theory put forward by Professor Mason of overthrusting by the surface ice, as against the more orthodox idea of solid advance *en masse* of the whole glacier, is new to me. Dr. Helbling I remember with pleasure in the Caucasus in 1903, with Rickmers: he is a man with great experience of Alpine regions in various parts of the world. Apparently he has advanced this theory. Professor Mason has come to practically the same conclusion, I understand almost independently, but, as I have said, it is new to me except in so far as Slater,[3] my companion in Spitsbergen in 1921, suggested something of the sort; but I am in a position to add a grain of evidence to the views advanced by Professor Mason.

In 1931 I visited the inland ice of Greenland—that is to say the main continuous 1300-mile ice-cap—camping at de Quervainshavn, north of Jakobshavn on the west coast, where access to the ice is easiest. My daughter and I gave up a day to visiting the Ekip glacier, a little north of our base camp. That glacier was very actively calving quantities of unusually small lumps of ice into the sea, making approach to the snout of the glacier by boat impossible, so that we could only get on to it by a walk of a mile or so inland. Here I expected to find easy ice conditions. Instead, the whole surface was broken up and toppling over in a way I had never seen anywhere before. There was neither regular crevassing nor the ridging usual in the lower part of such a glacier. In short, the surface conditions were so dangerous that we had to clear out.

I could not understand what I saw. On reading Professor Mason's paper last week it was borne in upon me that the top layers of the glacier ice were, in fact, sliding over the lower layers; that the upper fast-moving layer, becoming relatively thin, could not hold together but was literally crumpling as it moved. I think Professor Mason's is the only possible explanation—and I am glad to have had it—for phenomena of which I have never previously understood the cause.

Professor Mason's suggestion that snow or ice avalanches falling on the *firnfield* may be one cause of these icefloods may sound rather heretical to some; but mountaineers are familiar with relatively small detached hanging glaciers that would fill the part. I allude, for example, to the well-known "ice-wall" on the north ridge of the Mönch, which for the latter half of last century was almost unscaleable, but which gradually became lower and lower as the ice-bulge which formed it sagged down the mountain side. Another example could be given on the east face of the North Col of Everest. Such masses of ice which periodically, either quickly or slowly, join their main glacier must upset the balance of normal flow and, given the right topographical factors, could easily be a cause of these icefloods, as Professor Mason suggests. But I would by no means rule out the probability that in some cases a secondary lateral glacier, formerly ending short of the main glacier, but for some accidental reason of its topography periodically liable to sudden advances, by suddenly joining its main valley-glacier might produce in the main ice-stream such phenomena as we are discussing.

I agree that the evidence points to these advances being very rapid and to subsequent degeneration and retreat very much slower in phase. The actual

[1] *Geogr. J.*, June 1910, vol. 35, p. 647.
[2] *Alpine Journal*, Nov. 1920, vol. 33, p. 159.
[3] *J. of Geology*, May, June, 1925, vol. 33, pp. 438, 444.

formation of ice pinnacles I look on as due to meteorological conditions, owing to the very limited localities in which they occur in the typical form—always in a dry and relatively cloudless region. I think that the lecturer has demonstrated that these recurrent catastrophic advances—or icefloods, as I would prefer to call them—cannot be due to climatic or secular change, and must be due to topographical peculiarities.

May I stress the point that the mere observing of the position of the snouts of glaciers is of little value unless the thickness of the ice is also measured? Further, that our knowledge of the real topography of any glacier is very incomplete until we know something of the depth of the ice over all parts of it. In fact, our present knowledge of glaciers and their mechanics is still extremely fragmentary.

Another point: seldom, if ever, do mountaineers meet with crevasses that penetrate the whole depth of a glacier. I believe that it will be found that the rate of movement of glacier ice is normally greater on the surface than at deeper levels. This is to say, that the overthrusting postulated by Professor Mason to account for the abnormally rapid movements with which he is dealing to-night may be only an exaggerated form of a normal process which becomes catastrophic owing to topographical peculiarities in some glaciers.

The PRESIDENT: Mr. Pilditch is the Resident Engineer of the upper section of the Transandine Railway, the particular section which the glacier conditions affect. I will call upon him.

Mr. E. PILDITCH: I fear that I am somewhat of an interloper here this afternoon, not being a glaciologist, but merely a civil engineer, whose duties necessitated my being connected at first hand with the recent flood catastrophe in the Andes mountains. Consequently I am here now more with a view of obtaining information on this class of phenomenon than of propounding theories. As oon as I heard of the catastrophe I was anxious to discover not only the extent of the material damage caused, but also the real cause of the flood. Early reports mentioned loss of life, destruction of villages, of the Argentine Transandine Railway, of the Mendoza electrical power station, irrigation works, etc. These reports eventually proved to be, unfortunately, not greatly exaggerated.

The "Panagra" Air Line immediately placed at the disposal of the Argentine Government authorities a powerful aeroplane, and I was fortunate in receiving an invitation to accompany the Government engineers on an aerial reconnaissance to discover and establish the cause of such disastrous floods; an ice-dam of sorts was suspected, as large blocks of ice had been seen coming down on the flood waters. Owing to the height to which the machine had to climb, about 23,000 feet, very little could be seen of the damage incurred; but after about an hour's scouting round the glacial region at the headwaters of the Mendoza River, the cause of the trouble was located, viz. an ice-dam across one of the rivers of the Plomo valley. A few aerial photographs of this obstruction were successfully obtained. Then a more detailed study of the ice-dam was carried out by King and Yorke Eliot[1] who, being shown its approximate position on the map, were able to reach it, after a somewhat hazardous journey overland. Owing to the inaccessibility of the emptied lake basin, they were unable to descend into it, to examine the ground for traces of previous flood levels; the ice-dam was about 250 feet high, and the mountain sides of the basin precipitous.

What interests me now, of course, as being of first importance to the Transandine Railway, is whether a similar flood is likely to recur in the near future. This railway, which is the only direct line uniting the capitals of Argentina and Chile, is built over the greater part of its extension along the gorge of the Mendoza

[1] W. D. V. O. King, "The Mendoza River Flood of 10–11 January 1934—Argentina," *Geogr. J.*, vol. 84, p. 321.

River. That part of the line which was recently destroyed was constructed between forty and fifty years ago upon the banks of the river, mostly on rock screes, low terraces, and sand-flats; it crossed the main river in ten places with heavy bridges; seven of these crossings have been completely swept away.

Professor Mason has interested me extremely in the question of periodicity of the floods caused by ice-dams in the upper Shyok valley, where there appears to be an almost definitely proved interval of time between the major glacial movements in the different valleys. Unfortunately, in the case of the Plomo valleys, no such records have been made, but it would appear that the periodicity of abnormal floods is certainly not so short as those recorded in the Upper Shyok. Had a similar flood occurred, say, within the last century or so, then those screes, terraces, and sand-flats would not have existed to the same extent when the line was built on them. From their depth, extension, and the vegetation growing on them it is quite obvious, even to a layman, that their accumulation must have extended over a period of many centuries. This recent flood, which was discharging at the rate of some 3000 cubic metres per second for about six hours, simply purged the valley of all these screes and sedimentary deposits, leaving the cliffs at the side rising sheer out of the river-bed, to a height in some places of over 200 feet. As the glacier field in which this ice-dam is situated lies in a remote region rarely visited, nothing whatever is known of any major ice movements which must have taken place there in past years.

It is interesting to note that in October 1933, *i.e.* during the spring, a week of the hottest weather ever recorded for that month was experienced, the maximum sun temperature reaching 16° C. above normal. When King and Yorke Eliot visited the ice-dam in February 1934, the disintegration of its surface and the height of the névés were sufficient evidence to prove that the ice-dam had already been in existence for about three months. From this it may be inferred that its final movement took place in October or November. This leads me to believe very strongly that during the October heat wave, water must have percolated through the crevasses in the "white" ice, which overlies the "black" ice, and acted, as it were, as a lubricant between these two distinct layers, thereby lessening their frictional adhesion, and upsetting the equilibrium of the "white" ice, which must have slipped with considerable rapidity into the lower valley. Whether a discharge tunnel was formed under the ice-dam, when the latter became stationary, or whether water storage commenced as soon as it had reached the opposite side of the valley, is a matter for conjecture. Personally, I am inclined to favour the former possibility, and consider that storage commenced only when the roof of the tunnel fell in, as shown in the aerial photographs. I even go further and suggest that ice-dams have occurred at this identical spot at fairly regular intervals, like those in the Upper Shyok; but have not, until the present instance, succeeded in entirely blocking the river-flow for many centuries.

And so, Mr. President and Professor Mason, I came to this meeting thirsting for such information as may help us to decide our engineering problems on the Transandine Railway; and, after what I have just heard from such expert glaciologists, I have learnt much that will be of great use to us.

Dr. K. S. SANDFORD: Professor Mason's paper has made two things abundantly clear: first, we realize that glaciers in intertropical mountains are capable of movements that we have never seen nor suspected in temperate and polar lands; secondly, it is of paramount importance that such abnormal glaciers as Professor Mason has described should be studied and judged by their own standards, not with preconceived ideas learned in the Alps. Annual observation, measurement, and photography from fixed points are the most pressing needs. The officers

of the Gilgit garrison have made a serious start in this work, and it is to be hoped that every facility will be given them to carry out annually a more detailed programme of recording. The next stage must be detailed research with the most modern methods and equipment. A special set of instruments for serious measurements of precipitation, ablation, evaporation, radiation is being rapidly evolved in this country and in Scandinavia at the present time. In another five years we shall be in a far better position to take the pulse of collecting ground and glacier than we are at the present day.

The paper has also rubbed in what many of us already know but have not said, namely that in a given field the majority of glacier snouts may be stationary but some may be advancing and some retreating. There is no short period oscillation that we can yet claim to have established, and I doubt if such exists. If the majority of the snouts of a given field are stationary over a period of years, it suggests to my mind that the net amount of ice passed to the glaciers from the collecting ground is regular, within certain limits. If this is so the rapidly advancing glaciers surely owe their advance to peculiarities in the topography of their beds or collecting ground. We may admit that avalanches may be more abundant in some years than in others, but I doubt if such accidents are responsible for threatening glaciers. The regularity of the extreme advances after marked retreats suggests that there is an accumulative instability, *i.e.* snow or ice masses approach the angle of repose slowly; during these years there is a reduced flow of ice, but once the critical angle is exceeded the stored-up surplus is released. I have in mind in this matter the angle of repose of a glacier, *i.e.* the failure of gravity to induce flow until a certain surplus is achieved.

These advances are known in most parts of the world, and I may recall Tyrrell's and Wordie's notes on the Gregory glacier in Barents Island, which at some time between 1901 and 1920 advanced 2 miles and buried the Anderson Islands on which hunters used to winter. In this case the collecting ground is flat, avalanches are impossible, and the majority of the glaciers of the region have retreated or held their own in the interval. Certain other glaciers have indeed advanced in harmony with the Gregory glacier, but the Chinese walls reported by Garwood and Gregory have disappeared. One feels that a study of the topography would explain the continued advance during these years. In the interval precipitation, as far as we know, has not increased, rather the reverse. Most of the glaciers of Spitsbergen passed through a phase of activity and advance thirty years or more ago, and since 1900 their snouts have been stationary or recessive.

We might also recall the Lillehöök glacier in Western Spitsbergen. Adolf Hoel measured its rate of movement and found that between 1909 and 1912 the rate fell by 40–50 per cent.; the snout retreated. In high latitudes, maybe, a certain angle of bed allows the glacier to advance under its own momentum rather than by the excess of "push" from the collecting ground. The deep saucer-shaped depressions at their heads may thus be explained. If now we carry our minds to mountain valleys with varied and locally severe slopes we can realize that glaciers may advance when there is no apparent reason for them to do so. If moreover we add the vast body of melt-water available at certain seasons in intertropical mountains, we can appreciate that the repose of a mass of ice may suddenly be destroyed by the addition of unlimited lubricant, and the mass may move like a ship from well-greased stocks. If, above all, the shear-planes in the mass of the ice are similarly lubricated one can imagine that the results may be far reaching.

To my mind it seems especially significant that the flow of mud and water from the Yengutz Har ceased when the rapid advance of the glacier came to an

end. I cannot help feeling that accumulation till a critical angle is reached, plus lubrication by water on a scale that we do not appreciate in temperate and polar lands, form essential parts of the mechanism that Professor Mason has described so vividly. I am prepared to believe that some of the extraordinary movements may affect the collecting ground comparatively little, and that the deficiency may be most felt in the higher reaches of the glacier. We should not lose sight of the observation that the dates of rapid advance vary with the glaciers, and that each glacier may have its own period, while the field as a whole may show no change.

The PRESIDENT: Having regard to the hour, I think we must close the discussion now. It must be obvious to all who have listened to the very interesting paper that the problem discussed is one of vital importance. There are, it seems to me, so many ramifications of it that there is endless room for scientific investigation. Speaking as an ignoramus it seems to me that not only may the cause be climatic in one case and topographic in another, but that both influences may well be acting on the same glacier, and on the other hand that every or any glacier may be moving or behaving from quite different causes from its neighbour a few miles away. I have not the knowledge on which to discuss this vital question more than superficially, so I can only ask you now to join with me in thanking Professor Mason for his paper, and the other speakers, Mr. Goudge, Mr. Pilditch, Dr. Longstaff—whose remarks were particularly interesting—and Dr. Sandford, for kindly joining in the discussion.

THE ORIGIN OF THE RIO PLOMO ICE-DAM

DR. ROBERT HELBLING

The material secured by Messrs. King and Yorke Eliot (see the Geographical Journal for October 1934, *vol.* 84, *p.* 321), *at the Rio Plomo ice-dam which caused the disastrous flood, was submitted by the Argentine Transandine Railway Company to Dr. Robert Helbling, of Flums, who had explored and surveyed this region with Dr. Reichert in the years* 1908–12. *Dr. Helbling has made a report on the subject and the following is a summary by Mr. K. A. Goudge, of the part of the report dealing with the ice movement which caused the dam. Dr. Helbling's full report, in German and English, the photographic material* (73 *plates*), *and his maps have been deposited for the time being in the Map Room of the Society.*

IN these regions the presence or absence of glaciers is determined by the exposure. The prevailing winds are westerly and very strong. Snow accumulates on slopes sheltered from the wind, usually slopes facing east, whilst snow on slopes facing west is blown off and carried to more sheltered spots (see Plate 3). The influence of the sun is also great: compare the ice- and snow-covered north-east flank of the Nevado del Plomo with the adjoining face of the Cerro I (see Plate 4). The tributary glaciers overlie the main glacier when they reach it, and do not unite with it till far below the junction. Two glaciers are not lying side by side, but one upon the other.

In the melting region, streams of clear or white névé-ice, which come from the névé regions or from the tributary glaciers, overlie the grey glacier ice.

SOME NOTES ON EARLY IDEAS OF THE FORM AND SIZE OF THE EARTH: *A paper in Basic English read at the International Geographical Congress in Warszawa, by*

PROFESSOR E. G. R. TAYLOR

I have put this short paper into Basic English because it is a form of English of which it is easy to get some knowledge very quickly and by which correct ideas can be given to those whose knowledge of the language is not great; it is therefore the form of English which is the best for an International Conference. Some facts about Basic English are given with a word-list of which distribution was made at the Congress. Copies may be had from the Orthological Institute.

IT is my purpose to put before the Congress some examples of geographical writings in the British Museum, London, which give us great help in getting a true idea of the geographical thought of early times. The time covered is from A.D. 900–1500.

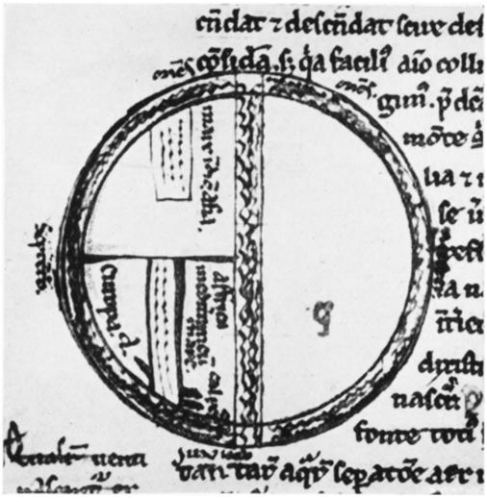
We are in error when we give overmuch attention to the writings of those foolish ones among early writers who said the Earth was flat. The reason why their views seem to us more important than they truly are is because they seem at first to be in agreement with the common maps of those days. On these maps were put only the lands and seas of which man had knowledge, around which a circle or square was made as an edge to the picture; but the best early writers put side by side with these maps a picture of the complete Earth ball, and only when we take a look at the two pictures together do we get a clear and true idea of the geographical teaching of those days.

