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CONTENTS

No. 3. September 1927.

No. 4. October 1927.

Maps.

LADAKH, WITH SPECIAL REFERENCE TO ITS NATURAL HISTORY

Col. R. Meinertzhagen, D.S.O.

Read at the Meeting of the Society, 2 May 1927.

IN February 1925 I decided to satisfy one of my long-cherished desires —to visit Ladakh. The object in view was to see the country from a zoological aspect whilst making an intensive study of the conditions under which life exists in high altitudes. It was essential for my purpose that Leh should be reached in early spring: there was therefore little time to waste in making preparations.

This paper has been divided into two parts. The first deals with the route and certain matters of interest encountered on the way, for without a clear conception of the character of the country Part II. of this paper would lose a deal of its value. Part II. deals with a contribution towards our knowledge of the origin of life in the Himalayas and on the Tibetan Plateau.

Part I. Our Route in Ladakh

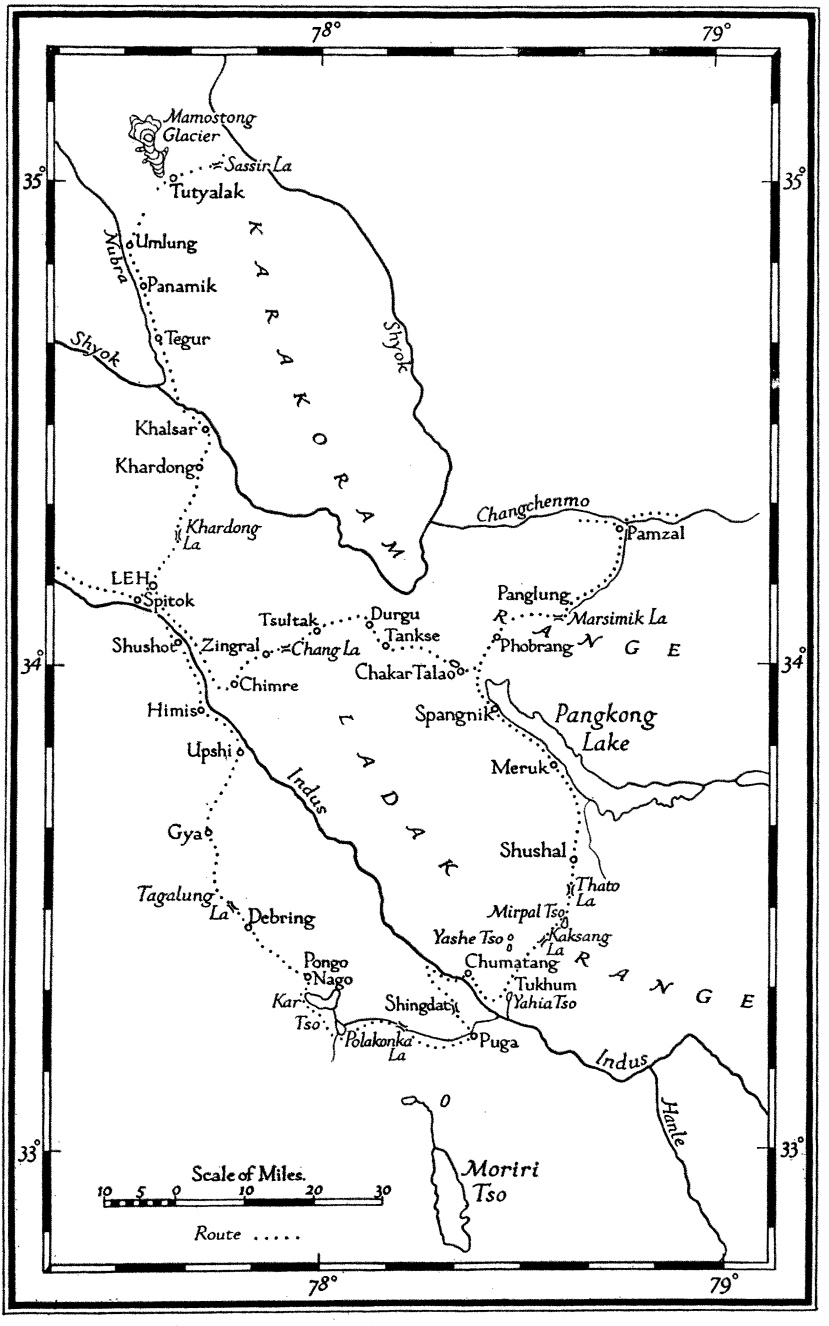
Passing up the Treaty Road we reached Leh on May 4. There is an interesting fact about Leh which appears to have escaped notice. The first European traveller to visit Leh was, I believe, Francesco de Azevedo on 25 October 1631. He writes, "It is built on the slope of a small mountain and numbers about 800 families. Half a mile lower down, but still quite visible, flows the river which goes to Lahore. By the town itself passes a mountain stream, which works a large number of mills; a few trees are found here."

This description does not fit modern Leh, which stands 6 miles from the right bank of the Indus. The old site of Leh is probably near Spitok, which abounds in *débris* of what might quite well have been the old town. The river Indus cannot have altered its bed, because modern Leh stands on an alluvial fan 500 feet above the Indus.

Leh is entered through an archway which leads directly into the main bazaar, the business centre of the Ladakhi capital. Everything centres round this bazaar, the monasteries and old palace of the Kings of Ladakh being perched on a serrated ridge above and to the north-east of the town.

My idea was now to proceed east to the Changchenmo, and then south down the Pangkong Lake, cross the Indus into Rupshu, and then return to Leh in time for a trip to the Karakoram.

Leaving Leh on May 17, we passed up the right bank of the Indus for a short distance, then striking left-handed up a tributary valley, we camped at the foot of the Chang La. At the neighbouring village of Chimre we were fortunate in meeting the Abbot of Himis, the spiritual head of Lamaism in Ladakh. He goes by the name of Guru Stagtsang



Sketch-map showing Colonel Meinertzhagen's route through Ladakh

Raspa, and is an intelligent, nicely mannered old gentleman. We called on His Holiness, who received us in a small heavily scented room on the top floor of the monastery. For the first half-hour we were bombarded with questions. His knowledge of geography was crude. London and Peking were both quite close to each other and three days by steamer from Bombay. He had many possessions, including a small camera, an electric torch, a bottle of Pascall's sweets, and a fine assortment of the flotsam of civilization. He also had quite a good collection of postage stamps. He was pleased to give his blessing to our travels, and wondered why we were so mad as to come to this desolate country for such crazy purposes.

Crossing the Chang La (18,000 feet) on May 22, we cut across the north end of the Pangkong Lake and reached Phobrang, the last village on this track. In order to reach the Changchenmo we had to cross a southern extension of the Karakoram by the Marsimik La—18,400 feet.

From here we had a gorgeous view of the snow ranges extending east and west, and also of the Ladakh Range, which runs between the Karakoram and main Himalayan systems.

On entering the Changchenmo Valley we encountered our first wild game of the Tibetan Plateau, the most numerous and characteristic of which is the wild ass, or, perhaps more correctly, the wild horse or Kiang. These thoroughbred little animals were always a source of joy to me, and I never wearied of watching them.

The problem of food for these wild asses is a puzzle. Spying a small herd feeding on a hillside, I marked out an area with my glasses and visited the spot. After much search I found a few blades of grass and an alpine plant or two. Measuring a space 100 yards by 10, I systematically collected every scrap of vegetation, and in the end had secured seventeen withered blades of coarse grass and seven small alpine plants, in fact, less than one would feed a guinea-pig on, and yet these herds of sheep and asses graze contentedly and with success on those barren hillsides. Their means of subsistence is still a puzzle to me.

We also saw near the Changchenmo the wild sheep, *Ovis hodgsoni* (the Ammon of sportsmen) and the Tibetan Antelope (*Pantholops*). These latter are of great interest, comprising a single-species genus peculiar to the Tibetan Plateau. The first party we saw were lying down, each animal in a small scraping which he had made for himself as a protection against the wind. Quite suddenly they all made off in different directions at a great pace, which is due to a biting fly coming among them. The Tibetan with me explained that they would all come back, so we waited, and sure enough back they all came from different directions and again lay down in their wind shelters. During the wait my Tibetan recounted a curious tale about these antelope. In the old days, if a Ladakhi came into the Changchenmo to hunt antelope, he brought with him a virgin, and the antelope, so delighted at the sight,

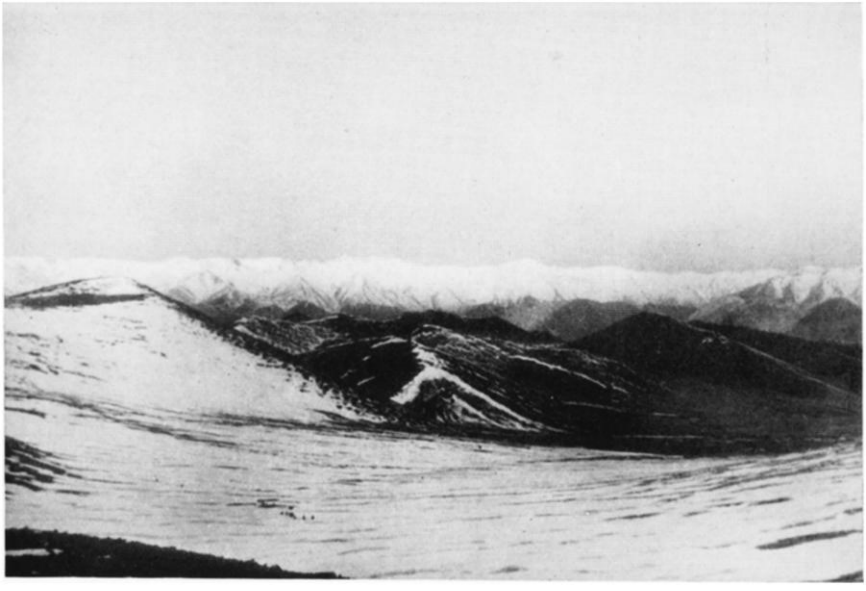
would all come up and lay their heads in her lap, when they were easily captured. I remarked that it was a pity we had not brought a virgin along with us. His sarcastic rejoinder was " I was referring to the old days."

It was in the Changchenmo that we were fortunate in seeing two snow leopard. They were crossing a stream, and to see the one pawing the icy water before he could take the plunge, and the other shaking the sparkling drops from his pelt after having successfully crossed, was a sight not easily to be forgotten. They were not over 30 yards from me, and quite unsuspicious—an unique opportunity for a right and left at this great prize among sportsmen.

We were fortunate in finding a sheltered spot for a camp in the Changchenmo, otherwise life would have been made quite intolerable by the incessant wind. Throughout Ladakh the wind was fairly bad, but in the Changchenmo it became a nuisance. Between 9 a.m. and 2 p.m. it would blow from the south-west or west. In the early afternoon it would veer round to the north. By sundown there were merely gusts from the north or a dead calm, but about 9 p.m. the wind would again spring up from the north and continue till it again changed to the west or south-west soon after daybreak.

I imagine the reason for these winds is as follows: The air of the Tibetan Plateau is highly rarefied and offers but slight resistance to solar rays. As the air becomes heated by the sun it moves slightly to the north, doubtless drawn in that direction by hot air rising from the Gobi and Mongolia. As noon approaches the velocity increases. I noted that on overcast days when the effect of solar rays would be felt less, the velocity of the wind was not so great, and also that as the sun sank the wind conformed. Westerly or easterly variation must be due to the rotatory movement of the Earth. The northerly night wind is probably due to cold air from Northern and Central Asia rushing in towards the plains of India, where there is little difference between day and night temperatures during the hot weather.

After a few days' stay in the Changchenmo, we retraced our steps to the north end of the Pangkong Lake and turned down its southern bank. The blue of the lake water was remarkable, excelling in depth of colour that of either the Cornish or Mediterranean Seas. It was almost a deep sapphire and not the usual turquoise blue. Though the water is salt there are many places along the shore where sweet water can be obtained. There are no boats on the lake, but it freezes every winter, when the local Tibetans take the opportunity of crossing on the ice and collecting firewood on the north bank, which is not inhabited. The lake is not prolific of aquatic life, though it contains fish, for a dead specimen was found. The presence of such fish-eating birds as goosanders is also evidence of fish in the lake. I found no trace of freshwater molluscs or shrimps, though these abound in all purely freshwater lakes in Ladakh.



Main Himalayan Range from the Chang La (18,000 *feet*)

The summit of the Marsimik La (18,200 *feet*), *E. Ladakh*

The northern end of the Pangkong Lake

Camp in Chanchenmo valley, E. Ladakh

Old beach-levels at the northern end of the lake were located at 35 and 46 feet above the present lake-level, and contained abundant freshwater shell fossils (*Limnæa*), a certain proof of freshwater conditions when the lake was at that level. At the north-west end of the lake where limestone is the predominant rock, sufficient lime has impregnated the lake water to congeal masses of pebbles along the shore, but this condition was not observed more than 18 feet above the present lake-level. The lake was therefore only 19 feet above its present level when it had an outlet.

The factors which went to form the Pangkong Lake seem to be two-fold. Primarily, land elevation which proceeded at a more rapid rate than river erosion could compete with; and secondly, a large alluvial fan from a tributary at the north end of the lake. There is evidence of both. The latest outlet was probably at the north-west extremity.

There is a curious shore-feature along the banks of the lake. Every few yards one comes across small lagoons, often landlocked by a bar of small pebbles. These bars are sometimes complete and sometimes with gaps. They vary from a few feet in length to over 100 yards. They are sometimes completely submerged and sometimes entirely above lake-level. The lagoons were in all cases deeper than the adjoining lake. They were usually situated at the terminal end of a dry watercourse, and at first I thought they were true bars. But some of them were formed across a re-entrant. What is the explanation? The prevailing wind on the lake is from the north, the depression in which it lies acting as a funnel and preventing the usual westerly or south-westerly wind blowing a true course. The small waves therefore break from the north and throw up these banks of pebbles: and in confirmation of this theory I noted that the bars were thicker and often more elevated on their north or exposed side. It was an effect of wind and water on the landscape, and gave to the shore a curious serrated appearance which I have only seen elsewhere on the west coast of Madagascar, though there the condition is on a much larger scale.

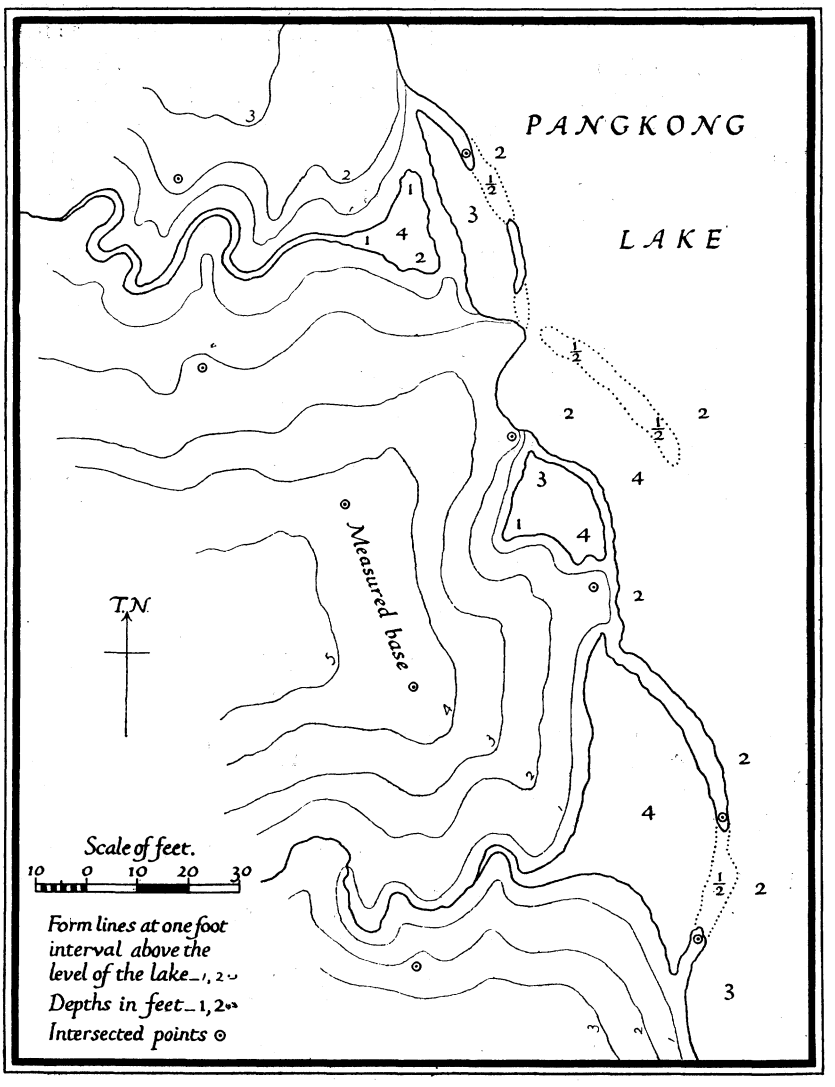
Leaving the Pangkong Lake at its south-west angle, we struck south to Shushal and crossed the Ladakh Range by the Kaksang La. Dipping down into the Indus Valley we crossed into Rupshu. On our way, and north of the Indus, we passed many small lakes.

The Mirpal Tso, not far from Shushal, lies in a deep depression surrounded on all sides by complete desolation. The bed of the lake is sandy and the water is fresh at the south end only. Freshwater shrimps (*Gammarus*) abound in the water-weed. Old lake-levels were noted at 27 feet above present lake-level, and wherever these were found a fossil freshwater shell (*Limnæa*) abounded. The lake to-day has no outlet.

Lake Yahia also lies at the bottom of a deep depression, but is fresh throughout, having an outlet into the Indus down a precipitous gorge. No high-level beach marks were noted.

The double lake known as Tso Kar lies in Rupshu on the left bank

of the Indus, and is of interest as its eastern or smaller half is fresh and the western half is salt, the two parts being connected by a stream. Twenty-seven old beach-levels were traced, the highest being 127 feet above present lake-level. The larger salt lake which has contracted a



Sketch-map of part of the shore-line of Pangkong Lake

lot by evaporation in recent years, has left behind it an extensive deposit of natron, similar to that found at Lake Magadi in Kenya Colony.

These Ladakh lakes are of course only a part of the great system of lakes which are spread over most of the Tibetan Plateau. They seem to

comprise two types, those which have been dammed by tributary alluvial fans, such as the Pangkong and Tso Kar, and others such as Mirpal Tso and Yahia, which seem to be pure rock basins, possibly scooped out by glacier erosion.

The many signs of much higher levels in Ladakh lakes, and indeed throughout Tibet, are proof of desiccation which is probably still proceeding. The greater rainfall of past ages is probably connected with the greater cold resulting from the Quaternary Ice Age.

Crossing the Taglaung La we descended the Gya gorge to the Indus, and arrived back in Leh early in July. We then struck north over the Khardong Pass and dropped down into the Shyok Valley, just above its junction with the Nubra.

This seems to be an opportune moment to introduce the yak, another mammal peculiar to the Tibetan Plateau and Kansu, and well adapted to the severe conditions to which he is exposed. Even on a cold day he shows signs of distress if hurried, and is only really in his element when an icy wind is blowing on a snowfield. The Tibetans maintain that the wild yak is quite a different species from the domesticated beast, but this is of course mere superstition which is of interest as showing that the yak was domesticated in the dim ages. The yak crosses freely with domestic cattle, the hybrid being called a Dzo. These Dzos give excellent milk, and are fertile *inter se*, but the offspring never attain maturity, always succumbing to a kind of vertigo when calves. The yak does not "moo" but grunts, hence his most appropriate name *Bos grunniens*. Many are hornless, and some of the quieter ones can be ridden.

They are nervous creatures, and quite small incidents alarm them. On one occasion after a 4000-feet climb, all my yaks were showing signs of distress, panting and grunting with their huge tongues lolling out. But on reaching the plateau, where they were faced by an icy blast, first one and then another commenced to frisk and buck like young goats, scattering their loads in all directions. The whole party became infected with exhilaration, and it was some time before they regained their composure and resumed their monotonous 2 miles an hour. But they are at their best in deep snow, and even though they sink in up to their bellies, they will gore their way through, seemingly to enjoy it thoroughly. And if they get too hot, they eat chunks of snow to quench their thirst.

Crossing the Shyok just above its confluence with the Nubra, we followed along the main Yarkand trade route, reaching the western foot of the Sassir La about Tutyalak on July 21, where we camped at 13,600 feet. The character of the Nubra Valley is quite different from that of the Indus Valley. Conditions are more favourable to agriculture, turnips, broad beans, peas, and apricots growing in profusion. The height is some 10,000 feet above sea-level, and abundant water pours off the Karakoram glaciers into irrigation channels.

Quite close to our camp was the ugly snout of the Mamostong (*olim*

Murgistan) Glacier, a black wall of ice scarcely recognizable as such. The height above sea-level of the snout is about 13,150 feet, and out of it flow two muddy streams which unite and form the Thulanbutichu River. The day on which I visited the snout was hot—78° F. in the shade at noon—and as the face and surface of the glacier were melting like a pat of butter in a frying-pan, I tried to measure the rate of decrease in ice. The face of the glacier at the snout was 214 feet high and about 1100 yards broad. As the ice melted under the strong sun, boulders and rocks embedded in ice became loosened and fell, which rendered the task difficult, as some of these boulders weighed from a ton upwards. Selecting a boulder which I located some little distance inside the ice, I dug down to it and found it was 4·8 inches in. In nearly two hours' time the boulder was flush with the ice-face, and after seven hours and two minutes the boulder, which was 19½ inches in diameter, had not only fallen out, but the rear of the cavity in which the boulder had rested was flush with the ice-face. The ice had melted 24·3 inches in that time. By using a similar method on the surface of the glacier, I ascertained that 11 inches of ice were lost in six hours.

Taking a sample of water from the stream which flowed from the Mamostong Glacier, I added alum, and after precipitation of all foreign matter was complete, three-tenths of the cubic contents were solid mud.

The Sassir La is of peculiar interest to the student of glaciers, as in that one area and from my camp I could see perfect examples of not only the " Valley " glacier but the less common type in the Himalayas, the " Hanging " glacier.

We explored the Sassir Pass on July 23, and wishing to see to what altitude plant and bird life would ascend in these latitudes, I selected an easy-looking spur north of the pass whence I fancied I might also be rewarded by a sight of K_2, but alas! though I had a superb view in most directions, on the north-west vision was blocked by a higher ridge. From what I saw it would seem that Mason (*Geogr. Journ.*, vol. **69**, No. 4, 1927, p. 319) is right in treating the Nubra–Upper Shyok divide as a continuation of the main Karakoram Range. At 18,800 feet I noted a flock of swifts feeding off some small insect which I could not detect. At 19,950 feet I shot a raven which showed undue inquisitiveness in my movements, whilst at 21,050 feet, the highest point I reached, I was delighted to find a family party of wall-creepers (*Tichodroma*) which had probably been bred at that altitude.

Mention can now conveniently be made of the influence of altitude on the human body. When in Ladakh I had the advantage of having a copy of Major Hingston's admirable paper on this subject with me (*Geogr. Journ.*, **65**, 1925, pp. 4–23).

The following observations were made on my own system:

	Pulse sitting.	*Pulse standing.*	*Time breath held.*
Sea-level	.. 76 ..	.. 76 ..	.. 110 secs.
11,500 feet ..	.. 78 ..	.. 81 ..	.. 58 ,,
15,000 ,, ..	.. 78 ..	.. 92 ..	.. 42 ,,
18,000 ,, ..	.. 86 ..	.. 98 ..	.. 39 ,,
21,050 ,, ..	.. 104 ..	.. 118 ..	.. 22 ,,

My respirations at sea-level are normally 14 per minute in a sitting position, whereas at Leh, at 11,500 feet, they were increased to 18, and at 18,000 feet to from 22 to 26.

I believe each individual has an altitudinal limit beyond which he cannot go without distress. Mine is 14,200 feet, and I had many opportunities of testing it. It will be found to vary in individuals from between 13,000 to over 15,000 feet. At over 14,200 feet I found breathing irregular—that is to say, there was an alteration in rhythm, especially when one first lies down. I seldom noted it when moving. This irregularity was often accompanied by hard jerks at the heart.

When walking on the flat or climbing at over 18,000 feet I could ease my breathing considerably by taking deep breaths at every step—that is to say, by inhaling more air than I should normally do. I breathed, in fact, as though I was out of breath and found it a great help. If I rested at over 18,000 feet I experienced greater breathing and heart distress than if I walked slowly. It therefore does not appear that the discrepancy between oxygen supply and oxygen demand is entirely responsible for lung and heart distress at high altitudes.

We all suffered from sore throats, which were attributed to increased passage of very dry air.

The general lassitude at over 15,000 feet was most noticeable. Movement defeated physical lassitude, but mental vacancy was more stubborn. One often felt inclined to sit in camp and do nothing. This was accompanied by a vacant brain which made writing an effort, but our memories did not seem to be affected.

Loss of appetite was the most serious consequence of continued sojourn in high altitudes, and this accounted for general physical deterioration and loss of weight. I lost over 16 lbs. in the first three months. At times we positively disliked food of any sort, though we had ravening appetites. The first mouthful seemed to allay the worst hunger. A small glass of wine was an excellent stimulant on those occasions. Sweet foods were most popular, especially marmalade, and we preferred liquid foods to solids. Meat in any form was distasteful.

Thirst was at times almost intolerable and quite unquenchable, this being due to the dryness of the air and not to heat. We found that large quantities of hot sweet tea were the best remedy.

The ultimate result of prolonged residence in high altitudes is affection of the nervous system. Slight headaches, insomnia, mental and physical lassitude, and, to a minor degree, indigestion are probably all the result

of the nervous system getting out of order. Intestinal flatulence, so common in Ladakh among my party, was also the result of the same conditions. Insomnia was a great inconvenience, but was not most acute at extreme altitudes. I would sleep well at 18,000 feet and get little sleep at 15,000 feet. In fact, I think I always felt altitude more between 14,500 feet and 16,500 feet than above the latter elevation.

We never became acclimatized to high altitudes, suffering as many inconveniences during the last month as we did during the first week. But it seems that aviators do become acclimatized, their systems adjusting themselves to the abnormal conditions. This is not easy to explain unless one accepts the theory that oxygen can be secreted in the lungs. And this theory seems possibly correct, for it would explain why the members of the Everest Expedition benefitted so slightly from administered oxygen.

We found tobacco beneficial, steadying the heart's action and respiration. Though I continually smoked a very strong tobacco and Burmese cheroots, no evil effect was experienced.

Alcohol when at rest was useful as a stimulant or appetizer, but on the move was definitely harmful.

High altitudes have a great effect on bacteria of all sorts, infectious diseases being almost unknown. Malaria, tetanus, cholera, and rabies have seldom if ever appeared in Ladakh. Cancer is almost unknown. Septic wounds following on operation are almost unknown in Leh at the Mission Hospital, but operations of a serious nature usually mean heart failure and death.

And now let me advert to Major Hingston's paper on " Life at High Altitudes " (*Geogr. Journ.*, **65**, 1925, pp. 185–198). I need hardly say that it gave me very real pleasure to read that paper. The writer's unrivalled powers of observation and his attractive style have always excited my admiration. But I cannot agree entirely with the substance of Major Hingston's paper. He has noted many peculiar adaptations of Nature to environment and rather labours the point that high altitude is the responsible factor. This aspect of his paper is, I venture to suggest, misleading.

He very truly says in his paper " Tibet is essentially a desert." I would add, a high-altitude desert. And it is the only place in the world where one finds both Arctic and desert conditions exerting influence over life in the same area.

It is of course true that animals in Tibet and in all deserts, and in fact in nearly every region of the Earth where animal-life lives under exposed conditions or where it is exposed to danger from enemies, Nature, or some such force, tends to render it inconspicuous. Instances could be enumerated *ad nauseam*. Protective coloration is the term usually employed for such conditions. The phrase is unsatisfactory, as " protective " implies purpose which probably does not exist except in

the guise of Natural Selection. A term such as Environmental Mimicry is probably more apt.

But though the curious resemblance between the colour of animal-life and the colour of the environment in which that life lives, establishes the fact that there is such a condition as environmental mimicry, why is it that certain nocturnal rodents in low-lying deserts, and also a bat in Ladakh, have this peculiar pale grey desert colour which their habits preclude them from using to advantage? And why is it that some birds and some mammals have not been influenced to the same extent and stand out amid their surroundings as conspicuous objects? It is agreed that environmental mimicry exists where it is needed. But the causation is still an unsolved problem, probably of a chemical nature. In some cases increase in pigmentation is a definite reaction to increased rainfall, in other cases it is as definitely not so. In some cases the character of the soil, rock, or other surrounding on which the animal lives, exerts an influence on the plumage or pelage: in other cases it is definitely not the case. But whatever the force or factors are, the laws of environmental mimicry are not confined to either deserts or high altitudes but are world-wide, wherever and whenever protection is vital to existence. If it were not so, competition in some form would overwhelm that species to whom environmental mimicry had not been extended.

Protection against wind and cold is provided for by an increased thickness of feather or fur, and here again the law is universal. Whether in the Arctic or Antarctic, on the Central Asian Plateau or in the Alpine zones of tropical Africa, we find the same law applying. The Scottish Mountain Hare has denser wool than the Brown Hare. Thomson's Gazelle of the Aberdare Mountains in Kenya has a longer pelt than the same species on the lower-lying Athi Plains. The Coal Tit of Kamchatka has denser plumage than the Coal Tit of Japan, and so on.

Major Hingston noted an interesting case of the Short-toed Lark building a rampart of pebbles on the exposed side of the nest, presumably to help in keeping off the wind. Other larks in Algeria, Palestine, 'Iraq, and elsewhere where winds and dust prevail, do precisely the same thing and for precisely the same reason, the habit not being born of high altitudes but of wind.

Major Hingston makes special mention of the Chough and its powerful bill, which he suggests is specially adapted to the frozen soil of Tibet. The Chough in Cornwall, Crete, or Morocco, where contact with frozen soil is exceptional, has precisely the same development of bill. It may also be added that the Chough in its present form as regards structure, almost certainly existed before the Tibetan Plateau came into being.

It is stated on p. 191 " that the peculiar environment of the Tibetan Plateau has caused some of the high-altitude birds to change their

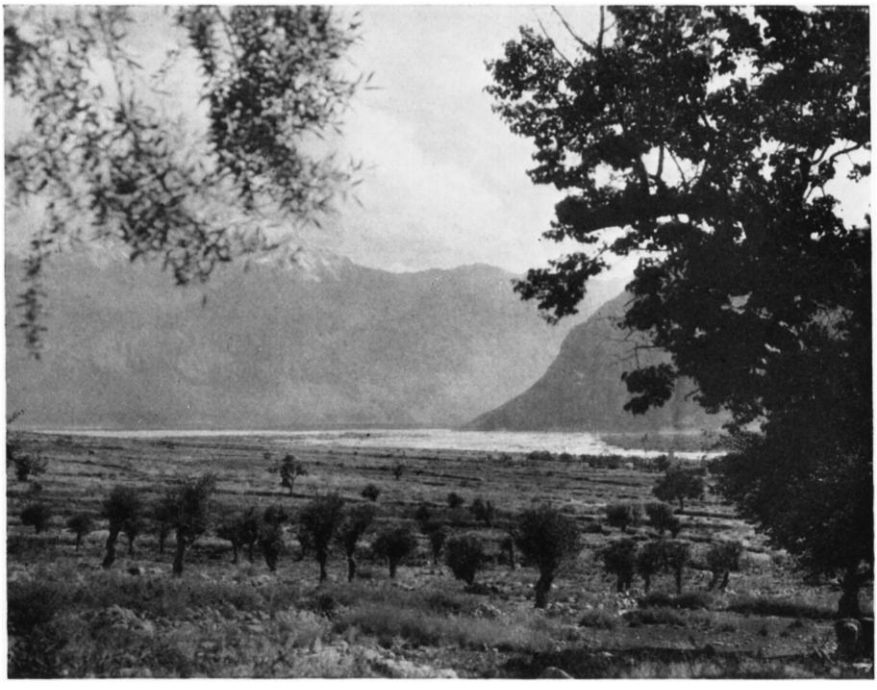
customary habits of life." The Tree Sparrow is quoted as having become an exclusively village bird, owing to the absence of trees. But the Tree Sparrow, except where he has been driven from villages by the House Sparrow, is essentially a village bird, whether in Baluchistan, Persia, Turkistan, Siam, Japan, or Singapore. It is not climate but competition which has induced the Tree Sparrow to leave his favourite abode, human habitations.

I would suggest that Major Hingston has attributed to high altitude certain habits and adaptations of life to environment which are in fact world-wide and not peculiar to the Tibetan Plateau.

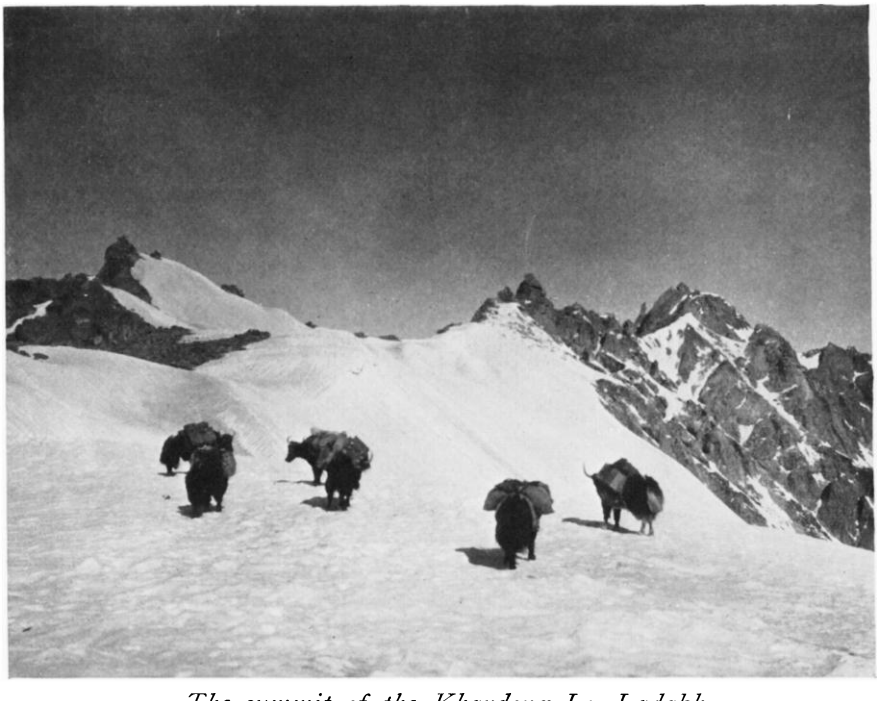
But there is one aspect of Tibetan Plateau life to which we must all wish Major Hingston had addressed himself. Those other portions of the globe which most nearly approach Tibet in climate are the Arctic and Antarctic. In Tibet and the Circumpolar regions we find many species of birds and mammals which live amid glacial conditions, and the effect is remarkably different in the two regions. In the Arctic we find all animals to whom environmental mimicry is essential, adopting a white garb, sometimes throughout the year and at other times only in winter. The only terrestrial animals which do not do this are those which do not need it. The musk-ox does not require protection and does not turn white. The raven, also a resident on the last remnant of the Ice Cap in Greenland, requires no white plumage, having no enemies. But other forms of animal-life, whether falcons, owls, foxes, or polar bear, which require environmental mimicry for aggressive purposes, or ptarmigan and hares which require similar adaptation for purely protective purposes, adopt a white garb in the Arctic.

This remarkable reaction to glacial conditions is not confined to the Arctic. In Scotland the Mountain Hare, the stoat, and the ptarmigan assume a white livery in winter. Among mammals this change is brought about by depigmentation of the fur, probably slightly assisted by moult.* Among birds it comes about by moult alone. The return in spring to normal conditions comes about invariably and entirely by moult among both mammals and birds. It is also an established fact that winter whitening is accelerated by early snow or frost. In the north of Scotland the stoat always turns white in winter; in the south of England winter whitening is of rare occurrence, intermediate areas disclosing intermediate conditions. The cold snap which occurred in the last fortnight of October 1926 had the effect of causing the stoats of Mull to assume their winter coat at least a month earlier than in 1925. Again, the Irish hare, but a geographical race of the Scottish hare, seldom turns white, living in a more temperate climate, and this character is so per-

* A Scottish hare kept alive in Cambridge during the autumn of 1899 by Barcroft, had turned almost completely white by January 1900 (*Proc. R. Irish Acad.*, **24**, B, 1903, pp. 303–314), but though it was under close observation no trace of moult was detected.



Junction of the Nubra and Shyok rivers, Ladakh



The summit of the Khardong La, Ladakh

Snout of the Mamostong Glacier, west of the Sassir La

The Karakoram at 21,050 *feet, above the Sassir La*

manently impressed on the race that even if transported to the territory of the Scottish hare winter whitening is still not the rule. It is significant that the Brown Hare (*Europæus*), which never shows decided winter whitening in the United Kingdom, often turns partially white amid the severer conditions of Northern Europe.

Again, our Red Grouse, which is but a geographical race of the Scandinavian Willow Grouse or Rhyper, never turns white in Scotland, though Caithness and Sutherland birds show a tendency to more white on the under parts in winter than is usual among, say, Yorkshire birds. In Scandinavia all Rhyper turn white every winter.

We see that in Northern Europe and in Circumpolar regions animal-life conforms to certain laws when the application of that law is necessary to existence. But on the Tibetan Plateau, where winter conditions closely approximate to those of the Arctic and are infinitely more severe than those of Northern Europe, we have no single case of winter whitening.