Here for example is a copy of the Anglo-Saxon or Cotton Map of about A.D. 990, which has been very frequently printed [not given here]. The second picture (Plate 1), an outline of the Earth ball, is not frequently seen, but it was made to go with the first, which is simply the expansion of a part of it. In my 'Tudor Geography' I have printed two more such pictures which were put together in one geographical work, and which we have to keep together in our minds if we are to get true ideas. One gives the complete round Earth and the houses of the winds, the other gives only the part of which man had knowledge, that is to say the three great lands, Europe, Asia, and Africa, and the water round them, named Ocean. When a man of learning had the design to give an account of the theory of Earth knowledge, he put on his pages simply the outline picture of the Earth ball and not a map. Here are two examples, from works of about A.D. 1150 (Plates 2, 3).

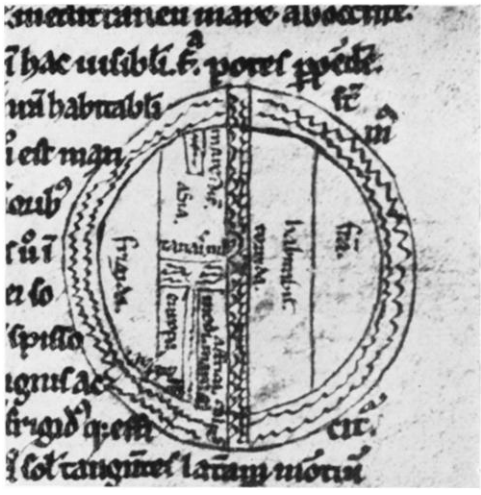
My fifth picture (Plate 4) is one which was designed for the purpose of making clear the facts about the way in which the shade of the Earth is seen on the moon (an eclipse), and the reason why it is seen from different parts of the Earth ball at different sun times. Cosmas Indicopleustes had no doubt seen such a picture, because he put one very like it in his noted book. He had, though, the purpose of making the idea of a round Earth seem false and foolish. I put the date of this picture at A.D. 1272. It is interesting, because of the use of the name Arym, a name taken from the Arab system of earth-knowledge.

Authority	*Data*	*Stadium to Mile*	*Value given to Unit in Feet*	*Degree*	*Great Circle of Earth*
Eratosthenes ↓ Macrobius ↓ Sacrobosco ↑	Circumference = 252,000 stadia 1° = 700 stadia	10	Itinerary stadium of 500 feet or 400 palmipes (short cubits)	70 miles	25,000 miles
Italian and Portuguese Sea hand-books				70 miles 17½ sea leagues	6300 leagues
MSS. of A.D. 900–1600		8	625 feet (St. Isidore)	87½ miles	31,500 miles
Ptolemy	Circumference = 180,000 stadia 1° = 500 stadia	8	625 feet	62½ miles	22,500 miles
Ananias Širacki (v. Mzik)		7	143 feet or 571 3/7 palmipes	71 3/7 miles	
'Philosophia Mundi' and 'Imago Mundi' (1100–1400)		8¾	571 3/7 feet	57⅐ miles	20,520 miles
Renaissance Cosmographers		8⅓	600 feet	60 miles	21,600 miles
Spanish Sea hand-books		10	500 feet	16⅔ leagues	6000 leagues
Alfragan ↓ Climata of Sacrobosco	Circumference = 20,400 miles 1° = 56⅔ miles		Miles of 4000 cubits or 6000 feet	67⅔ miles	24,480 miles
'Imago Mundi' of d'Ailly			Miles of 4000 short cubits or 5000 feet	56⅔ miles	20,400 miles
C. Columbus				14⅙ sea leagues	5100 leagues
Ibn Khordadhbeh	1° = 25 parasangs		Parasangs of 12,000 cubits or 3 miles	75 miles	
Albategni	Circumference = 240,000 stadia 1° = 600 stadia	10	400 cubits or 600 feet	60 miles	21,600 miles

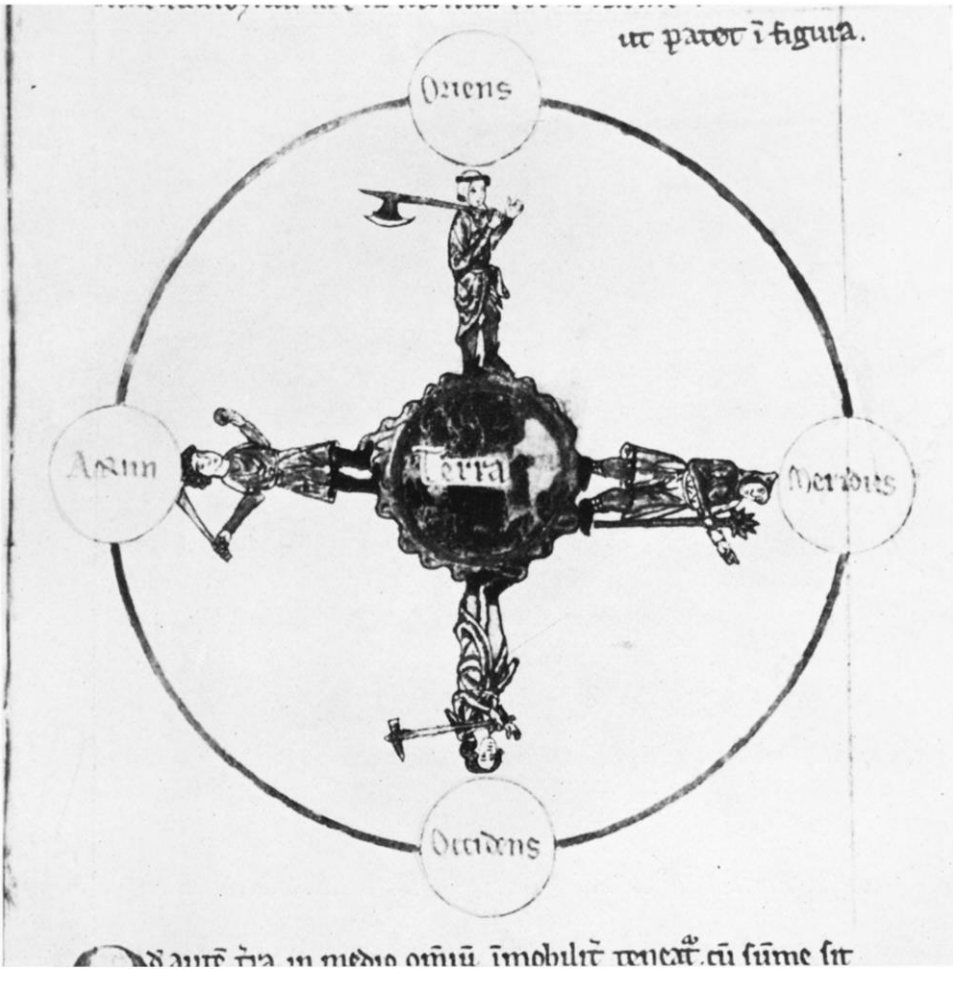
1. The Earth Ball (British Museum Cotton MSS. Tiberius BV.)



2. Outline picture of the Earth Ball (British Museum, Arundel MSS. 377)



3. Another picture of the Earth Ball (slightly enlarged) from the same MS.



4. Man on the Earth Ball (British Museum, Egerton MSS. 843)

In the Arab system the town or island of Arym was at the top (or cupola) of the Earth ball, but here it is put in the place of Septentrio or North.

My sixth picture [not given here] is taken from a group of maps and outlines which were made at St. Albans, England, about 1250–1260, by or for the noted writer of histories, Matthew Paris. What gives it interest is the fact that it is representative of the change from the Greek and Latin wind system to the new system that came into use with the north-pointing needle (*i.e.* compass). The old winds of Aristotle's day were eight in number, which with the later addition of the four points, north, south, east, and west, made twelve. The new winds, as given in this picture, were sixteen in number, and because English ship-men got their knowledge of the new way of sailing "by needle and stone" from their French brothers, the new names were at first, as you can see, in French. It is clear from the outline picture at which we are looking that the map-makers of St. Albans had knowledge that the Earth was round like an orange, but if we saw only the maps of Matthew Paris we would have no idea of this.

Here, on the other hand (Plate 5), is a picture by a writer who was not a man of learning. He has got mixed in his ideas, and he puts together a map of the three lands, Europe, Asia, and Africa, but puts above Asia the circles of air, fire, and water which in the system of Ptolemy had their true places about the Earth ball.

I come now to the ideas of the writers of these same times on the *size* of the Earth ball. The ideas which they had were taken from the writings of others in earlier times; they did not themselves make new measurements. Three values or measurements were commonly used, those of Eratosthenes, Ptolemy, and Alfragan. It is clear that some writers had knowledge of only one of these three, but others had knowledge of them all, and so had to make a decision as to which was right. But it was also possible to get an agreement between the three values by making an adjustment of the units used, and this was done by some writers.

I have put in table form a simple statement as to all the different values given to one degree of a great circle of the Earth which I have noted in early writings, and I have given some ideas of the adjustments possible because of the unlike values of the stadium which were in use.

It was on the authority of Macrobius, of whose writings in Latin every man of learning had knowledge, that the value or measure of Eratosthenes was made so widely current. Sacrobosco, an Englishman, and a student of Robert of Lincoln, was one of the men who, about A.D. 1250, made use of Macrobius, and as a result put the value of 700 stadia to a degree in his book. Most men made use of Sacrobosco's book, named 'De Sphaera,' and from it the early Portuguese shipmen, such as Vasco da Gama, got the value of a degree, which they put at $17\frac{1}{2}$ sea-leagues. But Sacrobosco was also a reader of Alfragan, and for the extent of the seven *climata* of the Earth ball he made use of Alfragan's measures, in units of miles. Was this an unconscious error, or was it his opinion that the two values of Eratosthenes and Alfragan were not unlike? In a number of old writings there is a statement that Alfragan's mile was of 4000 cubits, which is equal to 6000 feet (very nearly) if they are great cubits, but to only 5000 feet (very nearly) if they are small cubits. Most

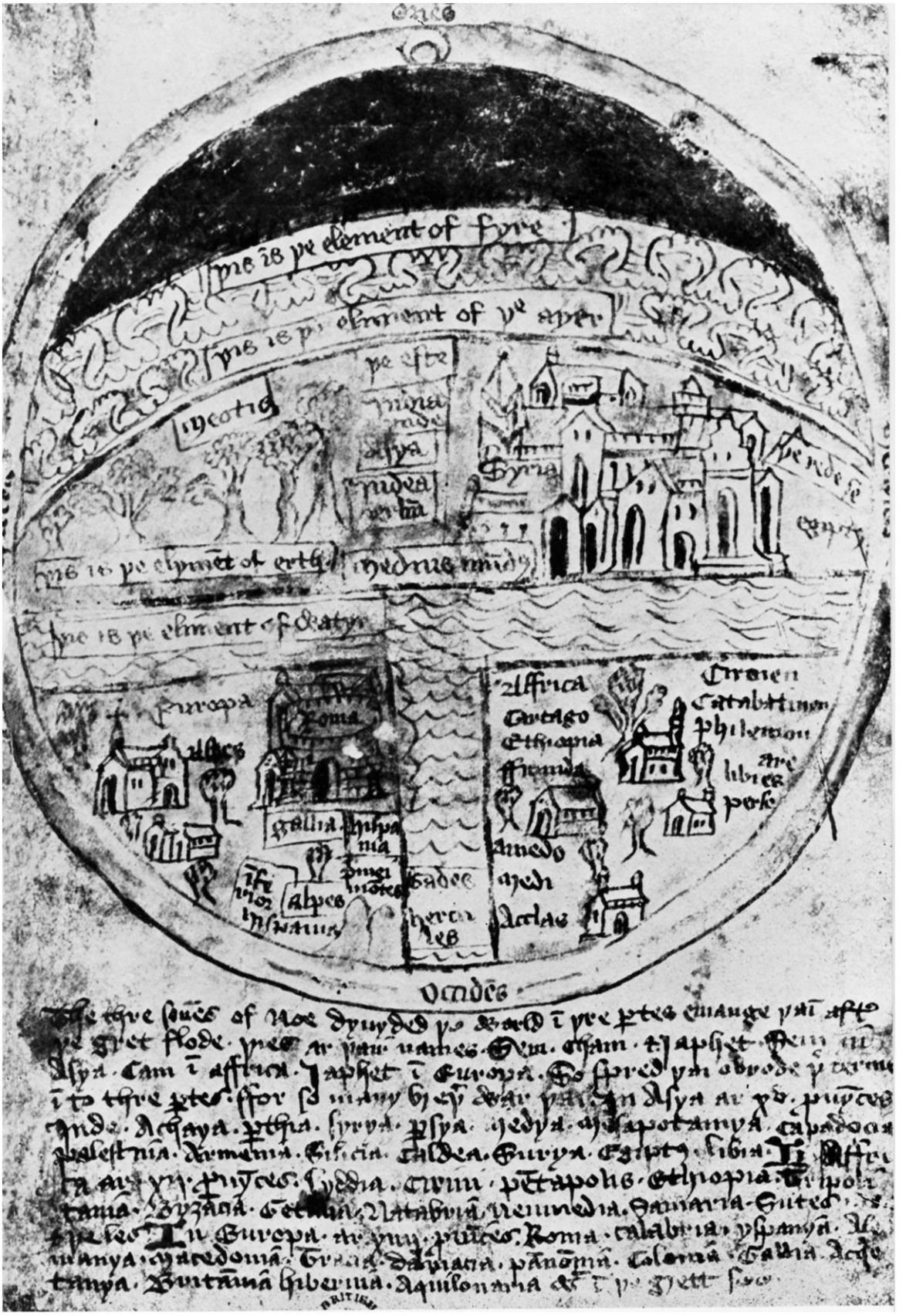
writers took them to be great cubits, and this gives to Alfragan's degree a value of 68 Roman miles, or very nearly the value of the Eratosthenes-Macrobius degree of 700 stadia, which is 70 miles. It should be noted that early Italian ship-men and Portulan chart-makers made use of the value of a degree of 70 miles (about A.D. 1300).

Ptolemy's measure of a degree was used in an important group of writings of which the 'Imago Mundi' of St. Honorius and the 'Philosophia Mundi' of William of Conches are representative. In all these writings we get the statement that the great circle of the Earth is "180,000 stadia, which is equal to 20,520 miles." This relation of the stadium to a mile is not the one in general use at a later day. These very early writers made use of the value $8\frac{3}{4}$ stadia (nearly) to the mile. We have no knowledge of such a stadium, but a stadium of 7 to the mile is often recorded. The relation $8\frac{3}{4}$ to 7 is as 5 to 4, and this is the relation of the palmipes or small cubit to the foot (see Table). We have here possibly an error caused by mixed units. But this error gives a measure of the great circle which seems to come near to that of Alfragan, namely 20,520 in place of 20,400 miles.

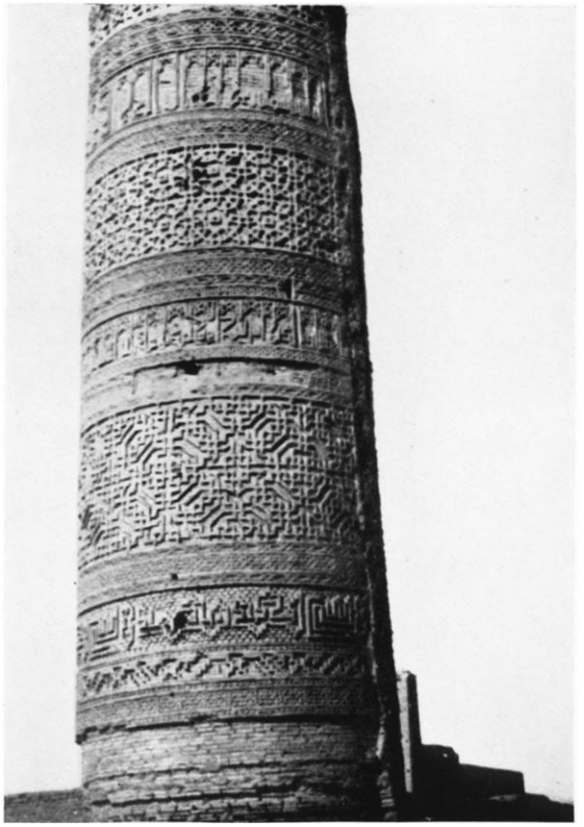
Those who took St. Isidore as their authority made use of the stadium of 8 to the mile. Five hundred stadia divided by 8 gave $62\frac{1}{2}$ miles for the degree of Ptolemy, a value which we get in very early unprinted and printed copies of Ptolemy's maps. A short time later the stadium of $8\frac{1}{3}$ to the mile (noted by Strabo) was very generally taken in the place of the stadium of 8 to the mile. Five hundred stadia divided by $8\frac{1}{3}$ gave a degree of 60 miles, which made the next division into minutes and seconds very simple.

Cardinal Pierre d'Ailly in his 'Imago Mundi,' a work which was based on a number of earlier writings such as those of St. Honorius and Sacrobosco, makes an attempt at an adjustment of the different measures of the degree. A like attempt is made in a work in Latin by an unnamed writer of which I made the discovery in the British Museum, and which has never been printed. This writer says: "Ptolemy's degree is 500 stadia of 400 cubits, which is 71 miles and three stadia taking 7 stadia to a mile. Alfragan's degree is 56 miles in miles of 4000 cubits. Albategni's degree is 600 stadia, or 75 miles. The degree of Theodosius (*i.e.* Macrobius) is 700 stadia, or 87 miles and 4 stadia. If we take a common measure for Ptolemy and Alfragan, *i.e.* 5 feet make a pace, 125 paces make a stadium, and 8 stadia make a mile, then Ptolemy's degree is 480 stadia or 60 miles. And the great circle of the earth is 21,000 miles." (The working is as follows: 1 stadium of 400 cubits=600 feet; 1 stadium of 125 paces=625 feet. As 625 : 600 so is 500 : 480). He goes on: "Alfragan's degree is 537 stadia and 75 paces, which is 67 miles and 1 stadium and 75 paces. And the great circle of the earth is 24,192 miles. That of Albategni is 27,000 miles. That of Theodosius is 31,500 miles. That of Aristotle is 24,000 miles."

I do not make the suggestion that these early writers were correct in their reasoning about the value of a degree. It is my desire to make clear what were their opinions and beliefs, and what arguments they used. Only if we have a true knowledge of their ways of thought can our reading of their works be free from error.



5. The Map and the Earth Ball mixed (*British Museum Add. MSS. 37,049*)



The minaret of the mosque of Muhammad ibn Malikshah

The minaret of the mosque of Sirhân

There is another old minaret in the town itself, beside the mosque now in use: it also has fine brickwork and a Cufic inscription, bearing the titles and name of ". . . el Mu'izz, Jalâl ed Daula, Sharaf el Mulk, Abu Dulaf, Sirhân (or Surkhâb) ibn 'Imâd ed Daula," and the date. The personage mentioned has not yet been identified, and unfortunately the date, which is doubtless one in the twelfth century, could not be photographed, as access to the roof of the mosque was not allowed.

The other old monuments are a dome, which the inhabitants declare once to have been the centre of the bazaar and sort of town hall, and the disused mosque which stands beside the old minaret, but is of a later date. Some very old brickwork would probably be found in the *anbars* or deep underground reservoirs for water built with prodigious flights of steps far below the soil in all the Saveh district.

THE DESIGNATION OF HIMALAYAN PEAKS

A SKETCH OF THE GEOGRAPHY AND GEOLOGY OF THE HIMALAYA Mountains and Tibet. By Colonel S. G. BURRARD and H. H. (later Sir HENRY) HAYDEN. Revised by Colonel Sir SIDNEY BURRARD and A. M. HERON. Second (1932–33) Edition. *Delhi: Government of India* 1933–34. Part I. The High Peaks of Asia. 12×9 *inches;* iv+68 *pages.* 5*s.* 9*d.* Part II. The Principal Mountain Ranges of Asia. 12×9½ *inches;* iv+69–140 *pages.* 5*s.* 3*d.* Part III. The Glaciers and Rivers of the Himalaya and Tibet. 12½ ×9½ *inches;* vi+141–276+xxvi *pages.* 15*s.* *Illustrations and Maps*

NO official publication, we believe, has ever been more highly valued and continuously studied than Burrard and Hayden's 'Sketch of the Geography and Geology of the Himalaya Mountains and Tibet,' published by order of the Government of India in four parts in the years 1907–08. The work originated in a proposal made by the Survey of India to the Board of Scientific Advice in May 1906: "The number of travellers in the Himalaya and Tibet is increasing and a wider interest is being evinced in the geography of these regions. It is therefore proposed to compile a paper summarizing the geographical position at the present time."

That time was nearly thirty years ago; the number of travellers in the Himalaya and Tibet has gone on increasing; every expedition has increased the demand for the book; and a second edition was required, both to incorporate their discoveries and to supply the needs of their successors. Meanwhile Sir Henry Hayden had been killed in the Alps in 1923 and Sir Sidney Burrard had retired from the service in 1919. But at the request of the then Surveyor-General he undertook about 1930 to revise the Geographical sections, for which he had been responsible so many years before, and the task of revising the geology was assigned to Dr. A. M. Heron. Their work is embodied in the Second Edition published again in four separate parts in 1933–34. It is of the highest interest to compare this second edition with the first. Then as now Part I is called The High Peaks of Asia, and by virtue of its title goes rather far afield, though it is far from including all the high peaks of Asia. It does not, for example, include Amne Machin and Minya Gongka, but it does take in a few of the highest peaks in the Kunlun, Qungur, and Tien Shan. For practical purposes however it is

limited to the Hindu Kush, Karakoram, and Himalaya, and it does not profess to be complete below 24,000 feet. Of those above 24,000 feet there were 75 in Tables I–V of the first edition, and there are 86 in corresponding tables of the second: numbered consecutively in order of descending height. Consequently the same peaks bear different numbers in the two editions, thus adding another to the complications which beset the identification of Himalayan peaks. Since it will be necessary to discuss nomenclature and numbering in some detail we may begin with a brief statement of the various systems employed.

Himalayan peaks are known by:

(*a*) Name: one European (Mount Everest), others Asiatic or corruptions of Asiatic, with serial numbers in Roman to denote members of a group, as Makalu II, Gasherbrum IV, or with English adjectives attached, as Masherbrum West, East Ibi Gamin.

(*b*) Roman numbers of the Indian Atlas, once assigned to all the highest peaks, as XV (Mount Everest), but now largely replaced by native names. The highest which survives is XLIII for one of the Dhaulagiri group.

(*c*) Initial letters and serial numbers of peaks in a region: principally the Karakoram, as K^2, which survives, while K^1 has become Masherbrum. N^{53} of the first edition, now Chomo Lonzo, seems to be a relic of a similar Nepal series, and the only survivor even in 1907.

(*d*) Similar initial letters and serial numbers of peaks triangulated by different observers, as T^{57} by Tanner (now Gyachung Kang) or B^{504} by Barckley, still nameless, north-east of Gosainthan.

(*e*) Karakoram peaks with a new set of serial numbers, now obsolete, as Karakoram No. 8 of the first edition, otherwise K^6, the Bride Peak of Conway, now Chogolisa after Collie.

(*f*) Similar range names and numbers not yet superseded, as Kunlun No. 1, Indus-Nagar Watershed No. 2.

(*g*) Descriptive names as Rimo Peak or Satellite of Kanchenjunga (which has for some reason not been treated as in (*a*)) or "close companion of K^{23} and K^{24}" on the Shyok–Nubra Watershed.

(*h*) Numbers in two series, upright and sloping, on the Triangulation Charts for each Degree Sheet, and in the accompanying pamphlet a third series of numbers Pk. 1, Pk. 2, etc., combining the two series of major (upright) and minor (sloping) into one series in order of increasing longitude east. Thus Cho Oyu is Pk. 5/71 L, but on the triangulation chart is No. 2 of compartment L on Chart 7. There is a 2 close by.

These peak and sheet numbers are given in Column 3 of Tables I to V in the second edition; but to find the peak on the triangulation chart the number has to be translated by reference to the pamphlet, which is highly inconvenient in practice.

In the first edition (p. 15) we read: "It is not often that a Surveyor can discover a native name for a peak: natives of the hills do not give names even to remarkable peaks. . . . Of the 75 great peaks included in Tables I to V but 19 have native names. . . . Colonel Montgomerie endeavoured to introduce for peaks a method resembling that of constellations, and he named the whole Karakoram region K, and its peaks K1, K2, K3, etc. . . . We cannot do better for Tibet and Turkistan than extend this simple system introduced by Montgomerie for the Karakoram: his method of constellations is more suitable for the peaks of Asia than a long series of successive numbers from west to east would be. . . . We can have rectangular constellations, enclosed by meridians and parallels."

In the first edition however Colonel Burrard did not follow up this idea, and his 75 designations for the peaks above 24,000 feet may be classified thus:

(*a*) European name 1. Asiatic names 23, with 15 companion peaks bearing the same names, but distinguished by numbers II, III, etc.
(*b*) Roman numbers alone: 15.
(*c*) Regional initials and numbers: 5.
(*d*) Observers' initials and numbers: 7.
(*f*) and (*g*) Range numbers and description: 9.

Tables I to V of the second edition contain 86 peaks above 24,000 feet against 75 in the first, and it would have been convenient if a column had been added to give the serial numbers of the first edition, for many names have replaced numbered initials, two spurious 25,000-foot peaks, T^{42} and B^{783}, disproved by the surveyors of the first Mount Everest Expedition, have been omitted, and two or three others discarded for reasons unknown. T^{45} becomes Cho Oyu (not Cho Uyo as used, apparently wrongly, by successive Mount Everest Expeditions), T^{57} becomes Gyachung Kang, and N^{53} Chomo Lonzo (spelled Lönzo by Colonel Howard Bury and Major Morshead). The two first were no doubt obtained by Morshead, but how or from whom is not, we think, anywhere recorded. Thirteenth in the list appears the name Broad Peak—in contradiction to all the good principles of the Survey of India. Dasto Ghil, Namcha Barwa, and Teram Kangri are notable additions. Five of the K series, five of the Roman number series, and B^{504} survive, and a few awkward descriptive names like Indus-Nagar Watershed No. 2, and Kunjut No. 3. The peak forty-eighth in the list, named as a Satellite of Gosainthan, is really one of the Dhaulagiri group. The most surprising feature of the list is the appearance of a new series of initial and number, E^1, E^2, and E^3, without explanation or remark. Of these E^1 is the fourth highest mountain in the world. Not until we reach Chapter 21 in Part III, headed "The Rivers of the Nepal Himalaya," do we come at last upon the explanation, in a criticism of the Mount Everest Committee which raises questions of the first importance. We must quote at some length from the section, tucked away among the glaciers and rivers, headed "The Symbols employed to designate the Satellite Peaks of Mount Everest."

> "The system adopted by the Survey of India of naming high peaks is the outcome of 100 years' experience. The co-operation of mountaineering expeditions in this system will be always appreciated. Within the mountain zone which follows the Tibeto–Himalayan border many thousands of peaks are situated and two networks for distinguishing the peaks have been thrown over them independently of one another; firstly came the network of poetic nomenclature which the various hill-peoples have attached to their peaks, and secondly there followed the network of scientific points which have all been named by means of scientific symbols. The principle observed by the Survey has been to confine its activities to the scientific net, and faithfully to record the popular nomenclature without adding to, or interfering with it.
>
> "On one occasion only has the Survey departed from principle, and trespassed upon the people's ground; the case of Mount Everest has been the only exception to its rule. In this case the requirements of world-wide geography could not be overlooked; the highest mountain in the world could not be left permanently nameless. The only disadvantage of the name Mount Everest has been the creation of a precedent; but the case was unique, it can never occur again, and the Survey has for 70 years refused to regard it as a precedent.
>
> "The method which the Survey has adopted for distinguishing the many hundreds of nameless Tibetan peaks from one another has been to classify all the peaks of one group under a letter of the alphabet and then to add a separate number to each peak.

The same system is followed in many other branches of science. . . . When no group letter is obtainable from a region it is convenient to have the observer's initial as the group letter. . . . In 1921 the map prepared by the Mount Everest Expedition made a new departure. The map-makers in London took the English names which had been useful to mountaineers in the field, and with the aid of a Tibetan linguist they converted these names into Tibetan names. The Asiatic Society of Bengal has rightly objected to these spurious Tibetan names. If such a system be continued it will lead to chaos. It will mean that every explorer has a right to invent Tibetan names. In the future when the origin of these inventions has been forgotten, map-students may be misled into drawing philological conclusions from them, and travellers when planning an expedition may be led to imagine that a district covered with Tibetan names must have a resident population.

"Moreover Tibetan names when invented are never in harmony with local thought. The peak in Nepal, which is 2 miles south of Mount Everest, was given in London the Tibetan name 'Lhotse,' meaning 'south peak'; this peak stands just inside the northern boundary of Nepal. In the map of Nepal the peak named 'south peak' will be shown in the extreme north of the state. Also on the other side of this boundary it will be necessary to explain to Tibetans that the peak near the southernmost limit of their country has been given the Tibetan name 'Changtse,' meaning 'north peak.' There is both a scientific and an artistic side to mountain nomenclature; scientists are not qualified to add to the nomenclature of the people. If we regard the Himalayan-Tibetan nomenclature as a whole, it presents a wonderful picture of historic art, and a geographer has no more right to add to it his own ideas than he has to add colours to Raphael's Madonna in the National Gallery.

"On the flanks of every peak there are numerous excrescences which may become triangulation points; but these satellite peaks, partly hidden by their giant companion, have not the importance of an independent isolated summit. In the case of Tirich Mir its satellites have been named Tirich Mir II, Tirich Mir III, etc., and the same plan has been adopted in the case of Teram Kangri. But the name Mount Everest is not a local name; it is a world-name; and it was not considered advisable to extend this unique name to all the satellite peaks on its slopes. The satellites of Mount Everest have therefore been given the group letter E, and have been designated E^1, E^2, E^3 in the Tables II to V of Part I. It was considered better to give the designation E^1 to the highest satellite and not to Mount Everest itself. Mount Everest is not a *primus inter pares;* it is of interest to the world, whereas its satellites have only a local interest."

Faithfully to record the popular nomenclature is ideal, but not always possible. "Natives of the hills do not give names even to remarkable peaks" (Burrard, First Edition, p. 15), and people who live in the plains on opposite sides give different names, if any. Makalu is believed to be a surveyor's corruption of Kamalung, but "the name Makalu has now an historic place in geography and cannot be changed" (Second Edition, p. 42). Nanga Parbat is the Kashmiri name: the regional name is Diamar or Daryamur or Diamarai (Bruce), and this regional name is applied to the mountain locally (p. 42). Gurla Mandhata is a Sanskrit name used by the Hindus, but the Tibetans, in whose country it lies, call it Memo-nam-nyim-ri (p. 44). Rakaposhi is the name known in Gilgit, but the Mir of Hunza used to declare it a British invention, the correct name in Hunza being Dumani (p. 50). "In the wild Trans-Indus country south of Dardistan there is a mountain range named Hindu Raj . . . General Bruce says that the name Hindu Raj is hopeless, and he asks why Hindu? why Raj? These questions cannot be answered" (p. 52). But they throw some doubt upon the faithful record of popular nomenclature, and suggest another little blot upon the "wonderful picture of historic art," already defaced by Mount Everest, Broad Peak, Masherbrum East and West, and the "close companion of K^{23} and K^{24}."