To what is this due? It seems that cold alone does not produce winter whitening. Snow is necessary. The Tibetan Plateau in winter, though gripped in the iron grasp of frost, is not snow-bound. Winter whitening would be a disadvantage to Tibetan animals, and it therefore does not occur. That terrible struggle for existence which reaches to a very high pitch on the Tibetan Plateau is centred round desert conditions and a very low temperature. In the Arctic it is centred round snow and the general whitening of the environment. Winter whitening of animal-life would not help in Tibet, and therefore does not occur. It is vital in the Arctic, where we find it to be almost invariable.

To return to our route. Retracing our steps into the Nubra Valley we tried to pass down the Shyok to Skardu, but floods compelled us to abandon the project. Three days of heavy rain turned every watercourse into a raging torrent, and it was only by wading breast-high along the banks of the Shyok that we were able to get out of the valley at all. We returned to Leh on July 31, and eventually reached Skardu by the Indus Valley.

Let me here refer to some interesting aspects of the Ladakh climate. A country devoid of vegetation means a paucity of soil. Storm water seldom soaks in, but comes roaring off the hills in flood. This produces the alluvial fans so characteristic of Ladakh valleys. The fan can be seen wherever a tributary valley joins a main valley, and is formed by a mass of water-worn boulders which for ages have been accumulated where the torrent debouches from the hills. An aerial photograph would be necessary to illustrate them to advantage, and as the fans caused by dredging on the Suez Canal are of precisely the same nature, an air photograph of one of these will show the formation equally well.

These fans are sometimes well over a mile in diameter at the base, and always much higher in the centre than at the sides. One which I measured in the Nubra Valley was 2040 yards across at its base, with

its centre raised 98 feet above natural ground-level. When in flood the torrent tears down the centre. In dry weather there is either no water at all or a mere trickle which is usually to be found at the edge of the fan. It is near these fans that villages are always situated.

Lowest levels of continuous snow were noted as follows:

Locality.	*Date.*	*Lowest Level of Continuous Snow-field.*
Namika La, Ladakh	26 iv.	.. .. 12,200 feet.
Marsimik La, Ladakh ..	29 v.	south slope 17,800 ,, north slope 16,200 ,,
Chang La, Ladakh	22 v.	south slope 17,200 ,, north slope 16,000 ,,
Khardong La	14 vii.	south slope 17,600 ,, north slope 16,400 ,,
Khardong La	31 vii.	south slope none north slope 17,100 ,,
Sassir La, Karakoram ..	23 vii.	.. .. 17,400 ,,
Zoji La, Kashmir	4 iv.	north slope 8,750 ,, south slope 10,600 ,,

In North Sikkim, which was visited in the following winter, snow was down to about 11,000 feet on Kangchenjunga in November, and down to below 10,000 feet in December and January.

Part II. The Origin of Life in the Himalayas and on the Tibetan Plateau

In order to arrive at the origin of life in the Himalayas and on the Tibetan Plateau, it is obvious that we need not push our inquiries farther back in the history of the world than the period when the Himalayas did not exist. In the first place we will deal with the purely geological aspect.

It is now generally conceded that Peninsular India was not connected with Continental Asia during early Eocene times, that is in early Tertiary. At that period there was no high land mass in Central Asia, and in fact vast areas of that region were ocean bed. Peninsular India may or may not have been connected through Gondwana to Madagascar and Africa.

In early Eocene times the Bay of Bengal reached far to the north, covering parts of Assam and the Eastern Himalayas, and the Indian Ocean stretched over the whole of Persia, Baluchistan, Afghanistan, the Indus Valley, and probably parts of the Ganges Plain. An arm of the sea reached up into Ladakh and Western Tibet. In Northern India the sea came at least as far east as Dehra Dun.

Thrusts from the north now pressed against Southern Asia, and being checked by the Salt Range in the west and the Assam Hills in the east, the Himalayas were squeezed up against those checking obstacles and the northern border of Peninsular India. This caused a gradual rise in Northern Assam which gave birth to the Eastern Himalayas

and appears to be the first connection which India had with Asia (or ancient Angara), a condition which allowed all the forms of life which had been developing in Central Asia to migrate south into the Indian Peninsula. And during this period of general low levels the monsoon without doubt could pass unchecked into Central Asia, causing considerable precipitation, rendering Mongolia and the Gobi fertile areas and great centres of development and distribution. This may be regarded as the first phase of the Himalayan uplift.

In the Miocene the ocean bed still covered Sind, but where now stands the Himalayas and Tibet one might have seen land of moderate elevation, intersected by huge rivers flowing from east to west and discharging into Tethys or the Indian Ocean. No marine fossils of Miocene Age have been found in the Punjab or sub-Himalayas, all deposits seeming to be fluviatile.

In the Middle Pliocene occurs a second phase of uplift, which was responsible for the main upheaval and determined the main trend of the ranges and the lines of watershed. As the plateau rose, so did the Tertiary seas (Tethys) of Central Asia drain away into the Indian Ocean, but the Himalayas commenced to form a barrier to the moisture-laden winds of the south-west, resulting in a slow process of desiccation which has probably not yet reached its maximum degree.

The third phase of uplift took place in the Upper Pliocene and was responsible for the Siwalik Range. Elevation by pressure or thrust continued not only through the Pliocene but far into Pleistocene times, and may still be at work. There is, in fact, evidence to show that during the Quaternary Glacial period, that is to say, some 20,000 years ago, the Himalayas and Tibetan Plateau were not so elevated as they are to-day. And they may still be rising.

Let us now examine the relation between animal-life and geology during the period of uplift of the Himalayas and Tibet. Geography is the determining factor in animal and floral distribution. Climate and geography are so intimately connected that as factors they must be considered co-equal. though exerting quite different influences on animal-life. The distribution of life is entirely dependent on the changing of the land surface of the globe, a fact which brings zoology and geography into such close union. There is, therefore, no necessity for explaining why it is necessary for me to go rather deeply into zoological questions before this Society, for, though geography dominates animal distribution, it is often the latter, under the guise of palæontology, which gives us the clue to the distribution of land and sea in ages gone by.

When the Himalayas and Tibet were still submerged below the ocean, nearly all the more comprehensive groups of animal-life already existed. The huge Dinosaurian reptiles, having reached their zenith in evolution, had gone for ever, having probably succumbed to changed climatic conditions. Whales, rodents, insectivores, the true cats, and in fact

nearly all groups of modern placental mammals, except the true oxen and the bears, existed when the Himalayas and Tibet were at or below sea-level.

The nature and distribution of flora in a country is, in the last resort, the determining factor which decides what types of animal-life can live therein. It cannot therefore be ignored. When the Himalayas were still in their infancy, or even before, such modern trees as the oak, plane, tulip tree, beech, alder, and poplar were in existence, as also were flowering plants. The floral landscape of the country was therefore not very different from what it is now, except where the hand of man—alas! almost throughout the globe—has changed it for the worse.

As India, from late Eocene to Miocene, became more and more a part of Asia, but with the Himalayas not a barrier to migration as it now is, and with a large fertile, well-watered area to the north teeming with life, where now all is desert and desolation on those wind-swept, desiccated, sand-covered wastes of Mongolia and the Gobi, so did all branches of life migrate south or spread south into this new land. During the Miocene and Pliocene nearly all the great African mammals could be found in Northern India. In fact, they were all then slowly moving south to where they are found to-day in modern Africa, Arabia at that period being connected with South Persia and Africa through the mouth of the Persian Gulf and Somaliland. India in the Pliocene could not have been distinguished from Africa of to-day, in regard to the larger mammals. And even more, the chimpanzee lived in the forests of the Punjab and the wild camel roamed the plains. The tiger had also come in from Siberia and the dawn of man was imminent.

But the Himalayas and Tibet were fast rising, cutting off the rain from Central Asia, converting that country into a desert, and isolating the Indian Peninsula from further migration of animal-life. In fact at the present day, except on the eastern frontier, India is so effectively isolated that even man has difficulty in gaining access to those countries beyond its borders. For all intents and purposes India is an island on the south coast of Asia, and despite the raising of the largest land-mass the world has ever known on its northern frontier, and which has connected it with Asia, it is still as isolated as it was before connection with Asia took place.

And then came an event which compelled all forms of life in the Northern Hemisphere to adopt two alternative methods of self-preservation. I refer to the Glacial Period. All forms of life had to decide whether they would adapt themselves to the new rigorous conditions, or migrate. To do neither was to perish, and much perished.

To what extent did the Ice Age affect Central Asia and India? We have two classes of evidence, the one primary and the other secondary. Our primary evidence is glaciation. What evidence is there of glaciation in Central Asia and India? The answer is that evidence is scanty

because intensive geological surveys have not as yet been carried out. Moraines and other signs of ice-flow have been found as low as 4700 feet in Kashmir and as low as 3000 feet in Kangra. There is also ample evidence to show that the present Himalayan Glaciers are but the disintegrating residue of older and more extensive glaciation which embraced not only the whole of the Himalayas, but the Tibetan Plateau. The Pir Panjal contains a mass of evidence of Pleistocene Glaciation. And furthermore, ice-borne boulders (wether-stones) have been located at Potwar, near Rawalpindi, which have without a doubt been carried in ice by flood water from the Himalayas into the plains of India.

In Ladakh signs of previous glaciation in the form of terminal moraines were observed commonly, not only in the Indus Valley at about 10,000 feet, but in the Nubra Valley at about the same elevation. At one spot near Tegur in the Nubra Valley there were obvious signs that a valley glacier had crossed the valley flowing from the east and had bumped its snout up against the cliffs on the west bank of the Nubra. That must have formed an extensive lake and would account for many signs of a former lake-bed around Panamik and farther north.

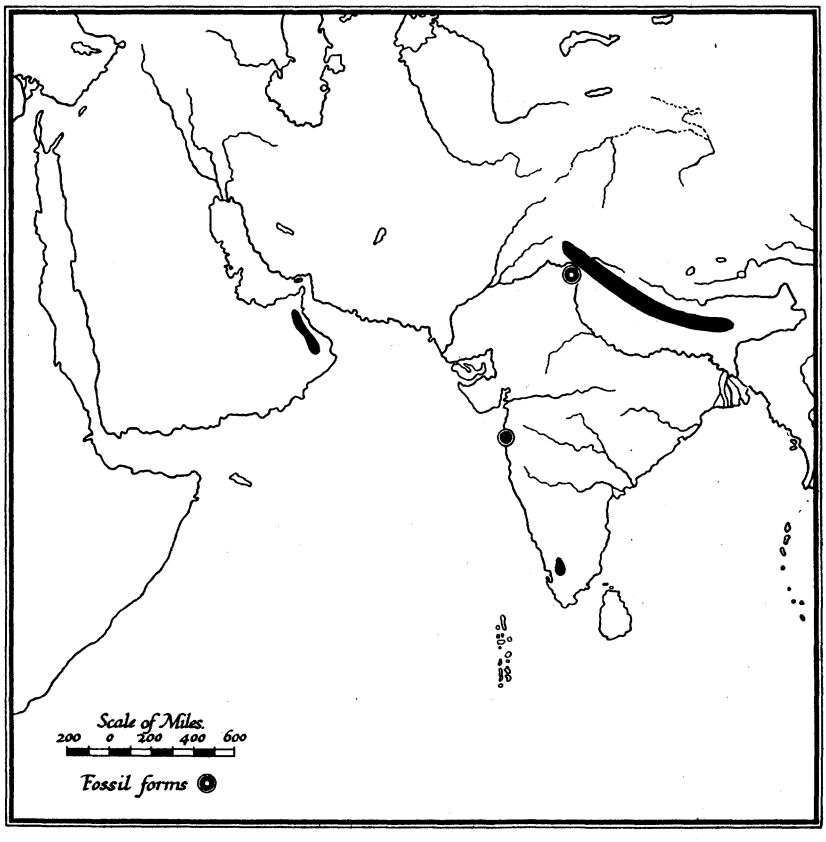
Evidence left by an ice-cap or extensive glaciation is unmistakable and abundant, as any geologist may know who has read the story of the Ice Age in Scotland. Extensive evidence of such a nature simply does not exist in the Himalayas, nor on the Tibetan Plateau. We may therefore assume there was no great ice-cap such as once existed in North-West Europe or as exists to-day in Greenland. But the absence of an ice-cap does not mean the absence of intense cold. No snow, no glaciers, and no tell-tale scratches on the ice, but the cold might have been as intense as existed in Northern Europe during the Ice Age.

It is a difficult and complex subject, about which we have not yet sufficient evidence on which to base much more than a superficial judgment. But for the purposes of this paper I would ask you to accept the opinion that the Glacial Period did not extend in an acute form beyond the confines of North-West Europe, and that it exerted a refrigerating influence not only over Southern Europe, but also over Western and Central Asia, and probably almost certainly over the Indian Peninsula; but that ice-caps (*in sensu stricto*) did not form on the Tibetan Plateau owing to lack of precipitation.

Secondary evidence of the effect of glacial conditions in Central Asia and India can be gleaned from a study of the distribution of animal-life as it stands to-day, but though we have the facts, evidence of this nature is not entirely reliable, as we are not certain what are the real causes of distribution. Distributional evidence, unless very carefully sifted, is a trap into which many have fallen. We shall try to obtain the significance of a simple case of discontinuous distribution which illustrates our argument.

In the Himalayas from Kashmir to Bhutan lives a goat-like animal

known as the Thar (*Hemitragus jemlaicus*). It is represented in the hills of Southern India by what is known as the Nilgiri Wild Goat (*Hemitragus hylocrius*). Again, in the hinterland of Oman lives another form which has been called *Hemitragus jayakeri*. Fossil forms of the same genus have been found in the Siwaliks and on Salsette Island. It may be taken as an axiom of distribution that all forms of life tend to increase and expand where suitable conditions exist and where there is no prohibitive competition. It is also another axiom that a discontinuous



Distribution of Hemitragus (Thar)

distribution represents isolated colonies of a once-continuous distribution, and that the genus or species whose distribution is discontinuous is usually more ancient than allied genera or species whose distribution is continuous.

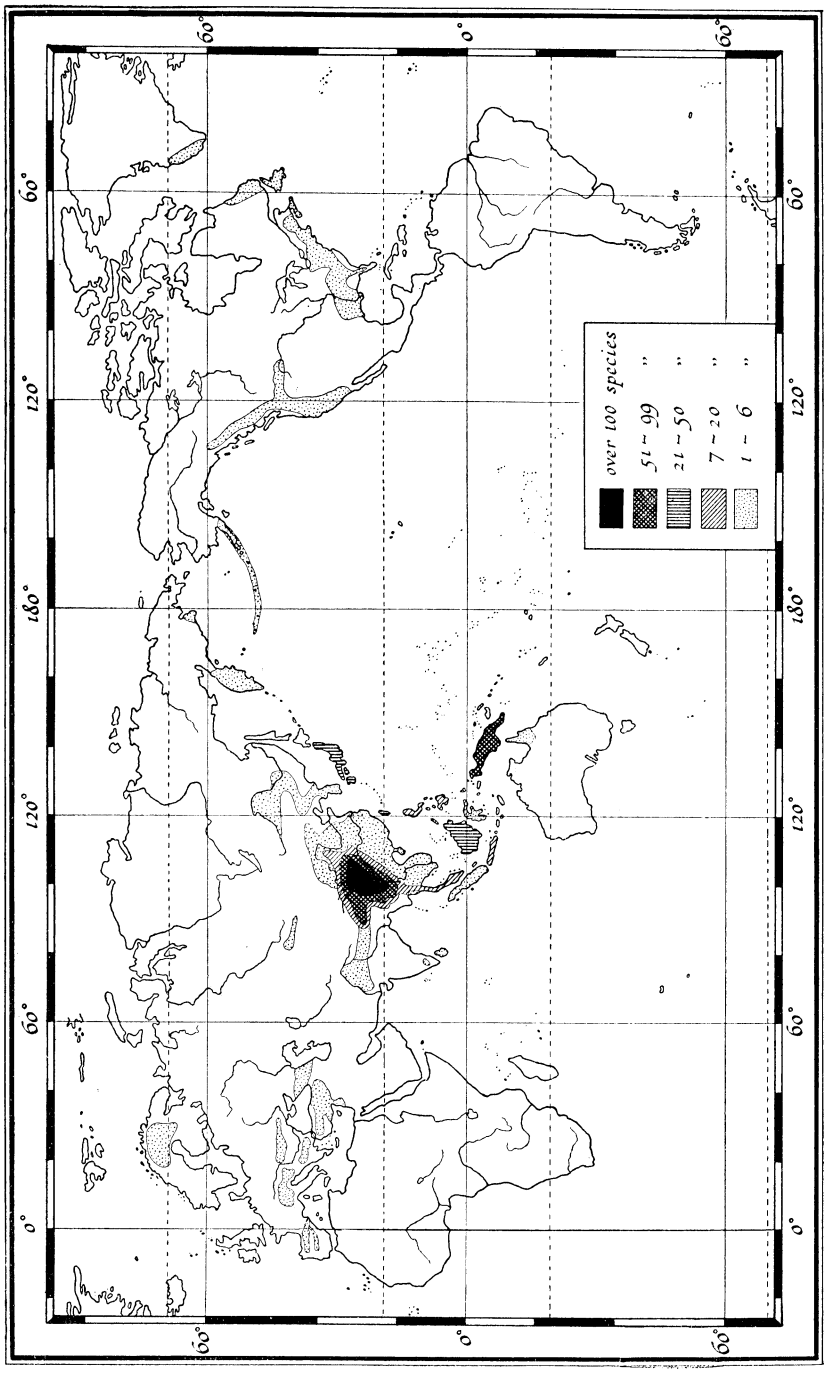
The significance of the distribution of living and fossil Thars is therefore that either suitable conditions for the Thar once existed in North and Central India and east through Persia and Southern Arabia, or that some such influence, as glacial refrigeration, compelled the Thar

to move south and west, and that with the cessation of refrigeration the Thar moved north again and reoccupied its old home. To accept the second alternative means that the Thar migrated south over the plains of India, for during the Pleistocene Indian physical geography was not very different from what it is to-day. Such a migration is unthinkable, and we must look further back in the history of India to find conditions suitable for the Thar in Central India. We must hark back well into the Tertiary, possibly to the Miocene, before we can find conditions which allowed the Thar to live in one unbroken distribution from Cape Comorin to the Siwaliks and from Bhutan to Oman. Competition in some form, physical or climatic, has exterminated the Thar in all intervening areas and left us with a few relic colonies. The Thar therefore probably existed in much its present form before the Himalayas had risen. It seems doubtful whether the refrigeration of Southern Asia during the last Glacial Period had much influence on modern distribution. It is, however, significant that the extinction of the Siwalik mammals coincides with the Glacial Period. It is by no means certain that the one caused the other.

Types of life are confined to particular types of country which satisfy their needs. Where those types of country do not exist, it is futile to search for those types of animals which affect them. A change of climate may compel life to migrate, but if it moves into an area unsuited to its habits, it must perish or adapt itself to new surroundings. As far as we know, the Thar has failed to adapt itself to any other country but precipitous mountains, and has perished in those regions which have changed their conditions and become unsuited to its habits. The Thar has failed to compete with competition, which brings us back to Darwin's theory that it neither was nor is fit to survive in those regions except when they are entirely suited to its habits. The present distribution of the Thar is a good example of the force termed natural selection or survival of the fittest. Eliminate that force, and the Thar will thrive in captivity at sea-level.

The Thar is not alone in having an isolated colony in Southern India. In the genus *Rhododendron*, with nearly 900 known species, we find an isolated colony in the Nilgiri Mountains. Here again we must presume that at one period the rhododendron extended throughout India, but has been exterminated by competition in intervening areas. Where plant-life is concerned there is always the possibility of seeds having been carried by wind or birds. The distance is too great for either contingency. The seed of the rhododendron is too heavy to allow it to be carried by wind for more than a few miles, and the digestion of a bird is too rapid to allow a seed to remain in its intestines for the period required in flight for 1600 miles.

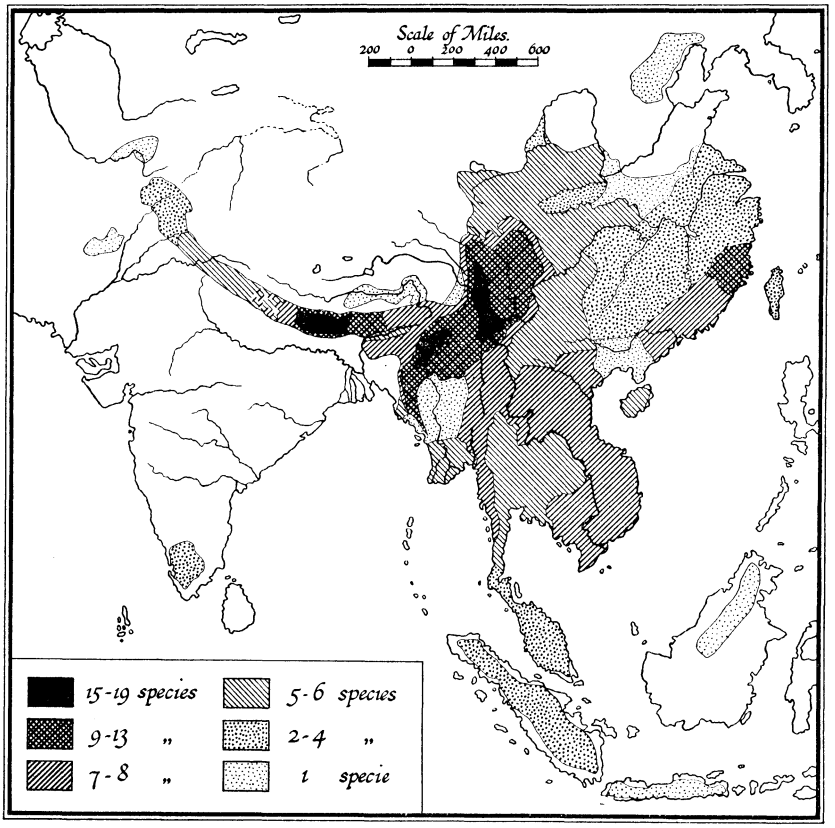
We find a similar distribution among certain insects and among several groups of birds, the most striking of which is that of the genus



Distribution of the Genus Rhododendron

Garrulax, or Laughing Thrushes. These remarkably similar distributions are probably the result of similar causes. The Nilgiri colonies of Himalayan life are relic colonies of a once continuous distribution which existed long before the effect of the Glacial Period was felt in India, and the Himalayas are probably as much a refuge for the Thar, Rhododendron, and Laughing Thrush as are the Nilgiri Hills.

What of the climate during the Himalayan uplift? All evidence



Distribution of Genus Garrulax

seems to point to there having been an almost tropical climate in what are now the Arctic regions during the Lower Eocene and Miocene, and this must have meant a climate not less cold in Central Asia and India. In fact, throughout the Northern Hemisphere the climate of the Miocene was both warmer and more uniform than it is at present. There is also evidence to show that as late as the period immediately preceding the last Glacial Period the Arctic was more temperate than it is to-day. The Mammoth, Woolly Rhinoceros, and Long-haired Tiger have all been found in a frozen condition with their wool still adhering, in Siberia,

the last-named as far north as the now isolated New Siberian Islands. We may therefore assume that when the Himalayas and Tibetan Plateau were in their infancy the climate was warm and uniform, slowly becoming colder and colder as they rose and as the Glacial Age approached, but with a gradual resumption of warmer conditions as the northern ice-caps receded.

So much for the origin of the Himalayas and Tibetan Plateau and the effect of the Glacial Period on contemporaneous life. We must now consider how the Himalayas and Tibet were colonized by the life which exists there to-day.

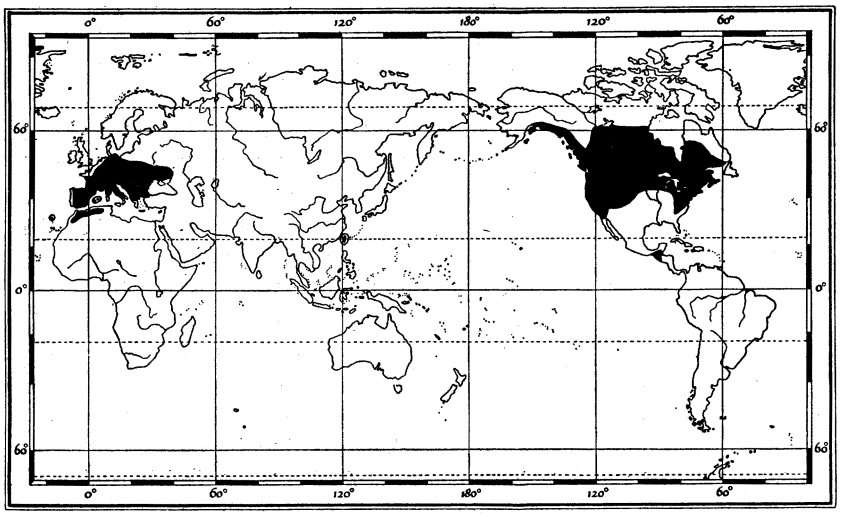
When the Himalayas and Tibet were yet at sea-level birds in more or less their present form existed. Good evidence of this is to be found in certain modern distributions, such as that of the Fire-crest Wren or the Blue Magpie. Here we find small island-like colonies with enormous distances separating them. And that is all that remains of a once continuous distribution from China to the Atlantic, a distribution which must have existed at the same time as when the Mediterranean was connected with the Chinese and Japanese Seas through what is now Central Asia, for how else can one account for the striking similarity between the fish of these now widely separated seas? More than half the generic types in Japanese waters occur also in the Mediterranean, and in many cases even the species are identical.

But what form of life first colonized the Himalayas is not known and never can be known. It certainly has little to do with life as we find it to-day, for conditions were very different. To speculate on such a subject is pure guesswork and unproductive. We shall therefore confine our inquiries to life as we find it to-day.

Tibet and the Himalayas can be conveniently divided into three sub-regions; the Tibetan Plateau, Kashmir, and the Himalayas from Southern Kashmir to Bhutan.

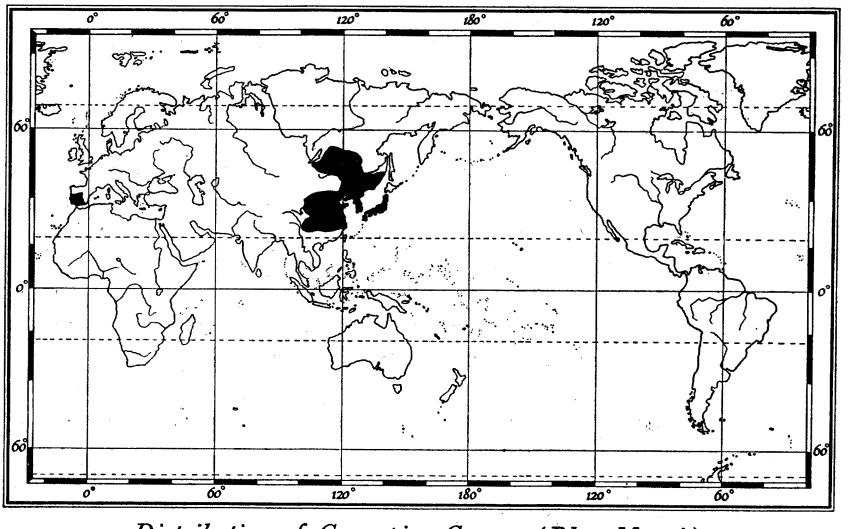
I shall first deal with the true Himalayan sub-region, namely, the hill tract extending from Southern Kashmir to Bhutan, bounded on the north by the tree-line and to the south by the foothills. This is neither the time nor place to enter into details. Suffice it to say that all evidence points to the afforested area of the Himalayas having been colonized from the east, that is to say, from the Chinese Hills. If one studies the distribution of genera or species of mammal, bird, or plant, and maps it out, this becomes abundantly clear. The cases where colonization might have come from any other quarter are rare and doubtful. There are, of course, many examples of infiltration from the plains of India, but in these cases the colonists have never reached any altitude. In most cases where there are many species of the same genus inhabiting the Himalayas, for every species at say Simla there will be two or more in Sikkim, and a still greater proportion as one nears the great centre of dispersal in Yunnan and Szechwan. This is well exemplified by the

distribution of the two genera *Rhododendron* and *Garrulax*. In *Rhododendron* we find 447 species in Yunnan and Szechwan, 40 in Sikkim and Bhutan, 6 in the Central Himalayas, and only 3 in Kashmir. In *Garrulax*



Distribution of Regulus Ignicapillus (Fire-crested Wren)

we find 19 species in Yunnan, 15 in Nepal and Sikkim, 6 in the Central Himalayas, and only 4 in Kashmir. It may be argued that the distribu-



Distribution of Cyanopica Cyanus (Blue Magpie)

tion of these two genera are governed by humidity. That is probably true, but does not alter the fact that they have spread along the Himalayas from the east. And the interesting part about these two genera is that

their present distribution well bears out their great age—*Rhododendron* having reached as far as Queensland before Australia was separated, and *Garrulax* having penetrated as far as Borneo. The reason why the plant has gone farther than the bird is of course due to the fact that flowering plants first appeared in Mesozoic times, whilst the modern form of bird did not appear until Tertiary times, or after Australia became a separate continent.

Now let us turn to the Tibetan subregion, and I include in this region only the Tibetan Plateau, not the whole of Political Tibet. Blanford was the first to recognize the importance of this sub-region, claiming that among mammals it had 5 genera and 24 species peculiar to it. On looking into the avian population, we find there are 15 species and 12 subspecies peculiar to the Tibetan Plateau. In plant and insect life we also find that many forms are peculiar. Such a profusion of generic and specific types is unparalleled in any other continental area throughout the world, and can only be compared with conditions so familiar to island fauna and flora. In islands, especially oceanic islands, we are accustomed to find relic forms which have continued to exist long after their continental relations have been engulfed or swamped by the competition of more vigorous types, and we may safely apply the same principles of distribution to Tibet as we would to either Madagascar or New Zealand. Its many peculiar forms have taken refuge on that inhospitable plateau whither their competitors have not been able to venture. Tibet is, in short, a huge alpine island, its fauna and flora originating and existing under precisely the same principles as govern the distribution and origin of life in the Arctic or any alpine region in the world.

Scharff rightly refers to Tibet as an island-like retreat of peculiar and delicate forms, and in this connection it is significant that on islands and peninsulas, Arctic forms exist in more southerly latitudes than they do on continents, for the reason that competition is less keen. We have the reindeer living in Caithness not so very long ago, the Arctic Hare occurs in Kamchatka, Scotland, and even Ireland.

With regard to other forms of life on the Tibetan Plateau, I shall confine my remarks to the distribution of two mammals and two birds which well illustrate the general principles of origin of life.

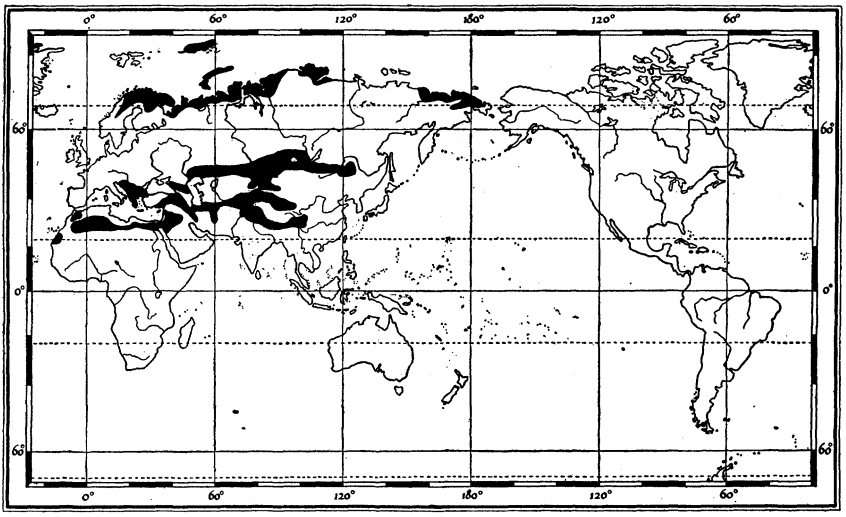
We must revert to the wild ass (*Equus hemionus*). It exists in six different forms in practically every part of Asia which is desert. One form (*kiang*) occurs on the Tibetan Plateau from Eastern Ladakh to Lhasa. Another (*hemionus*) occurs in the Altai region. A third (*indicus*) occurs in Kach and Baluchistan, a fourth (*castaneus*) round Kobdo in Western Mongolia, a fifth (*hemippus*) in 'Iraq, Syria and South-West Persia, and a sixth (*onager*) in North-West Persia and in the deserts round Tehran. The species formerly extended throughout Europe, where it is found to-day as one of the commonest fossils. The significance

of this distribution is that the species has been driven by competition into the most desolate parts of the world. What particular form of competition exterminated the wild ass in Europe is mere conjecture. But it has gone from every pleasant part of the Northern Hemisphere, condemned to live in deserts whether at sea-level or at 15,000 feet. Its status in Tibet is that of a refugee of probably northern origin.

The second mammal whose distribution is important for our purpose is the Arctic Hare (*Lepus timidus*). Its normal continuous distribution is circumpolar in regions where it has no apparent competition. All its southern colonies are relics of a once continuous distribution and exist only where it does not have competition. In Scotland it has been driven to the hills almost certainly by the Brown Hare. In Ireland, where the Brown Hare is not, it exists at sea-level. It again occurs in the Alps at elevations where the Brown Hare does not occur. Another race (*altiacus*) occurs in the Altai, and another (*oiostolos*) on the Tibetan Plateau. In Eastern Asia we find isolated colonies on Yezo, the north island of Japan, in Kamchatka, and the Khingan Mountains of Manchuria. In America there is a race (*bangsi*) in Newfoundland. This distribution displays much the same characters as that of the wild ass. The Arctic Hare cannot live with competition, and is compelled to exist in those parts of the world where it does not have to compete. In confirmation of this it may be noted that it formerly existed in Southern England, whence it has been driven by the new arrival—the Brown Hare. It is also found in fossil form in Italy. In Newfoundland, where the American Hare has been recently introduced, it has become rare and now only occurs in the bleakest parts, driven there by competition. Its status in Tibet is also that of a refugee.

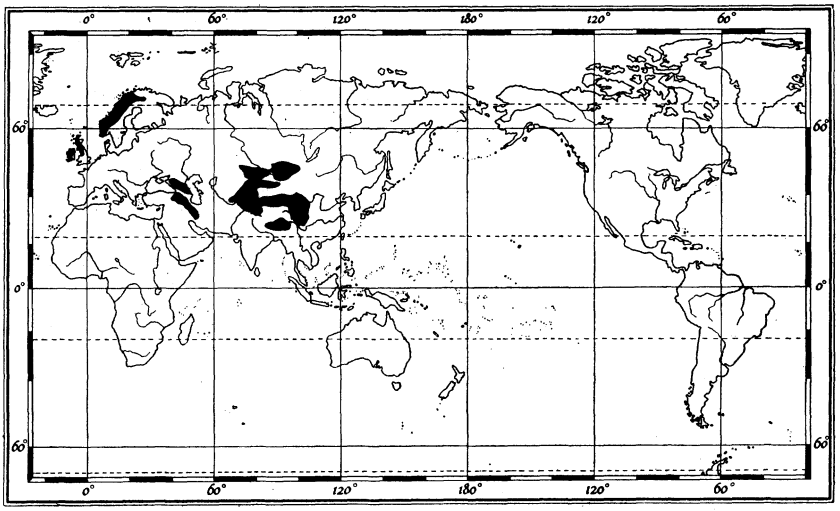
To turn now to birds. There is no case of a true Himalayan species occurring on the Tibetan Plateau, except one or two instances of cosmopolitan forms. Bird-life on the plateau can be placed in two categories. In the first place, those species which occur in most of the elevated parts of Asia and nowhere at low levels, and secondly, those species which exist in desert-like regions without regard to latitude or altitude. In the first category we have the snow-cocks (*Tetraogallus*), some of the Accentors and snow-finches (*Montifringilla*), and the Alpine Chough. In the second category, which embraces the majority of Tibetan birds, we have some remarkable examples of continuous distribution. The Tibetan Raven occurs in one unbroken distribution from latitude 80° in Greenland to Ladakh. The Horned Lark (*Eremophila*) is circumpolar with numerous forms spread out throughout the desert or mountainous portions of Europe, Asia, and North Africa, whilst in America an isolated colony occurs in the Andes of Colombia. A competitive force works against it in the Old World and compels it to live in deserts or at altitudes where other life has difficulty in living. It is undoubtedly a bird of northern origin and a refugee from more congenial climes. Some other

form of lark is probably its competitor in the Old World and has driven it out from pleasanter surroundings. The Twite is another example whose competitor is probably the closely allied Linnet. It occurs



Distribution of Eremophila Alpestris (Horned Lark), European and Asiatic

throughout the mountain ranges of Central Asia and in the Caucasus, turning up again in an isolated colony in Scandinavia and the British



Distribution of Acanthis Flavirostris (Twite)

Isles. Elsewhere it cannot compete. So here is yet another refugee of undoubted northern origin. Other birds give similar results if their distribution is mapped out.

What then is the origin of life on the Tibetan Plateau? We can safely say that Tibetan life comprises those branches which have failed to stand against competition and have taken refuge either on high mountain tops or in deserts, and Tibet satisfies both these conditions.

Before examining the Kashmir sub-region let me briefly refer to an interesting zone running along the north edge of the Himalayas and above timber-line. The Tibetan sub-region is part of the Palæarctic Region, and the afforested area of the Himalayas is true Oriental, though recently its higher levels have been (erroneously) regarded as Palæarctic. Between these two major regions runs a narrow strip of grassland at great elevation, sometimes but a mile or so across, sometimes up to 50 miles in extent, and sometimes in island-like patches. This narrow zone has some peculiar forms, some of which have come in from the north, though the majority have come in from the east and the south. It is a true contact zone between the Oriental and Palæarctic Regions. Among birds, such forms as *Lerwa*, *Grandala*, *Columba leuconota*, *Pyrrhospiza*, and others are characteristic.

Lastly we come to the Kashmir sub-region, in which is included Kashmir north of the Pir Panjal, Baltistan, Western Ladakh, Gilgit, Astor, and Chitral. Among mammals we find no representative of any exclusive Oriental genus, whilst certain typical Oriental forms, such as the Sambhar Deer, are lacking, though common in the central Himalayas. But, generally speaking, in nearly every genus which contains members inhabiting the Himalayas and Peninsular India, one of the species occurs in Kashmir. Perhaps the most remarkable mammal in Kashmir is the Kashmir Stag (*Cervus cashmirianus*), a relic colony of northern origin, and nearly related to our Red Deer.

Among birds we find some purely Palæarctic forms in Kashmir which breed nowhere else within British India, and of this group the Jackdaw is a good example. Then again we find certain forms such as the Kashmir Starling (*humii*), a Bluethroat, the Carrion Crow, the European Roller, and others which breed nowhere else within British India than in Kashmir. But perhaps the most instructive bird is the form of European Nuthatch (*cashmirensis*), which occurs nowhere else but in Kashmir. This form more closely resembles its European relatives than the other forms of the same species which occur elsewhere in the Himalayas or in Peninsular India, and was probably derived from the north or west, whereas Himalayan and Peninsular Indian forms were derived from the east.

What we find among birds and mammals we also find among insects and plants—a curious medley of eastern and northern forms. In many cases the movement of life from China along the Himalayas has not yet reached Kashmir.

When in Western Ladakh 19 species of butterfly were collected, which can be considered representative of butterfly life in that region, and of

these only one species extends into Peninsular India and only four extend east along the Himalayas. The remainder are all forms which occur commonly in Turkistan and Western Asia, and of nine species of moth collected in the same locality, not one extends either east or south of Kashmir.

Of 88 species of flowering plants collected and which can be considered representative of plant-life in Western Ladakh, 16 belong to genera which also occur in the Arctic, and 7 species occur in identical form in the Arctic.

Speaking generally, we can say that animal and plant life in Kashmir shows greater affinity to the Palæarctic than to the Oriental Region, and that certain exclusively Palæarctic forms have become isolated there, indicating a former continuous distribution. Oriental forms of life are probably of recent arrival in Kashmir, which is confirmed by such forms becoming fewer and fewer as we approach Kashmir along the Himalayas from the east.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: To-night we are to listen to Col. Meinertzhagen. To those who have read the *Journal* the name is not new; but I believe he has not previously addressed an evening meeting of this Society. To me his name is very familiar indeed. He was famous in the war for combining the pursuit of natural history, and particularly that of ornithology, with gaining accurate information of the enemy and even with provoking him! He is one of those travellers who is able to people deserts and waste spaces with living creatures, and his geographical interest is not greater than his zoological and ornithological. I always think that those who combine those interests are able to give us the most interesting papers. Therefore, with the utmost confidence, I ask Col. Meinertzhagen to deliver his address.

Col. Meinertzhagen then read the paper printed above, and a discussion followed.

The PRESIDENT: I think no one can speak to you more appropriately on the zoological side than Lord Rothschild, and I will call upon him now.

Lord ROTHSCHILD: When the President asked me to say a few words on the subject of animal and plant life in connection with Col. Meinertzhagen's lecture, I rather light-heartedly consented, thinking I should only have to say something from a purely zoological or botanical point of view. I was very much startled on getting Col. Meinertzhagen's paper to find that to say adequately anything about the most interesting address to which you have just listened would take me over the whole area of the origin of species from the Eocene period and also very far into what has proved a very thorny subject, namely, passive and aggressive mimicry. This is neither the place nor have we time to do any such thing. I will merely draw your attention to certain facts which must be taken into consideration when we think over what Col. Meinertzhagen has told us. I do not wish in any way to counter any of the conclusions that he has come to, but there are certain disturbing elements in the phenomena of animal and plant distribution in connection with Kashmir and Ladakh which must make us pause before we can realize exactly what Col. Meinertzhagen wanted to convey.

In the first place, I would mention in connection with his comment on Major Hingston's paper, about the so-called environmental mimicry, that I have found this very conspicuous in the North African desert with various species of rodents and also with the two sorts of crested larks. But I should like to draw attention to the fact that what Col. Meinertzhagen called species not in need of protection may also include such forms as have more recently come into the district and have not yet come under the stimuli which would bring about the protective coloration.

Again, I should like to say, on the question of the origin of the fauna and flora, that the two special groups that Col. Meinertzhagen has picked out, the *Garrulax*, or Laughing Thrushes, and the Rhododendrons, have certain features which also must make us consider very carefully their connection with the distribution of these forms. It is quite true that with both we find in certain regions round Yunnan and Szechwan that they have reached what I may call their zenith; that is to say, we find the largest number of species and races all crowded together there, but I am not quite sure whether it is absolutely necessary to consider that that is the central point from which these forms were distributed. For example, among the Rhododendrons you find three very distinct groups. There is the ordinary Rhododendron group consisting of numerous species and races allied to *R. arboreum*, with *R. Griffithianum* and *Dalhousiæ*, *R. Ponticum* in Europe round the Black Sea, and even in the Alps *R. ferrugineum*. Then you find the group which horticulturists call Azaleas, growing in some parts of India, in Japan, in many parts of North America, and even one little species, Rhododendron or *Azalea procumbens*, in the Alps and even, I believe, indigenous to Scotland. Lastly, you find a whole group of species with totally different habits and with quite differently shaped flowers, for they are tubular and more like the flowers of some of the creepers such as convolvulus, which form the *R. narcissiflorum* and *Javanicum* groups that reach their full development in the Malay Archipelago and extend to the Philippines, New Guinea, and Northern Australia.

Col. Meinertzhagen drew our special attention to the fact that there are rhododendrons in the Nilgiris. There is only one, *R. nilagiricum*, which is distinctly an *arboreum* rhododendron, and therefore directly connected with the Sikkim, Himalaya, and Yunnan species, but I am not at all sure that the azalea group, and especially the *Javanicum* group, have at all the same connection, nor whether they originated in the same areas as the *arboreum ferrugineum* group.

As to the thrushes, or *Garrulax*, I quite agree that the probability is that the family came directly from the East, but we are faced with a curious fact: that one species of *Garrulax*, a very conspicuous dark rufous-grey bird with snowy white head and neck, *Garrulax leucolophus*, extends in its typical form from Simla to the Himalayas and Sikkim, and to the most northern parts of Burma. That form in the northern parts of Burma has been recently separated as a local race, but I very much doubt if it is sufficiently distinct to merit separation. Then we find it again in quite a small corner of Yunnan round the settlement of Tengyueh and the Salween river, a very few miles from the border of Southern Burma and Siam. Less than 50 miles distant you find, in Southern Burma and Siam, two totally different races which, instead of having dark brown breasts, have more or less white breasts—*Leucolophus diardi* and *bellangeri*; and yet in this little corner of Yunnan, not 50 miles distant from where the white-breasted forms occur, you find the typical form, and do not find the white-breasted *Garrulax* anyhere else in Yunnan. I

believe, therefore, that there is a double migration, one west and one east, and it is not at all certain that, where these forms have reached their greatest abundance, they have originated and that they have spread from there. I think they may have had a different place of origin, and that in those districts where we find them most plentiful to-day they may have found some conditions which have enabled them to increase more largely than in other parts. But I do not think that we can, taking those points into consideration, doubt the general correctness of what Col. Meinertzhagen has said, namely, that a very large proportion of the fauna of Kashmir and Ladakh had an eastern origin.

The PRESIDENT: Major Hingston has been challenged to-night; perhaps he would like to get in his blow.

Major R. W. G. HINGSTON: I have, no doubt, been asked to join in this discussion because Col. Meinertzhagen has devoted a considerable portion of his lecture to a criticism of observations made by me while serving on the last Mount Everest Expedition. He brings forward two of my papers. The first deals with the effects of high altitude on the human body. With that paper Col. Meinertzhagen seems to agree; at least, he has repeated the various observations contained it it, and has found himself in substantial agreement with them. It is the second paper, one dealing with animal life at high altitudes, that he seems to disagree with entirely. He has prefaced his criticisms by some very kind remarks, and has then made quite a serious attack. Perhaps I may be allowed to adopt the same procedure.

It is a great pleasure to say kind and flattering things about Col. Meinertzhagen's excellent lecture. It is really a genuine delight to find a traveller coming back from the waste places of the Earth and telling us all kinds of interesting things about the beauties and the wonders of Nature, quite apart from the ordinary incidents of the journey. Col. Meinertzhagen has clearly kept his eyes wide open, for he has seen all kinds of interesting things and told us all about them. His paper deserves the highest praise. I can only assure him that I shall read it and re-read it, and always, I am certain, with instruction and delight. So much for the compliments.

I now pass to the lecturer's criticisms. Col. Meinertzhagen began by criticizing my definitions. Now it is a very good thing when starting a line of criticism to commence with a definition; but it is a very bad thing to be inaccurate in your definition, for the definition is, so to speak, the foundation stone, and if the foundation stone is faulty the superstructure is not likely to be sound. I am afraid Col. Meinertzhagen has chosen the faulty course. He begins by saying that Major Hingston defines Tibet as "essentially a desert." That is a very simple definition, but the lecturer apparently does not agree with it. He wants to improve it. He wants to elaborate it. He therefore says that he would define Tibet as "a high-altitude desert." Now I certainly will not quarrel with him on that little point, but his improvement is really quite unnecessary, because if he will turn again to that paper which he so pungently criticizes he will find that at the very commencement of it, in fact in the sixth line of it, I myself have defined Tibet as "a high-altitude mountainous desert at an elevation of about 14,000 feet." Having thus exposed the fault in the foundation, let us proceed to examine the superstructure.

The next point that comes up for criticism is in respect to some remarks that I made on the subject of protective coloration. I wrote in my paper that many of the animals which lived at high altitudes on the Tibetan plateau were protectively coloured in order to resemble the plateau soil. I quoted birds, mammals, insects, and reptiles amongst the examples. Col. Meinertzhagen

seems in some way to object to that statement. I do not quite understand if he objects to it *in toto*, or if he is just administering a series of pin-pricks. One thing, at any rate, he clearly objects to, and that is my expression "protective coloration." He thinks it ought to be changed into something simpler, and he applies the term "Environmental Mimicry." Now, why in the world does he want to change an expression which everybody understands into another expression which nobody understands? He wants to change it, he says, because protective coloration implies a purpose. And why should it not imply a purpose? If there is anything which is clear in the whole realm of Nature it is that the purpose of protective coloration is to protect. We see examples of it all over the world. We see desert animals coloured sandy in order to blend with the sand; Arctic animals coloured white for the purpose of blending with the snow and ice; insects living in the trees in great numbers coloured green for the purpose of blending with the green leaves; insects inhabiting the trunks of trees in many cases mottled in order to blend with the bark; leaf insects, stick insects, and flower insects all coloured in particular ways in order to blend with their particular haunts. Now, if there is anything at all in all this, it is that these creatures are coloured in these particular ways for the purpose of being protected in their particular haunts. But Col. Meinertzhagen does not seem to agree with that. He says there are exceptions. Of course there are exceptions. There are exceptions, or at least apparent exceptions, to every biological principle of that kind. Any naturalist could produce hundreds of them. Col. Meinertzhagen himself has produced exceptions. But the interesting thing about Col. Meinertzhagen's exceptions is that they are really not exceptions at all. Let me give an example. He says that there are certain rodents which live in low-lying deserts, and that those rodents blend with the sand, yet they come out only at night. Therefore it is, in his opinion, quite unnecessary that they should be protectively coloured, since they come out only at night. But are there not nocturnal enemies just as well as diurnal enemies? Do not wild cats, foxes, wolves, owls, and Heaven knows what not, prowl about by night in search of prey, and may it not be just as necessary for night-haunting creatures to be protectively coloured against nocturnal enemies as for day-haunting creatures to be protected against diurnal enemies?

Col. Meinertzhagen passes on to consider the causation of protective coloration. He thinks that rainfall may have something to do with it. And then he goes on to say that there may be some influence, some kind of emanation, I suppose, coming out of the rock or soil which has the effect of changing the colours of the animals and making them look like the soil. I do not think we are likely to get much further by following a theory of that kind. We should have to look for emanations in all kinds of curious places, one kind of influence coming out of the sand and making creatures like the sand; another out of the snow making creatures white like the snow; another coming out of the leaves making certain insects green so as to blend with the leaves and not having any effect on other insects, and so on. Yet we can get quite a sufficient explanation from the old masters of natural history. Darwin and Wallace clearly taught us that natural selection was sufficient: that those creatures which best assimilated with their surroundings survived, and those which did not assimilate so well were weeded out in the great struggle for life, and that this process of weeding and improvement coming down the centuries has produced that remarkable assimilation, in some cases that perfect camouflage, which exists in the world to-day. It is remarkable how attempts are made

again and again to alter or to put aside or to modify those great Darwinian principles, and equally remarkable how those great Darwinian principles always come back into their own once more.

I pass to the next point. I stated in my paper that certain mammals which live at high altitudes react to the strong winds which blow at those altitudes by growing thick coats of hair. I quoted yaks, pigs, and goats as obvious examples. Now Col. Meinertzhagen seems to object to that statement. According to him it is incorrect to say that these animals react to the cold winds at high altitudes by growing thick coats of hair, because there are mammals in other parts of the world at low altitudes—I think he said in Japan and Kamchatka—which also grow thick coats of hair when exposed to cold winds. I am afraid I cannot follow the lecturer's reasoning. If any one came to me to ask for advice about going to high altitudes, I would say that one of the special requirements of high altitudes is to wear plenty of thick clothes. I do not suppose that my questioner would disagree with me. But Col. Meinertzhagen would completely disagree. He would say, "You must not make such a statement. You must not say that it is a special requirement of high altitudes to wear thick clothes, because, you know, many people have to wear very thick clothes on a cold March day in London."

I come to another point. I stated in my paper that there are certain birds which live at high altitudes which have particularly long, strong beaks, and that such beaks are very well suited for boring into the frozen soil at those altitudes. I quoted the chough, the ground chough, and the Calandra lark as examples. Col. Meinertzhagen makes no objection to the ground chough and Calandra lark, but seriously objects to my including the common chough. He says, "You must not say that the common chough has a particularly strong bill adapted to boring into the frozen soil of Tibet, because the chough exists in Cornwall where the ground is very seldom frozen, and therefore the strong beak cannot be adapted for digging into frozen soil." In other words, his argument runs thus: that because a certain implement is not necessary for a certain purpose in England, therefore it cannot be useful for that purpose somewhere else. In this connection Col. Meinertzhagen drags in geology to his assistance. He says that the chough has lived for a long period of time in its present state; in fact, before the Tibetan plateau came into existence. That, of course, is a kind of final deathblow; because if the chough did exist before the Tibetan plateau came into being, then of course its bill could never have been intended for boring into the frozen soil of that plateau. But geology may prove to be a double-edged weapon, for if the chough did exist for that immense period of time before the Tibetan plateau came into existence, then it must have existed during those long periods when the greater part of Europe and the whole of the British Isles was under ice-sheets and when the ground was frozen hard. And for all Col. Meinertzhagen may know to the contrary, and certainly for all I know to the contrary, the chough may have actually been enabled to survive and may have been preserved by reason of the very fact that it possessed such a bill which was long enough and powerful enough to bore into the frozen soil of England.

I come to the next point. I stated in this paper which has been so pungently criticized that there is a short-toed lark at high altitudes in Tibet which possesses the interesting habit of building a rampart of pebbles round its nest. I said it did so in order to prevent the high-altitude winds of Tibet from blowing sand into its nest. Col. Meinertzhagen seems to object to that. He says, "You must not say that it builds a rampart of pebbles in order to protect itself from

high-altitude winds, because there is a lark in Mesopotamia which also builds a rampart of pebbles, another in Palestine which builds a similar rampart, and still another in Algeria which also builds a rampart, and they all do it for the same purpose; therefore you must not say that the lark which lives in Tibet builds a rampart of pebbles in order to protect itself from high-altitude winds."

I really think that he is making a mountain out of a molehill. Let me therefore give you, in conclusion, an exact parallel. Everybody knows that the people who live at high altitudes are very dirty. Everybody knows that the Tibetans never wash themselves and never change their clothes. Now, if I were to say, "It is a characteristic of the people who live at high altitudes to be very dirty," I do not suppose that any one in the audience would seriously disagree with me. But the lecturer would totally disagree. He would say, "You must not say that it is a characteristic of the people who live at high altitudes to be very dirty, because, you know, there are people in the slums of London who are very dirty, and because the Eskimo who inhabit Greenland are remarkably dirty, and because the inhabitants of Tierra del Fuego are notoriously dirty; therefore you must not say it is a characteristic of the people who live at high altitudes to be very dirty." And that, so far as I can see, sums up the whole of the lecturer's argument, and that is my simple refutation of it.

Mr. F. KINGDON WARD: After the delightful lecture that we have listened to this evening it seems a little ungracious to take up the position of opposition, and after the extremely interesting and amusing speech we have just heard I am afraid mine will seem a bathos. But there is one point which I should like to criticize, the question of discontinuous distribution, particularly with regard to Rhododendrons. It seems to me that discontinuous distribution does not necessarily mean previously continuous distribution; it may have been successive distribution. The lecturer quoted the example of *R. arboreum* or *Nilgiriense* found in Southern India, which is practically the same as *R. arboreum* of Sikkim; and through the whole length of India this plant does not occur. If we suppose that the plant has been pushed southwards by ice it is perfectly easy to conceive that it gradually took up different positions on its journey southwards, and eventually landed up in the Nilgiris. The country got warmer and warmer; the rhododendron simply stayed in the south; it never covered the whole land at all, and when the country got warmer there was one *R. arboreum* in the extreme south of India and another in Sikkim. Take a very simple illustration of the same effect. This country exports prize cattle to the Argentine. That is the same thing being done on a very much more rapid scale. The ice, or the cold we will say, creeping southwards gradually exported *R. arboreum* into the south of India. There is no continuous distribution of prize cattle between here and the Argentine. They simply have been moved from one place to the other.

The other point is the question of distribution of the flora through China westwards through Sikkim, Bhutan, and Kashmir. I do not question the lecturer's conclusion that the flora moved from the east to the west, but I do question his evidence for it. It may have been so, but I am far from convinced on the evidence I have heard to-night, because it is perfectly easy to conceive the flora starting in Kashmir, Sikkim, or Bhutan, and gradually moving eastwards. We will suppose there are quite a few species to start with, but they come into this wonderful country of Upper Burma and South-Eastern Tibet and decide to settle down, increase, and multiply. They proceed to do so, but it is no proof that because you get fewer species in the east than the west the flora must have moved from the more prolific to the less prolific country.

Dr. HEBER: I suppose, like most medical men who have lived at altitudes, I also have fallen into the temptation of trying to find out the effects of altitude on the human body. When I did so I too had had the pleasure of reading the paper by Major Hingston. I have come to the conclusion that I must be very careful what I say about Major Hingston! Col. Meinertzhagen has referred to the fact that at certain altitudes he felt more uncomfortable and at higher ones more comfortable. I think that is quite a common experience. I remember well going up the Kardong pass behind Leh for the first time. I got to about 14,000 feet and felt anything but well. I had a bad headache and all the symptoms of mountain sickness, and wondered how I was to get on at the top of the pass. But the higher I got the better I felt. In 1913 we had the Anglo-Italian Expedition in Ladakh with us, and Sir Filippo de Filippi, the then leader, told me that he felt worried about his second-in-command because he was feeling the altitude even in Leh, which is only about 11,000 feet, and they were going up to the Depsang plateau, which is nearer 20,000 feet. The Ladakhis feel unwell on certain passes and on others they are quite comfortable, and they say it is due to a certain plant which grows on the passes where they do not feel so well. I personally have never found the plant, but an Englishman sent me one which had a very pungent smell and would certainly be able to cause mountain sickness.

Then Major Hingston in his paper refers to the blood count. I also did a blood count in Leh, because it is chiefly through the blood that the altitude affects the body. My findings were not quite his, and I think the differences are interesting. I am speaking without book, but as far as I remember Major Hingston took his material up with him. If I am wrong perhaps he will contradict me—no doubt he will! The people on whom I made my investigations were actually born in the country and had lived there all their lives. I found that, taking Asiatics, they on the whole, had a higher blood count than we have here in England or at the lower levels, but their blood count was less than Major Hingston found with his material. What was most interesting to me was the fact that the Ladakhis as distinct from other Asiatics, and down-country Indians, had a still lower blood count than the Indians. The Ladakhis, as a matter of fact, were very little above the blood count for English, being about 5,800,000 red cells per cubic millimetre. It seems therefore as though the blood of the Ladakhi had learnt to do its work of carrying oxygen better, and therefore it was not quite so necessary to have such a great number of cells.

Col. Meinertzhagen has also referred to the fact that he found an increased respiration and pulse-rate. Again I investigated about 200 Ladakhis, and I found with them, too, there was an increase in both these things; but what to me was most interesting was that in the case of English people the lung capacity itself increased and the chest enlarged. My wife found that after two years' residence in Ladakh her chest measured 2 inches more than it did when she went up there. Some years ago I walked up from Srinagar, the capital of Kashmir, with a friend. Before leaving Srinagar I took measurements of her chest, and I found when I got to Ladakh these had increased by half a centimetre. You may object that that was accidental, that perhaps I had not held my measuring tape as firmly as I did in Srinagar. But when I took her measurements a second time I did not know what her first were; I had quite forgotten them. At any rate, I think it is established that residence at high altitudes does increase the lung capacity.

Another interesting point was that the right heart increased in size. I think you will see that this is quite a useful thing because it is the right side of

the heart which pumps the blood to the lungs, and you want more blood there. On the other hand, I found the blood pressure was rather lower, and that too is very useful. The left side of the heart has a good deal of strain at high altitudes. Therefore with a lower blood pressure it has less hard work to do.

May I refer to the Mystery Play at Hemis, which to me is still a mystery? We have tried unsuccessfully to connect the separate incidents of the performance into a consecutive plot, but this seems almost impossible. We have endeavoured to find out its meaning from priest and layman, but received as many explanations as we had informants. I cannot help thinking that the play as it exists to-day is a result of evolution, various scenes having been added at various times. Col. Meinertzhagen is quite correct in surmizing that on the whole it is to teach the layman what happens to the soul after death. The explanation often given by the Ladakhi is that we have to meet hideous demons when the soul leaves the body, and therefore it is wise to get used to the look of them in this life. There is also very definite teaching of vicarious suffering. The effigy which is cut up was, no doubt, a human sacrifice in former times. But, above all, the Devil Dance seeks to make clear to the layman that in order to obtain salvation the priest is absolutely essential. It is only the lama who can save the soul that is beset by perils after death, and thus the play brings grist to the monastic mill.

The PRESIDENT: I believe Mr. Wollaston would rather not speak, and as the hour is getting late, I will ask Col. Meinertzhagen if he would like to reply to Major Hingston or to anybody else. I find he would rather not say anything. Well, you must have had an amusing and even exciting evening, and realized what vitality there is in scientific circles. Quite seriously, I think we owe a great debt of gratitude to Col. Meinertzhagen for having poured out before us the result of his own acute curiosity and acute observation. It certainly, as I think Major Hingston said, is a great thing to find some one with the unique and singular qualifications that Col. Meinertzhagen possesses to devote his interest to the various features of a country so little known as the country above Ladakh. We have seldom had, I think, a paper in which so many different features of life, both human and animal, have been conjoined with a description of scenery. I ask you therefore to signify your gratitude to Col. Meinertzhagen in the ordinary way.

ATLASES OF THE BRITISH ISLES

The Printed Maps in the Atlases of Great Britain and Ireland. A Bibliography by **Thomas Chubb**. London: The Homeland Association. 1927. 13½ × 9, pp. 479. *Facsimiles.* £2 10*s. net.*

STUDENTS of British cartography owe a debt of gratitude to Mr. Chubb for the labour and research he has put into this monumental work, on the preparation of which he has been engaged for many years. In spite of the restriction of the field to maps in atlases or similar collections (those issued separately being left on one side), the undertaking was a gigantic one, and we can only admire the industry and perseverance which has brought it to completion with little or no assistance to the author beyond that of his colleagues in the British Museum Map Room. The task could hardly have been so successfully accomplished by any one lacking Mr. Chubb's advantage of constant access to the unrivalled collections housed in that department of the Museum,

Eleusinian Mysteries, centaur, and things of that kind; but we have not been able to find anything really definite as to their origin.

I might say that I was asked by the Government to report on the Bambudye society, and was able to satisfy our friends of the Administration as to the immoral practices, chants, etc. It is all too evident that they are foul. Our native is a strict exogamist, never marrying in his own village, but in the "kinyergele" of the Bambudye he gives way to the wildest promiscuity.

The PRESIDENT: We are very much obliged to Mr. Burton for the lecture which he has given and for his illustrations and, if I may so call them, the frills so unusual in lectures. In fact, I do not think that we have had so gifted a lecturer before us for a considerable time. But, quite seriously, what he has told us has shown not only that he has remarkable powers of representing the native, but also that he treats him with sympathy and puts an amount of diligence into studying him and his customs and practices—for instance, his drum-signalling—which are rare. Well, you have already, by your reaction to his lecture, amply assured him of the interest which you have felt in what he has said and the appreciation with which you have followed it.

THE STEREOGRAPHIC SURVEY OF THE SHAKSGAM

Major Kenneth Mason, M.C., R.E., Survey of India

Read at the Afternoon Meeting of the Society, 9 May 1927. Map following p. 416.

AT the afternoon meeting of the Society, on 13 April 1922, Mr. Hinks remarked that he had not come across any example of a stereographic survey on a scale smaller than 1 : 20,000, except that of a small area in the Cumberland Lake district by Lieut. F. V. Thompson, R.E., in 1907, on a scale of 1 : 63,360. This occasion was my introduction to stereographic survey, for I assisted Thompson both with the photography and with the subsequent plotting on his machine. Later, in India, I persuaded the Surveyor-General to obtain a Thompson Stereo-plotter, and in 1913 I took pairs of photographs during the course of geodetic triangulation on the Pamirs, and plotted them in the Thompson instrument on my return.

In both these small-scale surveys it was difficult to convince practical surveyors of the utility of the method. Stereoscopic accommodation is obtained by novices in varying degrees, and full accommodation—I include rapidity and ease—only comes with practice. Those with eyes of equal power will find stereoscopy easier than those with a powerful master eye, and those whose eye muscles have been developed by practice will find stereoscopy a pleasure. The practical surveyor, who has been brought up solely to use the planetable, and who cannot easily fuse a stereoscopic image, has always been sceptical. Those who believed in the method were dismissed as extravagant enthusiasts by the sceptics.

The result of this attitude has been that we, in England, have fallen behindhand in the development of photographic survey methods.

Though Thompson's instrument was admittedly very imperfect, its invention was a great step forward, and in the first British patent specification for the Von Orel Stereo-Autograph, Messrs. Zeiss referred to Thompson's paper in the *Geographical Journal*, and acknowledged their indebtedness to the inventor. Several automatic plotting machines are now on the market, all designed on the Continent. They have been evolved primarily for large-scale and technical surveys. In England, where the Air Survey Committee functions, reports have been collected on these Autographs and Cartographs, but their suitability for air survey, as against ground survey, has been the main consideration. Nevertheless, owing to modifications and great advances in design, the base conditions for stereoscopic survey, which were, owing to their limitations, the main cause of criticism in the earlier models, have become far less exacting. Both Mr. Hinks and I felt that the application of the method to reconnaissance and exploration work deserved consideration and experiment; and from my first mention of a wish to try stereoscopic survey in the Shaksgam, I enlisted the enthusiastic co-operation of the Secretary.

On 18 January last year, at an afternoon meeting of the Society, Major Hutchison and Mr. Hinks read papers describing the Wild Photo-theodolite. This was the instrument which the Council purchased after exhaustive inquiries to ascertain which of the various models on the market was most up to date. This photo-theodolite the Council kindly lent to me for the experiments, together with its accessories. Chemicals, developing outfit, Imperial Special Process plates, etc., were purchased for the Survey of India by the good offices of the Society, and the whole outfit reached me at Simla early in March last year.

This field equipment is designed for use with the Wild Autograph, which has been specially constructed to plot the photographic pairs rapidly and accurately. I am not going to attempt to describe this machine. I could not do so intelligibly without one to show you, however much I tried. I understand it myself, thanks to Mr. Hinks and Mr. Hunziker, and a very good and concise description of it will be published in the *Journal* by the former, together with this paper. I will here only say that though it is most complicated to describe and difficult to explain geometrically, it is comparatively simple to operate, extraordinarily compact, and magnificently designed and constructed. How all the moving parts fail to foul one another during the plotting is a never-ending source of amazement to me.

Before commencing to describe my Shaksgam work, I will answer at once the various questions raised at that afternoon meeting last year, in order to avoid mixing them up with details later. I will not describe again the photo-theodolite, for I cannot improve on the published account.

The first point is the accuracy of the theodolite. At Simla, before

starting, I tested my readings against those of a second observer. We often read the same second, and were never as much as four seconds apart. But the illuminating prisms should not be moved during a round of angles. At the close of the expedition, I took three or four rounds of angles to well-defined points and obtained practically identical readings, which never differed by more than 2·5 seconds. On the expedition itself, my observed points were often very ill defined, and I got larger differences, through no fault of the instrument.

I did not care for the specular illumination of the circles, and in reading the vertical angles, I always reflected light into the prisms with white paper. Mr. Wild is now adding white matt surfaces for reflecting the light. He is also considering the provision of a rack and pinion to insert the prism for reading the vertical circle. These improvements have already been incorporated in the larger model of theodolite.

Some doubt was expressed whether the complicated system of lenses and prisms would stand rough usage in the field. Either the instrument did not have sufficient rough usage to damage it, or it was capable of withstanding it. The sponge rubber cases supplied by the Society were excellent, and did not deteriorate, though I had to re-set them with rubber solution twice during the expedition.

The optical system was unaffected by dust or moisture. But it was not a severe test for the latter, for Ladakh is excessively dry and we had no fog or dew.

I found the collimating level a great boon. It kept in perfect adjustment and saved much time during the observations. The diagonal prisms for reading high elevations were also quite convenient, once one became used to reading the micrometer reversed.

The experimental electrical illumination for night work was not altogether satisfactory, being added at the last minute. Mr. Wild has already improved it.

In the dry climate of Ladakh, the wood of the tripod shrunk in the sockets, both near the head and at the feet. This was easily remedied by tightening up with the socket keys. We had some very high winds to contend with; the tripod was rigid enough for observations, though for safety I had to dismantle the theodolite on more than one occasion. I found that if I used the theodolite in a high wind without the camera in its place, it was not quite steady.

Colonel Jack doubted the method of fixing the theodolite with two quick-motion screws to the tribrach stage. These screws worked quite satisfactorily in practice. I found the omission of sights a drawback; but Mr. Wild has told us that he is now fixing them to his latest patterns. The milled heads are perhaps too much alike, but this is a minor point, and it did not offend me.

The only really serious drawback I found to the instrument was the limitation in elevation to 42°. This was inconvenient at times, for at

most of my photo-stations I wanted a sun azimuth to assist the computation for resection, and this meant that I must observe the sun before 9 a.m. or after 4 p.m. in those latitudes. I admit that the sun is best for azimuth before or after these hours, but at high altitudes beggars can't be choosers.

There are two points about the camera which I will mention: The objective is amazingly good. The plate-carriers were not light-tight. I had to use the utmost care not to touch the face of the carriers, and though I covered them with a velvet hood, kindly made for me by Mrs. Hinks, both on taking them from their box and during exposure, light filtered in sometimes. Mr. Wild has now designed a new pattern, which was recently tested satisfactorily in Switzerland by being exposed to sunshine for two hours. But for still greater safety, even this new design should be dulled.

I think I have answered all the points raised at last year's meeting. The photo-theodolite emerges from these tests very satisfactorily. The few criticisms are really very superficial matters compared with the beautiful design and workmanship, and with the many solid advantages which this type of instrument has over the old, both for accuracy and rapidity. For convenience of transport and rapidity of work at camera stations, I prefer to have the camera and theodolite both mounted on one tripod, and not separately, as has been suggested; and I can best sum up my own feelings on the subject by saying that I hope I shall never have to observe with an old-pattern theodolite again.

This is all rather a digression from the Shaksgam. But I must still explain that at no period did I intend to make a *complete* map by stereoscopy. I knew that the difficulties of transport and uncertainties of travel would prevent the possibility of a proper reconnaissance for camera stations, and as the whole method was experimental for this class of work, I preferred to rely for my general map on the planetable of Khan Sahib Afraz Gul Khan, which could be controlled by my triangulation with the photo-theodolite. Also I had no technical assistant, other than the Khan Sahib, in survey or photography, though Captain Cave learned to use the instrument during the expedition and was most helpful when available.

When we left for Kashmir I was personally convinced that the photo-theodolite was admirably suited to the experiments and that these had every chance of being successful, provided the previous triangulation on which I depended was sufficiently accurate for resection work. This triangulation was far from geodetic. It consisted almost entirely of reconnaissance and exploration points, generally snow peaks unmarked in any way, and often fixed from small bases by different observers. The test therefore was a severe one.

I will make three groups of our experiments. The first includes a number of photographs taken within the area of the planetable survey,

in order to form a comparison between the two methods. The second comprises a number of photographs taken from stations at the edges of our planetable survey, in order to test the value of the method for long-distance reconnaissance survey. And the third is a small series of photographs taken on the line of march through Nubra in Ladakh, without any control points identified for certain, to test the limitations of the method for the revision of old maps.

In these tests the bases were of various lengths up to about 900 metres, the smaller ones being measured with the subtense bar provided with the outfit, the larger ones being computed after resecting each end. In only one instance was the camera axis normal to the base, and on one occasion it was inclined as much as 50° to the normal. The camera was tilted downwards on two occasions, and at times the axes were convergent. The base was never horizontal, as much as 100 metres difference being measured between the two ends of one base. Both cameras were used, the focal lengths being 165 and 250 millimetres.

The views were taken across valleys, up and down valleys, in close and in open country, in order to find out what conditions were best. Camera stations, or one of them, were generally resected by the photo-theodolite, but in one or two cases I had to fall back on planetable re-sections. On these latter occasions the base was very carefully measured by the subtense bar.

I will mention a few points about the field work. Though the Wild Autograph will deal with, and actually did deal with, minor errors in the field, great care should be taken to level the theodolite carefully and to record correctly the various elements of inclination, tilt, and convergence. The Autograph finds out any errors and will correct them, but time is lost when setting, if this has to be done. In the field there was some difficulty in getting suitable camera stations and bases, but this was chiefly due, though perhaps not entirely, to the high altitude and my own lack of experience.

It is essential to use first-class plates and to take great care with the photography. The Imperial Special Process Plates left nothing to be desired, and were in every way excellent. But however perfect the plates, I am convinced, from previous experience, that where definition is essential, as it is in long-distance micro-stereophotography, the development of the plates must take place in the field. I am certain that after exposure to light even the best emulsions tend to deteriorate if development is delayed. I personally developed all my negatives in the field by the tank method as soon after exposure as possible.

I now come to the actual plotting of the results. The Government of India placed me on deputation to Switzerland for one month with Lieut.-Colonel Sackville Hamilton of the Survey of India. Mr. Hinks was deputed by the Council of the Royal Geographical Society to join us and study the working of the Autograph. Before leaving for Switzer-

land, Mr. Hinks and I collected all our data in what we considered the most suitable form, the former kindly converting my spherical co-ordinates to rectangular.

There are at present five Wild Autographs in commission in Switzerland, two being at Dr. Helbling's Topographical Institute at Flums. Dr. Helbling very kindly allowed us the use of one of these for one month, and placed the services of Mr. Guido Hunziker, his chief engineer, at our disposal for that period. I wish here to acknowledge our very deep gratitude to these two gentlemen for all their courtesy and assistance. To enable us to plot our photographs, and at the same time to fulfil his own contracts, Dr. Helbling had to put double shifts on to his other Autograph—a practice which is always inconvenient and expensive. We also took up a lot of the time of Dr. Helbling and Mr. Hunziker, both of whom helped us in every possible way to master the intricacies of the instrument. The plotting itself was done by Mr. Hunziker and myself, taking turns at the Autograph.

We plotted three maps, one for each type of experiment. The accuracy test is on the scale of 1 : 50,000 ; the long-distance test is on a scale of 1 : 250,000 ; and the Nubra experiment 1 : 125,000.