The ideal cannot be realized. When an uninhabited region is studied in detail by Europeans they must have some way of referring to familiar peaks and passes.

Sound opinion has rejected the fanciful names Bride Peak, Golden Throne, and Staircase used for want of better by Sir Martin Conway, and the personal names proposed by Mrs. Bullock Workman. When Mallory discovered the beautiful mountain west of Mount Everest now called Pumori on the maps of the expedition, he desired to call it Mount Clare, after his daughter. This could not be allowed, but "the map-makers in London, with the aid of a Tibetan linguist," invented the name Pumori, the Daughter Mountain, which fulfilled in spirit Mallory's intention. This was their happiest effort. Other peaks in the neighbourhood were called Pethangtse, Khartaphu, Khartachangri, not, if we recollect aright, by the geographers in London, but by Colonel Howard Bury in the field: peak-names fashioned on the analogy of Longstaff's Teram Kangri by annexing the Tibetan for peak or snowy mountain to a district name. There remained for treatment the principal summits on the Mount Everest massif, the South Peak, the West Peak, and the North Peak as they had been called provisionally. These were translated into Lhotse, Nuptse, and Changtse, and were so shown on the map of Morshead and Wheeler made from their surveys in 1921. In the map of Mount Everest and Environs, on the scale of 1 inch to 2 miles, published by the Survey of India in 1930, all these invented names are written between inverted commas, with the explanation "Tibetan names appearing in inverted commas are not used by the local inhabitants." The device was reasonable, but a little pedantic, if it was really adopted for the reason implied. Had Sir Sidney Burrard put these names into his tables in inverted commas no one could have complained. But we do not think he was justified in calling them E^1, E^2, E^3, in the tables of Part I, without a word of explanation until Part III was published in the following year. Nor do we find his eventual explanations sound.

Lhotse is not just inside the northern boundary of Nepal: it is on the watershed generally accepted as the boundary between Nepal and Tibet. Lhotse is not a satellite peak partly hidden by a giant companion. It stands up in full view in the panorama of Makalu and Mount Everest as seen from Sandakphu (Part I, Chart VI), but it was somehow missed by the triangulators. It stood up in full view of Mallory from the north-west ('Mount Everest: the Reconnaissance', Plate facing p. 218) and of Howard Bury from the north-east (Plate facing p. 138). If the South Peak is in the north of Nepal, it is in the south of Tibet, to which it belongs equally. And as for having to explain the name to the local inhabitants, it will at any rate be no more difficult than explaining E^1. For the intelligent local inhabitant may soon ask whether E is a regional initial, on the analogy of K, or an observer's initial, on the analogy of T or B, or why if the fourth highest mountain in the world is a mere satellite of the highest, it was not called E II, Mount Everest II, Mount Everest South, or South Mount Everest, for all of which there are precedents in Tables I to V; but no precedent for E^1 as a satellite of E. The case against Nuptse is a little better, for Nuptse is in Nepal, though it got named from Tibet. But Sir Sidney has not objected to Nuptse: he has just ignored the name and called the peak E^2.

The fact that these Tibetan-sounding names, invented in all good faith and with the best intentions to serve an urgent need, have been adopted on maps produced by the Survey of India, is in itself some justification for them. If future map-students are misled into drawing philological conclusions from them, they will be no worse off than those who study the name of the mountain called Kangchenjunga, Kanchenjunga, Kinchinjunga, Gans-chhen-mdzod-lnga, Kancan-jhanga; as well as Kong Lo Chu, Khumbh-Karan Langur, and otherwise (Burrard, pp. 26, 33, and 209–212). And if future travellers imagine that a district covered with Tibetan names such as Cho Oyu, Gyachung Kang, Lhotse,

and Pumori must have a resident population, they will have only themselves to blame.

"Scientists are not qualified to add to the nomenclature of the people." But geographers who take more interest in the high mountains than the people do have to find some way of naming or lettering or numbering the mountains. When they are in the country they may try to get their native followers to suggest names, as Major Mason did in the Shaksgam. But when afterwards at home they are working out their surveys and photographs, what are they to do? Imagination even aided by a Tibetan linguist soon fails. Does the "network of scientific points which have all been named by means of scientific symbols" assist them? Not in the least: for these are the points of the G.T.S. triangulation or intersection, and nothing can be added to them except by the Survey of India. One of the R.G.S. draughtsmen has been engaged for many months in making a provisional map of the Mount Everest neighbourhood, especially of the southern face, from photographs taken on the Mount Everest Flight, combined with Colonel Howard Bury's panoramas of 1921. We shall soon have hundreds of unnamed peaks and minor features identified on the photographs, and placed upon the map. Some method must be devised for reference from photographs to map, and *vice versa;* and the Survey of India method of sheet numbers for the peaks will be inapplicable. Not even Sir Sidney Burrard, writing for the Surveyor-General, could do anything better in this way than to invent the misleading series E^1, E^2, E^3. It is a real and urgent problem which has to be faced, and the Survey of India has given no lead.

Before leaving this vexed subject there are two matters of wider interest to be mentioned. In the spirited discussion following Major Mason's paper on Nomenclature in the Karakoram (read 12 May 1930), reported in the *Journal* for August 1930 (vol. 76, pp. 148–158), Sir Sidney Burrard said: "The Karakoram Mountains stand in Tibet"; and on June 2 he read a paper to the Royal Society, "The Geographical Representation of the Mountains of Tibet" (*Proc. R.S.*, ser. A, vol. 127), in which he said that "the main features of the Karakoram were determined . . . by Colonel Montgomerie's Surveys." An editorial note upon this paper, added to the above discussion in the *Journal*, remarked that Montgomerie was not concerned at all with Tibet. On p. 15 of Part I Sir Sidney takes us to task and maintains that Baltistan was called Little Tibet by Montgomerie, and the name "is still to be seen on the maps of the Survey of India": true, because the maps of Montgomerie may still be seen; but untrue of any maps published by the Survey in the present century. Further, in the first edition of the 'Sketch,' and so lately as in the above-mentioned R.S. paper of 1930, Sir Sidney spells the name Karakoram. In the second edition of the 'Sketch,' now under review, he has changed the spelling to Karakorum throughout, without, so far as we have discovered, any word of explanation. Whether the true pronunciation is best represented by *ram* (English "rum") or by *rum* (English "room" very short) is a matter on which authorities differ. But the Survey of India have spelled the name Karakoram in their publications and on their maps for many years, and it is disconcerting to find Sir Sidney Burrard using Karakorum without remark.

Part II is entitled "The Principal Mountain Ranges of Asia," but does not cover so large a field. It is largely occupied with the controversial subject of ranges and their names, and we cannot at this juncture usefully discuss the author's opinions. Some years ago our Society was invited by the Surveyor-General of the time to consider this question, and it became evident that nothing could be done without a map of the Karakoram area embodying all recent Surveys, and representing the relief by a system designed especially for the high

glaciated mountain areas. Such a map has now been drawn by the Society's senior draughtsman, and a preliminary edition, without any range names, will be ready in a few months. When it has been studied the Society will be in a position to resume the discussion which revealed such a lively difference of opinion in 1930.

Part III is nominally devoted to Glaciers and Rivers, but continually reverts to the controversies on peak names and ranges to which we have already referred. It contains a mass of information, but is not well arranged. Thus Chapter 18, "The Surveys of the Glaciers and of the Snows," mentions most of the principal expeditions of recent years, except the Mount Everest expeditions. Only in Chapter 21, "The Rivers of the Nepal Himalaya," do we find a brief reference to the Rongbuk Glacier: nothing of the East Rongbuk, nor of the Kangshung and Kangdoshung and Kyetrak glaciers, the Karma Valley, the Nangpa and Popti passes, and the Rongshar gorge, or of the many other contributions to Himalayan geography made by Colonel Howard Bury's expedition of 1921. A few lines on p. 169 mention Major Mason's exploration of the Shaksgam, but only in reference to the range question: there is no word of the Kyagar and Lungpa Marpo glaciers. The Duke of Spoleto's expedition which rounded off our knowledge of the valley is unrecorded.

We are compelled then, with real regret, to say that the second edition of this famous work gives a very inadequate picture of Himalayan geography in 1933. It is unequal and inconsistent, unduly controversial, sometimes unfair, and occasionally a little disingenuous. How far it represents the present opinion of the Survey is not clear; but it is published By Order of the Government of India. A. R. H.

THE DISASTER ON NANGA PARBAT

IN the great tragedy of Nanga Parbat in 1934 four German climbers and six of the finest Sherpa porters lost their lives; and the sympathetic concern of all Himalayan travellers was heightened by subsequent rumours of dissensions between the Europeans and the porters, of indifference to the fate of the latter, and of inadequate provision for their families. It is therefore a great satisfaction to know that a British officer of unsurpassed experience and authority in these matters, recently in Darjeeling, has spoken with the surviving porters, has found them absolutely satisfied with their treatment, perfectly ready to follow again the surviving climbers of the Nanga Parbat expedition, and quite undaunted by the catastrophe, while all proper provision has been made for the families of those who were lost. General Bruce's statement is confirmed by an official letter from the Himalayan Club addressed to the Alpine Club.

In a recently published book: 'Deutsche am Nanga Parbat: Der Angriff 1934,' Herr Fritz Bechtold gives the full story of the disaster; and we are indebted to Colonel E. L. Strutt, President of the Alpine Club, for the following account of this work:

Dedicated to the memory of the four Europeans and six natives who perished on the mountain, this is the narrative of the greatest of Himalayan tragedies. A miserable story of anticipated victory, of frustrated hopes, of final and complete disaster; of courage, of devotion, though of errors of judgment and leading if you will. In the manner of his telling, in the simplicity of his style, in his loyalty to comrades, Austro-German and Himalayan, Herr Bechtold has gained the respect and sympathy of every mountaineer. His book disposes effectively of those vicious rumours of indifference to the porters, emanating from anti-British sources in Kashmir, I believe, or possibly from the same mischief-maker who caused a strike among the Baltis by asserting that the Darjeeling men were receiving 5 rupees a day. From beginning to end of the expedition it is plain that Europeans and natives were in the best possible relation. The story is one long tribute to the thirty-five Darjeeling men and, reading between the lines, we realize mutual trust, mutual affection. The powers of the Sherpas and Bhotias have long been known, but still better is it to find well-deserved praise for the Balti men. It was, of course, impossible to fit out all these latter for really great heights; nevertheless some of the men carried 5000 feet and more of very steep and difficult glacier to Camp IV, at 19,000 feet, as often as thirty to thirty-two times.

At the start of the expedition all appears to have gone well. Conditions, weather, progress: all were satisfactory up to June 7, when Herr Drexel sickened and quickly died of pneumonia. This sad event, together with the non-arrival of the porters' rations, considerably delayed the assault. It was not till nearly a month later that Camp V (6600 m.) could be established, whence K_2 and the Muztagh Tower in the far Karakoram are stated to be visible. The Rakhiot peak was circumvented by a difficult and exposed rocky traverse, rendered safe by the fixing of nearly 500 feet of rope. This place is stated to be the extreme limit of difficulty for laden porters. The acclimatization of the party appears to have been very slow. From Camp VII, where

complaints of breathlessness among the Europeans were frequent, Herr Bechtold was obliged to descend with two porters suffering from mountain-sickness. He experienced great difficulty in bringing down the two completely exhausted men, but a fine performance resulted in all three, despite a storm, attaining Camp IV. To this enforced retreat the author and his companions doubtless owe their lives. Bechtold was under orders to ration the tents above him in readiness for the return of the victorious summit party, which, reduced from nineteen to the almost equally unwieldy number of sixteen, had meanwhile pushed on, the head of the column attaining a height of well over 25,000 feet before returning to Camp VIII, slightly lower down. The storm and its subsequent results are well known; the story makes painful reading. Herr Schneider's account has been published in the *Alpine Journal*, vol. 46, pp. 423–27, and I translate Herr Aschenbrenner's narrative (pp. 55–6):

". . . The dawn of July 8th brought in fact no improvement. A longer sojourn in the tents [these appear to have been very bad] became almost unbearable, while further advance towards the summit was quite senseless. At 8 a.m. Wieland came to our tent. We were all agreed that the first assault was defeated and nothing was left but retreat to Camp IV. This was a sad decision in view of the peak's proximity, but when the order came that Schneider and I were to proceed to break the trail with three porters, we prepared for the descent. We had the greatest difficulty in arousing the porters from their warm sleeping-sacks to face the howling storm. While I roped up the porters, Schneider decided with the others what should be left behind for the next attack. No one complained of any sickness: we were all in good condition. At the time of our departure Merkl, Welzenbach, and Wieland were already equipped for the descent and we were positive that they would follow at once. On attaining the *Silbersattel* the storm increased so much that we could descend the steep slopes only with the greatest precautions. Pinzo Nurbu and Nima Dorji were going very badly, while Pasang was in his best form. We had with us two sleeping-sacks, one for the porters and one for ourselves. Schneider was leading, the porters were in the middle, while I was last man, ready at any moment to check a slip. About 100 m. below the gap Nima Dorji was hurled by the storm from his steps and only with the greatest difficulty could Pasang and I hold him and thus avoid certain disaster to all. But the storm had torn the sleeping-sack from his shoulders; before our eyes the great mass sailed away like a balloon over the Rupal slope. We five men were left with but one sleeping-sack. Consequently it was of vital necessity to attain Camp V or Camp IV on the same day, if we wished to avoid death from freezing. In the raging blizzard we could not see 10 metres in any direction, and of course went frequently astray. To avoid these wanderings, fatiguing for the porters, we unroped over the not difficult terrain near Camp VII. On one occasion as the storm for a moment tore asunder the clouds, we perceived the second party coming down over the *Silbersattel*.

"In Camp VII the abandoned tent was still standing. On the way to Camp VI great lassitude overcame me. Every 30 metres I was compelled to sit and rest on the snow for a space. The snow particles were driven like red-hot needles against our burning faces. Our porters had vanished from

the zone of vision, but we surmised they were close behind. In any case they would be collected by the following party. In Camp VI the abandoned tent was deeply snowed in. In the complete lack of visibility, we considered it better to climb *over* the Rakhiot peak and not to turn it, although this entailed an ascent of 150 m. I had recovered again, but Schneider was overtaken by the same fatigue that I had now overcome. The descent over the steep exposed rocks of the Rakhiot north ridge put him to rights again. Lower down by the fixed ropes we descended quickly to Camp V. In the tents we found certain high-altitude rations besides sleeping-sacks. We ate heartily and recovered so well that we decided to descend to Camp IV. We arrived there late in the afternoon, joyfully received by Bechtold, Bernard and Müllritter. At last we were in safety, as if in an Alpine shelter-hut."

The party waited but no one arrived. The *Sirdar*, Lewa, was summoned next morning to a conference, but in the storm neither Europeans nor porters could do anything. At 11 a.m. to the dismay of all ranks a momentary clearing showed a large party descending but still no further on than the *Silbersattel;* disaster was imminent. The storm continued, snowing up the tents so that egress became almost impossible. In the afternoon of July 10, seven or eight persons were perceived descending the ice slopes of the Rakhiot peak, leaving an enormous furrow behind them. Finally the rescue party met but four porters, so exhausted that one of them plunged helplessly over a sérac wall. They were conveyed to the tents by the inexhaustible but dreadfully overworked Dr. Bernard.

And so the lamentable story continues: ceaseless efforts to ascend, endless defeats in bottomless masses of fresh and driven snow. A porter is found lying dead in the snow near Camp V, two more can be perceived dead among the ropes of the Rakhiot peak. Survivors and rescue party see nothing left save to abandon Camp IV on July 13. On that day however comes the last sensation. Three figures can be seen staggering down the ridge below Camp VII, the storm wafts faintly cries for help; there is yet another vain effort at rescue. Finally in the evening of July 14, frost-bitten and starving, from the very jaws of death, comes Angtsering the superman. He relates the end of Wieland and Welzenbach, the certain fate of Merkl the gallant leader, the last to perish in the post of honour, the extreme rearguard, together with the porter Gay Lay. Perhaps "the latter might have saved himself on July 14th with Angtsering, but remained with his Sahib-leader, faithful unto death" (p. 61). The last desperate but useless attempts were made on July 15, 16, and 17 by Schneider, Aschenbrenner, Raechl, and Misch; their efforts penetrated no farther than Camp V. But cries for help could still be heard on the ridge on July 16, though the waving figure, seen earlier above, had vanished. Camp IV was then evacuated, the sick and wounded porters were led or carried down by the Baltis under Lewa. Nurbu, Sonam, and Ramona the expedition cook were the last to leave.