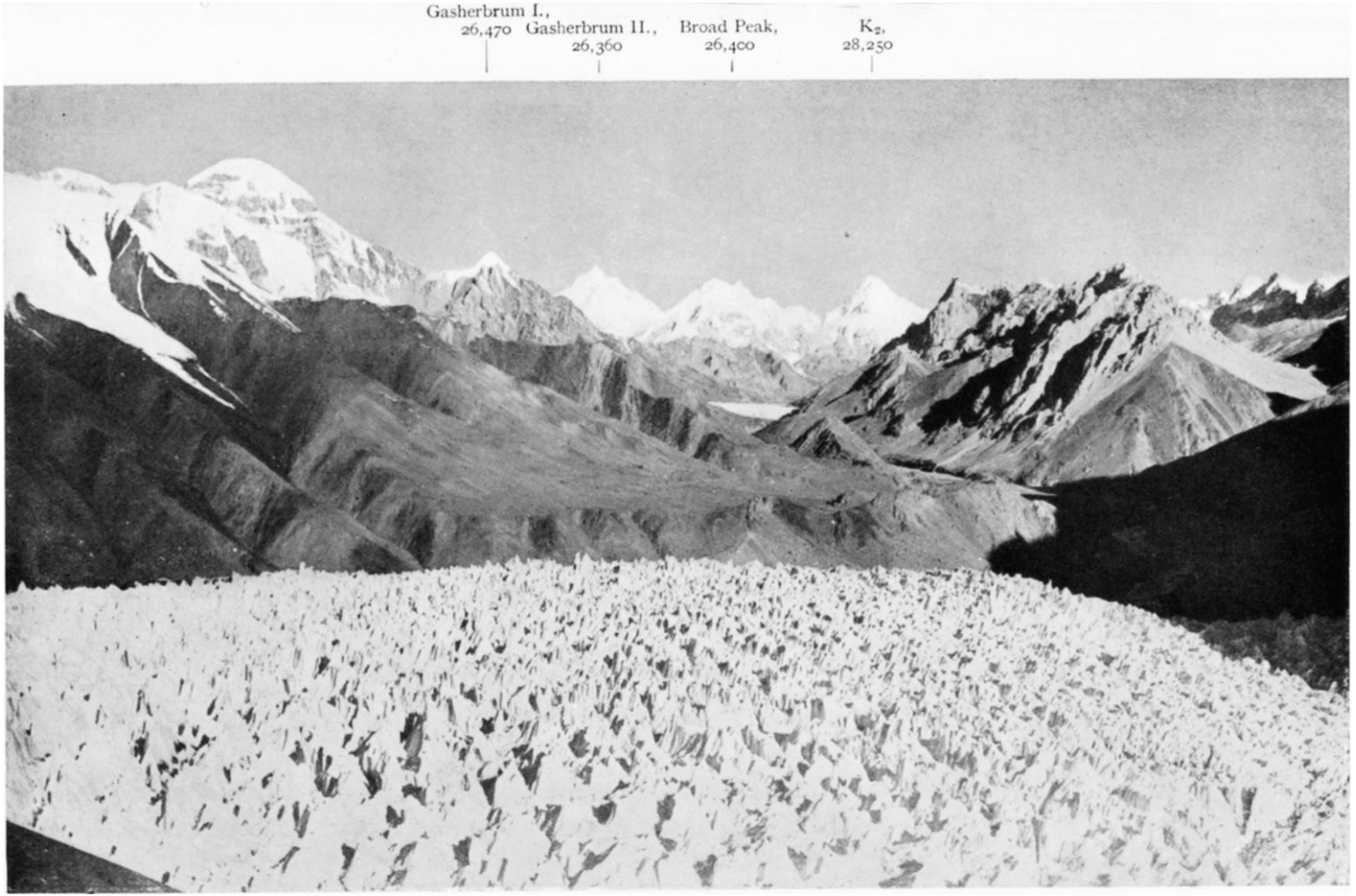
I will now take each map separately. We selected the Kyagar glacier and neighbourhood for the first test, partly because we had more control points, and partly because we could combine more pairs of photographs, and therefore could test the junctions of pairs better. Here we had four camera stations, W_4, W_5, W6, and W7, on the ridge east of the Kyagar glacier, and on the bases W_5W_4, W_6W_4, W_6W_5, W_7W_5, and W_7W_6 we had five pairs of photographs taken with the small camera. My stations were resected from the Survey of India positions for Teram Kangri I., the Gasherbrums, and K_2, and one of my own less accurate points. The centre pair was controlled primarily on Teram Kangri I., and the adjacent pairs were set on points of detail derived from the first pair and checked on the trigonometrical control. The rest of the detail of these other pairs agreed most satisfactorily. On the left, Grant Peterkin's peak No. 27 coincided almost exactly with the Autograph position, and the height was correct within 20 feet. Colonel Wood's two points, 16^1 and 16^2, fell on the Karakoram crest-line, though, as they were not peaks but only points on the ridge, it is not possible to say whether they are absolutely exact. Teram Kangri III. agreed perfectly in the next pair to the right, and accurate positions of the other salient peaks of the range in the neighbourhood of these peaks have been obtained. These positions may be considered as trigonometrically correct. On the extreme right of the series of photographs there was a difference of about 50 metres on the ground at a distance of about 10 miles, between the position of a point plotted on this scale and series, and the position derived from another pair of photographs, taken with the large camera and set on K_2 and the Gasherbrums, between 30 and 42 miles away,

plotted on the scale of 1 : 250,000. This is only 0·2 millimetre on the latter scale.

In Mr. Hinks' description of the Autograph, he describes the various gears of the instrument, by which the different ranges of plotting are obtained. For this series we used the gears 1 : 1 for the distance and 3 : 1 for the foreground. One could of course only generalize the contouring of the Kyagar glacier. Mr. Hunziker and I spent a happy and interesting afternoon with the Autograph index traversing the glacier, and I am more than ever prepared to take off my hat to the first person who succeeds in crossing it on foot. The best chance appears to me to be between the glacier and the marble cliffs, but it would mean probably at least three days' hard work with the axe to cut a track for climbers, and one may even then be held up by lakes. The snout here is about 2 miles across. Further up the glacier there are too many lakes and crevasses, to say nothing of the great ice pinnacles themselves, to render any passage practicable in its present condition, unless the eastern moraine is followed. This last leads to the eastern of the two Karakoram spurs, and from here a crossing appears to be practicable to the western promontory without excessive difficulty. But from this point the big glacier from Teram Kangri is a decided obstacle and much crevassed, though the pinnacles here are not more than 20 feet high. The western moraine does not look difficult, but it certainly will be most exhausting. The western side glaciers form obstacles, but by keeping to the main moraine for some way, the ends of these side glaciers can be passed. I think the whole passage by this route would take four or five days of strenuous work, and I recommend any one desirous of crossing to study the photographs in the stereoscope first.

The Autograph came out very satisfactorily from this test. The second experiment deals with the distant plotting. The longest base I could get for photographing K_2 stereoscopically was about 900 metres. Even with a base of this length, Gasherbrum I. was almost lost behind the foreground of the left-hand view. K_2 is 42 miles away from here, "Broad Peak" 37, and Gasherbrum II. 33 miles. That is to say, neglecting the inclination of the camera axes to the normal, the ratios of base to distance were 1 : 84, 1 : 74, 1 : 66 for these peaks. With this base, 2935·5 feet, to be exact, with the large camera, and with a measured convergence, we were able to plot the detail and the 250-foot contours of K_2 and the nearer peaks without much difficulty.

Combining my right-hand photograph here with another at W5, *i.e.* using a shorter base, 1054·1 feet, the ratios were reduced to 1 : 210, 1 : 185, 1 : 165, while Gasherbrum I. appeared now with a ratio 1 : 150. Though it was still possible to plot the summit of K_2 within a quarter of a mile, it was no longer possible to plot the detail either here or in the neighbourhood of the "Broad Peak." As however more detail could now be combined stereoscopically near the Gasherbrums, an attempt



Across the Kyagar Glacier and down the Shaksgam Valley

From Station W4. Focal length 165 *mm. Camera axis depressed* 6 *grades. Compare plate* 4, '*G. J.*', 69, *p.* 301, *taken with focal length* 250 *mm. axis horizontal*

Aghill Ranges and Gasherbrum I. from the Tatar La

*From Station W*15

was made to plot the contours also. It was found that they could only be plotted with extreme care, by joining up successive plotted points of the same height. I would therefore suggest that the ratio 1 : 165 is about the limiting effective ratio for the automatic plotting of detail.

In this series the heights of Gasherbrum I. and II. and of K_2 agreed within a few feet of the triangulated heights, after setting the Autograph height drum correctly for the Station heights and allowing for curvature and refraction. But Broad Peak appears in the Autograph to be only 26,400 feet in height, and not 27,132, as found by the Duke of the Abruzzi. If this peak had been at the edge of the plate, I would have given it the benefit of the doubt and assumed that either the instrument or I was at fault. But when controlled on both sides by such well-triangulated points as K_2 and the Gasherbrums for distance, direction, and height, an error of the Autograph is not possible. The height was checked at once by Mr. Hunziker, and we are convinced that this height, 26,400 feet, is correct within 50 feet, relative to K_2.

The other points of interest in this series are these. We were able to plot some of the great northern spurs of the Karakoram Range that enclose the Urdok and Gasherbrum glaciers. Neither the naked eye, nor the planetable, nor the Canadian method of photogrammetry could have found any detail whatever of these ridges, or could have even discovered their existence. They are rock and snow ridges against a background of snow and rock, and nothing but stereoscopy could hope to separate them or recognize individual points. In the Autograph these ridges stand out in wonderful relief and are easily plottable, thanks to the excellence of the objective and of the plates. I do not think that any of us quite believed that the Autograph would pick out these details, and Mr. Wild himself was certainly more than sceptical until he saw the diapositives in his stereoscope.

In this series we have also determined the positions of the snouts of two more glaciers beyond the Kyagar, and have plotted the bed of the Shaksgam far below any point we could see with the naked eye or without the magnification afforded by the Autograph. This point cannot have been more than a short distance from the spot reached by Sir Francis Younghusband, and must have been easily visible to him.

From the photographs taken from the Tatar La, we were able to contour the northern faces of K_2 and Gasherbrum I., and to obtain additional information in their neighbourhood. The detail joined up quite satisfactorily with that plotted from the Kyagar stations.

Another pair of photographs of this small-scale series is interesting. It was taken down the Sa Lungpa gorge, and at the time we were unable to identify for certain the distant peaks. We called them collectively "the Gasherbrums," but did not know which summits were concerned. After plotting the detail from the Kyagar stations we were able to identify the peaks in the Sa Lungpa pair, simply because four peaks fell on the

plotted points and the heights agreed very well *inter se*. The three Gasherbrums concerned were II., III., IV. The Autograph was now controlled on these three peaks with the 1 : 1 gear ; the gears were changed to 3 : 1, and a good deal of extra detail was plotted along the peaks of the " Red Wall." We were, however, not able to trace the intricacies of the bottom of the Sa Lungpa gorges.

I must draw attention here to the correction necessary for refraction and curvature. The Autograph will not allow for this automatically. Mr. Hinks therefore worked out a curve for the necessary corrections, and Mr. Hunziker kindly converted this to a scale. This scale was used for the plotting of individual heights, and great accuracy was obtained with it. When setting the height drum for the plotting of contours, it was found quite accurate enough to divide the area into distance zones, each with a separate correction. With a little practice, this method of correction became quite rapid.

I will now turn to the last series. On my return through Nubra, the Khan Sahib's survey was closed at Panamik. We then marched towards Leh, and it occurred to me that I might improve the existing map by photography. The map is very much out of date, badly controlled by very few triangulated points, and the hills are very weakly and inadequately shown by hachures. I took four pairs of photographs on a long day's march near the Nubra–Shyok junction, noting only one doubtful triangulated point in all the four pairs and without being able to resect my camera stations. At each of these I observed a round of angles with the theodolite, including my base, the camera axis, the doubtful point, and other unknown points in the views. The result was quite satisfactory, and the Autograph map will on reduction fit over the existing map and greatly improve it.

I must admit that the success of all three experiments far surpassed my anticipations. I fully expected that with my very imperfect knowledge of the instruments before starting, something would go wrong. I made a certain number of mistakes through inexperience as it was, but the Autograph always found me out. On one occasion the camera trunnion was not correctly seated in its support. The error was made evident by a very bad " Vertical Parallax " in the Autograph. Mr. Hunziker worked out the various corrections for tilt, convergence, and base length, resetting the pair on its control points, and it was plotted quite satisfactorily.

I made one error in the identification of a control point. The Autograph immediately found me out, and the pair was plotted from controls obtained from its neighbour assisted by theodolite angles.

I made an error in setting the camera at the right-hand station, so that the control points were shown in the Autograph nearly twice as far from the base centre as they should have been. My base length I knew was correct, for another pair taken with the large camera from it had

plotted well, and there was no vertical parallax. This indicated an error in convergence and not in tilt. An arbitrary convergence correction was applied to bring the control points correct, and the whole pair plotted perfectly and joined up well with the surrounding detail.

I will now mention two additional tests that we made with the Autograph. We found that if we intersected a distant point with each eye separately in the stereoscope, and then examined the point stereoscopically with both eyes together, the index appeared sometimes just behind and sometimes just in front of the point. This indicates that however much one tries to intersect an ill-defined point separately, as, for instance, by planetabling or by the Canadian method of intersections, one does not do so; whereas if one makes use of stereoscopic fusion, the simultaneity of the operation ensures exactness of identification, and therefore enables intersection at larger distances for short bases, with much less possibility of error.

The other test was this: We found that we were able to combine in the Autograph a photograph taken with the smaller camera (focal length 165 mm.), at the right-hand station and depressed 6 grades, with another photograph taken at a left-hand station with the large camera (focal length 250 mm.), with the axis horizontal. We obtained perfect stereoscopic accommodation. I may add that there was no combination of photographs that we put into the machine that we failed to plot.

The experiments bring out certain points about the field work that are probably well known to those who are using the method regularly, but which I had no means of knowing beforehand. The most ideal conditions for field work may be summed up as follows:

(*a*) Stations should be higher than the ground surveyed.

(*b*) Camera axes should be depressed, in order to prevent too much dead ground.

(*c*) Camera axes should be inclined not more than 30° to the normal to the base, to get full advantage of the base length.

(*d*) The ratio of base to distance should be if possible between 1 : 10 and 1 : 30; but it is still *quite easy* to plot, if these are extended 1 : 6 to 1 : 60; and it is still *possible*, if the ratio is decreased to 1 : 160.

(*e*) Photographs taken across valleys are to be preferred to those taken up or down valleys. The former will have a more limited field of view, but will be far more complete than the latter, which will however be suitable if the method is only required for fixing additional control points.

(*f*) For contouring the flat bottoms of valleys, stations should be sited as high as possible, and the camera tilted down as much as possible. If low stations only are available, details of roads, etc., are apt to be obscured by trees, and the tracing of contours also becomes less exact, owing to grazing rays of observation.

(*g*) It is important that shadows should not be too heavy, and they should be approximately the same in the right- and left-hand views. Otherwise stereoscopic relief is not easy. For the same reason, dense featureless snow slopes on the negative are difficult to plot where the sun blazes on them and obliterates detail. Where in nature dense white slopes are combined with heavy dark rocks, it might be advisable to take two pairs of photographs with different exposures.

The success of all these experiments exceeded our expectations. This is no doubt partly because of the climate and atmosphere of the Aghil ranges; but there is no doubt that it is mainly due to the excellence of the design of both the field and the office apparatus. At the same time I cannot close my paper without saying that the accuracy of Colonel Montgomerie's triangulation of the great peaks seventy years ago enabled us to prove the value of this new method to-day.

Before the paper the CHAIRMAN (Colonel Sir CHARLES CLOSE) said: There are not very many more interesting developments in the survey world than that of stereophoto surveying. Major Mason, as we all know, has been out to the Shaksgam country and has there had a great opportunity, of which he has taken full advantage, to test this method, and he has recently been to Switzerland to make use of Wild's machine for the automatic plotting of his maps. He is now to tell us all about it, and I think that we shall all find that we have something to learn, and that the method is likely to be the starting-point of a new system of survey. With those few remarks I will ask Major Mason to read his paper.

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

The CHAIRMAN: We are anxious to have a full discussion of this communication. I will ask Colonel Sackville Hamilton, who was in Switzerland with Major Mason, to speak first.

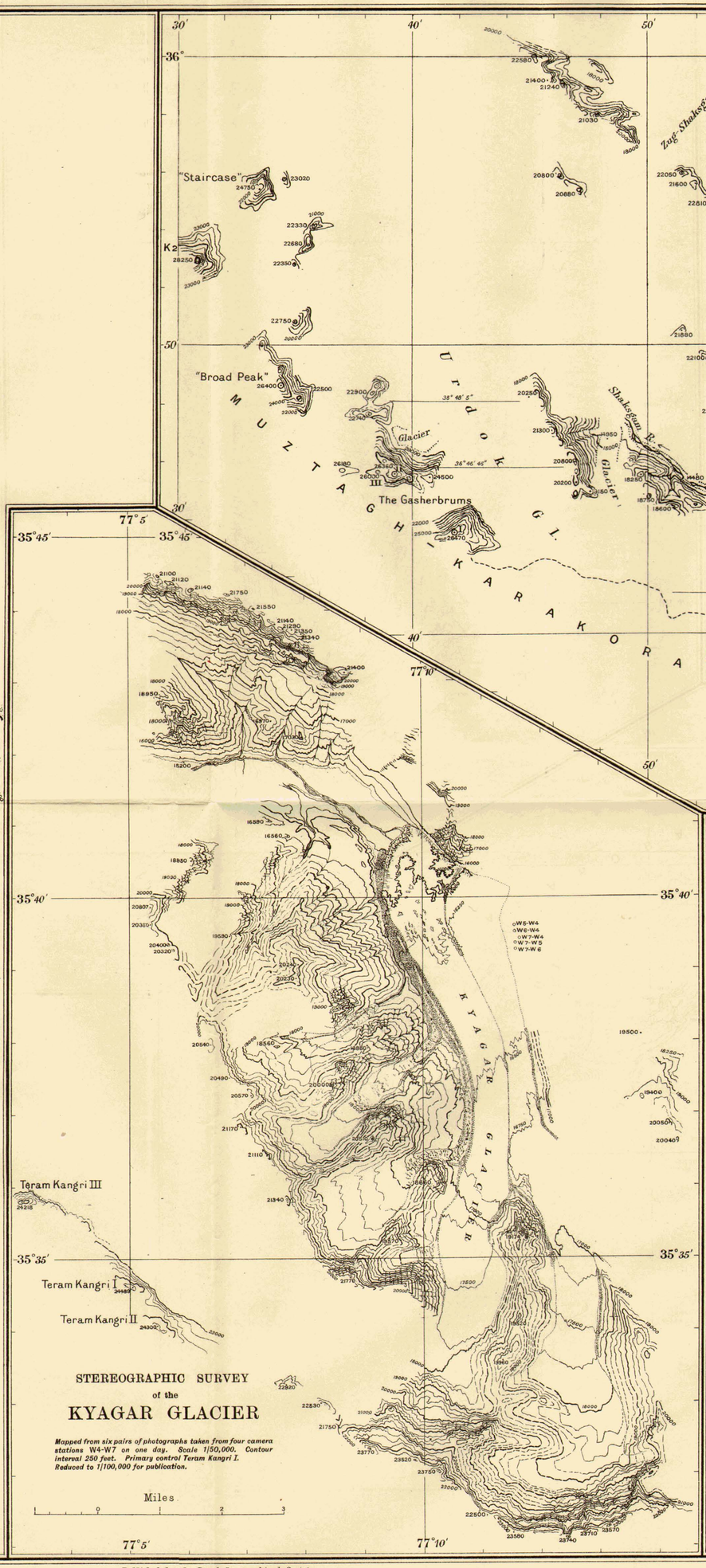
Lieut.-Col. SACKVILLE HAMILTON (Survey of India): I am disappointed not to hear Mr. Hinks give his description of the instrument, as I had the good fortune to be with him in Switzerland. I can assure you the instrument is extraordinarily good. I went to Flums prepared to be sceptical, but I have been much converted so far as ground survey is concerned. The thing that struck me most was the fact that Major Mason was able to contour K_2 at a distance of 42 miles. That, he has admitted, is due first of all to the excellence of the Wild objectives and of the Imperial plates. But I think we ought also to pay a tribute to the accuracy which Major Mason himself must have brought to his work. Future users of the method must not think that they are going to be able to do photogrammetric survey at 40 miles' range, because they cannot. A great deal of the success achieved is due to the wonderful clearness of the atmosphere in the Karakoram, where Major Mason has been working. You cannot expect that in other places. Personally, I am of opinion that 10 to 12 miles is the most we may expect.

While we are on this subject I think it would be interesting to discuss costs. It ought to be realized that this method is a going concern in Switzerland. There are two firms, Dr. Helbling's at Flums and another at Berne, turning out work by this method. Dr. Helbling has work in South America on the

STEREOGRAPHIC SURVEY of NUBRA-SHYOK JUNCTION

Mapped from two camera stations, I and II, with four pairs of photographs only, taken just off the line of march. No control points identified for certain. Scale 1/125,000. Contour interval 250 feet.

Miles



STEREOGRAPHIC SURVEY of the KYAGAR GLACIER

Mapped from six pairs of photographs taken from four camera stations W4-W7 on one day. Scale 1/50,000. Contour interval 250 feet. Primary control Teram Kangri I. Reduced to 1/100,000 for publication.

Miles

STEREOGRAPHIC SURVEY of the SHAKSGAM

Mapped from pairs of photographs taken from W4-W5, W4-W7, W10-W11 and W15-W16. Scale 1/250,000. Contour interval 500 feet.

Miles

STEREOGRAPHIC SURVEY OF THE SHAKSGAM

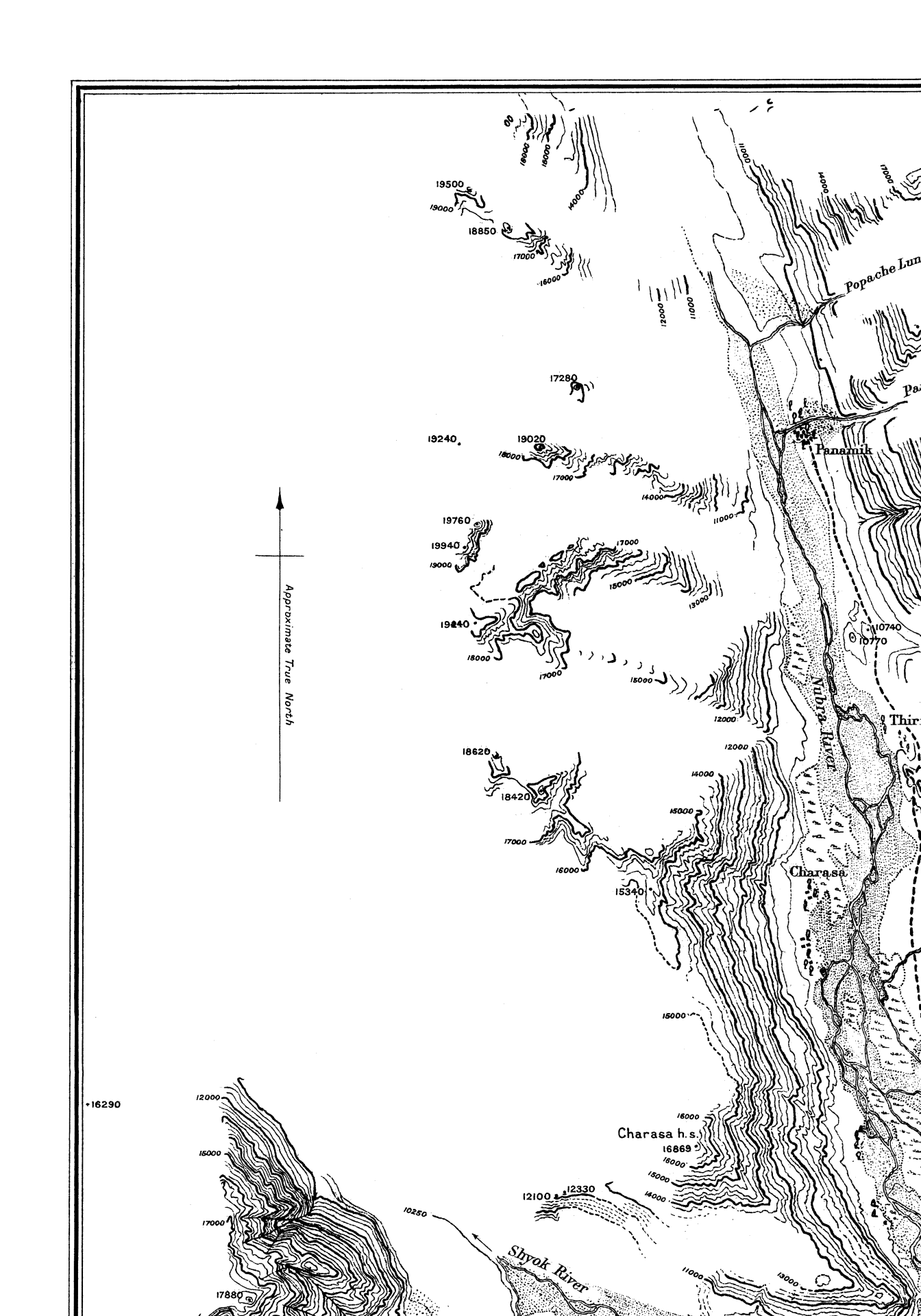
with the Photo-Theodolite and Autograph of Mr. Henry Wild

by

MAJOR KENNETH MASON, M.C., R.E.
Survey of India

Published by the Royal Geographical Society

SHAKSGAM: Stereographic Survey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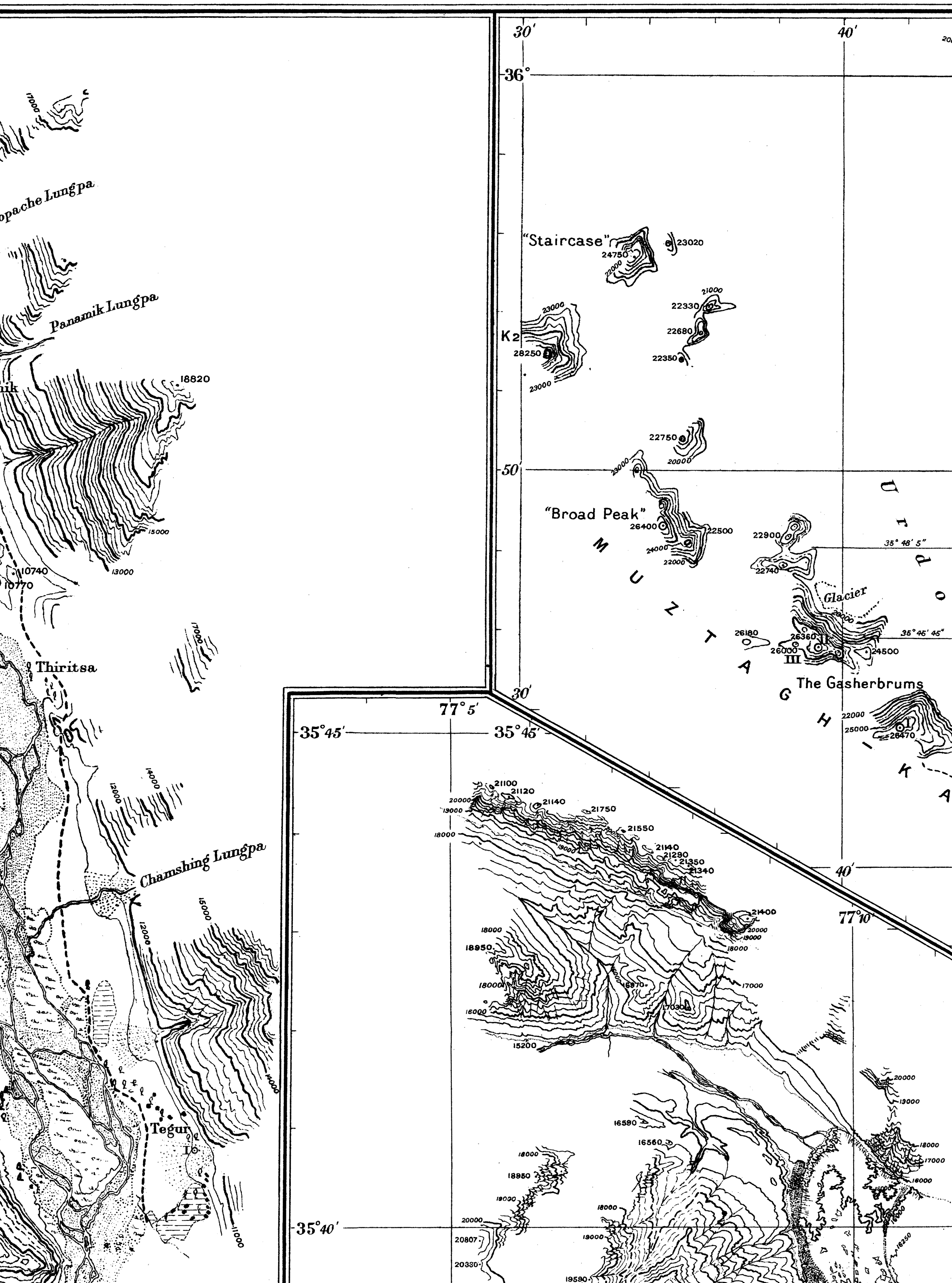
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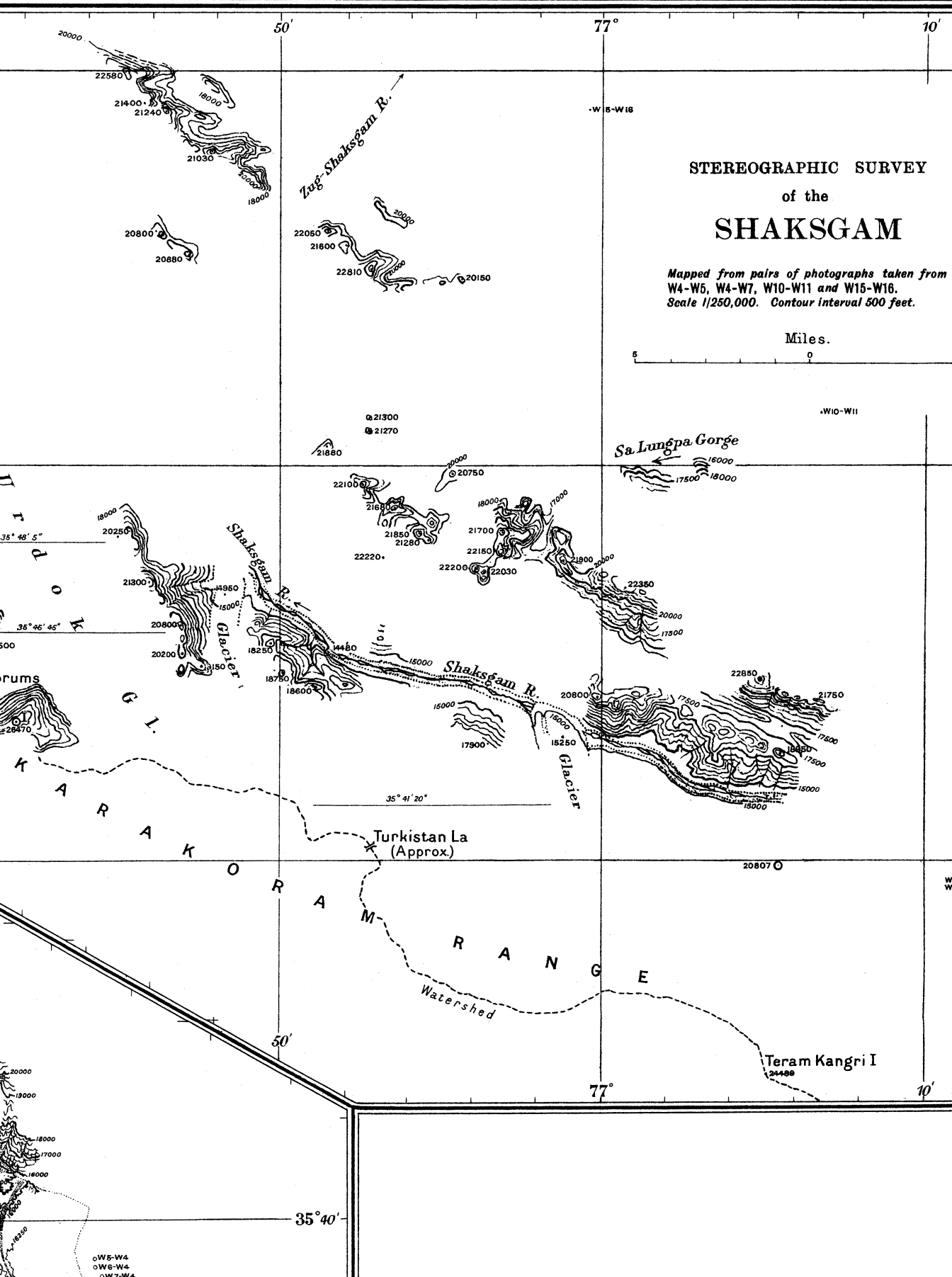
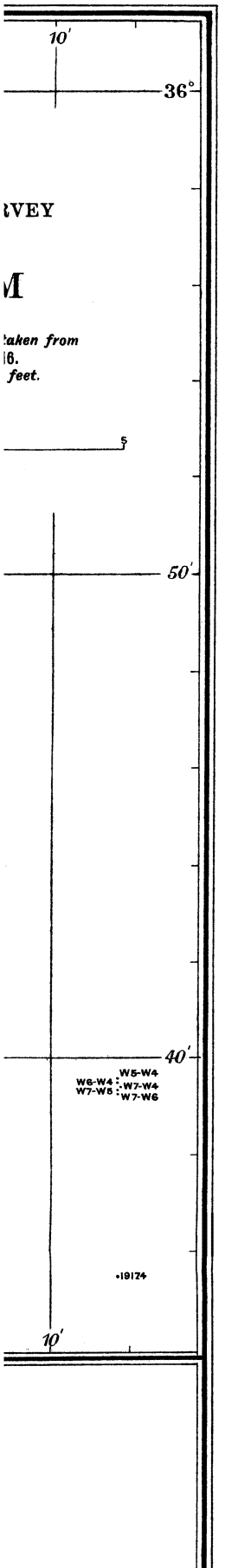
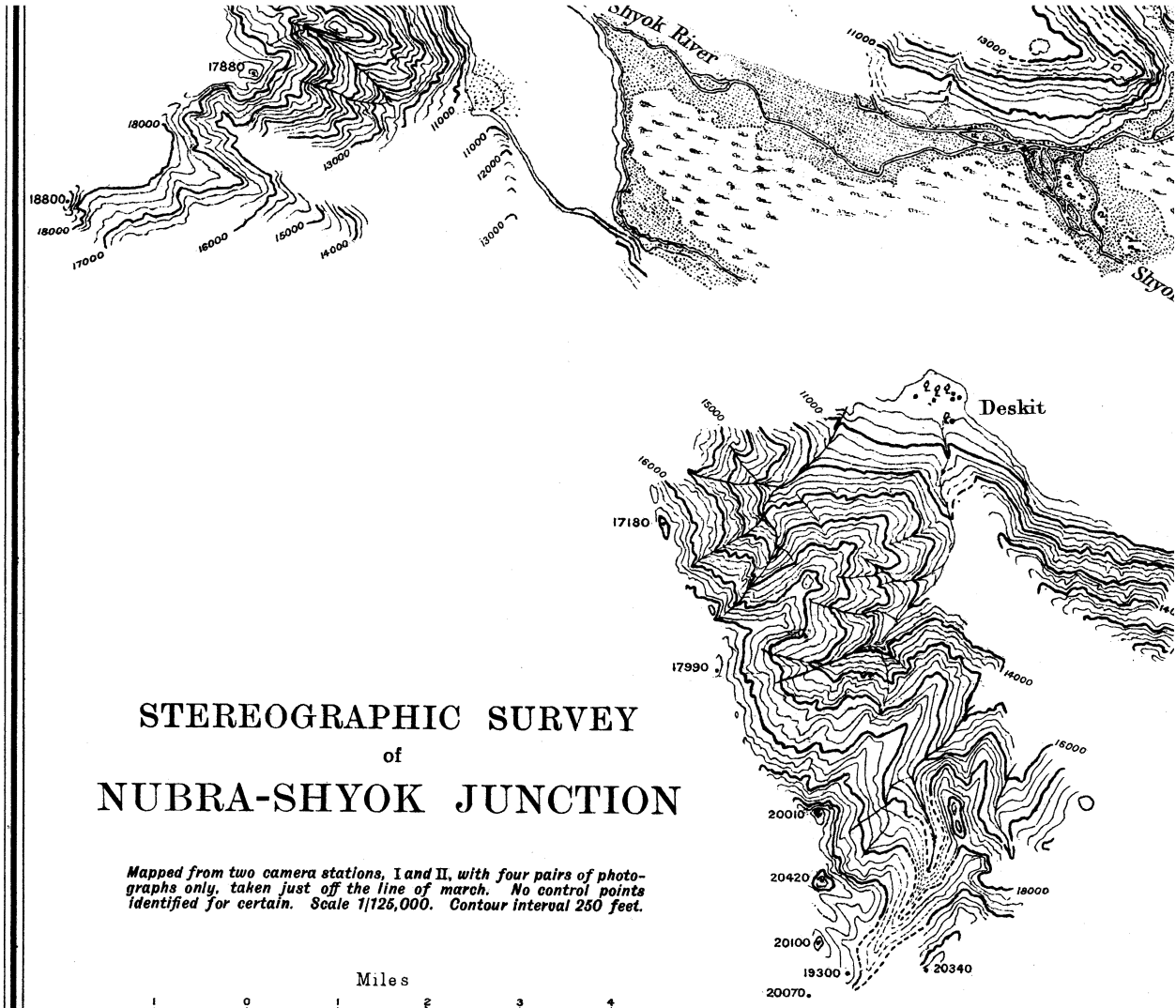
20330
19590
35° 40'