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NANDA DEVI AND THE GANGES WATERSHED: *A paper read at the Evening Meeting of the Society on 4 February 1935, by*

ERIC SHIPTON

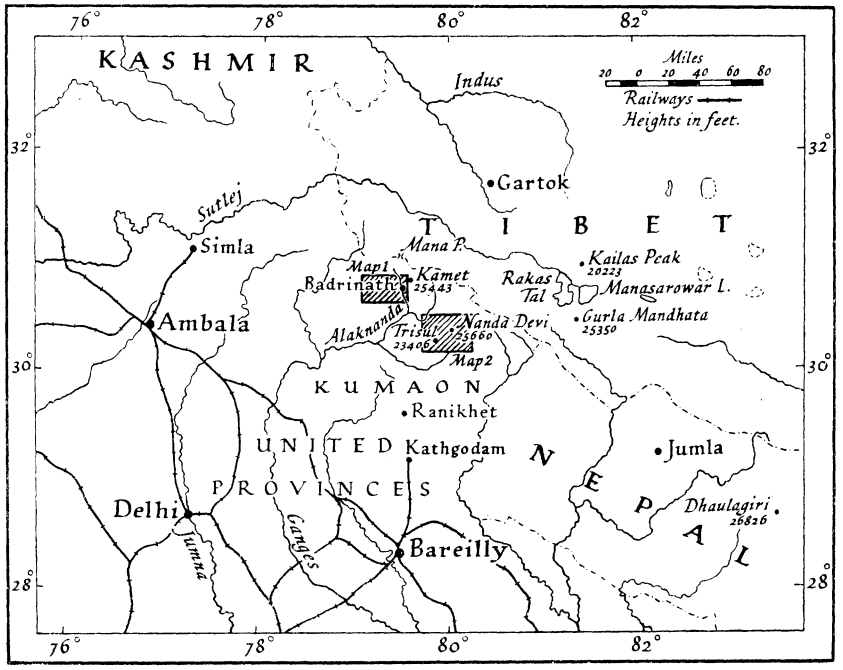
THE section of the Himalaya which gives birth to the river Ganges is perhaps the most visited portion of that vast range. A hundred thousand pilgrims throng each year to the sacred Hindu shrines of Badrinath, Kedarnath, and Gangotri, which are situated near the three main sources of the Holy River. A mass of fascinating legends and semi-mythical stories centre round these parts. Of these Hindu literature is full. This being so, it is curious that to this day the geography of the peaks, glaciers, and less accessible valleys of these parts is very little known, and vast tracts of country still remain unmapped and unexplored.

It is difficult to account fully for this fact. The country lies almost entirely in British territory, and no political difficulties have to be overcome before an expedition is allowed to visit it. Moreover the transport of supplies and equipment over the foot-hills to a suitable base is a simple matter, the organization of which does not require any previous knowledge of the country. There is only one obvious reason why there still remains so much minor exploration to be done in those parts, and that is the extraordinary character of the mountains and valleys themselves. These certainly present quite unusual difficulties of access. When I decided to take a small expedition to the Garhwal Himalaya this year I had plenty of choice and decided after due consideration to attempt to make a thorough exploration of the range which forms the watershed between the Badrinath, Kedarnath, and Gangotri valleys.

No one attempting mountain exploration in the Himalaya can afford to miss an opportunity of discussing his plans with Dr. Longstaff. When he gave me that opportunity therefore I accepted it with avidity. He was kind enough to give me two days of his time in spite of the fact that he was himself leaving for the Arctic in a short time. As a result of those two days, the Badri-Kedar watershed became a thing of secondary importance, and I had determined to make an attempt to force an entrance into the hitherto inviolate sanctuary of the Nanda Devi basin. I am glad that Dr. Longstaff is one of the very few who can fully appreciate the debt I owe him for this change of programme. I am

deeply indebted also to Mr. Hugh Ruttledge for much valuable advice and encouragement.

Regarding Nanda Devi I need not say much. It is the highest mountain entirely in British territory, and yet, though several expeditions had tried to reach it, no one had so much as penetrated to the glaciers which rise at the feet of the great mountain. The main difficulty lay in the fact that the peak is encircled by a vast amphitheatre of mountains which, I believe, is unique. It is hard for any one who has not studied the phenomenon at close quarters to form an adequate conception of this gigantic rampart, in places over 22,000 feet high, enclosing a bit of country, itself not above the limits of dwarf trees,



The Garhwal Himalaya, showing areas of Mr. Shipton's explorations

out of whose centre there rises a stupendous peak, 25,600 feet. The interior of this circle had never been visited and the foot of Nanda Devi never reached.

The water rising from the glacier system of this basin flows to the west through a narrow gorge, the Rishi Nala, which forms the one break in the huge amphitheatre. One would naturally suppose that the best line of attack would lie here, but the extraordinary difficulties of the gorge are such that, since Dr. Longstaff visited it in 1907, all aspirants to reach the foot of Nanda Devi have attacked the mighty walls of the basin.

As early as 1883 that redoubtable Himalayan explorer, W. W. Graham, accompanied by two Alpine guides, Emile Boss and Ulrich Kauffmann, made two determined attempts to force a route up the Rishi Ganga. The first was frustrated at the very mouth of the gorge by sheer walls of rock. Later, he contrived to avoid the lower part of the gorge by making a big detour to the

north, and, after overcoming immense difficulties, he contrived to force a re-entrance into the valley higher up. Here he was deserted by his porters, local men who believed the valley to be the abode of demons. Undaunted, he and his guides struggled on alone, but were at last forced to admit defeat by the sheer difficulties of the gorge.

Others tried later with less success. But it was not until 1905 that Dr. Longstaff devoted his indefatigable energies to the problem of gaining access to the Nanda Devi basin. In that year he was accompanied by the two Brocherels of Courmayeur. They approached the mountain from the head of the Milam Valley, which bounds the Nanda Devi group on the east, and ascended the Panchu Glacier, crossing a new snow pass at its head. This brought them on to the Lwanl Glacier running parallel with the Panchu, and not into the Nanda Devi basin as their map had led them to expect. They descended to the main valley for supplies, and shortly afterwards re-ascended the Lwanl Glacier. After three days' climbing they gained the Kumaon–Garhwal water parting, which forms at this place a part of the rim of the Nanda Devi basin. From here for the first time in history they looked down on to the glaciers at the southern foot of the great mountain. A descent on the other side of the ridge was found to be impracticable.

Further exploration of the group was made in 1907 by Dr. Longstaff, General Bruce, Mr. A. L. Mumm, and three Alpine guides. Their first objective was the Rishi Valley. Examination of the lower gorge decided them to attempt Graham's route, the first part of which was known to the Tolma and Lata shepherds. But they were too early in the year and found too much snow to allow them to make a passage of the Durashi pass. The party moved round to the Bagini Glacier, and after several days of difficult mountaineering, crossed a 20,000-foot pass at its head. Again they were disappointed. They had hoped that the pass would lead them onto a glacier flowing down into the Nanda Devi basin; but on descending the glacier they found themselves in the Rishi Nala at a point below that which Graham had reached in 1883. It was soon after this that Dr. Longstaff made his famous ascent of Trisul.

Afterwards he visited the mouth of the upper gorge. I should like it to be understood that no serious attempt was made by the party to force a route up this upper gorge and that Dr. Longstaff did not have the time or food enough to do so. Several attempts to get into the basin were made since that date, notably those of Mr. Hugh Ruttledge, who, in 1932, tried with the guide Emile Rey to cross from Maiktoli, a gap at the head of the Sonadhunga valley on the south.

It is a mountaineering axiom that each successive attempt upon a problem makes that problem easier to solve. Few great mountains were climbed and few passes crossed at the first attempt. The man who eventually reaches the summit of Mount Everest will have done so, not by his own efforts alone, but over the shoulders of the pioneers—Mallory, Norton, Somervell—without whose hard-won experience he would have stood no chance. It should be clearly understood therefore that what measure of success we have had this year we owe primarily to those who had gone before us.

It was our plan to attempt once more to get up the Rishi Nala. Our first project was to get a month's provisions to the junction of the Rhamani stream

with the Rishi, which was about the farthest point previously reached in this direction. From here Dr. Longstaff advised us to attempt to force a way across the cliffs of the southern side of the gorge.

It was necessary to conduct the expedition with the strictest regard to economy. Careful accounts were kept of expenses both in England and India. The total cost worked out at £287. We were in the mountains for just under five months. On Dr. Longstaff's advice the party was a small one, and I was extremely lucky in having four ideal companions. They were H. W. Tilman, with whom I had climbed a good deal in East and Central Africa; Angtharkay, who was one of the two Sherpas on Mount Everest last year who sat through that three-day blizzard at Camp 5 and then volunteered to carry to Camp 6; Passang Bhotia was another Camp 6 man; and lastly Kusang Nangir, a man of extraordinary toughness and imperturbability.

The party reached Ranikhet on May 9. We engaged twelve Dotial porters for the march across the Kuari pass and left Ranikhet early on the morning of the 11th, reaching Gwaldam the same night. For nine delightful days we wandered through the lovely foot-hills of the range, over passes clothed with pine, oak, and rhododendron woods. Here and there we obtained superb views of the peaks we were making for. An early morning view from the Kuari pass showed us that wonderful panorama in its most inspiring setting.

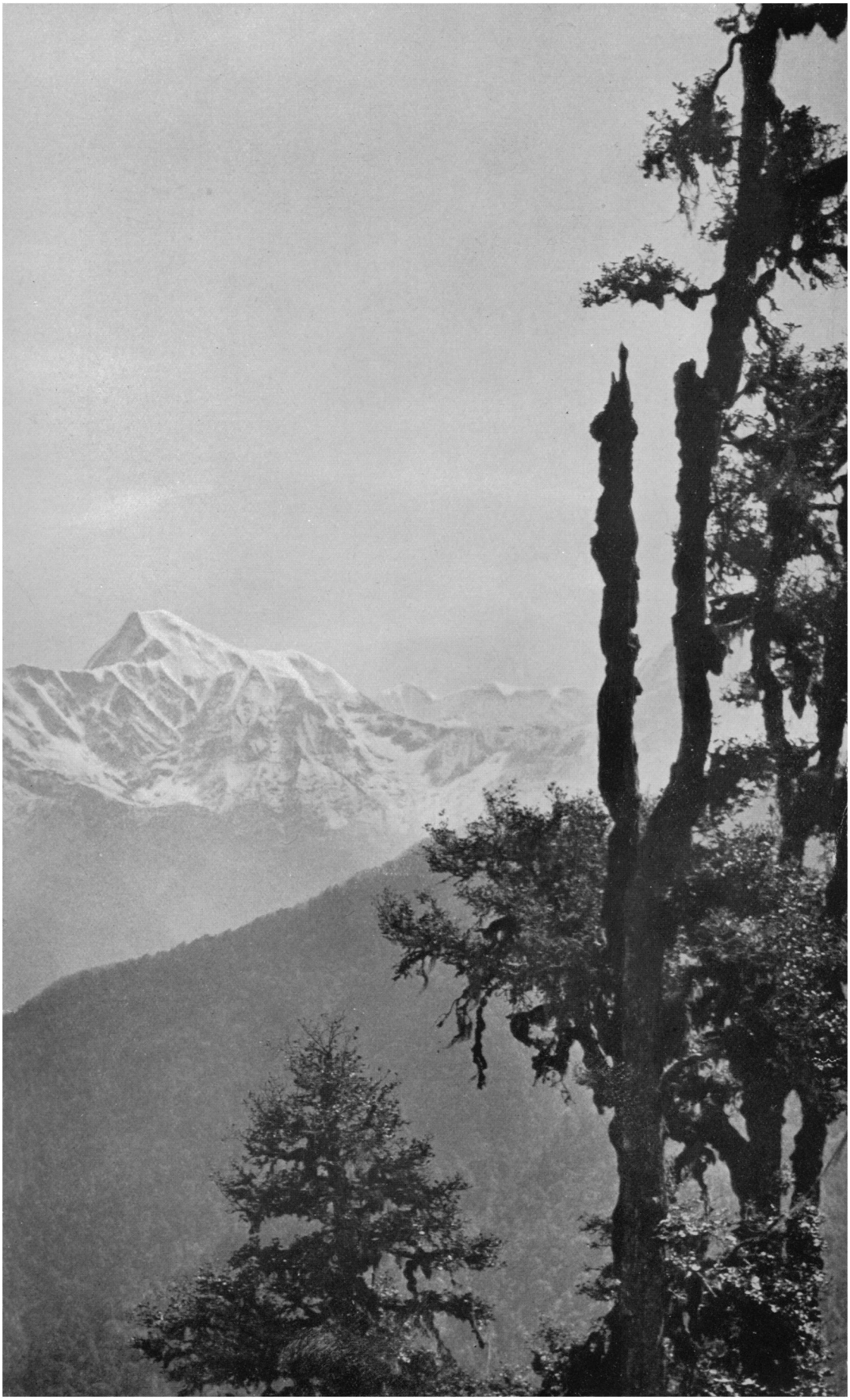
We reached Joshimath on the 19th and spent a busy day in the arrangement of our bandobast. Eleven of the Dotials requested to be allowed to remain with us as long as we required porters. With them we left Joshimath on May 21. On May 22 from Tapoban, in the Dhaoli valley, three of the party ascended the little Lata peak so as to get a view up the Rishi Ganga and to get started with our plane-table, descending that evening to Surai Tota.

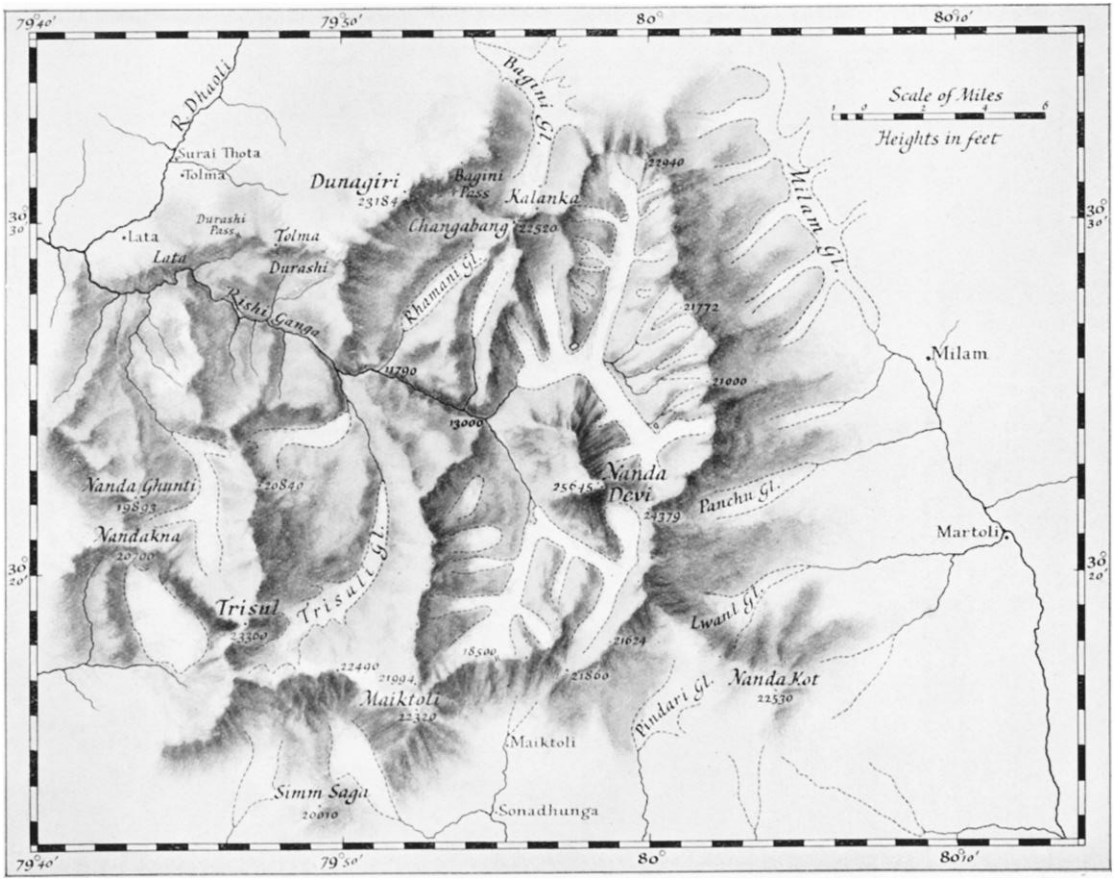
The following morning we collected supplies of food at Surai Tota and engaged the services of eight more local people to help with the transport and to supply local knowledge for at least the first part of the route. We left the same morning (May 23). It was early in the season and there was a great deal of snow on the passes which constitute Graham's "back-door" entrance into the middle section of the Rishi Nala. These passes are used in summer by the Lata and Tolma shepherds of the Dhaoli valley, who take their sheep across them to a little alp known as Durashi.