50'
77°
10'
STEREOGRAPHIC SURVEY
of the
SHAKSGAM
Mapped from pairs of photographs taken from W4-W5, W4-W7, W10-W11 and W15-W16.
Scale 1/250,000. Contour interval 500 feet.
Miles.
5
0
W5-W16
W10-W11
Zug-Shaksgam R.
Sa Lungpa Gorge
Shaksgam R.
Shaksgam R.
Glacier
Glacier
Turkistan La
(Approx.)
KARAKORAM RANGE
Watershed
Teram Kangri I
35°40'
35°41'20"
35°46'45"
35°48'5"
W5-W4
W6-W4
W7-W4


10'
36°
tVEY
M
taken from
16.
feet.
5
50'
40'
W6-W4 : W5-W4
W7-W5 : W7-W4
W7-W6
•19174
10'

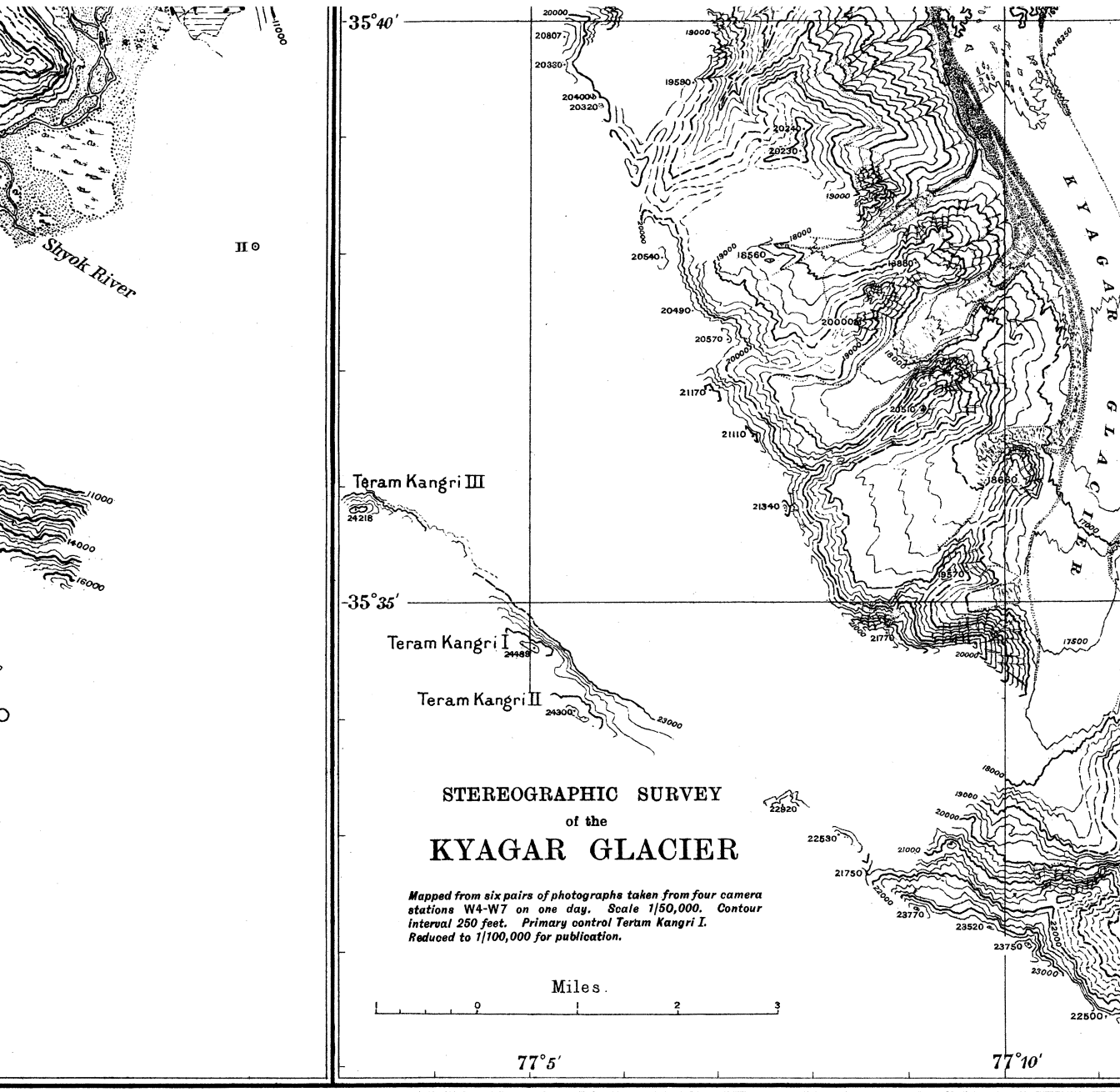


STEREOGRAPHIC SURVEY
of
NUBRA-SHYOK JUNCTION

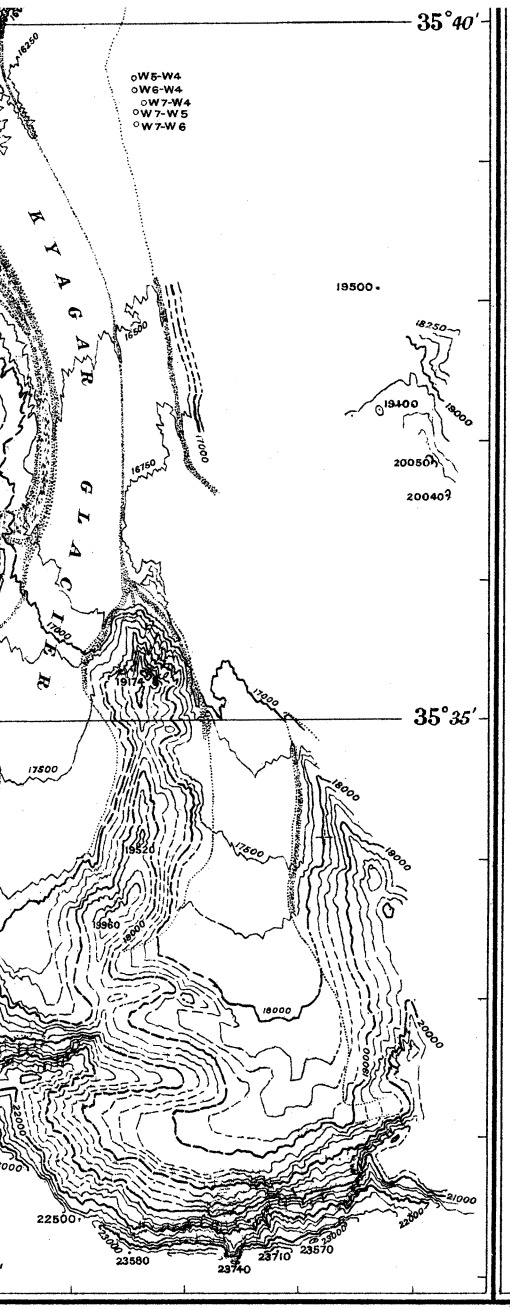
Mapped from two camera stations, I and II, with four pairs of photographs only, taken just off the line of march. No control points identified for certain. Scale 1/125,000. Contour interval 250 feet.

Miles

0 1 2 3 4



Published by the Royal Geographical Society



STEREOGRAPHIC SURVEY

OF THE

SHAKSGAM

with the Photo-Theodolite and
Autograph of Mr. Henry Wild

by

MAJOR KENNETH MASON, M.C., R.E
Survey of India

SHAKSGAM: Stereographic Su
Mason

/EY

., R.E.

ohic Survey

Cordillera Railway, and has also contracted for work in Asia Minor for railway concessions. The machine is also doing other large-scale work, and remember for the present it is really a large-scale instrument. As regards costs, I discussed these with Dr. Helbling before I left Flums, but it is extremely difficult to give any accurate figures. It depends so much on the actual negatives, what detail is required, the area covered, and so on. The autograph costs in Switzerland £2800. When I asked Dr. Helbling as to rates for work which we ourselves might wish to send him, he told me that the use of the Autograph, including the pay of the two operators and overhead charges, would be 300 Swiss francs per day; that is, provided all the data be given to them already worked out in rectangular coordinates, heights in metres and angles in grades, and work can be commenced with the machine without increased labour for their computing staff. Given that, Dr. Helbling estimated in respect to ground survey only, assuming that the greater portion of each of the pairs of negatives contained useful detail which was required to be plotted, that in an eight-hour day they could plot five pairs per day on the scale of 1/20,000; four pairs on the scale of 1/50,000; three pairs on scales of 1/100,000 to 1/150,000; two on 1/200,000; and one pair on the scale of 1/250,000. That, of course, is a rough estimate: it might be more and it might be less.

The number of pairs of photographs given as being plotted in one eight-hour day is the maximum number for each particular scale that can be set and adjusted and fully exploited in the machine in that time. Nothing has so far been done with this Autograph on photographs taken from the air, but it is readily and easily adjustable to this interpretation.

Col. C. H. D. RYDER: I personally must honestly admit that I am a dreadful conservative. In connection with Col. Hamilton's remarks as to costs, what we really want to know is the cost of the instrument, of the intelligent and practical surveyor who is going to work it, the people who are going to make the result into maps; and then we have got to compare that with the cost of other methods. In India we all swear by the planetable. We have very cheap and good surveyors who do a lot of planetabling. There are of course, as one finds from an expedition to the Shaksgam, certain areas which it would be practically impossible to get at with a planetable. Nevertheless, I think that the planetable will remain supreme for the greater part of explorers' work; and that this sort of instrument or photography of some kind should really be looked on as a supplement to regular survey work, that is, as regards the photographic part. I was very glad to hear Major Mason say that the theodolite part of the instrument was first-class, and his certificate that he would sooner use that than any ordinary theodolite is a distinct recommendation in favour of the instrument as a theodolite. Major Mason is an enthusiast on the subject, and he has given us a very interesting description of the instrument. I know the method is in its infancy, but Mr. Hinks, Major Mason, and Col. Hamilton all went over to Switzerland and all spent a month either learning or improving their knowledge and working up a map. Well, those are three very able gentlemen, and one wonders whether, taking into account the amount of intelligence used and the value of their brains, we could attain equally good results with the ordinary old wooden planetable, except in those exceptional cases where you cannot get near the object.

Col. E. M. JACK (Ordnance Survey): Major Mason has answered a number of queries raised in regard to the photo-theodolite last year, but there is one point that was raised, I think at the discussion or afterwards, that he will perhaps give his opinion on, and that was the question whether it was really sound to

combine the theodolite with the camera in one mounting. I know that the opinion was expressed that it was unsound; that it was better to have the theodolite entirely separate from the camera. Major Mason has had a good deal of experience now, and I should rather gather that he has found no disadvantage. In the experiments that were carried out I think we have to remember, as Col. Hamilton said, that the atmosphere was extraordinarily clear and also that the whole of that country is, apparently, rock, snow, and ice. I wonder what the effect would be in a country where the atmosphere was less clear? Would there be merely a limitation of vision so that you could not work at such a great distance, or would there be any other effect? Also, what would be the result of attempting this method in country covered with forest? About the cost of the method, I think Col. Hamilton and Col. Ryder have both rather anticipated me. We of course must know more what the costs are, and we have got to come down to hard facts. We must know what would be the cost of this method per square mile as compared with other methods. Although this method is, for survey on small scales, in its infancy, I think surveyors while being conservative should at the same time be enterprising and entertain all possibilities. We have been shown quite clearly that there are most extraordinary possibilities in this method, and while at present I quite agree with Col. Ryder that it must be auxiliary to our old methods, we may find, of course, eventually that it will supplant the older methods, and I think we must be prepared to accept that. Otherwise I have only to say that it seems to me quite extraordinary that Major Mason has obtained the results he has with these very small bases; it is quite a remarkable thing. That he has such wonderful results is, I believe, partly due to the clearness of the atmosphere, but cannot be put down wholly to that. I should like to congratulate him very much on a most interesting paper which I have enjoyed immensely.

Mr. HOTINE (Geographical Section, General Staff): I have little to say beyond adding my thanks to Major Mason for his paper. I do not think there can be much doubt as to the value of the Wild Autograph in large or possibly medium scale photographic surveys from ground stations. It has also been designed to allow of its use for air photographs; but there it has yet to be proved. In dealing with air photographs, what Major Mason referred to as his mistakes are the rule rather than the exception, and it was illuminating to hear his remarks on the subject of trial and error setting in the few cases where he did make mistakes. Major Mason remarked that the rectification of his mistakes was helped on by the observation of what he called "height parallax." That is a literal translation from the German of a property known to us as "want of correspondence," and it is the only indication by which we can, without a dense ground control, rectify the "mistakes" occurring in air photographs. Unfortunately, the particular movements of the Wild machine are not entirely suitable for correspondence setting. So far only one machine has been designed which introduces movements suitable for this purpose, and that is not yet in the experimental stage.

Col. H. L. CROSTHWAIT: I am afraid I have not had any experience of this kind of surveying, but there are one or two points I should like to ask Major Mason. All the photographs he has shown us have been of mountainous country. It do s not seem to me that you could apply this system to any but hilly ground. Col. Hamilton raised the question of cost. Has the cost rate per square mile been worked out? You might have a pair of photographs that had a great deal of ground in them; you might have a pair with a lot of

dead ground which would have to be gone over by the ordinary planetabling methods in order to fill it up. Perhaps the system has not gone far enough to enable us to estimate what the cost per square mile would be on an average. I should like to congratulate Major Mason on his paper, which I think has been very interesting to all present.

Mr. HINKS: I have been described to-day as an enthusiast, and therefore you will allow me to express, without shame, my great enthusiasm for the results of the experiment that Major Mason has made. He has told you how we had been in correspondence for a long time before the Shaksgam expedition started. I was partly responsible for reporting to the Council upon the desirability of doing what Major Mason asked: "Can you, if you are going to make a contribution to my expedition, provide me with the instruments for stereo-survey?" I think almost everybody who has heard the paper this afternoon will be very glad that the Council were able to do that, and will congratulate Major Mason upon the striking success of the experiment. Unfortunately, at present there is not in this country any machine that can deal with the stereoplotting of the beautiful pictures that Major Mason has taken, and therefore we had to arrange to work them up upon the Autograph. I was not at Flums for the whole month. I left England on April 6, and found Col. Hamilton and Major Mason well established at Ragaz, near by. They had kindly saved up one or two rather troublesome little problems to occupy me on my arrival, one of them being how we were going to correct these pictures at a distance of 60 or 70 kilometres for the curvature of the Earth and refraction. At a distance of 70 kilometres the correction to the measured height of K_2 referred to the base station ran up to something between 300 and 400 metres. A thousand feet had to be added to the measured height of K_2 to allow for the combined effect of refraction and curvature. One might have expected that there would be some difficulty in deciding upon the coefficient of refraction to be used. I think we made a happy and fortunate shot, for we were able to establish a table of corrections at this great distance which, as it proved, worked very well. The first time we tried it we determined the height of K_2, which came out at the triangulated height within 1 metre! Of course, that would not happen every time. It is what happened on that occasion, and it much cheered us up.

I never had a more difficult task set me than to write an intelligible description of the maze of complicated movements in the Autograph, to get the geometry of it all clear, and to show how the thing worked in all the various cases of inclined and convergent plates. The genius of Mr. Wild has succeeded in getting into a very compact space an instrument that will deal with all those various complications. I cannot think anybody would welcome an attempt to describe the mechanism this afternoon, especially the device of the double cam which is unique in Mr. Wild's instrument and is, as far as I know, understood by Mr. Wild himself and by nobody else. We have got some way towards understanding it, but when I tell you that the double-cam motion has to give motions to the plate which are comprehended in two trigonometrical expressions, one of which involves the square root of the product of a sine and a tangent, you will see that the mechanism of that motion requires a little care. I will not attempt to describe the instrument, but will ask those who are impatient to know about it to exercise their patience and wait until the description is published in the *Journal*.

Before going on to deal with one or two points, I should like to associate myself with Major Mason in expressing our most sincere gratitude to Dr.

Helbling, who, in the midst of his very important and also very lucrative work for the railway companies, considerably disorganized his establishment in order, out of a real scientific interest, to make these experiments in survey upon a scale totally different from what he had ever worked on before. We are indebted equally to Mr. Hunziker, his chief engineer, as well, of course, as to Mr. Wild in the first instance.

I do not think that Major Mason, perhaps, quite sufficiently emphasized the fact that this was the first experiment made with these instruments upon geographical scales. They normally work upon the scale of 1/2,000, and then make a combined reduced sheet upon the scale of 1/20,000, as you see on the Argentine Railway surveys. Being geographers, we were not so much interested in scales of 1/2000 or 1/20,000, but in scales of something like 1/200,000, and it is that work upon the small scales that has been so successfully accomplished though never tried before, so that the method is justified as a geographical and not a purely engineering method.

But one must not forget that there are certain things that geographers will want to be done upon those larger scales. When I first talked about the uses of this instrument I suggested that it would be extraordinarily interesting and important to survey very carefully certain areas that were liable to considerable denudation, such as Wastwater screes and Striding Edge on Helvellyn, and to establish now, correct within a few inches, a contoured map, so that it can be compared in one hundred years' time in order to see what has happened in the way of denudation. A similar question which could be most readily studied by the use of these machines would be to measure the changing volume of glaciers. It would be easy to contour glaciers, or to make a sort of integrator attached to the instrument and to measure the difference of volume from one year to another. An accurate estimate of the volumes of glaciers in India would be not only of scientific interest to India but, more important, of real, almost commercial interest, because it would indicate how fast the storage of water is changing.

We have heard a most interesting account from Col. Sackville Hamilton of an estimate of the costs, not of course in exactly the form in which a Surveyor-General would require to look at it. I take it—and this point Major Mason did not mention—that the Swiss Federal Topographical Survey having decided to re-survey the whole of Switzerland by this method shows that the costs are, at any rate, well within the power of such surveys to meet, and that they consider the expense well justified.

In particular reference to something Col. Ryder has said I would, with some strength, repudiate the suggestion that probably the amount of work represented in those three sheets was not worth the time of two senior officers of the Survey of India and one amateur enthusiast. It seemed to me a grossly unfair comparison. After all, when you are proposing to take up a new method it is presumably worth while for the Director of the Survey or some of his senior officers and advisers to devote a part of their time to studying the method in its inception and to discover whether or not it is worthy of adoption. The value of the time spent in preliminary experiments is surely not to be charged to the cost of the first results. But whether or not the method is economical for a regular survey I do not think matters to this Society. I would suggest that there are possibilities to geographers which are of inestimable value: the possibility of being able to secure material in rare circumstances in the course of a few days, such as on the expedition in the Shaksgam, to which you can devote as much labour as you like when the results have been success-

fully brought back to this country. Therefore any arguments as to whether it is worth while to adopt this method on the Ordnance Survey or the Survey of India for ordinary work has very little relevance in the case of us geographers, because the result you can obtain by seizing a rare opportunity may be quite inestimable. It would be undoubtedly expensive to introduce this machine into the country; but I believe the results Major Mason has shown you make you, or at any rate many of you, hope that some means may be found by which we shall be able to get the necessary number of thousands of pounds to establish one of the Wild Autographs here in the Society, and to undertake to work up plates contributed by geographical expeditions in distant parts of the world.

Major MASON: The first point is one which Col. Sackville Hamilton brought up. I quite agree with him that in a country where there are clouds and mist you cannot survey up to 40 miles. But there are many countries in the world where you do get a clear atmosphere, and then you can. In Switzerland they only plot up to about 15 or 16 miles, owing to the climate, which is really unsuitable. Nevertheless the Swiss topographical maps by the new method answer many points raised this afternoon. I did not mention them because I was speaking about the Shaksgam. The work in Switzerland brings out the advantages of having the camera and theodolite mounted together. The very small loss in accuracy is fully compensated by the great saving in time and transport. I had a second theodolite with me on the expedition. I left it behind at the depôt to save transport, and found the Wild instrument ample.

Wooded country can be plotted on these small scales. But on large scales, say 1/2000, the height of the trees is a difficulty. For small-scale work you can make your index traverse among the trees, and estimate the bottoms with an inappreciable error. I had a simple example of it in the scrub country in Nubra. The question raised about accuracy of detail is answered well by comparison with the old and new Swiss surveys. If you look at the two displayed on the wall, you will see that one is accurate and the other inaccurate: at least, the two are certainly by no means the same. The Swiss Government were so astonished that they had a comparison made by their own surveyors on the ground. In every point of difference the Autograph map was correct, and the old planetable survey was wrong. And look how wrong it is! In some spots features are omitted and in some the contours are at right angles to their true direction.

Doubtless the new method has limitations: so has every method of survey. These limitations are fully recognized by those who are making it a commercial success. In Switzerland they do not attempt to make a complete map by this method alone. They take photographs and plot from these all the detail and contours that they can, economically. A few small gaps remain, actually 5 per cent. in the example shown. Then a planetabler, one man only, goes out and completes the map and fills in the gaps and names. This is more economical than surveying every gap by photography, and the planetabler now has a very good control for his small gaps. The combination is more economical and more accurate than planetabling alone.

One other point. Swiss maps are plotted on the 1/25,000 scale, and reduced to 1/50,000. This has been criticized as uneconomical. But if you think for a moment, it is not so. The Autograph operator works at the same pace, whatever the scale. But on a large scale the pencil moves faster and more regularly. It is like an efficient draftsman compared to a slow worker. With

the large scale, by the use of gears, one can plot nearer the base centre than on small scales. There are also other advantages which need not be mentioned.

Cost of course, in these hard times, must be taken into consideration. But surely it is no good paying any money at all for an incorrect map. I feel fairly confident that a survey department that neglects now to make maps as accurate as modern methods allow, will in a few years find its maps as out of date as the old caterpillar hachured maps are to-day.

The CHAIRMAN: I think most of those who have listened to this discussion and Major Mason's excellent lecture will have come to the conclusion that the method is here to stay. We may be rather slow at taking up a thing, but eventually we shall be as well equipped as other countries are now. It was not mentioned that there are several machines of different types. There are two Zeiss machines in Madrid at present working commercially, and when I was there a year ago they were making a map of Bilbao. I think most of those present are convinced that we have to study this method not only because it gives us the means of making surveys in positions where otherwise it might be impossible, but also because, ultimately, we shall get even more accurate surveys than we have now, and certainly done with greater facility. I was struck by Major Mason's account of the machine finding out if mistakes had been made. It rather reminds me of the story of Babbage's machine. It was said that his machine, when it wanted a logarithm, used to ring a bell. You put a logarithm in. If you put the right one in, everything went well; if you put in the wrong one, the machine ground away for some little time and then spat the logarithm out! However, seriously, we have had an excellent account by Major Mason of the fruits of an admirable expedition. I am sure the results are worthy of the expedition, and I do not think I can say more. In your name I thank Major Mason most heartily for his paper.

AN ATTEMPT TO DESCRIBE MR. WILD'S STEREOPLOTTING MACHINE—THE AUTOGRAPH

Arthur R. Hinks, C.B.E., F.R.S., Sec. R.G.S.

Folding plate follows p. 416.

Introduction.

IN the discussion following Major Mason's paper on the Stereographic Survey of the Shaksgam I related briefly the circumstances in which the following paper was written. While Major Mason and Mr. Hunziker were plotting the Shaksgam plates on one of the Autographs established in the Vermessungs-Bureau of Dr. Helbling at Flums, it was my task to study and attempt to describe the theory and construction of the instrument, so far as is necessary for understanding the principles of Mr. Wild's solution. Mr. Wild himself has not as yet published any account of his machine; but its theory has been described in general terms by Mr. H. Härry in a useful collection of papers read at the meeting of the Schweizerischer Geometer-Verein at Zurich in May 1926 and published under the title: *Die Photogrammetrie und ihre Anwendung bei der Schweizerischen Grundbuchvermessung und bei der allgemeinen Landesvermessung* (Brugg. 1926). A rough translation of this paper,

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ALEXANDER'S CAMPAIGN ON THE INDIAN NORTH-WEST FRONTIER

NOTES FROM EXPLORATIONS BETWEEN UPPER SWĀT AND THE INDUS

Sir Aurel Stein, K.C.I.E., F.B.A., Indian Archæological Survey

Folding map following p. 512.

MY recent tour of archæological and geographical exploration across the Indian North-West Frontier led me through a fascinating region, hitherto inaccessible for the most part, upon which my eyes had been fixed for fully thirty years. The hill tracts stretching northward beyond the Peshawar border owe their special antiquarian and historical interest to two facts. The fertile valleys drained by the Swāt river, together with the tribal territory of Bunēr south-eastward, had long ago been recognized as corresponding to the ancient *Udyāna*,* a country famous in Buddhist tradition. The early worship and culture which once flourished there were known to have left their traces behind in numerous as yet unsurveyed ruins. But what invests this whole region with an additional historical interest, and one likely to appeal to a wider public, anyhow in the West, is the fact that it must have been the scene of important events in that arduous campaign which brought Alexander the Great from the foot of the snowy Hindukush to the Indus and preceded his triumphant invasion of the Punjab. The present account of the explorations carried out by me on this ground from March to May 1926 will be restricted in the main to what indications I succeeded in tracing of the Macedonian conqueror's passage.

Before, however, I proceed to record these and kindred antiquarian observations we may pass a rapid glance over the general geographical features of this region. Its central and most important part is formed

* For the sake of convenience we may continue to use this long-accepted Sanskrit form of the name, though the researches of Professor F W. Thomas and M. Sylvain Lévi have proved the true form of the name, as attested by Buddhist Sanskrit texts, to be *Uḍḍiyāna* or *Oḍḍiyāna*; cf. *J.R.A.S.*, 1905, p. 461; *Journal Asiatique*, 1915, I, pp. 105 *sqq.*, and below, p. 436.

by the territory of Swāt. The river which drains the whole of it and from which it takes its name (a very ancient one, mentioned already in the Rigveda as *Suvāstu* and by Megasthenes as Σόαστος), descends from the high ice-crowned range between Chitrāl and the headwaters of the Gilgit river and joins the Kābul river not far from Peshawar. The Swāt valley is quite alpine in its upper portion where I saw it flanked by magnificent glacier-clad peaks rising close to 19,000 feet in height. But below the hill tract known as Tōrwāl it widens greatly, and for a distance of over 60 miles comprises a wide expanse of fertile plain on either side, easily irrigated and used largely for rice cultivation.

Bold spurs descending to the river from the watershed range in the south divide this open and rich portion of the main Swāt valley at two points. Down to the barrier formed by the Shamēlai spur above the town of Mingaora the valley continues the almost due north-south direction it follows in the mountains. From there it turns south-west to where the precipitous Landakai ridge forms a natural dividing line between Upper and Lower Swāt. Thence the valley takes a more westerly course, still retaining its fertile riverine plain for some 20 miles farther. But beyond, from above the confluence with the Panjkōra, it contracts rapidly. Finally it is through narrow and in parts almost impassable gorges that the river forces its way down to the great open plain of the Peshawar valley. Together with the numerous large side valleys on both sides, Swāt is a territory singularly favoured by nature and of great potential wealth. Occupied now by Pathān tribes, comparatively recent invaders, Swāt has for the last four centuries or more suffered greatly from a state of chronic disorder such as seems endemic in that race when left uncontrolled by some strong power.

South of the lower part of Swāt lies the open plain of the Peshawar valley, the ancient *Gandhāra*, drained by the Kābul river and now as of old the most important district on the North-West Frontier. It has always served as a passage wide open for invaders of India from the north-west. Where the barren but picturesque hill range dividing the Peshawar valley from Swāt rises higher and takes a decided turn to the north-east, it throws off a branch at right angles which runs down to the Indus and encircles the territory of Bunēr. Less extensive and less fertile than Swāt and accessible from it by a number of comparatively easy passes, Bunēr seems always to have shared the political fate of its northern neighbour. As we follow the main range above the left bank of the Swāt river farther up, its height steadily increases and its character as the great divide between the Swāt river and the Indus becomes more defined.

The valleys which run down from this watershed towards the Indus, though not large, are still comparatively open and fertile and hold now a Pathān population closely allied with that of Swāt. But above the mouth of the Ghōrband river the Indus valley rapidly contracts

into a succession of narrow and very difficult gorges comprehensively designated as the Indus Kohistān. The small independent communities of Dard speech which are settled there, together with those to be found in Tōrwāl and elsewhere on the headwaters of the Swāt river, may safely be recognized as a remnant of that pre-Muhammadan population which once held Swāt and the adjacent tracts, and which the Pathān invasion has driven back farther into the mountains or gradually absorbed. The great height of the snowy range separating this portion of the Indus valley from the Swāt river drainage sufficiently explains why there is no need to pursue our rapid survey in this direction further.

Turning now to the west we find Upper Swāt bordered by the territory known as Dīr and drained by branches of the Panjkōra; this joins the Swāt river before the latter emerges on the plain of the Peshawar valley. The tract on the northernmost headwaters of the Panjkōra, in respect of its forests, its ample grazing-grounds and its remnant of Dard-speaking hillmen, resembles the corresponding portion of Upper Swāt. Here too the land-owning population in the lower valleys is Pathān. But neither in size nor in natural resources can Dīr bear comparison with Swāt, and its political importance is due solely to the fact that through it leads the direct route connecting Chitrāl and its Hindukush passes with the North-West Frontier. Crossing the Panjkōra to the west the Pathān tribal tract of Bājauṛ is reached. Considerable as its area of arable land is, Bājauṛ lacks the advantages of abundant irrigation such as Swāt derives from its large snow-fed river; otherwise, too, the territory is far less favoured by nature. To the west there stretches the Hindurāj range forming the watershed between Bājauṛ and the large valley of the Kūnar river, included in the Afghān kingdom. Here we find again great natural resources assured by the abundance of water which the Kūnar or Chitrāl river carries down from the snow and ice-clad heights of the main Hindukush range. With the alpine tracts of Kāfiristān which lie between the latter and the Kūnar valley we are not concerned here.

My first chance of visiting at least a small portion of this wide region came after the Chitrāl campaign of 1895 had resulted in the military occupation of the Malakand pass leading into Lower Swāt and of the fort of Chakdara which guards the passage of the Swāt river on the route towards Dīr and Chitrāl. During short Christmas holidays of 1896 and 1897 I was enabled through the help of the late Colonel (subsequently Sir Harold) Deane, the first Political Agent for Dīr, Swāt, and Chitrāl, to pay rapid visits to such ruins of Buddhist shrines and other ancient remains as are situated within that comparatively small portion of tribal territory in Lower Swāt which had passed under British protection. It was largely due to the support of the same kind friend that in January 1898 I was permitted to accompany the field force which under the command of General Sir Bindon Blood carried out a punitive expedition

into Bunēr, and to use this opportunity, short as it was, for an archæological survey of the chief ancient sites traceable in that territory.*

Military considerations did not permit my being allowed on that occasion to visit, as I had eagerly hoped, Mount Mahāban in the south-eastern extremity of Bunēr. There a conjecture, first put forward by General Abbott in 1854 and since widely accepted, had proposed to locate the rock stronghold of Aornos, the scene of the most famous exploit in Alexander's campaign west of the Indus. But my eager wish to test this location on the spot—it was based solely on observations made from a great distance—found fulfilment in the autumn of 1904. Through arrangements with the neighbouring tribes Sir Harold Deane, that great Warden of the Marches, then raised to the Chief Commissionership of the newly created North-West Frontier Province, made it possible for me as the first European to visit and survey the heights of Mahāban. Careful examination of the topographical features of this conspicuous massif, overlooking the plains between the Kābul river and Indus, proved that they could not be reconciled with essential details recorded in the Greek historians' account of that celebrated military feat.† It was a result purely negative. But the state of "tribal politics" then prevailing precluded any attempt being made to visit the ground higher up near the right bank of the Indus, where, as various considerations suggested to me, the true site of Aornos might possibly have to be looked for.

Conditions of chronic disturbance among the Pathān tribes along this portion of the North-West Frontier, together with deep-rooted fanatical distrust of Europeans and all their doings, continued to bar access to Upper Swāt and the adjacent tracts for close on two decades longer. But on the start of my second expedition to Chinese Turkestān, in 1906, I was able to take my way towards Chitrāl and the Pāmīrs by the British-controlled road past Malakand, Chakdara, and Dīr. This gave me a chance of crossing the ground between the Panjkōra and Swāt which must have seen the Macedonian columns pass by. The record of the impressions then received gave me subsequently an opportunity of reviewing in some detail such notices of ancient Swāt and its *topographia sacra* as the accounts of early Chinese pilgrims visiting its Buddhist sites have fortunately handed down to us.‡

It was not until after my return from my third Central-Asian journey (1913–16), and after the strain experienced on the Frontier during the war and in the years immediately following had passed by, that I was able to make a fresh attempt to reach the ground on the Swāt river and the Indus which had so far remained closed to antiquarian research.

* See Stein, 'Detailed Report of an Archæological Tour with the Bunēr Field Force' (Lahore, 1898); reprinted in *Indian Antiquary*, January-March 1899.

† See Stein, 'Report of Archæological Survey Work in the N.W. Frontier Province and Baluchistan' (1905), pp. 19–31.

‡ Cf. Stein, 'Serindia,' i. pp. 1–5.

Guided by such local information as I had been able to gather in December 1921, on a rapid tour along the Hazāra border where it runs near the left bank of the Indus, I approached Sir John Maffey, then Chief Commissioner of the North-West Frontier Province, with a view to being enabled to visit the tribal territory on the opposite side of the river. There a big spur descending from the Swāt–Indus watershed range approximately faces the Black Mountain, the scene of more than one hard-fought Frontier expedition. My special attention had been first called to that ground by my lamented friend Colonel R. A. Wauhope, R.E., of the Survey of India, who on two of those expeditions, in 1888 and 1891–2, had sighted it across the river from the Black Mountain side, and who thought that a likely location of Aornos might there be possibly looked for.

My hope of being allowed to test this suggestion by actual exploration was frustrated for some time by the political situation, more than usually disturbed, which then had arisen in that transborder region. Aggravated dissension between the several tribal sections of Upper Swāt had weakened whatever authority the Miānguls, descendants of that famous saint, the Ākhund of Swāt, and inheritors of a kind of spiritual authority in the land, were able to exercise. The opportunity offered by this state of internal division was being seized by ambitious neighbouring chiefs to extend their territories at the expense of Swāt. While the Nawāb of Dīr was gradually occupying most of the rich tracts on the right bank of the river from the Swāt Kohistān downwards, the Nawāb of Amb and Darband on the Indus was invading Bunēr and threatening to absorb the rest of the main valley of Swāt from the south-east. Fortunately for the modern destinies of ancient Udyāna and incidentally also for my desired explorations, the few years immediately following saw the rise to power in Swāt of a very capable ruler in the person of Miāngul Gul Shāhzāda, the elder of the two grandsons of the great Ākhund. He succeeded in driving out both invaders after a prolonged struggle in the course of which his younger brother was killed. Having thus become undisputed master of Upper Swāt he was soon able to extend his sway also to Bunēr, to the lower portion of the Swāt Kohistān, and to the valleys of Ghōrband, Kāna, Chakēsar, and Pūran between the Swāt watershed and the Indus. All these territories are closely linked to Swāt by geographical relations and history.

The peaceful consolidation of the large "kingdom" thus created during the last four years is being greatly facilitated by the close and satisfactory relations which the Miāngul, or "Bādshāh" as he is now universally known to his people, has wisely fostered with the administration of the North-West Frontier Province. It was solely through this fortunate concatenation of events that the realization of my long-cherished plan of exploration became possible, and to an extent far greater than I had originally ventured to hope for.

Under the instructions kindly given by the Hon'ble Sir Norman Bolton, Chief Commissioner of the North-West Frontier Province, to whom I had re-submitted my proposal from England in the summer of 1925, my old and ever-helpful friend Colonel E. H. S. James, then Political Agent for Dīr, Swāt and Chitrāl, was able to secure the ruler of Swāt's approval for my intended visit to his territory and for the researches I was anxious to effect there. The truly enlightened spirit of the ruler induced him to use all resources at his disposal to facilitate my labours and to assure free and safe movement on ground hitherto inaccessible to Europeans, It thus became possible for me to extend my explorations over most of his territory instead of the comparatively small area to which my original request had applied. In the same way he readily agreed to my archæological investigations being accompanied also by proper topographical surveys such as they necessarily called for on ground but imperfectly known before from native route reports and the like.

It was no small privilege for me to be enabled to spend two and a half months of last spring over antiquarian and geographical exploration in a region which presents exceptional interest to the historical student, and which for the most part had never been visited by a European since ancient times. For this and for all the advantages assured to my efforts I must record here my sincerest gratitude in the first place to the ruler of Swāt. I feel that I owe warm thanks also to those on the British side who gave all needful help for the execution of my plan, after its acceptance by the Miāngul had been secured; to the Government of India in the Archæological Department, which on Sir John Marshall's recommendation sanctioned my employment on the proposed tour and provided a grant of Rs.2000 for its expenses; to Colonel W. J. Keen, who, as Officiating Chief Commissioner of the North-West Frontier Province, encouraged me greatly by his kind personal interest in the enterprise. From Mr. H. J. Metcalfe, I.C.S., Political Agent, Dīr, Swāt, and Chitrāl, I received much useful advice and constant proofs of friendly care both before and after my start from his headquarters on the Malakand. The Survey of India Department once again offered me very valuable help by providing a fully trained and extremely hardworking assistant for topographical work in the person of Surveyor Tōrabāz Khān. In the course of our travel he succeeded in mapping a total area of some 1800 square miles on the scale of 2 miles to the inch. The accompanying sketch-map embodies these surveys. Nor should I omit to mention here the devoted services in connection with practical archæological tasks which were rendered by Naik Abdul Ghafūr, the capable "handyman" deputed with me from K.G.O. Bengal Sappers and Miners.

Before I proceed to set forth those archæological and topographical indications which my recent explorations have enabled me to gather concerning particular points of Alexander's campaign in the region now controlled by the ruler of Swāt, it will be convenient rapidly to

review the main historical data to be gathered about that campaign from the available classical records. These notices have been often discussed, and as a clear and critical account of them is readily accessible in the late Mr. Vincent Smith's 'Early History of India,' our review may be brief.* Alexander in the spring of 327 B.C. crossed the Hindukush from Bactria towards the Kōh-i-dāmān above Kābul. There he strengthened the hold he had secured upon this part of the present Afghanistan two years before, and then set out for his Indian campaign. There can be no doubt that as far as the country west of the Indus was concerned this enterprise meant, in theory at least, but a reassertion of the sovereignty of that Persian Empire to which he claimed succession and which down to the last Achæmenidian 'King of Kings' had its satrapies right up to the Indus. At Nikaia, a place not yet exactly determined, in the upper valley of the Kābul river, he divided his army. One large force was to move to the tract of Peukelaotis (Sanskrit *Pushkalāvatī*, safely located near Chārsadda, north-east of Peshawar) and to effect the submission of the country as far as the Indus. The other corps was led by Alexander himself into the hill country to the north of the Kābul river, obviously with a view to securing the flank of his main line of communication along it.

The details of the route followed on Alexander's operations against various towns by "the river called Khoes" and against the tribe of the Aspasioi cannot be determined. But it may be considered as certain that they took him for a considerable distance up the large and populous valley of the Kūnar river.† Geographical facts make it equally clear that the scene of subsequent operations, when he had crossed the mountains and moved east,‡ was the present Bājauṛ. This is rendered quite certain by the mention of the river Guraios, which had to be passed by the Macedonians before Alexander could lead them into the country of the Assakēnoi; for the identity of the Guraios with the Panjkōra, coming from the mountains of Dīr and flowing east of Bājaur before it joins the Swāt river, is well established.§ No definite attempt can be made to identify the localities mentioned west of the Guraios, as long as Bājauṛ remains inaccessible for research.

With the passage of the Guraios or Panjkōra we are brought close to the territory which directly concerns us here; for it has long ago been recognized that the country of the powerful nation of the Assakēnoi,

* See 2nd edition, pp. 45 *sqq*. Full translations of the notices furnished by Arrian, Diodorus, Curtius, and some minor sources are to be found in M'Crindle, 'The Invasion of India by Alexander the Great' (1893).

† See my remarks on the importance of the Kūnar valley and the indications pointing to its having been the scene of those operations, in 'Serindia,' I, p. 3.

‡ Cf. Arrian, 'Anabasis,' IV. xxiv.

§ See 'Serindia,' I, p. 2, note 2. The difficulty of the passage across the Guraios which Arrian, IV. xxv., specially comments upon, is illustrated by the experience of the British forces when operating against Bājauṛ from the Swāt side and across the Panjkōra in 1905 and 1907.

the invasion of which was begun after crossing the river, could be no other than Swāt. The numerical strength of the nation and the size of the territory held by it are sufficiently indicated by the numbers recorded by Arrian for the army (" 2000 cavalry and more than 30,000 infantry, besides 30 elephants ") which had gathered to oppose Alexander's advance. Yet we are told that when the barbarians saw Alexander approaching they did not dare to encounter him in the open, and dispersed to their several cities in order to defend them.*

From this and the account of the several sieges which followed the inference seems justified that the Assakēnoi, though a brave race, could not have been addicted to those fierce and very effective methods of fighting which make the present hill tribes along the barren parts of the North-West Frontier so formidable opponents on their own ground. From the superior type of the abundant structural remains still extant in Swāt from early Buddhist times, and from what we know through the Chinese pilgrims' account of the character of its inhabitants at a later period, it may, in fact, be safely concluded that the material civilization and culture prevailing in that region in Alexander's time and for centuries after was far higher than those to be met with there now, or among the semi-barbarous Pathān tribes holding the barren hills from the Mohmand country down to Wazīristān. Nor should it be forgotten that the possession of lands so fertile as those of Swāt, combined with the enfeebling effect of the rice cultivation preponderant in its valleys, tends to have a debilitating influence on the inhabitants. This is apparent even from the present Pathān population, and must have asserted itself also in the case of its earlier occupants.

As regards the ethnography of the region through which Alexander's hill campaign took him, two points may conveniently be noted here That the invaders classed the inhabitants as Indians is certain. This fully agrees with what we know from later records about the Indian character of the civilization and religion which prevailed before the Muhammadan conquest along the whole Kābul river valley from the Hindukush to the Indus. At the same time there is good reason to believe that the languages then spoken in that region and in the adjacent hill tracts, including Swāt, were not Indian, but belonged to that independent branch of Aryan speech, designated as Dard or Dardic, which still has its representatives in the valleys south of the Hindukush from Kāfiristān to Kashmīr. In fact, I have shown elsewhere that the very name *Assakēnoi*, in its relation to the corresponding Sanskrit form of *Aśmaka* as attested among tribal designations of the Indian North-West, bears distinct philological evidence to the Dard speech of those to whom it was applied.†

That the territory held by the Assakēnoi was a large one and com-

* Cf. Arrian, ' Anabasis,' IV. xxv.

† See Stein, ' Serindia,' I, pp. 4 *sq.*

prised the whole of the present Swāt, together probably with Bunēr and the valleys to the north of the latter, is clear; for the operations which were needed for their effective subjugation, extended, as the classical records show, from the Panjkōra to the right bank of the Indus. The accounts given by both Arrian and Curtius of these operations, though recorded in some detail, do not suffice—in the absence of local investigations—to fix with any critical assurance the position of the sites which they mention. Only for the initial stages of Alexander's march through this large territory was definite guidance available, and that supplied by plain geographical facts. It is certain that in ancient times, as at present, the direct route, and the only one of any importance, must have led from the Panjkōra through Talāsh and across the easy saddle of Katgala into the wide open valley which stretches down from Wuch to the Swāt river and to its strategically important crossing now guarded by the fort of Chakdara.

Beyond this the only indication to be derived from geography is the very general one that the several strong places in which the Assakēnoi had taken refuge, and which Alexander successively besieged and captured, are likely to have been situated in the main Swāt valley which at all times just as now must have been the most fertile and populous portion of the territory. Arrian, whose account of Alexander's campaign is throughout the most reliable and avowedly based on a careful examination of sources largely contemporary, distinctly tells us that Alexander "marched first to attack Massaga, which was the greatest city in those parts." The reference made to its chief under the name of Assakēnos shows that Massaga was considered the capital.

Arrian gives a lengthy account of the siege which, after battering engines had been brought up against the walls and the chief killed, ended with the city's capitulation. But he furnishes no clue as to the position of Massaga; nor does the elaborate description recorded by Curtius, VIII. x., of the defences with which both nature and man had provided the city (called by him Mazaga), help us to locate it at present. At none of the sites examined by me have I been able to find topographical features resembling those which this description indicates.* Until further search can be made on the ground, I must content myself with expressing the belief that the site of Massaga may probably have to be looked for farther down in Swāt than has hitherto been supposed. Owing to the great expanse of fertile alluvial soil which is to be found there, Lower Swāt must at all times have been a very populous and rich portion

* "For on the east, an impetuous mountain stream with steep banks on both sides barred approach to the city, while to south and west nature, as if designing to form a rampart, had piled up gigantic rocks, at the base of which lay sloughs and yawning chasms hollowed in the course of ages to vast depths, while a ditch of mighty labour drawn from their extremity continued the line of defence. The city was besides surrounded with a wall 35 stadia in circumference," etc.; cf. M'Crindle, 'Invasion of India,' pp. 194 *sq.*

of the whole valley. Its economic and military importance must have been greatly increased in ancient times, just as it is now, by the ease of direct access from it to the open plain of Gandhāra. It appears to me on various grounds very unlikely that Alexander, having been brought by his route from Bājauṛ and the Panjkōra straight to Lower Swāt, could have carried his operations far up the main valley, as has been supposed,* before he had secured his rear and the direct line of communication with the rest of his army on the lower Kābul river. For this it was necessary first to defeat such resistance as that important lower portion of Swāt was bound to have offered to the invader.

Two points recorded in connection with the capture of Massaga deserve to be briefly noted here. One is the mention made of 7000 Indian mercenaries brought from a distance who shared in the defence of the place, and ultimately after its capitulation made a vain endeavour to regain their homes and in that attempt were exterminated. The employment by a local chief of so large a paid contingent from outside clearly indicates conditions of organized defence wholly different from those with which a modern invader of tribal territories on the North-West Frontier would have to reckon. In the second place attention may well be called to the fact that in spite of the recorded great valour of the defenders, Arrian's account puts the total loss suffered by Alexander in the course of the four days' siege at only twenty-five men. In the cheap price paid for this success we may recognize a proof of the ascendancy which the Macedonian force of highly trained and war-hardened veterans derived, in addition to all other advantages, from the possession of superior armament; for both Arrian and Curtius specially testify to the overmastering effect which the use of the besiegers' war engines, including movable towers and powerful ballistæ, had upon the defenders.

For tracing the further course of Alexander's operations in Swāt we can fortunately avail ourselves of archæological as well as topographical indications. Arrian † tells us that Alexander

"then dispatched Koinos to Bazira, believing that [the inhabitants] would capitulate on learning of the capture of Massaga. He further sent Attalos, Alketas, and Demetrios the cavalry leader, to Ōra, another town, with instructions to invest the town until he himself arrived. A sally made from the latter place against the troops under Alketas was repulsed by the Macedonians without difficulty and the inhabitants driven back within their walls. With Koinos matters did not fare well at Bazira; for its people trusted to the strength of the position, which was very elevated and everywhere carefully fortified, and made no sign of surrender.

"Alexander on learning this set out for Bazira. But having come to know that some of the neighbouring barbarians, prompted to this by Abisares, ‡

* See V. Smith, 'Early History of India,' 2, p. 50.

† Cf. Arrian, V. xxvii. 5; M'Crindle, *loc. cit.*, pp. 69 *sq.*

‡ By Abisares is meant the king of the territory known from Sanskrit texts by the name of *Abhisāra* and located in the lower and middle hills between the Jhelam and Chenāb rivers; in Alexander's time it comprised also Hazāra; see Stein, 'Rājatarangiṇī,' transl., 1, pp. 32 *sq.*, and below, p. 439.

were preparing by stealth to enter Ōra, he first marched to Ōra. Koinos was instructed to fortify a strong position in front of Bazira, to leave in it a garrison sufficient to keep the inhabitants from undisturbed access to their lands, and to lead the rest of his force to Alexander. When the people of Bazira saw Koinos departing with the greatest portion of his troops, they made light of the [remaining] Macedonians as antagonists no longer equal to themselves and descended to the plain. A sharp encounter ensued in which five hundred barbarians were killed and over seventy taken prisoners. The rest fled together into the town, and were more strictly than ever debarred from access to the land by those in the fortified position."

Subsequently, we are told, when the inhabitants of Bazira learned of the fall of Ōra they lost heart and at the dead of night abandoned the town.

I believe the convergent evidence of position, remains, and name enables us to locate Bazira safely at the conspicuous hill which rises with precipitous rocky slopes above the left bank of the Swāt river near the large village of Bīr-kōṭ and on its top bears the ruins of an ancient fortification. *Bīr-kōṭ*—this is the name as I heard it regularly used by the local people, the " Bari-kot " of the map being the form preferred for some reason in the Persian correspondence of scribes and Mullahs—is a considerable place situated at the point where the three large and well-cultivated valleys of Kandag, Najigrām, and Karākar, descending from the watershed range towards Bunēr, join and debouch on the Swāt river. Where the broad spur flanking the Kandag valley on the west approaches the left bank of the river it curves round to the north-east. After descending to a low and broad saddle near the village of Guratai it rises again with bare rocky slopes and ends abruptly in a rugged isolated hill, washed at its northern foot by the river. This hill, known as *Bīr-kōṭ-ghundai* (" the hill of Bīr-kōṭ "), terminates at its top in a bold rock pinnacle, with a triangulated height of 3093 feet. Its maximum elevation above the point where the united stream passing Bīr-kōṭ village joins the river is close on 600 feet.

The hill is roughly crescent-shaped and falls off on its convex side towards the river with precipitous rocky slopes, very difficult to climb and in places quite impracticable. On the concave side to the south the central portion of the hill is lined with unscalable crags, culminating in the rock pinnacle already mentioned. Towards the south-west the hill runs out in a narrow rocky ridge, utterly bare throughout and in addition for the last 300 feet or so of its height very steep. The south-eastern extremity of the hill which runs down towards Bīr-kōṭ village presents a rocky crest and for the most part is also very steep. But here and there the slope affords room for small terraces, and these are covered throughout with debris from stone walls of roughly built habitations and with abundance of potsherds.

Above the highest and largest of these terraces there rises an imposing stretch of wall (Fig. 1), massively built with rough but carefully set stone slabs, to a height of close on 50 feet. Extending

for a distance of about 80 yards and facing to the south-east, this wall protected the fortified top of the hilltop on that side where the natural difficulties of attack were less than elsewhere. At the same time the ground filled up behind it served to enlarge considerably the level space available on the top. This wall, which is clearly visible from the lands by the village and river, continues at approximately the same height to the north. It forms there a bastion-like projection, and then with a re-entering angle turns round the head of a precipitous rocky ravine which runs down to the river. From there the line of the circumvallation, less massive and less well preserved, is traceable all along the river front. From where a small mound marks the north-western end of fairly level ground on the fortified hilltop the wall turns for short stretches to the south and south-east. Here remains of small towers or bastions (Fig. 2) occupy projecting rocky knolls and protect that face of the top which was exposed to attack from the previously mentioned narrow ridge descending to the saddle above Gurutai.

From the point where the wall turns to the south-east its line could be followed only for a short distance. The hill is crowned here with sheer cliffs, and no fortification was needed to make it unassailable from the plain. Here the rocky pinnacle already referred to rises steeply to a height of about 60 feet above the level plateau formed by the rest of the hilltop. The sides facing this bear remains of ancient masonry wherever there was room for walls. This and the abundant pottery debris strewing the slopes and summit clearly indicate that this steep knoll had been turned into a kind of keep and occupied for a prolonged period.

The level ground of the circumvallated area on the top measures over 200 yards from north-west to south-east, with a maximum width of over 80 yards. Plenty of low ruined walls cover the whole of it, marking badly decayed habitations. A mound rising to a height of about 12 feet above the bastion at the south-eastern end may hide the remains of a completely destroyed Stūpa. Another and somewhat lower debris mound at the opposite north-western extremity of the area might also be taken for a ruined Stūpa, but for the masses of broken pottery which lie thickly on its top and all round. Most of the decorated pieces of pottery which were picked up at this site show types which, in view of subsequent finds at approximately datable ruins of Upper Swāt, can be definitely assigned to the Buddhist period.

What time I could spare for this ancient stronghold from the survey of the numerous and interesting Buddhist ruins in the several valleys above Bīr-kōṭ would not allow of any attempt at excavation. But on the line of wall protecting the north-western end of the hilltop (Fig. 2) we came upon curious relics of the means once employed for its defence. We found there numbers of round water-worn stones, undoubtedly brought from the river-bed, of different sizes such as would be used for slings or as heavier missiles. In one heap which a little experimental digging

revealed as one of the ruined towers, there came to light not less than thirty-eight " rounds " of such antique ammunition.

An assured water-supply was essential for the occupation of the site as a stronghold, and in this respect the hill of Bīr-kōṭ was very favourably situated. A main branch of the Swāt river flows round the rocky northern slopes and washes their base so closely that no practicable track can be found there. The steepness of the eroded slopes shows that the river must have flown past there for ages. It is certain that as long as the hilltop was defended it was very difficult for an enemy to cut off access to the river-bank. There might have been defences on this side also; for when I descended from the hilltop, in places with difficulty, on the slope to the west of the above-mentioned ravine I noticed remains of old walls and everywhere abundance of ancient potsherds. Walled-up terraces and remnants of old foundations clinging to the rocky slopes were found also to the east of the ravine.

There is some reason to suppose that the occupants of the ancient fastness were not content to trust for the safety of their water-supply entirely to the natural defence provided by the precipitous slopes. I had been told of two rock-cut passages leading into the hill from above the river, and on my descent from the top was shown the entrance to one of them at an elevation of about 180 feet above the river. The height of the entrance is only about 4 feet at the outside. But once a low doorway, built with masonry of the peculiar type familiar from Buddhist structures in Gandhāra, is passed the height of the gallery, vaulted with horizontal courses of roughly cut slabs, rises to over 10 feet. The width of the gallery between the masonry lining is about 3 feet. In places this lining had fallen and left the rock walls bare. I could ascend the gallery only for *circ.* 16 yards, where I found it blocked by fallen rock. Recesses for a square bolt on either side of the low doorway showed that it could be closed from the inside.

After descending the precipitous slope to about 100 feet above the river, I was shown the exit of another tunnel farther to the east. It could be entered only with some difficulty, and looked in places more like a succession of natural rock fissures which had been utilized by man. Here, too, ancient masonry of the Gandhāra type was to be seen in places over the distance of some 25 yards which alone was possible of ascent. Large fallen blocks of stone barred progress beyond. Judging from the local reports both passages had often been searched for " treasure." Only thorough clearing which would claim time and adequate preparations, could furnish definite evidence as to their direction and purpose. But that one of them, if not both, were meant to provide safe access to water for those holding the fortified hilltop appears to me distinctly probable.

The great antiquity of the site and its prolonged occupation are abundantly attested by the plentiful finds of coins which are made on the top of the Bīr-kōṭ hill and on its slopes, especially after rain. Most

of the coins are melted down promptly or, in the case of gold and silver pieces, find their way down to dealers at Peshawar or Rawalpindi. But even thus a rapid search made at Bīr-kōṭ village secured me a large miscellaneous collection of copper coins of pre-Muhammadan date. The specimens range from issues of the Indo-Greek and Indo-Parthian kings and of the Indo-Scythian or Kushana rulers down to the mintages which preceded the downfall of the Hindu Shāhi dynasty before Maḥmūd of Ghazna, about the beginning of the eleventh century. Most numerous are pieces issued by Azes, Azilises, and other Indo-Scythian kings who exercised extensive rule on the north-western confines of India during the first century B.C., as well as specimens of the copper coinage of the Kushana Emperors who succeeded them.

But coin finds of these early periods are not confined to the Bīr-kōṭ hill alone. They are very frequent too at the numerous sites, marked by remains of Buddhist sanctuaries and ancient settlements, which I was able to trace in the vicinity of Bīr-kōṭ village and in the side valleys which debouch there. The results of the rapid archæological survey I was able to carry out during the four days of March, while my camp stood at Bīr-kōṭ, conclusively prove that Bīr-kōṭ must have been the centre of a populous and important tract during the centuries which immediately preceded and followed the beginning of the Christian era. The great natural advantages for defence which the isolated rock-girt hill of Bīr-kōṭ offered, are likely to have been appreciated long before the period to which the oldest of the coins there found belong. Only systematic excavation could show how far back the occupation of the stronghold dates. But that it existed already at the time of Alexander's invasion, and that it is the place to which Arrian's account of the siege of Bazira refers, can, I think, be proved by convergent topographical and philological evidence.

To take the topographical indications first, it is clear that the Bīr-kōṭ hill fully answers the description given of the position of Bazira, "which was very elevated and carefully fortified." It is easy to understand why no rapid success could be gained there by the force under Koinos, and why Alexander while himself marching upon Ōra was content, instead of attempting a direct siege of Bazira, to leave a small portion of Koinos' troops behind for the purpose of masking the stronghold. The hill of Bīr-kōṭ was a place very difficult to take by anything less than a protracted and arduous siege. It also was a position from which it was easy for Alexander's opponents to block the main road leading up the Swāt valley and to interfere with whatever operations he might wish to carry out in that direction. Hence the order to Koinos "to fortify a strong position in front of Bazira," and "to leave in it a garrison sufficient to keep the inhabitants from undisturbed access to their lands." Where that fortified camp is likely to have stood it is impossible to state. But from what I saw of the ground it appears to me that the elevated area

now occupied mainly by graveyards just above the point where the streams coming from the Karākar and Kandag valleys meet, about half a mile from the foot of the Bīr-kōṭ hill, would have well served the tactical needs in view.

On the philological side it is easy to prove that the name *Bīr-kōṭ*, "the castle of Bīr," preserves in its first part the direct phonetic derivative of the ancient name which the Greek form *Bazira* was intended to reproduce. The Greek letter ζ, *z*, was regularly used for the rendering of both the palatal media *j* and the palatal semi-vowel *y*, two sounds common in the Indo-Aryan and Dardic languages but not known to the Greek alphabet, and *vice versâ*. This is conclusively shown by the evidence of Greek transcriptions of indigenous names belonging to the very region and period with which we are here concerned. Thus in the Greek legends of coins issued by rulers on the North-West Frontier within three centuries of Alexander's invasion we find the name of an Indo-Parthian Satrap who is called *Jihuṇia* in the Kharoshṭhī legend of his coins rendered by Zeionises in the Greek legend of the obverse, while the name of the Greek king Zoïlos is reproduced in Kharoshṭhī script on the reverse of his coin as *Ʒhoïla*.* The two Indo-Scythian kings who are known from their Greek legends as Azes and Azilises and whose coins are found with exceeding frequency at sites of Swāt, are called *Aya* and *Ayiliṣa* in their Kharoshṭhī legends. On the Greek side of the coinage issued by the founder of the Kushan dynasty his name appears as Kozulo Kadphises while the Kharoshṭhī legend of the reverse renders it by Kujula Kasa.† Similarly we find the early Turkish princely title of *jabgu* on the coins of the Kushān Kadaphes reproduced by *Zaoou* in the Greek writing of the obverse, and by *Yaüa* in the Kharoshṭhī of the reverse.‡

From the restored form **Bajira* : **Bayira* it is not difficult to trace the gradual phonetic change into *Bīr* or *Bir*. In the development of all Indo-Aryan languages, as illustrated by the transition from Sanskrit into Prakrit and from this into the modern Indo-Aryan vernaculars, the elision of intervocalic mediæ *j* and *y* is a well-known rule, and this holds good also of the related Dardic languages.§ The subsequent reduction of the resultant diphthong *ai* in **Baira* into *ī* or *i* is a phonetic change for which analogies are equally plentiful in the two language groups.‖ In the same way the disappearance of the final short vowel under the

* See *e.g.* Whitehead, 'Catalogue of Coins in the Panjab Museum,' 1, pp. 65, 157.

† Cf. *ibid.*, 1, pp. 104 *sqq.*, 133 *sqq.*, 179. On certain coins of Kozulo Kadphises and of Kadaphes, his supposed successor, the first part of the name is rendered by the Kharoshṭhī legend as *Kayala* or *Kuyula*; cf. *ibid.*, pp. 180 *sqq.*

‡ See Marquart, 'Erānšahr,' pp. 208 *sq.*

§ Cf. Grierson, "Paiśācī, Piśācas, and Modern Piśāca," in *Z.D.M.G.*, 1912, p. 79; 'The Piśāca languages of North-Western India,' pp. 109 *sq.*

‖ See Grierson, "The Phonology of the Modern Indo-Aryan Vernaculars," in *Z.D.M.G.*, 1895, pp. 407 *sq.*, 419.

influence of the stress accent on the penultimate conforms to a phonetic law uniformly observed in all modern Indo-Aryan and Dardic vernaculars.* Thus we can account without any difficulty for the successive change of **Bajira (Bayira)>*Baira>Bīr*. The addition of the designation *kōṭ*, "castle, fort" (Sanskrit *koṭṭa*), to the name is readily understood, the term *kōṭ* being generally applied to any fortified place throughout the North-West of India, whatever the language spoken.†

In view of what has just been stated as to the probable pronunciation of the name recorded by Arrian as Bazira, it is of special interest to note that we find the same place mentioned by Curtius under the name of *Beira*.‡ His notice, very brief, follows upon the account of the operations which Arrian more clearly relates as having taken place in the country of the Aspasiol and Gouraioi, *i.e.* in Bājaur. We are told that Alexander, "having crossed the river Khoaspes, left Koinos to besiege an opulent city—the inhabitants called it Beira—while he himself went on to Mazaga." I have elsewhere indicated the reasons for believing with Marquart that by the Khoaspes the Panjkōra is meant, which Arrian more correctly calls Guraios.§ Though Curtius, manifestly by error, makes the siege of Beira simultaneous with, instead of subsequent to, that of Mazaga (Massaga), yet there can be no doubt, in view of the reference to Koinos, that the Beira he mentions is identical with Arrian's Bazira. His form of the name is obviously but another attempt to reproduce the indigenous designation of *Bajira or *Bayira.

Curtius tells us nothing more of the stronghold now safely located at Bīr-kōṭ. From Arrian, too, we only learn that the people of Bazira, when they heard of the fall of Ōra, "lost heart and at the dead of night abandoned the town; [they fled to the rock]. Thus the other barbarians, too, did; leaving their towns, they all fled to the rock in that country called Aornos." Before we follow Arrian's narrative further in order to look for the probable site of Ōra and then to trace the true position of that much-discussed fastness of Aornos, I may note here two observations bearing on this flight of the people of Bazira. One is that in the text of Arrian the words of which the rendering has been put above into brackets have been treated as an interpolation, rightly as it seems, by some editors. Hence the text does not necessarily imply that they too fled to the "rock" of Aornos. The other is that topographical considerations seem to me distinctly averse from this interpretation.

We shall see that the position of Aornos must certainly be looked for close to the Indus. Now the shortest distance from Bīr-kōṭ to any point on the right bank of the Indus where a hill fastness corresponding in

* Cf. Grierson, *loc. cit.*, p. 400.

† The term *kōṭ* is quite common in local names of Hindukush valleys, like Darēl and Tangīr, where Dardic languages are spoken, and is used also separately in Pashtu.

‡ See 'Historia Alexandri,' VIII. x.

§ Cf. Stein, 'Serindia,' **1**, p. 2, note 2; Marquart, 'Untersuchungen zur Geschichte von Erān,' **2**, pp. 243 *sq.*

general features to Aornos could possibly be situated, is over 32 miles as the crow flies, and to the spur of Pīr-sar where I believe Aornos to be located is fully 40 miles. The straight line to which these measurements apply would lead right across a succession of steep hill ranges, and if a route following easier ground along valleys and across passes were chosen, the distance would certainly be still greater. One such route, as the map shows, would have led up the main Swāt valley and thence across one of the passes eastwards to the Indus. But this route was in all probability barred by the Macedonian main force operating, as we shall see, higher up on the river.

A nearer and far safer line of retreat would have lain to the south-east up the Karākar valley, which descends straight to Bīr-kōṭ from the main Swāt–Bunēr watershed; by it the fugitives could have reached within little more than a single night's march a mountain refuge as secure as any that might be sought by them far away on the Indus. I mean Mount Ilam, that great rocky peak, rising to 9250 feet above sea-level, which dominates the watershed range between Upper Swāt and Bunēr, and with its rugged pyramid-shaped summit forms a very conspicuous landmark for both territories. The top of Mount Ilam is girt on all sides with crags and very precipitous slopes which would render an attack upon those holding it most difficult if not practically impossible. The top is formed by two distinct rocky eminences enclosing a hollow space which holds a spring and affords room for a small camp. Sacred legends have clung to this mountain since Buddhist times, as the record of the famous Chinese pilgrim Hsüan-tsang shows,* and its top is still the object of an annual pilgrimage by the Hindus of Swāt and neighbouring parts. A track used by modern pilgrims leads up to Mount Ilam from the side of Bīr-kōṭ through the picturesque Nullah of Amlūk-dara, a branch of the Karākar valley holding fine Buddhist ruins. The distance from Bīr-kōṭ to the top may be estimated at about 11 miles. In view of these local observations the suggestion appears to me justified that the place of safety sought by the fugitives from Bazira was much more likely to have been Mount Ilam than the distant Aornos by the Indus.

The definite identification of Bazira (or Beira) with the ancient fortress above Bīr-kōṭ may help us to locate also the town of Ōra, Ὦρα, which Arrian's above-quoted account of Alexander's operations after the fall of Massaga brings into obvious relation with its siege. We have seen that Alexander, after having set out for Bazira, subsequently was induced to proceed straight to Ōra, for the preliminary investment of which he had previously dispatched certain detachments. From the fact that he ordered Koinos, who stood before Bazira, to join him for the attack upon Ōra with the main portion of his force, and at the same time took care

* For the identification of Hsüan-tsang's *Hi-lo* mountain with Mount Ilam, first proposed by M. Foucher, 'Géographie ancienne du Gandhāra,' p. 48, and confirmed by what I saw on my visit in May 1926, cf. 'Serindia,' I, p. 16.

to have Bazira masked by the remainder holding a post of observation, we may reasonably draw two conclusions: One is that Ōra is likely to have lain in the same direction as Bazira but beyond it, and the other that Ōra was a place of importance which Alexander felt prompted to secure quickly in view of the reported move to reinforce its defenders.*

Taking into account the general geographical features, we are thus led to look for Ōra higher up in the main Swāt valley and at some point which the presence of ancient remains would definitely indicate as having been occupied by a fortified town of importance in early times. Now the Upper Swāt valley above Bīr-kōṭ at present shows a number of large villages which might be called towns, such as Mingaora, Manglawar, and Chārbāgh, all on the left bank of the river. But at none of these did I succeed in tracing definite evidence of ancient fortification. Nor did I learn of such remains at any of the large villages to be found near the right bank. It is different at Uḍegrām, a considerable village and now seat of a "Tahsīl," situated about 10 miles by road above Bīr-kōṭ, where the fertile and well-irrigated riverine plain attains its widest in Upper Swāt.

Immediately to the south-east of the village there opens the mouth of a small side valley descending from a steep rocky hill range behind which there lies to the east the large valley of Saidu. The crest of this rugged range rising close on 2000 feet above Uḍegrām, and the extremely precipitous slopes which run down from it westwards, bear a very remarkable mountain fastness, undoubtedly of ancient date, known to the local Pathāns as "King Gira's castle." A full description of the site must be reserved for another place. But the few following details will help to convey some idea of the peculiar hill formation which here had offered itself as a natural stronghold.

Where the serrated crest of the range, only some 20 yards across at the widest and in places a mere knife-edge, overlooks the valley of Saidu, it falls off with sheer vertical rock walls for hundreds of feet. Yet even on this side where a successful attack would scarcely have been practicable for the boldest climbers, remains of massive walls cling to the bare rocky crest for a distance of over 500 yards. From the ends of this fortified top ridge there descend two very narrow and precipitous spurs of bare rock crowned with the flanking walls of the stronghold (Fig. 3). These walls, about 7 feet thick on the average, are built of carefully packed courses of rough stones which have been set in mud plaster now hardened. Notwithstanding their apparently insecure position on steep slopes, these walls still stand in places to a height of 9–10 feet. About 1000 feet below the crest the gradual convergence of the rib-like rock spurs makes the two flanking lines of wall approach each other within some 200 yards. Here a line of very massive walls, bearing terraces and in places

* See above, pp. 426–7.

strengthened by small bastions, curves round from the west and joins them up.

Within the area thus protected and only a little above the point where this cross-line of wall runs close to the northern flanking wall, there issues a fine perennial spring from among big boulders filling the bottom of an otherwise dry torrent bed. It was the presence of this spring, the only source of water available within the fortified area, which rendered it capable of use as a place of safety. The importance attached to the spring is shown by the massive construction of the walls, here doubled, which descend into the gorge to defend it. Wherever higher up on the rocky slopes terraces or little ledges afforded room ruined walls of dwellings mark ancient occupation. Their far-advanced decay as compared with the remains of Buddhist monastic quarters, etc., surveyed at other sites, distinctly points to great antiquity. Plenty of low crumbling walls from ancient structures are to be met with lower down, too, amidst the thick growth of scrub and thorny trees which covers the widening gorge below the bottom portion of the defences. Such remains are equally frequent also at the foot of the southern spur. There a succession of walled terraces, all once, no doubt, occupied by houses, orchards, or fields, affords the easiest approach to the fortified area. This explains why we found the fairly level ridge where the flanking wall on that southern spur ends, guarded by a particularly massive bastion still rising in places to a height of over 20 feet.

Pottery debris of distinctly ancient type could be picked up in plenty over most of the ground here briefly described. Yet in view of the extreme steepness of the slopes over which the remains of ruined dwellings within the walled area are scattered, and the consequent inconveniences of approach and communication between them, it seems to me hard to believe that these quarters were regularly occupied except at times of danger. On the other hand, the construction of massive defences on such difficult slopes and up to 1000 feet above the nearest water must have implied such exceptionally great efforts that it is not likely to have been undertaken except for the purpose of assuring a safe retreat for the inhabitants of an important locality. For such a place the open mouth of the valley towards Uḍegrām village, now covered with extensive Muhammadan burial-grounds and sacred groves belonging to the Ziārat of Pīr Khushhāl Bāba, would have afforded ample room. Finds brought to me of small fragments of Græco-Buddhist sculpture, an inscribed seal, and coins belonging to Indo-Greek and Indo-Scythian issues distinctly indicated early occupation of this ground. But owing to its sacred character no systematic search was there possible. Muhammadan local tradition ascribes the conquest of "King Gira's fortress" to Maḥmūd of Ghazna, whose forces after a long siege took it from the last infidel king of Swāt under the leadership of the saint now buried at the Ziārat below.

It has appeared to me desirable to record these observations about the remarkable hill stronghold above Uḍegrām in some detail; for the indications already discussed as to the direction of Alexander's operations beyond Bazira, in conjunction with what I shall presently show about the name of the place, suggest the question whether we ought not to look there for the probable location of Ora. Unfortunately, Arrian's further brief mention of Ōra supplies no topographical or other local hint. It is confined to the bare statement that "Alexander did not find the siege of Ōra difficult, for he took the town on the first assault against its walls and secured the elephants left behind there." Nor does Curtius' account help us. He mentions indeed a place Nora to which Alexander dispatched a force under Polysperchon after the capture of Mazaga, and this has been generally assumed to be the same as Arrian's Ōra. But all we are told about it is that Polysperchon "defeated the undisciplined multitude which he encountered and pursuing them within their fortifications compelled them to surrender the place." *

As regards the name *Uḍegrām*, it should be explained in the first place that it is certainly a compound of which the second part is the word *grām*, "village" (Sanskrit *grāma*), well known to Dardic languages and very common in local names of Swāt, as a reference to the map shows. The first part *Uḍe-* (also heard as Udi-) is pronounced with that distinctly cerebral media *ḍ* which to European ears always sounds like a cerebral *r*, and often undergoes that change to *r* also in Modern Indo-Aryan as well as in Dardic languages.† The temptation is great to recognize in Arrian's Ὦρα the Greek rendering of an earlier form of this name *Uḍe-*, and to derive the latter itself from that ancient name of Swāt which in its varying Sanskrit forms of *Uḍḍiyāna*, *Oḍḍiyāna*, has been recovered by M. Sylvain Lévi's critical scholarship from a number of Buddhist texts.‡ The simplification of the double consonant *ḍḍ*, the complementary lengthening of the preceding vowel *ŭ* (*ō*), which would explain the long initial vowel in Ὦρα, and the subsequent shortening of this vowel in modern *Uḍe-* (when becoming the antepenultimate in the compound Uḍegrām), all these phonetic changes assumed in the history of the name can be fully accounted for by well-known rules affecting the transition of Sanskrit words into Prakrit and thence into modern Indo-

* Cf. Curtius, VIII. xi.

† Cf. Grierson, *loc. cit.*, *Z.D.M.G.*, 1896, p. 5; 'Piśāca Languages,' p. 104. For an example of *ḍ* being rendered by Greek *r*, cf. Ptolemy's name *Larikē* for Gujarāt, reproducing a Prakrit derivative **Lāḍikā* of the Sanskrit name *Lāṭa*; also Weber, "Greek pronunciation of Hindu words," *Indian Antiquary*, **2**, p. 150.

‡ See S. Lévi, "Le catalogue géographique des Yakṣa dans la Mahāmāyūrī," *Journal Asiatique*, 1915, janv.-fèvr., pp. 105 *sqq*. There, too, it has been convincingly shown that the form *Udyāna* ("the Garden"), commonly accepted by European scholars as the Sanskrit name of Swāt, is but an *idolum libri*, based upon a "learned popular etymology" which a gloss on the Chinese notice of Swāt in Hsüan-tsang's *Hsi-yü-chi* first records.

South-eastern portion of fortifications on Bīr-Kōṭ hill

Ruined towers at north-west end of Bīr-Kōṭ hill

Wall on northern spur flanking ancient stronghold above Uḍegrām

Aryan forms.* Nevertheless, it will be well to bear in mind that the nexus of names here indicated must remain conjectural until epigraphical or other evidence helps to establish it.

Arrian, after recording the fall of Ōra and the abandonment of other towns by their " barbarian " inhabitants, has nothing to tell us of further operations in the country of the Assakēnoi. He gives a brief description of that mighty mass of rock called Aornos to which they all had fled, and relates how the fame of its impregnability fired Alexander with an ardent desire to capture it.† This account of Aornos may be left for discussion further on. We are next told that he turned Ōra and Massaga into strong places for guarding the country and fortified Bazira. Then the narrative takes us suddenly south to that division of his army which under Hephaistion and Perdikkas had been sent down the Kābul river to secure the Peshawar valley. Under Alexander's orders they had fortified there a town called Orobatis, for which no satisfactory location has as yet been found; having garrisoned it, they had proceeded to the Indus to bridge it.