The Surai Tota men deserted us after the first day. This produced a serious crisis which threatened to destroy at the very outset our plans for the exploration of the Rishi Ganga. For, in these parts, a very short time remains between the melting of the winter snows on the lower passes and the breaking of the monsoon. However the Dotials shouldered enormous loads and followed us with wonderful determination and loyalty.

Being now without the help of local knowledge we floundered for nearly two days through snow waist-deep before we could get across the passes to Durashi. Part of the route lies across some cliffs at an altitude of 14,700 feet. From here we could look down an 8000-foot precipice into what must be one of the most fantastic gorges in the world. It has never yet been penetrated by any human being and it is believed by the local people to be the abode of demons: a superstition we were quite ready to share. The river, only just visible in the depths below us, sent up a roar like that of Niagara.

Nanda Ghunti from above the Wan Pass





The Nanda Devi basin, from a plane-table survey by E. E. Shipton and H. W. Tilman

In making our way along the northern flanks of the Rishi Valley we were again greatly handicapped by the lack of local knowledge, which the Surai Tota men would in all probability have provided. The flanks of the valley are steep and cut into innumerable ravine-like gulleys. We were constantly reaching some cut-off which could be avoided only by making a big detour. It was terribly hard work for the Dotials, who carried their huge loads with remarkable skill and courage. Also we kept them at it all day, as food was a vital consideration and each extra day we spent in getting to our base meant three days less for our work beyond.

We kept to the northern side of the valley until a mile or so beyond the junction of the Trisuli stream. Then we bridged the river and crossed to the southern bank. Late in the evening of May 28, in a heavy snowstorm, we reached the point where the Rhamani stream flows into the Rishi from the north. Here under the overhanging walls of the canyon we established our base. The Dotials were discharged and early on the following morning they started down the valley, leaving us to our own resources.

Our next task was to find a route through the unknown upper part of the Rishi Nala into the Nanda Devi basin, now barely 4 miles distant. Our base camp was on the southern shore of the river, at a point where the gorge forms one of its narrowest bottle-necks. We made our height 11,800 feet, which agreed well with Dr. Longstaff's reckoning. Dr. Longstaff had advised us to concentrate our search for a route mainly on the southern side. Indeed it was not long before we saw how utterly impregnable the cliffs of the northern side were. They rise straight out of the river-bed, seemingly without a break, and culminate in peaks of 20,000 odd feet.

We started at once upon our hunt for a route along the southern wall of the canyon. It was absorbing work and we spent our time being led alternately into a state, first of wild excitement, then of exasperation, as we traversed along some narrow ledge to some impassable cut-off. Looking at those grim, relentless cliffs, the chances of a continuous route along their precipitous sides seemed very slender indeed, and it was only due to a series of freak rock formations that, after an exhaustive search, we succeeded in effecting a passage along a series of delicate traverses over giddy drops to the river, 1000 feet below. Several sections of the route had to be roped up. Food and kit were then carried up in relays.

The last half-mile of the gorge looked so hopeless that we decided to try a route along the river-bed itself. When the river was low we actually succeeded in getting through that way, though we had to ford the stream six times to do so. We found it impossible however to get our loads up, and after some unpleasant adventures were obliged to abandon the route and search for another. Later we came to regard these river crossings as most serious obstacles. One's legs were numbed by the icy water and lashed and cut by innumerable stones swept down by the river. We found that when the water reached our waists it was impossible to resist the current. The usual procedure was for the first pair to cross holding hands for mutual support, then the others would follow hanging on to a rope stretched across the river.

Careful search revealed a continuation of our route 2000 feet above the river on the southern side, and on June 6, after nine days' work (from our base in

the Rishi Valley) we established an advance base (13,000 feet) in the Nanda Devi basin, with sufficient food to last our party of five for three weeks. We had left food dumps at intervals down the gorge.

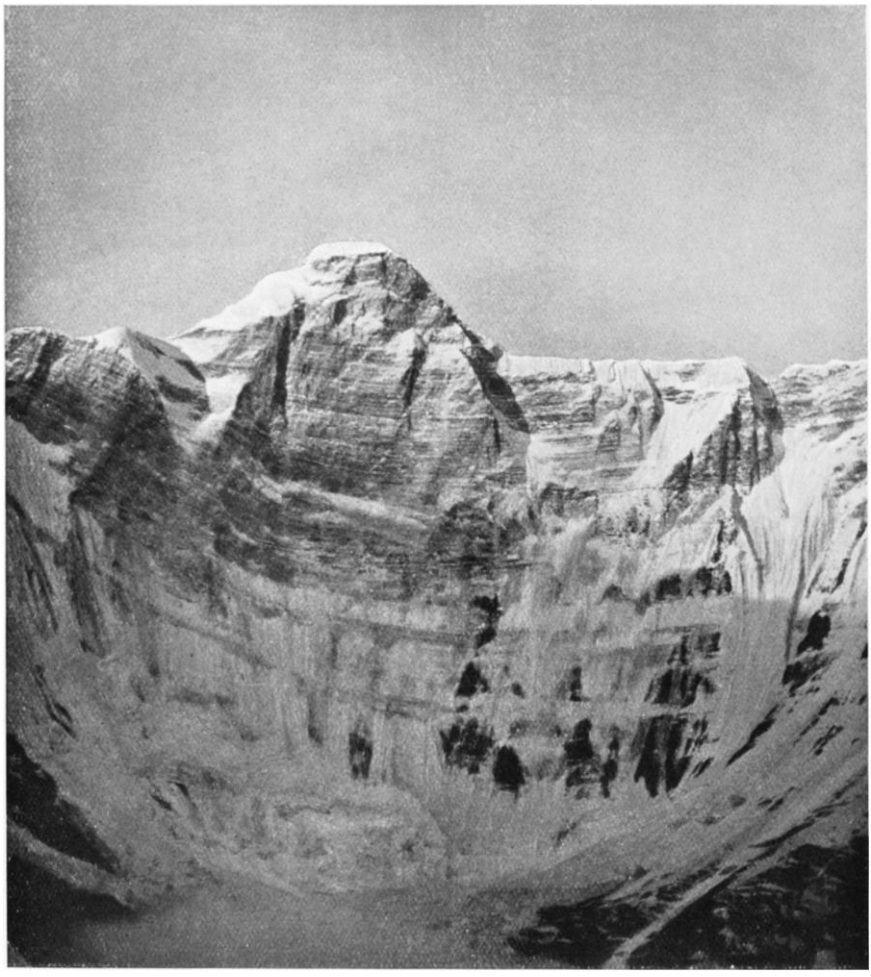
The country we were now in is an extraordinary freak of nature, and is, to the best of my knowledge, unique. As I have said, it is enclosed by a gigantic rampart of scores of peaks between 20,000 and 23,000 feet in height. The only breach in this amphitheatre is the gorge we had just come up. In the centre of the basin rises one of the most colossal masses of rock in the world, the majestic peak of Nanda Devi, whose sides are so exceedingly steep that even the plastic Himalayan ice can find little room to cling. North and south of the peak flow two great glaciers, the streams issuing from which unite some miles below the snouts of their respective glaciers and form the Rishi Ganga, which later adds its water to the Ganges. A large number of subsidiary glaciers flow down from the peaks of the amphitheatre to the main glaciers.

With a bare three weeks at our disposal we decided to concentrate on the exploration of the northern section of the basin, and to return if possible after the monsoon to investigate the country to the south of Nanda Devi. The interior of the basin was very different from what we had expected. I had pictured deep, steep-sided valleys entirely filled with moraine-covered glacier. Actually we found the country to be wonderfully open. There were extensive areas of rich pasturage, gay with wild flowers, and lakes on whose deep blue and green surfaces were reflected the icy crests of the great peaks. We found too a considerable variety of birds, and large herds of tar and bharhal, which were so tame and regarded these strange new visitors into their country with such curiosity that I was very glad not to have brought a rifle with which to supply ourselves with food.

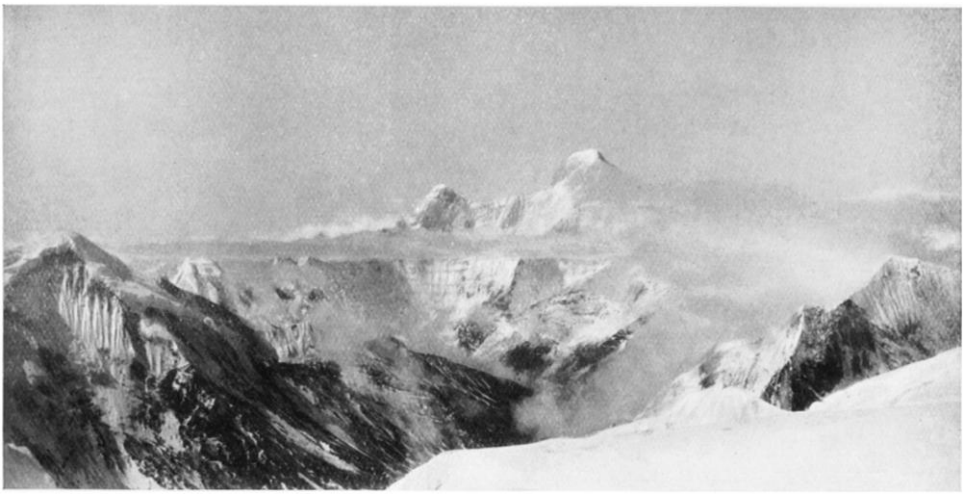
In consequence of the open country we found travel to be much easier than is usual in the glacier regions of the Himalaya. This was a welcome change after our recent experiences in the Rishi Nala. Nevertheless we had an exceedingly busy time and none to waste. The first two days in the basin were spent in ascending various points above the snout of the main north glacier, which commanded views suitable for our plane-tabling. We soon found how exceedingly difficult it was to identify any of the triangulated peaks on our graticule sheet with any degree of certainty. Over-confidence in this respect led us into a lot of trouble at first; and it was some time before we came to know which points we could trust, and to build from them a network of suitable fixed points inside the basin.

On June 9 we reached a beautiful little lake, about 8 acres in extent, near the junction of the three biggest glaciers of the northern section. The main north glacier takes a sharp southward bend hereabouts, and is joined by a very large glacier coming in from the north. This came to be known as the Great North Glacier. Half a mile farther south another ice-stream comes in from the combe formed by the ridges of the two majestic peaks of the G.T.S. A.21: Changabang and Kalanka of Longstaff's map. Tilman suggested the name Changalanka for this glacier and seemed disappointed when I expressed my doubt if it would be accepted by the authorities. The difficulty however was overcome when we subsequently discovered another big ice-stream flowing from the north-east face of Kalanka. A camp on the farther side of the Great

The north face of the main peak of Nanda Devi



North face of eastern peak of Nanda Devi, 8000 feet above the glacier



The twin peaks of Nanda Devi from the ice-plateau at the head of the Great North Glacier

North Glacier served us as a main base for the rest of our stay in the northern section. For convenience we called it Junction Camp.

Our first task was to investigate the valleys coming in from the eastern rim of the basin. For the sake of convenience we numbered these, starting from the south. It was our plan to put light camps in each of the valleys in turn; these were to be occupied by Tilman and me, while the Sherpas worked between the lower camps and the higher. A remarkably broad strip of grassland ran outside the well-defined lateral moraine of the main glacier; this provided us with a high-road almost up to the head of the main valley.

From our camp in lateral valley No. 1 we were able to see to its fullest advantage the colossal northern face of the twin peaks of Nanda Devi. From the summit ridge it falls in one unbroken sweep to the glacier which lies at its foot. For hours on end, in every combination of light and shadow, we were able to gaze upon that cirque, but I never got tired of doing so or lost my early amazement at the sight.

Above this camp, at an altitude of about 18,000 feet, I came upon a bharhal. It was about 25 yards away and we stood and looked at one another for some minutes before the animal moved slowly away. Unfortunately I had not got my camera with me at the time. A taste for mountaineering seems to be the only explanation for these creatures visiting such altitudes.

We succeeded in reaching a 20,000-foot col on the eastern rim above Glacier No. 2, and from it climbed a peak of about 21,000 feet (June 11). From these points we got views to the east over an extraordinary tangle of peaks in the Milam district.

Within half an hour of returning to our high camp after climbing the peak I was stricken by a fever. It started by a violent attack of shivering and an acute pain in the top of the right leg. It lasted for about thirty-six hours, was accompanied by some mild delirium, and left me as suddenly as it had come. Nearly a week later Tilman was confined to his bed by a complaint exhibiting almost exactly similar symptoms.

We reached another point on the eastern rim above Glacier No. 3, also above 20,000 feet. We were anxious to find a practicable route out of the basin in this direction but from the points we reached we could see no way down on the other side. Throughout the whole season we struck vile snow conditions. This was one of the most serious obstacles we had to contend with.

On June 16 we started up the Great North Valley. Travel here was considerably more difficult. The glacier is a good deal longer than the main one above the junction and has a number of considerable tributaries coming in from the ridges of Kalanka and from the peaks of the "rim." It rises from an extensive snow-field between G.T.S. peaks 113 and 110. In bad weather we pushed a camp high up in this direction, and spent some days investigating the complexities of this great ice plateau. We reached a col of some 20,500 feet between the two peaks. From here we looked straight down on to the moraine-covered Bagini Glacier, a sheer drop of nearly 5000 feet. We also made two attempts (June 19/20) to climb peak 110, which is nearly 23,000 feet high. On both occasions we failed on account of dangerous snow conditions. We were anxious to get up it, primarily in order to get a more comprehensive

idea of the complex topography of the country to the north. Our time in this fascinating valley was all too short.

As we descended (June 22) the glacier once more we found that there was an alarming increase in the rate of melting of the ice. The surface streams were enormously swollen and from deep down in the bowels of the glacier there came an ominous roar. Before we could reach the southern bank of the Rishi we would have to ford both the northern and the southern streams and we were in some danger of being cut off.

On June 24 the monsoon broke. This surprised us as we had not expected it for at least another two weeks. On the 25th we began our retreat to the Rishi Ganga. Our fears regarding the state of the rivers were well founded and we had a very tough job to cross the one below the snout of the Main North Glacier. Lower down we found that the Rishi was in flood. We were forced to cross it by a natural rock bridge below our base camp and to climb for 2000 feet up the Rhamani gorge before we could find a possible line of traverse. Our dumps of food were small and we were delayed by weather and conditions so that we had to press on as fast as we could. Tilman, during our last few days in the basin, had developed a carbuncle on his foot and these forced marches must have caused him considerable pain; but he insisted on carrying his share of the loads and never murmured a word of complaint. Crossing the Durashi Col on July 1 we reached Joshimath in pouring rain on July 2. Here we spent a few days resting, eating, and making plans for our next move.