That Alexander himself had with the capture of Ōra concluded his campaign in the Swāt valley and moved across the hill range into the Peshawar valley is clear from what follows. He is said to have marched to the Indus and to have received the submission of the city of Peukelaōtis, where he placed a Macedonian garrison. This city has long ago been identified with *Pushkalāvatī*, the ancient capital of Gandhāra, close to the present Chārsadda on the Swāt river and north-east of Peshawar. It is wrongly described by Arrian as lying not far from the Indus. The error must warn us as to possible geographical mistakes even in the most reliable of the narratives dealing with Alexander's Indian campaign. We are next told that Alexander " reduced other towns, some small ones situated on the Indus," while accompanied by two chiefs of this territory; their names, Kophaios and Assagetes, are unmistakably Indian.

Before I proceed to analyze the data we possess concerning the famous " rock of Aornos," to the siege and conquest of which Arrian's account now immediately turns, it will be convenient briefly to indicate certain considerations of a quasi-geographical order which, I believe, deserve specially to be kept in view when looking for the right identification of that much-discussed site. We have seen that Alexander's operations along the Swāt river must have covered Lower Swāt and that most fertile and populous portion of Upper Swāt which extends to the great bend of the valley near Mingaora above Uḍegrām. We have also learned that after the fall of Ōra, which must certainly be located above Bīr-kōṭ and

* Cf. Grierson, *loc. cit.*, *Z.D.M.G.*, 1895, p. 414; 1896, pp. 21 *sqq.* Closely corresponding rules can be shown to have affected also the phonetic development of Dardic languages, especially of that Sanskritized Dardic tongue which, from the evidence of the present Tōrwālī and Maiyā in the Swāt and Indus Kohistān, must be assumed to have been spoken in Swāt before the Pathān conquest.

† See Arrian, IV. xxviii. 2.

probably below that bend, all the inhabitants abandoned their towns and fled for safety to " the rock of Aornos."

Now if we look at the map and keep in mind the situation created for the Assakēnoi by the Macedonian posts established at Massaga and Ora, it will be clear that the bulk of the fugitive population evacuating the towns farther up the valley could have sought safety neither to the west nor to the south. In the former direction the way was obviously barred by the invaders. To the south as far as it could be reached by routes not commanded by the Macedonian posts guarding the main valley, there lay Bunēr, a country singularly open for the most part and accessible by numerous passes from the side of the Peshawar valley. The plains of the latter had already been reached by the portion of Alexander's army sent down the Kābul river; thus Bunēr, too, lay open to invasion.

Safe lines for general retreat were obviously restricted to the north and east. In the former direction the main Swāt valley continues remarkably easy and open for a distance of close on 30 miles above Mingaora, and the same remark applies to the side valleys opening from it, at least in their lower parts. No safe refuge from invasion, so swift and determined as that of Alexander, could be hoped for there. Higher up where the Swāt river breaks through the narrow gorges of Tōrwāl, invasion would, no doubt, be kept off by the natural difficulties of the ground. But there, just as at the high alpine heads of the valleys which descend to the Swāt river from the snow-covered watersheds towards the Panjkōra and Indus, local resources would have been far too limited for the maintenance of a great host of fugitives. Nor should the great climatic hardships be ignored which those fleeing from the towns of the valley plain would have had to face at the time in those alpine parts of Swāt. We know that the Macedonian invasion must have reached Swāt in the late autumn of B.C. 327, and the rigours of the approaching winter to be faced high up in the mountains would have sufficed to deter any large numbers from seeking safety northward.

Conditions were distinctly more favourable to the east. There a number of large and for the most part very fertile valleys comprising the tracts of Ghōrband, Kāna, Chakēsar, Pūran, and Mukhozai stretch down to the Indus from the Swāt watershed. They can be reached by several easy passes, none much over 6000 feet in height. All are throughout the year practicable for laden mules and ponies, from the open side valleys which leave the Swāt river at the large villages of Manglawar, Chārbāgh, and Khwāja-Rhela, respectively. A single day's march from the riverine plain of Swāt suffices to bring the traveller over any of these passes to the head of the Ghōrband valley, whence access is easy to the rest of those valleys. In addition there are routes from Mingaora, more direct if not quite so easy, connecting that important place in Central Swāt with Pūran and Kābalgrām on the Indus.

The advantages which this side would offer for retreat from invaded

Swāt are clear enough. By crossing the watershed range towards the Indus the fugitives would place a natural barrier between themselves and the enemy. In the tracts there reached they could count upon finding resources sufficient for their maintenance until the danger had passed.* The great distance intervening between those tracts and the Peshawar valley might offer protection from the Macedonian forces in the plain. Finally, having secure access to the Indus, they could easily draw help from across the river when further attack threatened, or else continue their retreat to that side if fresh resistance failed.

With regard to the last-named advantage the evidence available from historical facts both ancient and modern may conveniently be at once pointed out here. We have seen already above that what prompted Alexander to hasten in person to the siege of Ora was the news of assistance being sent to its defenders by Abisares.† It is true that the Abhisāra territory whose king is here meant comprised in later times mainly the lower and middle hill tracts to the east of the Vitastā or Hydaspes, the present Jhelam.‡ But there is good reason to believe that at the time of Alexander's invasion its ruler's power extended also over the hill portion of Uras'ā, the present District of Hazāra, east of the Indus. This is proved by what Arrian tells us of the Indians who after the capture of Aornos had fled from neighbouring parts across the Indus to Abisares, and also by what he subsequently relates of an embassy from Abisares which Arsakes, ruler of an adjacent territory, attended as a feudatory.§ It has been recognized long ago that by Arsakes the chief of Uraśā is intended, the territory which in Ptolemy's 'Geography' appears under the name of Ἄρσα or Οὔαρσα.‖

The close relation between Swāt and Hazāra is fully explained by the map. This shows us that the above-mentioned tracts of Chakēsar and Ghōrband are faced immediately to the east of the Indus by the comparatively large and open valleys of Nandihār and Allāhī. These are now occupied by Pathān tribes, all here, as also farther down by the Black Mountain, closely linked with those established on the other side of the river. From these valleys easy routes lead to Agrōr and the

* The extent of these resources even at the present time is illustrated by the following data ascertained on my passage through Chakēsar and Pūran. Both tracts have suffered severely from protracted local feuds as well as by the heavy fighting which preceded their conquest by the Miāngul in 1923. Yet the revenue in kind paid now to the ruler of Swāt at the lightly assessed rate of one-tenth of the produce was reckoned at 6000 maunds of grain for Chakēsar and at about 4000 maunds for Pūran. Yet in the latter area I noticed that a very great portion of the available land had gone out of cultivation. In Chakēsar, too, abandoned cultivation terraces could be seen in many places. Half-deserted villages were conspicuous in Kāna and in what I saw of Ghōrband.

† See Arrian, IV. xxvii. 7; above, pp. 426–7.

‡ Cf. Stein, 'Rājataraṅginī' transl., notes on i. 180; v. 217.

§ Cf. Arrian, IV. xxx.; V. xxix.

‖ For the identification of Arsa and Arsakes, cf. my note on 'Rājataraṅginī,' v. 217.

fertile central plain of Hazāra known as Pakhli, about Mansehra and Baffa. This geographical nexus is well illustrated by the fact that the population of this part of Hazāra is largely composed of a tribe known as Swātīs, descended from the pre-Muhammadan inhabitants of the Swāt valley whom historical records and living tradition alike prove to have been driven out of their original seats by the Pathān invasion of the fifteenth century. The same close relation is reflected also, to come down to very recent times, by the fact that during the several Black Mountain expeditions since the annexation of the Panjāb, the various Pathān tribes settled on both the Swāt and the Hazāra sides of the river always took their common share in the fighting.

(*To be continued.*)

PROGRESS IN THE STUDY OF THE HYDROLOGY OF THE NILE IN THE LAST TWENTY YEARS

Dr. H. E. Hurst, Director-General Physical Department, Ministry of Public Works, Egypt

Read at the Meeting of the Society, 13 June 1927.

PREVIOUS papers to the Society on the subject of the Nile were read in 1908 by Sir William Garstin and in 1909 by Sir Henry Lyons, and I am honoured by being asked to follow them.

Many workers have contributed to the results to be described, of whom one may mention Sir Wm. Garstin, Sir Henry Lyons, Sir Murdoch MacDonald, Sir Ernest Dowson, Messrs. C. E. Dupuis, P. M. Tottenham, J. I. Craig, E. P. Shackerley, D. A. F. Watt, W. D. Roberts, E. W. Buckley, O. L. Prowde, A. B. Buckley, F. Newhouse, G. W. Grabham, Dr. P. Phillips, E. S. Waller, and R. P. Black. It will be realized that there are many other officials of the Irrigation, Survey, and Physical Departments without whose energy and devotion to duty the work on the Nile could not have been accomplished, and that the men who have sat in a hot sun recording the revolutions of current meters or pushed lines of levels through bush and swamp are essential agents in the study of the Nile. It is pleasing to record that Egyptian Ministers have always appreciated the value of the information collected, and one may perhaps mention particularly Sir Ismail Sirry Pasha, who was Minister of Public Works during a large part of the period under review. The amount spent by Egypt at the present time in collecting information about the Nile Basin is of the order of £100,000 a year.

The main motive for hydrological studies of the Nile has been the wish to increase the water-supply of Egypt and to distribute it more efficiently. The great landmark in recent history is the re-opening of the Sudan in 1898. Previous to this, knowledge was fragmentary and

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ALEXANDER'S CAMPAIGN ON THE INDIAN NORTH-WEST FRONTIER

NOTES FROM EXPLORATIONS BETWEEN UPPER SWĀT AND THE INDUṢ

Sir Aurel Stein, K.C.I.E., F.B.A., Indian Archæological Survey

(*Continued from page* 440.)

AFTER this rapid survey of the ground to which the Assakēnoi, the early predecessors of those "Swātīs," are likely to have retreated for safety, we shall be better able, I think, to consider the questions raised by what our extant accounts relate of Alexander's great feat at Aornos. Among them Arrian's record is the fullest and undoubtedly also the most reliable. We may attach to it all the more critical value because one of the two contemporary authorities whose narratives Arrian in his preface declares as more worthy of credit than all the rest, and whom he principally follows, was that Ptolemy, son of Lagos and the first of the Ptolemies of Egypt, who personally had played a chief part in the conquest of Aornos.*

After recording the barbarians' flight to Aornos, Arrian immediately proceeds to inform us of the reason which filled Alexander with the eager desire to capture that rock fastness. Arrian's statements on this point have a peculiar interest for the historical student; for they help to throw welcome light on certain psychological factors which undoubtedly have played an important part in more than one of Alexander's wonderful enterprises—just as they did in those of his modern counterpart, Napoleon. At the same time we may recognize in those statements a significant indication of the critical attitude with which Arrian—and perhaps his chief authority also—was apt to view the fabulous element fostered by the hero of his story.†

We are told of Aornos:

"This is a mighty mass of rock in that part of the country, and a report is current concerning it that even Herakles, the son of Zeus, had found it to be impregnable. Now whether the Theban, or the Tyrian, or the Egyptian Herakles penetrated so far as to the Indians I can neither positively affirm nor deny, but I incline to think that he did not penetrate so far; for we know how common it is for men when speaking of things that are difficult to magnify the difficulty by declaring that it would baffle even Herakles himself. And in

* Cf. Arrian, 'Anabasis,' Prooemion, where Ptolemy's name significantly meets us as the very first word.

† See also 'Anabasis,' V. iii., where Arrian expresses similar critical misgivings in connection with Alexander's visit to the city of Nysa, alleged to have been founded by Dionysos. He quotes there Eratosthenes' view "that all these references to the deity were circulated by the Macedonians in connection with the deeds of Alexander to gratify his pride by grossly exaggerating their importance" (M'Crindle).

the case of this rock my own conviction is that Herakles was mentioned to make the story of its capture all the more wonderful. The rock is said to have had a circuit of about 200 stadia, and at its lowest elevation a height of 11 stadia. It was ascended by a single path cut by the hand of man, yet difficult. On the summit of the rock there was, it is also said, plenty of pure water which gushed out from a copious spring. There was timber besides, and as much good arable land as required for its cultivation the labour of a thousand men.

"Alexander on learning these particulars was seized with an ardent desire to capture this mountain also, the story current about Herakles not being the least of the incentives." *

We may never know whether the ambition stimulated by such reports about Aornos was the sole incentive for Alexander to decide upon its capture. This decision may possibly have been due quite as much, if not more, to the strategic consideration invariably kept in view by Alexander of not leaving an enemy behind until he had been completely crushed. But anyhow we have seen that instead of pursuing the fugitive Assakēnoi to their mountain retreat, Alexander moved from Swāt into the Peshawar valley. Thereafter resuming contact with that portion of this army which had already arrived by the route of Kābul river, he organized Macedonian control over this important district and then proceeded to the Indus.

In view of what has been shown above as to the direction to the east of the Swāt–Indus watershed which the retreat of the inhabitants of Upper Swāt was likely to have taken, it is easy for us to understand the sound strategic reasons underlying what might otherwise seem a needless deflection from an important direct objective. An attack upon that mountain retreat of the Swāt fugitives from the south by the Indus offered several distinct advantages. Entanglement in a mountainous region where passes and narrow defiles, if defended, might seriously hamper advance would thus be avoided. It would become possible to cut off the fugitive host from retreat into the territory east of the Indus and from such assistance as Abisares, the ruler on that side, might offer. Nor were the facilities likely to be neglected which the Indus valley and convenient access south to the fertile plains of the Peshawar valley would offer in respect of supplies and other resources in case of prolonged operations.

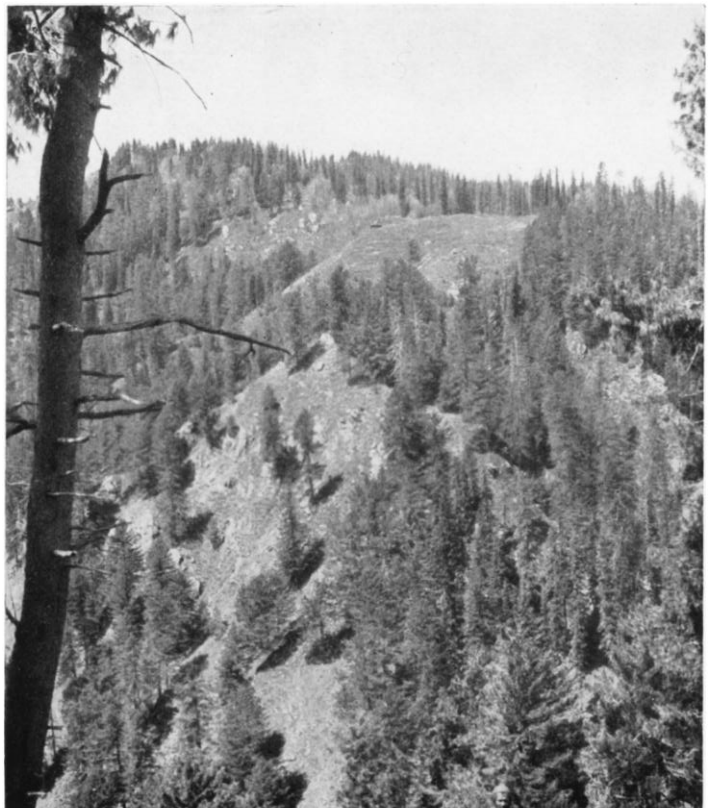
The importance of the last consideration is clearly indicated by what Arrian tells us immediately after the passage already quoted, which records the reduction of a number of small towns situated on the Indus.

"After he had arrived at Embolima, which town lay not far from the rock of Aornos, he there left Krateros with a portion of the army to collect into the town as much corn as possible and all other requisites for a prolonged stay, in order that the Macedonians having that place as a base might by protracted investment wear out those holding the rock, in case it were not taken at the

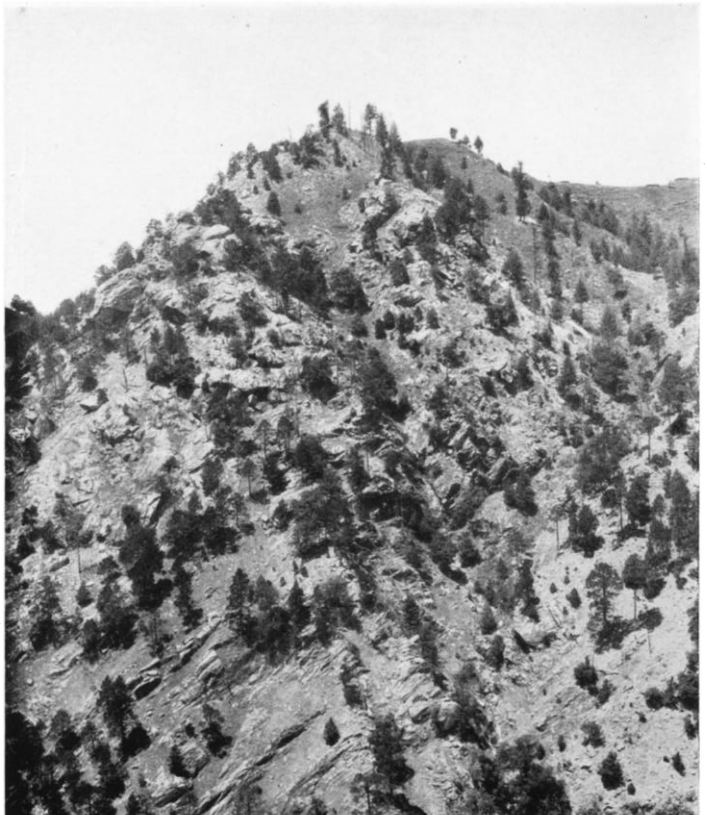
* 'Anabasis,' IV. xxviii. 1–4; translation by M'Crindle, 'Invasion of India,' pp. 70 *sq.*

4. *Pīr-sar ridge (Aornos) from southern slope of Ūṇa-sar peak*

5. *Indus valley and snowy Kagan divide from below south end of Pīr-sar*



6. *Būrimār alp from Māshlun shoulder, below north end of Pīr-sar*



7. *Rocky slopes below Kuz-sar end of Pīr-sar*

first assault. He himself taking with him the archers, the Agrianians, the brigade of Koinos, the lightest and best armed from the rest of the phalanx, two hundred of the companion cavalry and hundred mounted archers, marched to the rock."

Arrian does not furnish us with any indication as to the position of Embolima. But as the accounts of Curtius and Diodorus agree in placing Aornos on the Indus* the town which was to serve as Alexander's base of supplies may with good reason be also looked for on the Indus. This is borne out by Ptolemy's mention of Embolima as a town of Indo-Scythia situated on the Indus, with coordinates corresponding to those which he indicates for the confluence of the Indus and Kōa or Kābul river.† But as no reliance whatever can be placed on Ptolemy's latitudes and longitudes as far as his map of India is concerned, this does not help us further to determine the exact position of Embolima.‡ Nor can we derive guidance in this respect from the fortunate fact that Professor Sylvain Lévi has discovered references to the same locality in Buddhist texts which mention it under the original Sanskrit form of its name as *Ambulima*;§ for these texts contain no definite local indications.

General Abbott, when discussing in 1854 at great length his location of Aornos on the Mahāban range to the south of Bunēr and Chamla, proposed to recognize Embolima in the village of Amb, situated on the right bank of the Indus, from which the present semi-independent chief of Tanāwal territory in Hazāra takes his title.|| The identification of Mount Mahāban with Aornos, though generally accepted for many years, proved untenable in the light of what the close examination of the ground, carried out by me in 1904, showed as to the true topographical features of the supposed site.¶ For these could not be reconciled with the plain and comparatively precise indications that are supplied to us by the classical accounts, and in the first place by that of Arrian, as to the character of the natural stronghold and its immediate surroundings.

But a recognition of this fact will not necessarily invalidate the location of Embolima at Amb. Arrian's narrative shows that it took Alexander two marches from Embolima to reach the neighbourhood of Aornos.

* See below, p. 528.

† See 'Geographia,' VII. i. 27, 57.

‡ More useful, perhaps, is the relative bearing to the south-west of Embolima, which Ptolemy indicates for *Asigramma*, mentioned by him as another town of Indo-Scythia and as situated on the Indus; for Asigramma can probably be identified with the ruined site of Asgrām situated about 2 miles to the west of the Indus just outside the extreme north-east corner of the Peshawar District; cf. my 'Archæological Survey Report, N.W.F.P.' (Peshawar, 1905), p. 47. But as no value can be attached to the indication of distance between the two places as deduced from the respective coordinates, no safe conclusion is possible as to the exact position of Embolima.

§ See S. Lévi, *loc. cit.* in *Journal Asiatique*, 1915, janv.-févr., p. 103.

|| See "Gradus ad Aornon," *J.A.S.B.*, 1854, pp. 338, 344. This identification had been suggested already by M. Court, one of Ranjit Singh's generals; cf. *Journal of the Bengal Asiatic Society*, 1839, p. 310.

¶ Cf. 'Archæol. Survey Report, N.W.F.P.' (1905), pp. 28 *sqq.*

Hence even if the above location is accepted we may still look for Aornos higher up the Indus, in that area comprising the tracts of Ghōrband, Chakēsar, and Pūran, to which the considerations fully set forth above point as the ground most likely to have been sought by the population retreating from Upper Swāt. It should, however, be remembered that the identification of Amb with Embolima (Sanskrit *Ambulima*) rests so far solely on the identity of the modern name with the first syllable of the ancient one, and that the assumed apocope of fully three syllables at the end of the latter is more than can easily be accounted for by the rules governing the phonology of modern Indo-Aryan vernaculars. If Embolima were to be looked for farther up the river the position occupied by Kābalgrām, a large village at the mouth of the fertile Pūran valley and a centre of local trade, might suggest itself on topographical grounds as a likely site.

Ever since my visit to Mahāban in the autumn of 1904 had furnished conclusive evidence against the location of Aornos on that range, I had kept in view " the possibility of our having to look for Aornos higher up the great river." * But it was only in 1919, after the return from my third Central-Asian expedition and after prolonged labours on the results of the second, that my attention was drawn in a definite fashion to ground where a likely solution of the problem could be hoped for. The right bank of the Indus and all the adjacent territory to the west of it had, indeed, remained as inaccessible as before. But fortunately work on the maps reproducing the surveys carried out during my three Central-Asian expeditions brought me in 1918–19 into close contact with the late Colonel R. A Wauhope, R.E., at the Trigonometrical Survey Office, Dehra Dun.

The personal knowledge which this highly accomplished officer of the Survey of India had gained of that ground during the survey work conducted by him on the left bank of the Indus during the Black Mountain expeditions of 1888 and 1891–2 furnished me with a very valuable clue. From high survey stations then established on the Black Mountain range, and again during the occupation of the Chagharzai, Nandihār and Allāhī tracts, Colonel Wauhope had ample opportunities for becoming familiar with the general features of the hills on the opposite side of the Indus valley all the way between the Hassanzai country, above Amb, and Chakēsar. Being a sound classical scholar all his life, he was interested in the question of Aornos, and what he had observed at the time had led him to form the belief that a position corresponding to that described by Alexander's historians was more likely to be found on the spurs descending steeply to the Indus opposite Thākōt in Nandihār than anywhere else. But as an experienced topographer he rightly recognized also that a definite location could be hoped for only by close examination on the spot.

* See ' Archæol. Survey Report, N.W.F.P.' (1905); p. 30.

The spurs just referred to are the easternmost finger-like offshoots of the range which trends with a due easterly bearing and a total length of close on 20 miles from the Swāt–Indus watershed above Manglawar and Chārbāgh to the Indus. On the opposite side the river there passes the mouths of the Nandihār and Allāhī valleys. From the available Survey of India maps, including Sheet No. $43\frac{B}{N.E.}$ on the scale of 2 miles to the inch, it was seen that the range may be roughly described as dividing the valleys of Ghōrband and Chakēsar ; that its crest rises to triangulated heights between 9265 feet in the west and 7011 feet in the east ; and that round its eastern foot the Indus flows in a wide bend. Little else could be made out from the map, based as it necessarily was for this ground on sketches made from a distance, on native route reports and the like.

My first endeavour, made in 1922 after a rapid visit to Agrōr and the Indus banks facing Amb, had been to secure access to the ground just indicated from the tribal territory of Nandihār on the opposite side of the river. But by the time I was able to renew the attempt in 1925 that same ground, together with the rest on the right bank of the Indus down to the Barandu river some 9 miles above Amb, had passed under the sway of the Miāngul ruler of Swāt. The question of giving me access had therefore to be taken up with him by the political authorities of the North-West Frontier Province. The first definite news of his assent reached me early in December on my return to India. I felt particularly gratified by the condition which the Miāngul had indicated, that I should visit the tract in question not from across the Indus but from the side of Swāt ; for obviously I could thus hope for a chance of extending my exploratory work over far more of interesting ground than originally contemplated. From the same letter I learned that the site of Aornos, which had been mentioned as the principal objective of my visit, was locally known by the name of *Pīr-sar*.

This precise information as to the locality to be looked for was bound to be received by me with surprise ; for former experience in this region had shown me that genuine local tradition of Alexander's campaign twenty-two centuries ago survives there as little as it does anywhere else on the North-West Frontier or in the Panjab. Indeed, none could reasonably be expected considering the great length of time passed, the far-reaching ethnic changes, the ephemeral character of the great Macedonian's passage, and the total absence of any historical recollection concerning him and his invasion in the whole range of Indian literature, as distinct from the "Alexander romance" introduced in its Persian garb through the Muhammadan conquest. What I subsequently had occasion to hear from Sipāh-sālār Aḥmad 'Alī, the Miāngul's commander-in-chief, who accompanied me throughout my tour, and from others of the ruler's *entourage*, has confirmed my belief that their connection of Alexander's name with that particular locality of Pīr-sar had originated

merely from the way in which the object of my proposed visit had been communicated to the Miāngul in official correspondence, and from the interest which had thus been directed towards a site likely to answer the general description conveyed. Nevertheless the apparent precision with which the local inquiry made at the ruler's desire had fixed upon that locality, was a moment not to be ignored. This will explain why, when the completion of our surveys in Upper Swāt allowed me to turn towards the Indus and to approach there the ground to which Colonel Wauhope had drawn my attention, I wished to visit Pīr-sar in the first place.

Our route starting from Khwāja-khe in Upper Swāt led first across the Karōrai pass into the northern portion of the Ghōrband tract. Thence over the Shalkau pass, close on 10,000 feet in height and still deeply covered with snow, the head of the large and fertile valley of Kāna was gained. Here we closely approached the still inaccessible portion of the Kohistān on the right bank of the Indus. By descending the Kāna valley from north to south the lower course of the Ghōrband river was reached. Along it lies a much-frequented route from the Indus to Swāt. Fa Hsien on his way from Darēl, and probably other Chinese pilgrims, had followed it.* Almost opposite to the mouth of the Kāna valley there descends a valley from the above-mentioned range dividing Ghōrband and Chakēsar, and an easy pass at its head above the village of Upal forms the most direct connection between the two tracts.

Starting on foot from the village of Upal on the morning of April 26, we ascended first to a spur which at a height of about 6000 feet bears a small plateau occupied by a Gujar hamlet and its fields. Here at the ruin of a small walled enclosure remains of ancient decorated pottery, as well as an ornamental bronze bracelet of very early shape, were picked up practically on the surface. From there the ascent lay first past terraced fields and then steeply over slopes clothed with luxuriant conifer and Ilex forest to the crest of the range reached at an elevation of a little under 8000 feet. Along this crest, very narrow and rocky throughout, or on the steep southern slope close below it, led the track, such as it was, eastwards. Fine views had been obtained before of the great glacier-clad peaks above the Swāt river headwaters, and on passing below the top of the eminence, shown with the triangulated height of 8360 feet on the map and known as Acharo-sar, there was sighted through the pines and firs the Indus valley below and the long snow-topped range of the Black Mountain beyond it. Past a very fine spring issuing below Acharo-sar we reached soon the open top of a side spur which lower down bears the grazing plot known as "Little Ūṇa." And from this point there came into view the bare rocky peak of Ūṇa-sar, or "Mount Ūṇa" (shown on the map with the triangulated height of 8720 feet), which I had before heard mentioned as the highest on this side of the range, and

* See 'Serindia,' i. pp. 7 *sq.*

stretching away from it southward I sighted the flat-topped ridge of Pīr-sar.

It was a very striking sight, this long almost level ridge, as it rose there, girt all round with cliffs, above the precipitous smaller spurs and steep ravines which were seen to run down to the Indus close on 6000 feet below (Figs. 4, 5). At its northern end it was seen to slope down from a steep tree-clad hill, and this from where we stood, about 2 miles off to the west, appeared to join up with the main crest of the range as it continues to the east of Ūṇa-sar. Pīr-sar seemed near enough as I looked across the deep valley flanked by precipitous slopes which separated us from it; but in the end it took us nearly three hours more to reach it.

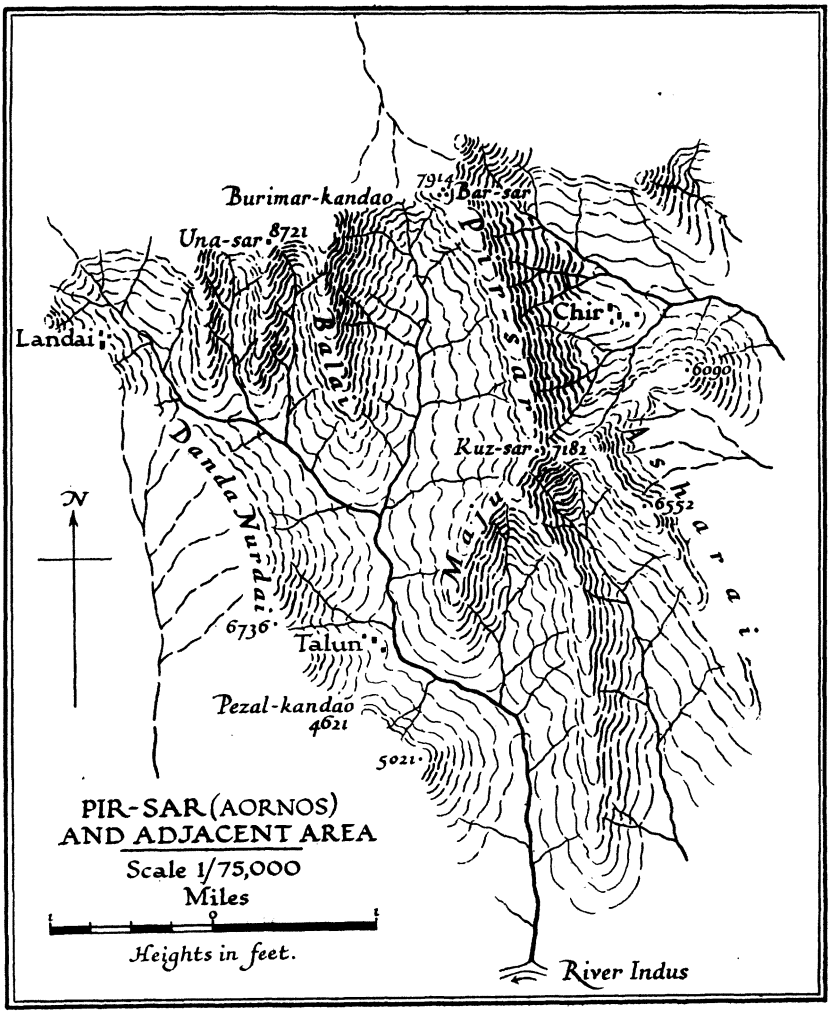
First we had to make our way past the steep southern face of Mount Ūṇa, and as lower down this falls off with sheer walls of rock, to ascend by a troublesome track to within 200 feet or so below the summit. Then it became possible to cross to the northern slope of the crest, steep too, but well timbered, and thus to descend to the small tree-girt alp of Būrimār (Fig. 6), where we found some summer huts of Gujar graziers and the fenced-in resting place of some Muhammadan saint. At first Būrimār seemed to link up with the wooded conical height marking the northern end of Pīr-sar; but when the lower edge of the gently sloping alp was reached I noticed, with some dismay at the time, I confess, that a deep and precipitous ravine previously masked by close tree growth still separated us from that height. The descent to its bottom, which, as careful aneroid observations on two separate occasions showed, lay fully 600 feet lower, was very fatiguing owing to the steepness of the slope and the slippery nature of the ground.

When the bottom of the gully was at last reached in the gathering dusk it proved to be a very confined saddle, less than 40 yards long and only about 10 yards across. Fallen trees encumbered the saddle and lay thickly also in the narrow ravines descending on either side. Progress was trying, too, along the precipitous cliffs lining the south-western slopes of Bar-sar (" the top hill "), as the northern end of the Pīr-sar ridge is known. It was with real relief that at last long after nightfall level ground was reached where the flat portion of the top adjoins Bar-sar. It was a strange sensation to pass for close on a mile along what the full moon shining under a cloudless sky showed to be verdant fields of young wheat. Then camp was pitched near a rudely built mosque, at an elevation which subsequent observations with the mercurial barometer proved to be fully 7100 feet above sea-level.

I have thought it expedient to describe the march which brought us to Pīr-sar in some detail, because it may help to visualize better those topographical features which lead me to believe that this remarkable ridge represents the long-sought-for site of Aornos. For the same reason I may proceed at once to record the observations gathered by a careful

examination of the ridge and the surrounding ground in the course of a three days' stay. Reference to the accompanying sketch-map, from the survey on the scale of 3 inches to the mile prepared by Surveyor Tōrabaz Khān under my direct supervision, will best help to illustrate them.

Pīr-sar is but one of a series of narrow spurs which the range stretching



from Upal throws out south towards the Indus, before it drops rapidly in height beyond the triangulated point 7011. There it flattens out fanlike towards the low plateau of Maira washed at its foot by the Indus. Of these spurs Pīr-sar preserves its height farthest, and, owing to the uniform level and the very fertile soil of its top, affords most scope both for cultivation and grazing. The practically level portion of the top

extends at an average elevation of about 7100 feet for over 1½ miles. At its upper end this flat portion is adjoined for some distance by gentle slopes equally suited for such use (Fig. 8).

Owing to its greater height and the depth of the valleys on either side Pīr-sar forms a dominating position; overlooking all the other spurs, it offers an exceptionally wide and impressive view. This comprises the whole of the Indus valley from below the Mahāban range in the south to where the winding course of the great river lies hidden between closely packed spurs descending from the high snowy ranges towards Kāgān and the Swāt headwaters (Fig. 5). To give some idea of the extent of the vast panorama commanded from Pīr-sar, it must suffice here to mention that it includes northward the great ice-crowned peaks above Tōrwāl, Dubēr, and Kandia, and to the east all the ranges which adjoin the central part of Hazāra; southward the plain of the Peshawar valley above Attock could be distinctly sighted.

The spur from its level top, to which the name *Pīr-sar*, "the holy man's height," is properly applied, falls off both on the east and west with very steep rocky slopes. In places these form sheer cliffs, while in others pines and firs have managed to secure a footing. The southern end of Pīr-sar rises into a small but conspicuous hillock, known as Kuz-sar, "the lower height," as opposed to the Bar-sar at the northern end (Fig. 4). There the spur divides into three narrow branches, all flanked by precipitous rocky slopes (Fig. 7). The crest of the middle one is in its upper portion so steep and narrow as to be practically inaccessible. That of the eastern branch, known as Ashārai, is very narrow too, but bears some knolls which afford room for small patches of terraced cultivation. The shortest branch, called Māju, which juts out like a bastion to the south-west, also bears two such small patches on its crest, before it terminates in sheer cliffs at a level of about 1600 feet below the top of Pīr-sar.

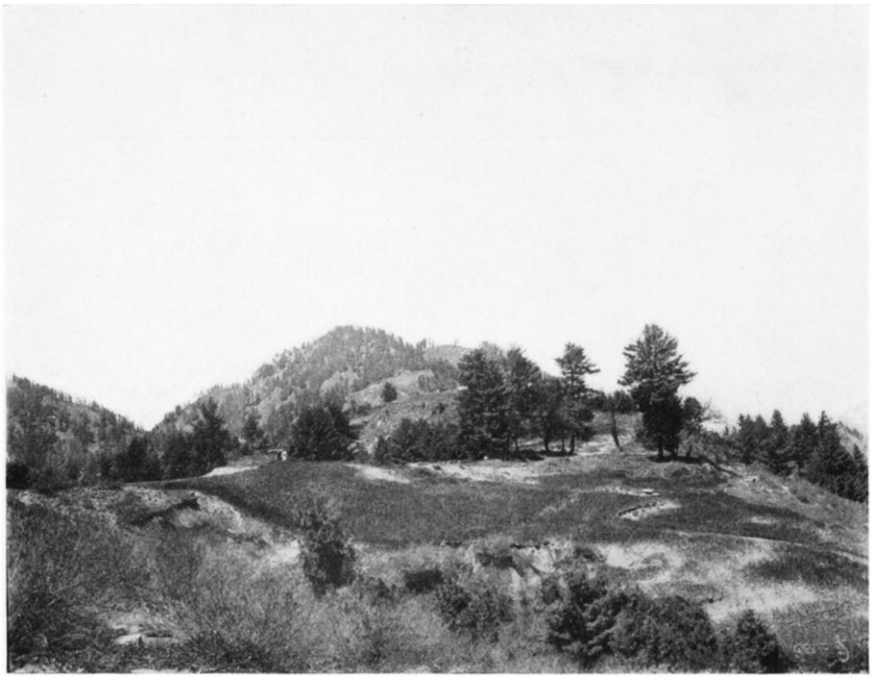
The western slopes of Pīr-sar descend steeply for some 2000 feet into a very confined valley (Fig. 4). This in parts of its bottom is an impracticable ravine, while in others little terraces bear a few scattered fields. On the opposite side of the valley there rises with formidable bare cliffs, almost perpendicular in places, the small spur of Balai. It has short stretches of more gentle slope on its top used for summer grazing; but these are practically accessible only from the crest of the main range just below the Ūṇa-sar peak. A deep ravine divides the spur of Balai westwards from another and much longer one, known to the local Gujars as Danda-Nūrdai. This separates from the main range near the grazing-grounds of Landai and farther down faces the south-western slopes of Pīr-sar. Its narrow serrated crest is crossed by two passes. The lower one, called Pēzal-kandau, at an elevation of about 4000 feet, gives access to a portion of the valley where opposite to the cliffs of Māju some cultivation is carried on by the scattered homesteads of the Gujar hamlet of

Tālun. From below the Pēzal-kandau it is possible to ascend by a difficult track to the crest of the Māju spur, and thence to the southern end of Pīr-sar. Across the other pass, about 6500 feet above sea-level, a somewhat easier route leads from the valley behind the Nurdai-Danda spur to the grassy slopes below the alp of Little Ūṇa, and thence joins the track passing along the top of the main range. We shall see below that these passes may claim some interest in connection with the proposed location of Aornos on Pīr-sar.