To the north-west of Joshimath lies the Badrinath range, which gives birth to the three sacred rivers, Bhagirathi, Mandakini, and Alaknanda, the three head streams of the Ganges. Though the birthplace of the Holy River of India is the goal of all devout Hindus, surprisingly little is known about the topography of the watershed itself. Our chief concern last year lay in the Nanda Devi basin, but it was decided to devote the monsoon period, when heavy rain and snow would make work so far south impossible, to an attempt to make a complete crossing of the range from Badrinath, first over to Gaumukh at the source of the Bhagirathi, and then over to the Kedarnath valley-system at the source of the Mandakini. In this way we hoped to connect up the sources of these three rivers. We hoped also to be able to trace the watershed as far as time and weather permitted, and to fill in roughly some portions of what might well have been left a blank space on the Survey of India Maps.

Several expeditions had visited various parts of the range. Before the War, Mr. C. F. Meade with the two Alpine guides, Pierre and Justin Blanc, went up the Alaknanda valley and, reaching a gap in the range, were able to look down on to the glaciers flowing to the north-west. In 1931 the Kamet Expedition spent two weeks exploring the head of the Arwa valley and discovered two passes, which if crossed completely would undoubtedly lead eventually to the Gangotri glacier; while in 1933 an expedition led by Mr. Marco Pallis visited and explored the lower reaches of that glacier, perhaps the longest in the Central Himalaya.

We reached Badrinath on July 11, and on our arrival we received a welcome visit from Master Ram Serikh Singh, former Professor of Philosophy at the University of Bhagalpur. The Professor has now retired and spends the

summer months in solitary contemplation in one or other of the beautiful alpine glens near Badrinath. The word professor perhaps conveys the wrong idea of the man, for he was a robust and imposing figure whose whole appearance harmonized with the magnificent mountain scenery amongst which he lived. He was kind enough to spend the whole evening with us, and gave us a fascinating discourse on the history and mythology of those parts, on which subject his knowledge appeared to be boundless. He has travelled extensively and has made, among other journeys, the pilgrimage round the holy peak of Kailas, in Tibet. From him we received a great deal of encouragement in our project.

The next morning we left Badrinath and made our way along the northern bank of the Alaknanda. We had with us enough food for more than three weeks and eight local coolies to assist with the transport as far as the head of the valley. Friday the 13th lived up to its evil reputation for providing ill luck. We were confronted early in the morning by a stream of quite moderate dimensions, as compared with the ones we had encountered in the Rishi Nala. While fording it Passang lost his footing and was swept away load and all by the current. Fortunately for him his load broke loose and sailed down the stream, and he managed to save himself from having his head dashed against the rocks. He lost his ice-axe and in trying to rescue the load Tilman lost his. The load was stopped and brought in before it was swept into the Alaknanda, where it would have been irretrievably lost. Passang was badly shaken and later the loss of the ice-axes proved serious.

Three days' march from Badrinath took us to a point some 5 miles up the Bhagat Kharak Glacier (pronounced Bhagrathi by the natives). There the valley takes a gradual bend of some 37° to the north. Opposite us there rose a massive snow peak which we identified as the G.T.S. peak Kumaling, 23,420 feet high, the highest peak of the Badrinath Range. To its right lay the col visited by Mr. Meade. The route to it appeared to us to be in danger of being swept by ice avalanches. We took the local porters on for another day, carrying heavy loads of juniper firewood collected lower down the glacier, and camped right at the head of the moraine-covered part of the main glacier at an altitude of 16,200 feet. From here we discharged them and were left again to our own resources. On the following day (July 16) Tilman and I climbed a peak which commanded a superb view of the cirque of mountains which encloses the head of the Bhagat Kharak. The cliffs of this cirque are some of the most precipitous I have seen.

After making a rough exploration of the lateral glaciers of the cirque we started northwards. We were carrying enormous loads and our progress was rather slow. The weather too, which had been fair up till this time, became bad. The snow conditions were abominable, and however early in the morning we started we never found a surface crust to prevent us from sinking in up to our knees and even to our waists. In all my mountain experience I have never struck such continuously bad snow conditions. Things had been very different when we were in the Arwa valleys about the same time of year in 1931.

During the next week we crossed a series of passes to the north, each between 17,000 and 20,000 feet high. This landed us in the Arwa glacier system, and we were thus able to connect up the lateral valleys of this part of

the watershed. We climbed (July 22) another peak of 21,000 feet which provided us with excellent mountaineering but no view.

As we got farther north the mountains took on a more rounded appearance, which suggested that we were approaching the border of the Tibetan plateau. We passed several of those curious glaciers which are such a typically Tibetan feature and which appear to have no névé. Having reached the glaciers of the Arwa system we turned west and crossed the main watershed on July 25 by a col of 19,400 feet, probably one of those visited by Captain Birnie in 1931. From now on we left dumps of food and fuel against our return. This lightened our loads and we were able to press forward at a good speed.

When we reached the Gangotri glacier two days later we were surprised to find that we were only about $2\frac{1}{2}$ miles above its snout. We camped here in a little garden of wild flowers, which provided us with a welcome contrast after so long amid the harsh colourlessness of the glacier regions. The following day (July 28) we went down to Gaumukh, chief of the sacred sources of the Ganges. Thus for the first time had a route been made across the range between the headwaters of the Bhagirathi and the Alaknanda rivers.

Half a mile above the snout of the Gangotri glacier another large valley comes in from the north-east. How this fits into the puzzle of the northern part of the range I cannot say. A whole season devoted to the exploration of this fascinating section of the range by a competent party interested primarily in the unravelling of topographical problems should produce interesting results.

We would have given much to have been able to make a push for the untrodden upper reaches of the Gangotri glacier, and if we had had four days' food to spare I think we would have been able to reach its head. But our food was exhausted and we had to make all possible speed back by the way we had come. Our return journey was a lot easier for having no food to carry, as each evening we picked up one of the dumps we had left. From the head pass we made our way down the Arwa valley in bad weather and so reached Badrinath on August 2.

Of the many legends of these parts believed to have been founded on fact is a story that, many hundred years ago, there was no high priest of the Kedarnath Temple, and that the high priest of Badrinath used to hold services in the temples of both places on the same day. The shortest known route between the two temples was well over 100 miles, and over a high mountain pass at that. Tradition has it that a quick way across the watershed was known to the priests of those days. But though the natives believe that the two places are only $2\frac{1}{2}$ miles apart, in actual fact the distance is some 24 miles as the crow flies.

Our observations from the Bhagat Kharak had suggested to us that if a pass could be forced from the head of the Satopanth, it would lead us into the Kedarnath valley system. If this proved to be the case we should stand very little chance of getting down on the other side owing to the immense depths of the valleys there. However a view from the crest of the ridge would solve for us many interesting problems. We had intended to return to the Rishi Ganga about August 10, and August had already come round. But by now we were thoroughly absorbed in the manifold problems of the watershed, and to have to come away without investigating the head of the Satopanth glacier would have left our task only half finished.

A peak on the eastern rim of the Nanda Devi basin

A dense mantle of cloud still hung over the peaks as we left Badrinath and plodded once more up the valley towards Mana on August 5. We had brought with us provisions for only twelve days, and four local men to assist with the load-carrying up the lower part of the Satopanth glacier. Remembering our little contretemps with the Bhasudhara stream a few weeks before, this time we kept to the southern bank of the Alaknanda. When we reached the junction of the glacier we bore to our left and followed a lateral moraine of the Satopanth glacier. We found that this branch was the more frequently visited of the two, and that the grazing extended far up the side of the glacier. Some tiny shrines and quantities of prayer flags suggested that this part of the country was as sacred as Bhasudhara itself. The going was easy, and in three days we were able to pitch camp (August 7) near the head of the Satopanth glacier. From here we discharged the local men.

Early in the morning of August 8, carrying heavy loads, we started towards an obvious gap below the tremendous southerly walls of Kumaling. Throughout the day we worked slowly up the ice-fall which forms the head of the Satopanth glacier. But at length, when only 1000 feet from the col, we were brought up by a huge crevasse which, running from one side of the glacier to the other without a break, formed an impassable barrier. We were forced to camp where we were in heavily falling snow. Throughout the night the gulleys and hanging glaciers of Kumaling kept up a continuous bombardment of ice avalanches from which however we were protected by the crevasses about us.

The following day, in thick mist and falling snow, we managed to find our way off the glacier on to some rocks to our left, and by the middle of the afternoon we reached a level expanse of snow which forms the crest of the col. We hunted about to try and get some idea of our surroundings, but visibility was restricted to a few yards, and at length we decided to remain where we were lest we should blunder into some avalanche-swept area. For the next eighteen hours the heavy mist enveloped us. It was extremely tantalizing, as we were far from sure where the gap was leading us to. I had an idea that we should find ourselves at the head of the Gangotri glacier.

At 7.30 the next morning (August 10) Tilman and I set off to reconnoitre. The snow had stopped falling and our tracks provided sufficient safeguard against the possibility of losing ourselves. We worked down for twenty minutes before we were brought up on the brink of an ice-cliff. We were looking for a way out of this difficulty when all of a sudden the fog rolled away from us and we found ourselves looking down a glacier of tremendous steepness into a narrow ravine-like valley some 6000 feet below. It was now obvious that we were not on the Gangotri ice-stream, and we concluded that we must be looking down into the Kedarnath valley system. The glacier we were on descended in a series of three exceedingly steep ice-falls, separated from each other by small ice plateaux.

We returned to find that the Sherpas had already struck camp and were waiting for our return. We shouldered our loads and hurriedly started the descent. All through the day we worried our way down the intricate tangle of ice, halting only once for a meal. The mist hindered us a good deal, and several times we were forced to retrace our steps for a considerable distance before we could find a way through the maze of crevasses and séracs.

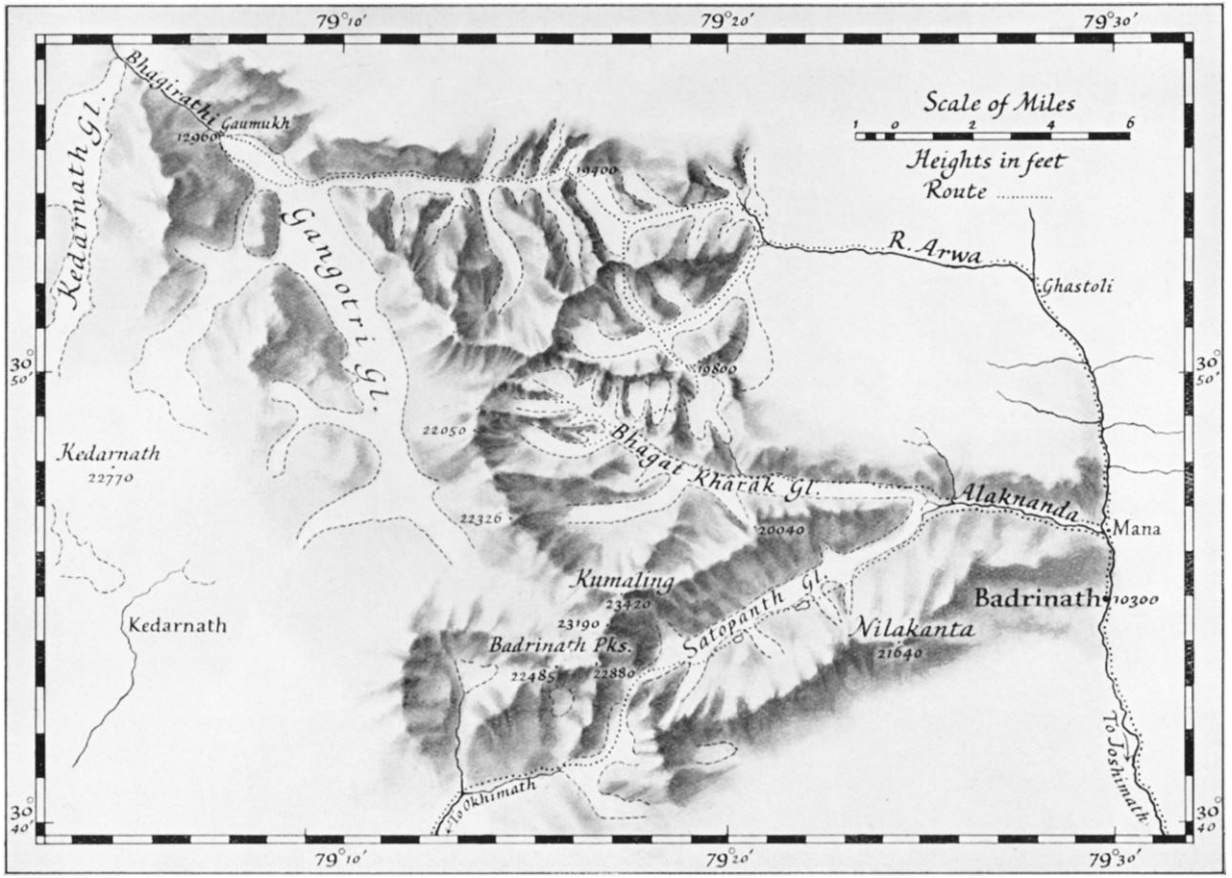
Head of the main ice-stream of the Bhagat Kharak Glacier

Late in the evening we reached the brink of the glacier's final downward plunge. We were now working on dry ice and much step-cutting was required. The angle of the glacier was becoming so steep that we began to think that we were on a hanging glacier. Indeed the prospect of getting down the last bit appeared so hopeless that Tilman and I would have decided to abandon the attempt had it not been for the extraordinary enthusiasm of the Sherpas, who insisted upon investigating every conceivable possibility. Here was another striking example of the loyalty of these men. What we were doing must surely have seemed very pointless to them; and yet, because we had shown our desire to get down to this valley below us, they were willing not merely to follow us, but to undergo any amount of labour, to face any danger in order that we might fulfil our purpose. At dawn the next day (August 11) we resumed our task and eventually succeeded in lowering our loads and ourselves into a steep rock gulley at the side of the ice-fall, by means of our 180 feet of climbing rope. We were able to climb down the gulley and so to reach the level glacier which lay at the foot of the great ice-fall.

At sunrise that morning we had had a fine view of the country to which we were descending. Beyond the glacier we had seen what we took to be a pleasant grassy valley; beyond this dark vegetation stretched away as far as the eye could see. This we took to be pine forest. Two days' marching at the most, we thought, would take us through this agreeable-looking country to some habitation. Also it seemed reasonable to suppose that we should strike some path and be able to cover, if necessary, some 12 miles a day. We knew that it could be no very great distance from the snout of the glacier to the Kedarnath pilgrim route. We were soon disillusioned. Immediately on leaving the glacier we found ourselves in dense undergrowth. We now struck really bad weather. Rain fell in torrents most of the day and night. All our kit got waterlogged, which made the loads very heavy, and the task of hacking a way a tedious one.

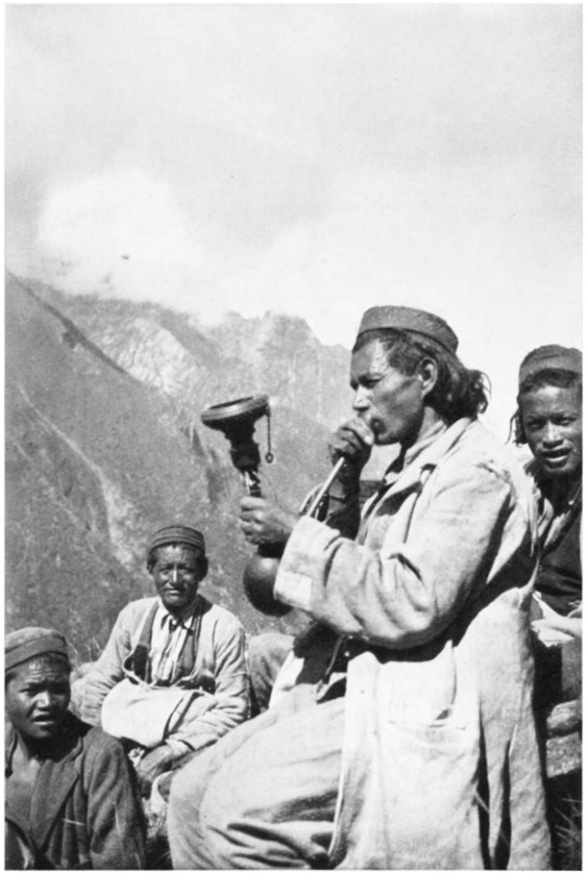
On the evening of the first day (the 11th) we reached the brink of a sheer drop of 1000 feet in the floor of the valley. For a short distance above this the river disappears underground and spurts out of the side of the cliff in an impressive waterfall. In camp above this precipice we took stock of our position. Our food supply was beginning to run short and what remained of the *satu* and *ata* was soaking wet and was rapidly going bad. A discussion of the problem as to whether we should go on or turn back lasted late into the night. It was a difficult decision to make, but the prospect of retracing our steps and committing ourselves once more to the icy slopes we had just left did not appeal to us, and eventually we agreed to go on down.

The precipice provided us with more rock climbing than we were then inclined for, but by roping down the worst sections we reached the forest at its foot. Here, under the spread of giant trees, the undergrowth was not so thick, and we made good progress until we reached the upper limit of bamboo at about 10,500 feet. The bamboo shoots were ripe for eating, a fact which undoubtedly saved us from a very serious predicament. We were also able to collect a small supply of forest-mushrooms, which, though they did not last long, gave us one or two square meals. The forest was full of bear-tracks, which greatly alarmed the Sherpas, so that they sang and shouted all day long



The Badrinath Group, from a compass sketch

Glacier table in the southern section of the Nanda Devi basin



Porters from Mana smoking the ceremonial pipe

in order to frighten the animals away. This they did so effectively that we only got one close view of a bear during our sojourn in the forest. He was of the black variety.

Late in the evening of the 12th we reached a narrow gorge containing a formidable torrent coming in from the north. During the whole of the 13th, in a perfect deluge of rain, which made the visibility extremely bad, we searched for a way across this obstacle without success. On the following morning however we managed to bridge the stream near its mouth. Here further trouble befell us. Passang had a small bone in his foot broken by a boulder falling on to it. This put him out of action for any work, and the task of keeping up with us over the precipitous country which followed must have caused him frightful pain.

Beyond the gorge the going became very bad indeed. The side of the valley was exceedingly steep and we had to hang on to the undergrowth to prevent ourselves from sliding down, while we hacked our way through the dense thorn-scrub. At times it took us as much as an hour to cover 25 yards, and we were hard put to it to go more than a mile a day. We used to halt each evening at 5.30. This gave us just time before dark to build a bamboo shelter under which we could protect a fire from the pouring rain, and so cook a meal of bamboo shoot and tea. Dead bamboo, however sodden it might be, makes most excellent kindling, and without it and a fair supply of paraffin we should have had to have foregone the luxury of a fire. Thus this excellent plant provided us with shelter, fire, and food. Without it our plight would have been a sorry one.

We made our way through this type of country for five days after crossing the gorge before we reached (August 18) the tiny hamlet of Gaundar in the Madmaheswar valley. This was nine days after reaching the col, an air distance of 6 miles. The few inhabitants were very poor, and though they gladly gave us shelter we had the greatest difficulty in extracting from them a few handfuls of flour and a cucumber. For these we paid lavishly, but quite willingly.

We now got onto a good path, and on August 20 in the still torrential rain we reached the temple of Okhimath [1] where we were received with a hospitality whose warmth will live amongst my most cherished memories.

But the high priest, who made a practice of holding services at Badrinath and Kedarnath on the same day, was surely a little overworked.

Time was getting short and we could not afford to halt anywhere. In bad weather we crossed a beautiful pass to Chamoli and so reached Joshimath in six marches from Okhimath.

On August 27 we began our hurried preparations for our second Nanda Devi expedition. Early that morning Angtharkay started off with instructions to recruit fifteen men from the Mana valley and return with them as soon as possible. Meanwhile we were busy working out ration lists, collecting food, packing up, and planning our last little campaign. Late on the night of the 29th Angtharkay arrived with as tough a squad of men as we could have

[1] This is the spelling employed by the temple authorities. It is spelled Ukimath on the Survey of India map and pronounced locally more like Weekimāt.

wished. He brought also kind messages of congratulation from His Holiness the Rawal and other of our friends in Badrinath. We were particularly gratified to get a message from Master Ram Serikh Singh who, on hearing of Angtharkay's arrival, had rushed down from his camp in the lovely valley below Nilkanta to hear our news. From him we learnt that while we had been on the Satopanth pass, Badrinath had experienced some of the worst weather on record, and that there had been a belief that we were lost.

We left Joshinath on August 30 and camped that night at Tapoban. The weather was still bad and we were somewhat worried about our food getting wet. We reached Durashi this time in four marches *via* the Lata Kharak. When we got into the Rishi Nala we found that a great many landslips had occurred in our absence. The rains must have been terrific. Some small, steep side *nalas*, normally dry and with very little collecting capacity, showed signs of having had as much as 7 feet of water coming down them. We were now able to appreciate the tremendous advantage of local knowledge when traversing difficult country. Across places which had previously cost us hours of anxious toil we were now able to lead our party safely in half the time. We used the high-level route and crossed the Rhamani 1500 feet above its junction with the Rishi.

I should like here to pay a tribute to the skill and willingness of the Mana men. They had not, of course, to undergo the hardships which the Dotials had suffered on our first journey, but before very long I came to have considerable respect for them as cragsmen, while their ever-ready wit and carefree laughter will remain as one of my pleasantest memories. They and the Sherpas came to be the very best of friends and I think there was a measure of genuine regret when the Mana men had to take their departure.

We reached our old base-camp in the Rishi Nala on September 5. From here on we knew every inch of the route and were able to take ten of the Mana men with us. It was by a lucky chance that none of the vital points of the traverse had been seriously altered by the landslips. On September 8 we reached the basin and discharged the Mana men. We established a base near the snout of the southern glacier (about 14,000 feet) which we were surprised to find is over 3 miles above the junction of the two streams. The weather now (September 9) became fine and we were able to work without interruption. We found the southern section to be a great deal less complicated than the northern.

There are two main ice-streams which cover the floors of the upper valleys. The larger of the two rises in the great snow-fields which form the northern face of the highest peak on the southern rim of the inner basin, which is called by the Survey of India East Trisul, but for which I would suggest the name Maiktoli Peak, from the local name Maiktoli of the grazing ground to the south-east; or perhaps better, Maiktoli for both peak and grazing ground, if there is no objection to the same name, as in Dunagiri. It flows in a northerly direction and ends abruptly 100 yards from the snout of its rival. The smaller glacier rises partly under the grim precipices which form the south-east rim of the basin and partly from vast ice-fall which extends a long way up the southern face of the Nanda Devi East. The tributaries of these glaciers are few and of no great consequence.

We were extremely anxious to force a route either across the ridge which connects Nanda Devi East with the southern rim (which Dr. Longstaff had reached in 1905 from the Milam side), or towards the south across the col by which Mr. Ruttledge and the guide Emile Rey had attempted to get into the basin in 1932. I am afraid that our activities in the southern section were governed largely by this ambition.

On September 11 we set out to climb Maiktoli. We put a camp at about 20,000 feet on the glacier face referred to above. Tilman became unwell on the way up and unselfishly went down with Passang in order that Kusang and Angtharkay should be able to occupy the camp with me in his place. The next day we climbed the peak (22,320 feet) in bad conditions. We encountered a severe wind which was almost up to Everest standard. All the way up and from the summit we saw views of surpassing grandeur. Even the great southern faces of Nanda Devi seemed to be dwarfed by the mere extent of the panorama. West and north, Badrinath, Nilkanta, Kamet, Ghori Parbat, Dunagiri, and their numberless satellites merely served as a foil the better to display those extraordinary ranges towards the borders of Nepal. To the south, at our feet, lay the little Simm Saga range, beyond this was a cloud sea stretching as far as the eye could reach.

On September 15 from a camp far up on the left bank of the eastern glacier we climbed to about 20,500 feet on a south-eastern ridge of Nanda Devi in order to get a comprehensive view of the southern section of the basin. On September 17, having completed to our own satisfaction the reconnaissance of the southern section we set out to attempt the crossing of the col on the southern rim. We were carrying food sufficient for twelve days, which we had found was the maximum we could manage without having to make double journeys. The climbing on the northern side was easy but on the southern side we became involved in very difficult work which kept us hard at it for two long days before, late in the evening of September 20, we reached the little grazing ground of Maiktoli. Although this gap provided us with a means of escape from the basin it would probably be too severe a task to tackle it in the reverse direction, particularly if heavy loads were carried; and I fully endorse Mr. Ruttledge's judgment in abandoning his attempt of 1932.

These last two days provided a fitting climax to our little season of supreme happiness. There followed the marches back over the wooded foot-hills, whose ravishing beauty must leave an indelible memory with all those who have travelled amongst them. Behind us, floating in the upper air, were the giants whose presence we had just left. So ended at Ranikhet five crowded months, amongst some of the most glorious mountains of the world.

DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: We are going to hear to-night an account of an exploration of the Nanda Devi basin and the Ganges watershed. Those of you who have been in India will probably remember Ranikhet and Almora in the district of Kumaun, a very beautiful bit of country for a starting-point. We are going to hear of the task, a very difficult one, of penetrating into the basin surrounding the great mountain of Nanda Devi, the highest peak in British India, 25,600 feet, and a very beautiful peak,

too. Mr. Shipton and his companion, Mr. Tilman, own properties in Kenya. Mr. Shipton, it will be remembered, came to England when he heard of the plans for the last assault on Mount Everest in the hope of being able to join that expedition. When that was over he thought he would make another journey in the Himalaya before returning to East Africa, and Mr. Tilman, with whom he had climbed a good deal in East Africa, came and joined him in his Nanda Devi project. They were a very small party, themselves and six porters, but they accomplished a very fine piece of work which Mr. Shipton is now going to describe. Without more ado, I ask him to read his paper.

Mr. Shipton then read the paper printed above, and a discussion followed.

The PRESIDENT: Mr. Tilman has promised to add a few words. I now call on him.

Mr. H. W. TILMAN: I have never previously faced an audience, and I beg to be excused more than a word or two. Really, there is nothing for me to add to what the lecturer has said. He has made clear every aspect except, of course, what he himself did. I should like to say that these small successes of ours were not quite fortuitous but mainly the result of very careful planning on the part of the leader. He expressed appreciation of the work of the Sherpas, but it must be remembered that those men will only give of their best under such leadership as we enjoyed. He also observed that we climbed on the shoulders of our predecessors, so I venture to hope that means will be found to build upon our work, in the near future.

The PRESIDENT: As you know from what the lecturer said early in his paper, he owed to Dr. Longstaff the idea of undertaking this particular piece of work. I hope Dr. Longstaff will come and address us.

Dr. T. G. LONGSTAFF: I am familiar with the mountains of Garhwal; I think they are the most beautiful part of the Himalaya. I also know a good deal about all the expeditions which have been there, and I do not know of any which has done more or better work than that of which we have heard to-night. The success achieved by Shipton and Tilman is a shining example of concentration on the tactical objective through every stage of the expedition. They have solved the problem of the Rishi gorge—so difficult that they took nine days to cover the last untrodden 4 miles. I did not get through; therefore I am very glad they took nine days over it because no one can say it was very easy. They thus had the tremendous excitement of being the first human beings—because no natives have ever been there—to enter the inner sanctuary of Nanda Devi. Incidentally, the double peak of Ushba, the most celebrated peak in the Caucasus, is very like Nanda Devi except that the latter mountain happens to be twice as high. Their base camp at the immediate foot of Nanda Devi was at 13,000 feet, and the top of Nanda Devi was 12,600 feet above that. Is there any steeper scarp in all the Himalaya?

After all this excitement they solemnly concentrated on exploring the northern basin, and throughout the whole of the trip they were plane-tabling: they have brought back a survey of the ground they have covered, which is a vast improvement on the old maps. When caught by the monsoon they went off and completely connected up the Badrinath–Gangotri and the Badrinath–Kedarnath glacier systems, perhaps the most arduous work of all in view of that appallingly steep ice-fall. This time they managed to do 6 miles in nine days, 2 more miles than they had done in getting up the gorge of the Rishi. That extra 2 miles entailed living on bamboo shoots and fungi, which the lecturer politely called mushrooms. After the monsoon they returned to the south basin of Nanda Devi and actually climbed up Nanda Devi itself to 20,500 feet. We saw a fine

picture of their descent of the great ice-falls above Maiktoli, a feat demanding the highest sort of mountaineering competence.

There are many remarks I could add with regard to this piece of work, the finest that has ever been done in the district. It is surely a striking proof of what all experienced travellers know: that individual competence and the personal qualifications of the traveller are far more important to his success than the size of his bank balance. These two men, both, I am glad to say, fellow-members of the Alpine Club, and of course skilled mountaineers who have climbed many difficult heights, did their work accompanied by only three Sherpas. They carried loads themselves: they did their own work and yet, at the same time, they continually used the plane-table and, as I have said, brought back a survey of the ground they traversed. They spent five months in the Himalaya, using cargo boats out and home—seven months in all—at a total cost of £287: £143 10*s*. apiece. It is certain that lack of funds always entails extra hardships, but if their resources had been multiplied tenfold, could these two men have done more than they have done? Personally I do not think anybody could have done more. In this respect, as in many others, they have set up a standard hard to follow.

Brigadier E. F. NORTON: You have called upon me quite unexpectedly, Mr. President, and I have to hurry to catch a train. Nevertheless, I am glad to have this opportunity of expressing my admiration for the expedition about which we have heard. I regard it as the ideal type of expedition—a type of which we have seen all too few in the Himalaya since Dr. Longstaff first set the fashion. Since the Mount Everest Expedition everybody has, of course, been aware of Mr. Shipton's reputation, but not so many know Mr. Tilman. I had the privilege of working with him nearly twenty years ago during the Great War. From what I knew of him then I am not at all surprised to hear that he was so able a seconder of so fine a leader. I must now catch my train, but I should like once more to congratulate the lecturer not only on his lecture and his beautiful pictures but on the modesty with which he told his story.

The PRESIDENT: We have with us the President of the Alpine Club, and I hope he will give us some comment from the point of view of the alpinist.

Colonel E. L. STRUTT: I feel, like Brigadier Norton, that I ought to run off to catch a train, but as I have been called upon, as President of the Alpine Club, to comment on this most remarkable expedition I can say, honestly, that I have not been within 1200 miles of the district. Therefore I am hardly an authority on it. I do however know something of the ground that Dr. Longstaff and Mr. Graham traversed, and I can endorse Dr. Longstaff's remark that we have heard described one of the finest bits of exploration that has ever been carried out.

As has been said, we all know Mr. Shipton's record. Mr. Hugh Ruttledge told of his exploits on Mount Everest. Some of us are not quite so much up to date with Mr. Tilman's record. All I know of Mr. Tilman, beyond the personal acquaintance of which I am very proud, is that he last year crossed Africa from east to west on a push bicycle. During that period he spent, I think I am right in saying, six days in making a solitary ascent, that is without a companion of any kind, of Kibo, the highest peak on Kilimanjaro. That proves him a pretty tough specimen.

The PRESIDENT: You have heard such eloquent tribute paid to the travellers' performance that there is little more that I need say. They have undoubtedly carried out a most wonderful piece of work, and the ridiculously small sum for which they managed to do all they did was indeed a triumph of economy. We heard from them what they did during daylight and how they camped for the night and at 7.30 a.m. they proceeded onwards and so on, but they told us nothing of their night experiences on the mountain. In fact it was difficult to realize

while Mr. Shipton was lecturing in the simple way in which he told his story the extraordinary endurance their exploration entailed. They have both referred in grateful terms to the behaviour of the Sherpas, and we know how much we owe to them in connection with climbs in the Himalaya and Karakoram, especially the assaults on Mount Everest; thoroughly reliable and brave men that they are.

Mr. Shipton is, I am glad to understand, planning another expedition. It seems that he and his comrade cannot tear themselves away from the mountains. Let us hope that Mr. Shipton will be able to carry out another expedition this summer, if funds permit, and that we shall hear from him again next winter. I ask you to join me in congratulating him once more on his splendid achievement, and thanking him for the interesting evening he has given us. Mr. Shipton, I am sure you will realize from this very hearty applause how much we have appreciated your lecture.