From here we must turn back to Pīr-sar to acquaint ourselves rapidly with the ground which adjoins eastwards. That it differs in some aspects from that observed to the west is due mainly to the fact that the main range, after throwing off to the south the commanding spur of Pīr-sar, very soon falls off in height and becomes bare of tree growth. The drainage descending here from it does not flow south in well-defined separate valleys, but gathering in one wide trough takes its course to the Indus south-eastwards. Between the deeply eroded nullahs which join this trough there rises a succession of short knolls and ridges. All have very steep slopes, but are crowned by little plateaus which as seen from Pīr-sar give them an appearance curiously suggestive of small detached islands. Most of these little hilltops bear patches of cultivation ; but all are devoid of trees and water, and only capable of temporary occupation. The slopes of Pīr-sar facing east descend also very steeply. About 1500 feet below the middle of the spur they become somewhat easier and here allow room for the small hamlet of Chīr, permanently tenanted by about a dozen of Gujar households. But as its terraced fields occupy the angle between two deep-cut ravines, with rocky scarps descending precipitously for some 500 feet, access to Pīr-sar is made very difficult from this side too.

It only remains for me briefly to describe the top of the Pīr-sar spur. This presents itself for a distance of a little over 1½ miles as an almost level plateau, occupied along practically its whole length by fields of wheat. The width of the flat ground on the top varies from about 100 to 200 yards, with strips available for grazing by the side of the fields. Fine old trees form small groves in places (Fig. 9), and one of these near the middle of the ridge shelters a much-frequented Ziārat, or shrine. There are several small springs in the little gullies which furrow the steep slopes close below the ridge, and these feed the streams which pass near the fields of Chīr or drain into the valley above Tālun. But in addition two large reservoirs, as shown in the plan, have been constructed with *bands* of rough stonework in order to store plentiful water from rain or melting snow, and thus to meet the need of the herds of cattle brought for grazing during the summer months. We found them filled to a depth of several feet. Over two dozen of homesteads, roughly built in the Gujar fashion, and scattered in groups over the plateau, serve to shelter the families which move up

8. *North end of Pīr-sar ridge with Bar-sar hill above, and Swat–Indus watershed in distance*



9. *Fields near the middle of the Pīr-sar ridge*

10. *Gujars examined about local traditions on Pīr-sar*

from Chīr and Tālun with their cattle and occupy Pīr-sar from the latter portion of spring till the autumn. The mosque to be referred to below forms the centre of the settlement. The fact that the Pīr-sar ridge stretches from north to south and is nowhere shaded by higher ground assures abundance of sunshine to its top. In consequence this gets clear of snow very early in the year. This explains also why, in spite of an abnormally late spring and the bitterly cold winds still blowing down from the Indus Kohistān at the time of our stay (April 27–29), we found the wheat already standing high.

At its southern end Pīr-sar is guarded, as it were, by the hill of Kuz-sar already mentioned, which rises about 100 feet above the plateau and completely commands the difficult paths leading up from the Māju and Ashārai crests. At the northern extremity the plateau is still more effectively protected by the bold conical hill of Bar-sar, which rises to a height of about 7900 feet, and is thus on its top about 800 feet higher than the plateau. The approach from the latter to the thickly wooded top lies first over easy grassy slopes (Fig. 8), but from about 300 feet below it becomes very steep and rocky. The top portion of Bar-sar, as the plan shows, has a distinctly triangular shape. The sides of the triangle to the east and south-west are lined with crags and very precipitous. The same is the case with the side facing north-west. From the angle pointing north there leads an easier slope down 200 feet to a narrow saddle, and beyond it there rises close by a small flat-topped outlier of Bar sar known as Lānde-sar ("the lower height"). Its elevation is but little less than that of Bar-sar, and the slopes below it are very steep and rocky on all sides except where the saddle links it with Bar-sar.

It is by the angle pointing west that Bar-sar joins up with the main range, in the axial line of which it lies. But it is just here that the continuity of the range is broken by the deep and precipitous ravine which we encountered on our first approach to Pīr-sar. The bottom of this ravine lies approximately on the same level as the plateau of Pīr-sar and about 600 feet below the alp of Būrimār which, as we have seen, faces Bar-sar. I have already had occasion to describe the troublesome descent from Būrimār to the bottom of this ravine known as Būrimār-kandao. But the angle at which the narrow rocky *arête* from the top of Bar-sar runs down to it is still steeper. The succession of crags, in places almost vertical, is here, however, broken at one point by a projecting small shoulder, called *Māshlun*. This, visible in the distance in Fig. 8, is quite flat on its top and extends for about half a furlong westwards, with a width of some 30 yards at its end. Trees grow on it thickly, just as on the rocky slopes above and below too. This shoulder of Māshlun juts out at a height of about 450 feet above the bottom of the ravine, and behind it precipitous cliffs rise for another 350 feet or so higher to the summit of Bar-sar. I shall have to recur further on to

the remains of an ancient fort traceable on this summit, and to the important topographical indication presented by the shoulder of Māshlun.

Having now described the actual configuration of Pīr-sar, I may briefly sum up the essential features which were bound to invest it with exceptional advantages as a place of safety and natural stronghold for the ancient inhabitants of this region. Its great elevation, more than 5000 feet above the Indus, would suffice to make attack difficult. The extent of level space on its top, greater than that to be found on any height of equally natural strength further down on the right bank of the Indus, would permit of the collection of large numbers both for safety and for defence. Its central position would make Pīr-sar a particularly convenient place of rally for large and fertile hill tracts such as Chakēsar and Ghōrband, as well as for that portion of the Indus valley lying close below where the space available for cultivation is wide and villages accordingly large and numerous. The great height and steepness of the slopes with which Pīr-sar is girt would suffice to make its defence easy in times when those fighting from superior height had every physical advantage on their side. And in this respect full account must also be taken of the fact that even on the side where the spur is adjoined and overlooked by the main range, the deep ravine of the Būrimār-kandau assured isolation.

From this survey of Pīr-sar we must now turn back to the record of Alexander's operations where we left it on his arrival in the vicinity of Aornos. Arrian's description of them is so clear and instructive in its topographical details that it appears best to reproduce it here *in extenso*.* I give it in Mr. M'Crindle's translation, with a few slight alterations which reference to the original text seems to me to render desirable.

"Some men thereupon who belonged to the neighbourhood came to him, and after proffering their submission undertook to guide him to the place most suited for an attack upon the rock, that from which it would not be difficult to capture the place. With these men he sent Ptolemy, the son of Lagos, and a member of the bodyguard, leading the Agrianians and the other light-armed troops and the selected hyspaspists, and directed him, on securing the position, to hold it with a strong guard and signal to him when he had occupied it. Ptolemy, following a route which was trying and difficult, secured the position without being perceived by the barbarians. He fortified this all round with a palisade and a trench, and then raised a beacon on that part of the mountain from which it could be seen by Alexander. The signal fire was seen, and next day Alexander moved forward with his army; but as the barbarians offered valiant opposition, he could do nothing more owing to the difficult nature of the ground. When the barbarians perceived that Alexander had found an attack [on that side] to be impracticable, they turned round and attacked Ptolemy's men. Between these and the Macedonians hard fighting ensued, the Indians making strenuous efforts to destroy the palisade and Ptolemy to hold the position. The barbarians had the worse in the skirmish, and when night fell withdrew.

"From the Indian deserters Alexander selected one who knew the country

* 'Anabasis,' IV. xxix.–xxx.

and could otherwise be trusted, and sent him by night to Ptolemy with a letter importing that when he himself assailed the rock, Ptolemy should not content himself with holding his position but should fall upon the barbarians on the mountain, so that the Indians, being attacked on both sides, might be perplexed how to act. Alexander, starting at daybreak from his camp, led his army to that approach by which Ptolemy had ascended unobserved, being convinced that if he forced a passage that way and affected a junction with Ptolemy's men, the work still before him would not be difficult. And so it turned out; for up to mid-day there continued to be hard fighting between the Indians and Macedonians, the latter forcing their way up while the former plied them with missiles as they ascended. But as the Macedonians did not slacken their efforts, others succeeding to others, while those [before] in advance rested, they gained with trouble the pass in the afternoon and joined Ptolemy's men. The troops being now all united were thence put again in motion towards the rock itself; but an assault upon it was still impracticable. So came this day to its end.

"Next day at dawn he ordered the soldiers to cut a hundred stakes per man. When the stakes had been cut he began from the top of the height on which they were encamped, to pile up towards the rock a great mound, whence he thought it would be possible for arrows and for missiles shot from engines to reach the defenders. Every one took part in the work, helping to pile up the mound. He himself was present to superintend, commending those that with eagerness advanced the work, and chastising any one that at the moment was idling.

"The army on that first day extended the mound the length of a stadion. On the following day the slingers, by slinging stones at the Indians from the mound just constructed, and the bolts shot from the engines drove back the sallies made by the Indians on those engaged upon the mound. The work of piling it up went on for three days, without intermission. On the fourth day a few Macedonians had forced their way to and secured a small hillock level with the rock. Alexander without ever resting drove the mound forward, intending to join the mound to the hillock which the handful of men already held for him.

"But the Indians, terror-struck at the unheard-of audacity of the Macedonians who had forced their way to the hillock, and on seeing the mound already connected with it, abstained from further resistance, and sending their herald to Alexander, professed their willingness to surrender the rock if he would treat for peace with them. But the purpose they had in view was to consume the day in spinning out negotiations, and to disperse by night to their several homes. When Alexander perceived this he gave them time to start off as well as to withdraw the round of sentries everywhere. He himself remained quiet until they began their retreat; and then he took with him seven hundred of the bodyguard and of the hypaspists and was the first to scale the rock where it had been abandoned. The Macedonians climbed up after him, pulling one another up, some at one place, some at another. And then at a preconcerted signal they turned upon the retreating barbarians and slew many of them in the flight; some others retreating in terror flung themselves down the precipices and died. Alexander thus became master of the rock which had baffled Heracles himself."

With this clear, sober, and full record of Arrian the accounts given by Diodorus and Curtius agree in all essential topographical points. That

both these authors used common sources here as elsewhere also, is evident from various indications. But Diodorus contents himself with a much-condensed abstract, and Curtius' narrative owes its greater length mainly to his usual expansion of such minor aspects of the story as specially lend themselves to rhetorical treatment. It will therefore be sufficient, in the case of either account, to note only those points which have a bearing on the location of Aornos.

Diodorus describes the "rock" as a natural stronghold, 100 stadia in circumference, 16 stadia in height, and with a level surface forming a complete circle.* The Indus washed its foot on the south; elsewhere it was surrounded by deep ravines and inaccessible cliffs. An old man familiar with the neighbourhood promised against a reward to take Alexander up the difficult ascent to a position which would command the barbarians in occupation of the rock. Following his guidance, Alexander first seized the pass leading to the rock, and as there was no other exit from it, blocked up the barbarians. He then filled up the ravine which lay at the foot of the rock with a mound and getting thus nearer vigorously pushed the siege by assaults made for seven days and nights without intermission. At first the barbarians had the advantage owing to the greater height of their position. But when the mound was completed and catapults and other engines had been brought into action, the Indians were struck with despair and escaped from the rock at night by the pass from which Alexander had on purpose withdrawn the guard he had left there. Thus Alexander secured the rock without risk.

Curtius in his description of the rock (*petra*), which he calls by the name of *Aornis*, does not give any dimensions but mentions that the Indus, deep and confined between steep banks, washes its foot.† Elsewhere there are ravines and craggy precipices. In rhetorical style, apparently inspired by a reminiscence from Livy, Curtius likens "the rock" to the *meta* of the Roman circus, "which has a wide base, tapers off in ascending, and terminates in a sharp pinnacle."‡ This description, if it is based on some passage of his original source, would suggest that one portion of the "rock" rose into a steep conical point. We are told that under the guidance of an old man from the neighbourhood a light-armed detachment was sent ahead by a detour to occupy the highest summit unobserved by the enemy.§

Curtius next relates that in order to make an assault practicable a ravine was being filled up with a mound. For this the trees of a forest

* Cf. Diodorus, 'Bibliotheca,' XVII. lxxxv.; M'Crindle, 'Invasion of India,' p. 271.

† Cf. 'Historiæ,' VIII. xi.

‡ See M'Crindle, *loc. cit.*, p. 197, referring to Livy, Bk. XXXVII. xxvii.

§ As the leader of the detachment is mentioned Mylleas (or Mullinus), the king's secretary; neither form of the name is otherwise known. The substitution of his name for that of Ptolemy shows that Curtius follows here a source distinct from that of Arrian.

close at hand were cut down and their trunks stripped of branches and leaves thrown in. Within the seventh day the hollows had been filled An assault up the steep slopes by the archers and Agriani was then ordered. Thirty selected youths from among the king's pages under Charus and Alexander formed the forlorn hope. In the highly rhetorical description which follows it is, however, the king himself who is said to have put himself at the head of the assault. Many are said to have perished, falling from the steep crags into the river which flowed below, " since the barbarians rolled down huge stones upon those climbing up, and such as were struck by them fell headlong from their insecure and slippery footing." We are then told in lengthy poetical words of the death of the two leaders, Charus and Alexander, who had got up high enough to engage in a hand-to-hand fight, but were overpowered and fell.

The king, affected by these losses, then ordered the retreat, which was carried out in an orderly fashion. Alexander, though resolved to abandon the enterprise, yet made demonstrations of continuing the siege. Thereupon the Indians, with a show of confidence and even triumph, feasted for two days and two nights, but on the third night abandoned the rock. When their retirement was discovered, the king ordered his troops to raise a general shout. This struck such terror into the fugitives that many " flinging themselves headlong over the slippery rocks and precipices " were killed or were left behind injured.

The three accounts translated or analyzed above are the only ones which have come down to us furnishing any specific data about Aornos. From their comparison we can deduce the following definite indications as regards the locality intended. Aornos was a natural stronghold, situated on a mountain of great height, which precipitous rocky slopes and deep-cut valleys below rendered capable of easy defence against an aggressor. It is important to note that no mention is made anywhere of fortification by the hand of man. There was sufficient level space on the top to permit of considerable numbers finding there a safe refuge. The site was near to the Indus, which flowed at its foot.* Its relative height must have been very striking to account for the definite measurements of 11 and 16 stadia respectively, which Arrian and Diodorus record, approximately corresponding to 6600 or 9600 feet. In the same way the circuits of 200 and 100 stadia respectively which these two authors mention, approximately corresponding to 22 or 11 miles, can obviously apply only to a mountain massif or range and not to a single hill or peak.

That Aornos was situated on such a massif or range is in fact made

* Both Diodorus and Curtius definitely mention this point, and Arrian's silence does in no way contradict it. On the other hand, no weight can attach to the statement in Curtius' highly coloured description of the siege which makes those who lost their foothold in scaling the " rock " from the ravine fall into the river; for the possibility of this is manifestly excluded by his comparison of the rock with a meta " which has a wide base, tapers off in ascending," etc.

perfectly clear by what all three authors relate of the commanding height attacked by the Macedonians before the start of the siege and reached after an arduous ascent. Both Arrian and Curtius state that the march by which the light-armed detachment sent ahead by Alexander secured this position under local guidance remained unobserved by the enemy. This distinctly suggests that the route followed to that commanding height led up a valley which was hidden from the view of the defenders of Aornos. This assumption finds strong support in Arrian's reference to the pass (*πάροδος*) to which Alexander, when subsequently following the same difficult route, had to ascend amidst severe fighting, before he could join Ptolemy's detachment holding the position above Aornos. Incidentally the opposition here encountered by Alexander indicates that this route leading to the height of the range, though not visible from Aornos and hence not obstructed on the first occasion, was yet accessible to its defenders without their having first to dislodge the detachment on the height. We see from Arrian that an attempt to dislodge it had in fact been made on the preceding day but had failed.

We come now to the most significant among the topographical features recorded in connection with Alexander's siege of Aornos: I mean the deep ravine separating the heights on which the Macedonian camp stood from the nearest part of the "rock." Here, too, Arrian's account is the fullest and clearest. It shows us that the primary object for which Alexander had to resort to the expedient of constructing a great mound across this ravine was to bring the opposite slope held by the enemy within effective range of what by an anachronism might be called his troops' small arms and field artillery. The precipitous nature of that slope would lend itself to easy and most effective defence, in particular by means of large stones rolled down, a formidable method of defence the actual use of which Curtius here specially mentions.* No assault could succeed here until "it would be possible for arrows and for missiles shot from engines to reach the defenders."

We obtain some indication of the great width of the ravine, and indirectly also of its depth, from Arrian's statements concerning the construction of this mound. By the united efforts of the troops it was extended on the first day the length of a stadion, *i.e. circ.* 600 feet. After this it became possible for slingers posted on the mound and for shots from the engines to drive back sallies made against those engaged upon the mound. But "the work of piling it up went on for three days without intermission," before an assault made on the fourth enabled a handful of Macedonians to establish themselves on "a small hill which was on a level with the rock." Yet even after this, we are told by Arrian, the construction of the mound was continued until it was joined up with the

* Very striking illustrations in modern times of the results which may be obtained by this means of defence on alpine ground, were supplied by its use on the part of the valiant bands of Tyrolese peasants who successfully defended their country in 1809 against invasion by Napoleon's French and Bavarian troops.

position thus gained.* This position must have lain still considerably below the crest of the height which faced the ravine from the side of the "rock." Thus only is it possible to account for the stiff climb which it cost Alexander and his selected 700 men to reach the top and fall upon the retreating barbarians during the night following their offer of surrender.

I may now proceed to show how easy it is to recognize all the topographical details elucidated above as regards Aornos and Alexander's siege of it in the local features of Pīr-sar and its environs as illustrated by the map and my preceding description. Taking the general features first, we see from the map that the Indus flows in a wide bend round that eastern extremity of the range of which the Pīr-sar spur is the largest and most conspicuous offshoot. Diodorus' more specific statement that the Indus washed the rock on its southern side is borne out by the map. This shows that the portion of this bend nearest for those coming up the Indus valley lies due south of Pīr-sar. The relative elevation of Bar-sar at the northern end of the spur (7914 feet by clinometer), if measured from the bank of the Indus (*circ.* 1700 feet at Thākōt) agrees remarkably well with the height of Aornos, 11 stadia or about 6600 feet, as recorded by Arrian.† If the relative height of the Ūṇa peak (8720 feet above sea-level by triangulation) rising immediately to the west of Bar-sar is taken, the agreement becomes, if anything, still closer. Obviously no such test can be applied to the measurement of the circuit; for we do not know on what lines or on which level it was taken. It is curious to note that if a map measurer is passed round the foot of the eastern extremity of the range from near Sarkul on the Indus past the Takhta pass to Shang and thence back again behind the Ūṇa peak we get a total direct length of some 22 miles. But of course other measurements, greater or lesser, would also be possible.

Coming next to the commanding height near Aornos which a light-armed force was sent ahead under Ptolemy to occupy, it is clear that the small plateaus on either flank of Mount Ūna would exactly answer the purpose in view. This was to secure a position on that side from which the "rock" was most assailable. Taking into account all the tactical advantages which the possession of higher ground must have implied for the assailant, in times before the invention of long-range firearms even more than since, there can be no doubt that the side whence an

* This notice of Arrian about the continued extension of the mound disposes of the apparent discrepancy which certain commentators have found between his account and that of Diodorus and Curtius, who mention seven days as the time taken over the construction of the mound.

† Bar-sar as well as the rest of Pīr-sar is visible from more than one point of the right bank of the Indus between Sarkul and Gunahghar. It is obvious that the height measurement recorded by Arrian must be a relative one, and that the river-bank can reasonably be supposed to have been the place from which it was taken. A height measurement of this kind from a convenient base is a simple geometrical task, and Greek surveying knowledge at the time of Alexander was fully equal to it.

attack upon the rock-girt plateau of Pīr-sar would offer most chances of success would be where the spur joined on, and was overlooked by, the main range. This is the Būrimār plateau on the eastern shoulder of the culminating peak of Ūṇa (Fig. 6). But there are considerations which make me inclined to favour the gently sloping alp of "Little Ūṇa" immediately below the western flank of Ūṇa-sar as the most likely site of Ptolemy's fortified encampment. From here it was easier to guard the route leading up from the river, and thus to give that assistance for the subsequent ascent of the main force which Arrian's account shows to have become indispensable once the defenders had discovered the Macedonian move. "Little Ūṇa" offers also the advantage, anyhow nowadays, of easier access to water, and by its situation it was less exposed to attack from the enemy's main position on Pīr-sar.

The route by which the crest of the range where it overlooks Pīr-sar could best be gained from the river certainly led up the valley to the west of the Danda-Nūrdai spur, and thence from its head to "Little Ūṇa." The information collected by me showed that this route is considered the easiest from that side for reaching the grazing-grounds on the top of the main range. It is regularly used by the local Gujars when moving there from their hamlets above the Indus. The ascent in the valley is undoubtedly steep, but its bottom is less confined than that of the valley on the other side of the Danda-Nūrdai spur towards Pīr-sar. Near the head of the valley the pass shown in the map with a clinometrical height of 6471 feet gives access to the lower slopes of Little Ūṇa, and from these the alps occupied by the Gujar huts of Achar and Little Ūṇa can be gained without difficulty.

It is the route just described which for the reasons indicated I believe to have been followed first by Ptolemy and then also by Alexander's main column. Arrian tells us that after Alexander had seen the beacon lit by Ptolemy on the mountain he had occupied, he next day moved forward with his troops, but as his progress was obstructed by the barbarians, "he could do nothing more on account of the difficult nature of the ground." A look at the map explains how easy it was for the enemy collected on Pīr-sar to obstruct Alexander's march in that valley once Ptolemy's preceding move had been discovered and had indicated the direction which Alexander's attack was likely to take. The valley west of the Danda-Nūrdai spur is within easy reach from the south-western outlier of Pīr-sar across the heights above the pass known as Pēzal-kandau, 4620 feet above sea-level. By crowning these heights the enemy could seriously interfere with the Macedonians' move up the valley without risking a battle in the open. It was equally easy for them, when Alexander's advance up the valley had been brought to a standstill, to turn round and moving higher up to attack Ptolemy's detachment holding the fortified camp which, we have seen, may be placed at or near Little Ūna.

This attack was beaten off, and when Alexander on the next day resumed his advance up the valley, the Indians who contested it were attacked in the rear by Ptolemy, to whom Alexander during the night had managed to send orders to this effect, as recorded by Arrian. The importance of this help, as well as the difficulties encountered by Alexander, can be well understood by looking at the map. Not until the pass marked there with the height of 6471 feet had been taken could the junction with Ptolemy's force be effected, and considering its elevation and the steepness of the Danda-Nūrdai spur, Arrian's description of the severe struggle it cost to gain this pass (πάροδος) cannot have been exaggerated. Once the Macedonian forces were united in the course of the afternoon the further advance towards the " rock," which Arrian mentions as having been made during the remainder of the day, could present no difficulty. This advance would necessarily lie along the crest of the range as far as the Būrimār plateau. That it came to a standstill, as Arrian records, without any attack on the rock being possible at the time is fully explained by the great natural obstacle met beyond, the fosse of the Būrimār ravine.

I have already described above the general character of this ravine, its considerable depth and the precipitous nature of its slopes. But in order to realise better how fully its features explain Alexander's resort to having a mound constructed to cross it, attention must be called to some details. I have referred above to the protection afforded to Pīr-sar by the extremely steep rocky slopes with which the Bar-sar hill forming its northern bastion falls off towards the ravine some 800 feet lower separating it from Būrimār. These slopes, so easily defended from above, could not be attacked with any chance of success unless they could be brought within the range of missiles. Now the direct distance separating the top of Bar-sar from ground of approximately equal level on the Būrimār plateau is some 1300 yards, and that between the Māshlun shoulder of Bar-sar and a corresponding elevation on the slope below Būrimār certainly not less than 500 yards. It hence follows that since the *ballistai* and *katapeltai* forming the Greek artillery of that period could throw stones and darts only to a distance of some 300 yards,* and slingers and bowmen their missiles not much farther, it was necessary to advance the position from which their " fire " was to be used. This could be done here with effect only in a horizontal direction, for a descent into the ravine would not have increased the chance of commanding the higher slopes.

The ingenious expedient of constructing a mound to secure this object is thus fully accounted for by the configuration of the ground observed at the Būrimār ravine. In the same way the use made of timber for its construction, whether in the form of stakes or tree-trunks, fully agrees with the abundance of tree growth still observed on the slopes both above and below the Būrimār plateau. Undoubtedly this plentiful timber

* Cf. M'Crindle, ' Invasion of India,' p. 21.

available on the spot would supply the handiest material for the purpose. That the mound is said to have been advanced a stadion or about 200 yards on the first day is easily understood in view of the slope near the eastern edge of the Būrimār plateau being comparatively easy. But it becomes steadily steeper and steeper as the bottom of the ravine is approached, and in consequence the rate in the daily advance of the mound was bound to decrease in proportion to the greater depth to be filled up. Thus it is explained why, even when on the fourth day a few Macedonians had forced their way to a small hillock on the opposite slope, it was necessary to continue work on the mound in order to join the two, as Arrian tells us.

I believe we can safely recognize this "small hillock" (ὀλίγον γήλοφον) in the shoulder of Māshlun, described above. Its level as measured by aneroid is about 450 feet above that of the bottom of the Būrimār-kandao, and about the same above the flat portion of Pīr-sar. It is true that Arrian calls this small hill ἰσόπεδον τῇ πέτρᾳ, "level with the rock." But this is easily understood, considering that a continuous slope passing Pīr-sar connects Māsh-lun with the plateau portion of Pīr-sar. That there still rose a steep height above the "small hillock" is made perfectly clear by Arrian's own narrative, where he describes the stiff climb which brought Alexander and his 700 to the top of the "rock," after the mound had been joined to the hillock and while the defenders were abandoning Aornos. I myself retain a very vivid recollection of the trying scramble over steep crags by which the summit of Bar-sar was gained after my visit to Māshlun. I can hence realize what this ascent of about 350 feet may have meant for men encumbered by armour. That the height of Bar-sar was a very convenient place for the Macedonians to assemble and then at a preconcerted signal to turn upon the retreating barbarians, as related by Arrian, is obvious. In the same way it is easy to understand that some of the latter in their terrified flight during the night lost their lives by falling down precipices below Pīr-sar.

The above observations will show how closely all topographical details about Pīr-sar agree with what our extant records tell us of Aornos and Alexander's operations against it. But this identification may be supported also by antiquarian and philological evidence. There is no mention whatsoever in our texts of the natural defences of Aornos having been strengthened by the hand of man, and we may attach all the more significance to this negative fact in view of the obvious desire of our authors to emphasize the greatness of the difficulties overcome at the capture of the stronghold. That Aornos was recognized by them to have been solely a natural stronghold is clearly shown by the fact that they ordinarily designate it simply by the term *petra*, "the rock." *

* The same notion seems to be conveyed also by Curtius, where, in recording Alexander's triumph, he speaks of him as "rex locorum magis quam hostium victor"; cf. 'Historiæ,' VIII. xi., *fin.*

But we are told by Arrian that Alexander after the capture built there a fortified post and entrusted its guard to Sisikottos, an Indian deserter who had joined him in Baktra and proved trustworthy. Curtius, too, mentions Sisicostus as having been charged with the guarding of the rock and the adjoining territory. Curtius further mentions that Alexander erected altars on the " rock " to Minerva and Victory, while Arrian refers merely to sacrifices performed there by him.

In view of Arrian's statement it is of distinct interest that I found the badly decayed remains of what undoubtedly was a small fort on the summit of Bar-sar. The walls occupy whatever level space there is on the top, and to the north, towards Lānde-sar, descend also on the slope. They form an irregular quadrilateral, of which the longest side eastwards measures 136 feet and the shortest to the north 60 feet. The walls, 5 feet thick throughout, are deeply buried in debris and earth, largely humus deposited by decay of the luxuriant forest vegetation which has grown up and flourished evidently for centuries between and over the ruins. It was only by a careful search that the lines of the enclosing walls and some small rooms in the southern part of the area enclosed could be traced. What little excavation was possible within the limits of time and labour showed masonry of a type not unlike that found at Bīr-kōṭ and at ancient dwellings of early Buddhist times in Swāt, stone slabs, unhewn but fairly uniform in thickness, being set in mud plaster. Among the potsherds brought to light from the floor of one of the rooms there were some showing ornamentation similar to that found at Buddhist sites of Swāt but less finished.

What pointed to considerable antiquity was the far-advanced decay of the whole structure as compared with the fair condition in which most of the ruined dwellings and fortified mansions dating from Buddhist times are found at Swāt sites. Yet these by their position are far more exposed to erosion and other destructive factors than the very top of Bar-sar could be. The position is such as could not have been chosen for any other purpose than defence. Whether the remains indicated can go back as far as the Macedonian invasion, and whether they mark the spot where the fort erected under Alexander's orders might have stood, it is impossible to assert without thorough investigation, such as was not possible at the time of my visit. But it is certainly noteworthy that the ruined fort crowns just that height which protects the Pīr-sar plateau on the side where, as we have seen, it was most exposed to attack.

The old Gujars who had been summoned from the hamlets below as depositories of local lore (Fig. 10), knew of no special tradition attaching to those ruined walls.* Nor had they ever heard of Alexander having visited these parts. But they had been told by their elders that Pīr-sar had

* Among them was Ibrāhīm Bāba, a venerable old man, who was brought up with much trouble in a litter and declared to be a fountain-head of local information. He remembered having fought as a man between twenty and thirty against the British at the Ambēla Pass in 1862.

served as the summer abode of a Rāja called Sirkap, who otherwise lived below at the village of Sarkul on the Indus opposite Thākōt. This name of "Rāja Sirkap" is widely attached to ancient sites in these parts on either side of the Indus, *e.g.* to the ruins of the earliest as yet explored city at Taxila. But it gives no clue beyond indicating a traditional belief that the Pīr-sar plateau was occupied in early times long before the advent of Islām. The same Gujar informants derived the name Pīr-sar from a Saiyid Pīr Bēghan, who is said to have lived on the plateau before the Pathāns took the land, and to have been buried as a saint at the previously mentioned Ziārat, near the centre of Pīr-sar.

Whether the ground now under cultivation or occupied by Gujar huts and graveyards on Pīr-sar hides any datable remains it is impossible to say. But in the mosque which lies some 300 yards south of the Ziārat there are two large carved slabs of white calcareous stone, now used to support the roof but undoubtedly ancient. Their exposed portions measure 6 feet in height, with a width of 16–17 inches and a thickness of 4 inches. They were said to have been dug up somewhere near the centre of the area some time ago. But nobody could or would indicate the exact spot; my inquiry here, as elsewhere, suggested, no doubt, an intention to hunt for buried "treasure."

There still remains the philological evidence to be set forth. It is furnished by the name *Ūṇa*, in Pashtu also spent *Ūṇṛa*, applied to the peak rising immediately above Būrimār and overlooking Pīr-sar. We do not know the exact indigenous form of the local name which the Greek Ἄορνος was intended to reproduce. But if we assume it to have sounded **Avarna*, it is as easy to account for its phonetic transition into modern *Ūṇa* (*Ūṇṛa*) as it is to prove that Ἄορνος was the most likely Greek rendering of it. As regards the latter, it will suffice to point to the Greek Ἴμαος as the well-known rendering of the Sanskrit *Himava(n)t*, applied like its doublet Ἱμωδός, *Haimavata*, to the Himālaya range, or what was believed by the Greeks to be a portion of it.* That the name rendered by Ἄορνος appealed to Greek ears also by its apparent Greek meaning "[the mountain] where there are no birds," is likely enough. We know from the reproductions of other Indian local names how ready Alexander and those with him were to seek an echo of Greek words in the Indian appellations they heard.† But there is not the least reason to doubt that Ἄορνος was meant to render a genuine local name and was not a freely invented Greek designation.‡

* Cf. Arrian, 'Indikē,' ii. 3. In Ptolemy's Geography Imaos undoubtedly represents the great meridional range which joins the T'ien-shan to the Hindukush.

† See Weber, "On the Greek pronunciation of Indian words," *Indian Antiquary*, ii. pp. 147 *sqq*. For well-known instances of this kind of "popular etymology," cf. *e.g.* Ἀκεσίνης, "the healer," as Alexander's rendering of the old Sanskrit name *Asiknī* of the river Chenāb in the Panjāb, and the inauspicious interpretation of its other name *Chandrabhāga* as Σανδαρόφαγος as "eater of Alexander."

‡ It deserves to be noted that the fanciful interpretation of the name as meaning "inaccessible even to the birds" is only to be found in such very late authors as

There is definite philological evidence to show that in the modern name *Ūṇa* (*Ūṇṛa*), pronounced with that peculiar cerebral *ṇ* sound which in Pashtu spelling also figures as *ṇṛ*, we may safely recognize a direct phonetic derivative of an earlier form **Avarna*, the assumed original of Aornos. The contraction of an earlier *ava*, both initial and medial, into *ū* is well known to the phonology of the Dardic as well as of the Indo-Aryan language branches.* Similarly the regular assimilation of the cerebral consonant *r* to a following *n* and the subsequent simplification of the resulting double consonant *ṇṇ* into *ṇ*, with eventual complementary lengthening of the preceding vowel, is fully attested in the phonetic development of both Indo-Aryan and Dardic languages.†

I have left it to the last to consider a classical notice which, if it is taken to refer to Aornos, as I believe it must, is of quasi-chronological interest and indirectly helps to support the proposed location of that stronghold. Chares of Mytilene, one of Alexander's chief officials, is quoted by Athenæus as having in his history of Alexander recorded a method of conserving snow used at the siege of the Indian town of Petra. According to Chares, we are told, " Alexander ordered thirty trenches to be dug close to each other and to be filled with snow, branches of trees being also thrown in, in order that the snow in this way may be preserved longer." ‡ I believe that in this stray notice we have a useful indication both of the elevation of the " rock " and of the season when Alexander besieged it.

We know from a record of Aristobulos, who shared Alexander's campaign and is quoted by Strabo, that the army, having set out for India from the Paropamisadai, *i.e.* the valleys between the Hindukush and Kābul, after the fall of the Pleiades spent the winter in the hill territories of the Aspasioi and Assakēnoi, but in the early spring descended to the plains and moved to Taxila, thence to the Hydaspes and the country of Poros. § That the siege of Aornos was the last of the major operations carried out before the crossing of the Indus and the advance to Taxila is quite certain from the concordant records of Arrian and the other

Dionysios Periegetes and Pseudo-Callisthenes (see C. Müller's edition, III. iv. note). It could scarcely have appealed very seriously to the Macedonians, who on their passage from Baktra across the Hindukush had seen mountains so much higher than any to be met in this portion of the Indus valley.

* See Grierson, ' Piśāca Languages,' pp. 88, 126; " Phonology," *Z.D.M.G.*, 1895, p. 409.

† Cf. Grierson, *loc. cit.*, pp. 21, 123; *Z.D.M.G.*, 1896, pp. 21, 28.

It deserves to be noticed that the strongly cerebral sound *ṇ* (*ṇṛ*) of Pashtu occurs not only in words borrowed from Indian dialects, but also represents the Old Iranian combination, *r* + *n*; cf. Darmesteter, ' Chants Populaires Afghans,' pp. xlvii. *sq.*

‡ See Athenæus, III. p. 124, C, as quoted by C. Müller in his edition of Arrian, ' Fragmenta,' p. 117. Anspach, ' De Alexandri Magni expeditione Indica ' (Leipzig, 1903), p. 32, note 90, rightly observes that the erroneous designation of Petra as a " town " must be attributed to Athenæus, not to Chares.

§ Strabo, ' Geographia,' XV. p. 691.

historians. And also that this operation was undertaken after Alexander had descended to the plain of the Peshawar valley. We can therefore place that siege neither much before nor much after the month of April 326 B.C.

Now from my personal experience on my recent explorations in the Swāt region during March, April, and May, and from the climatic conditions previously observed on similar ground of the North-West Frontier, I may safely assert that in April snow could not be found there much below an elevation of 6000 feet. On the other hand, should water be needed for large numbers, the need of preserving snow for drinking purposes on heights situated between 6000 and 9000 feet might well arise at a season when slopes are exposed to the powerful sun of an Indian spring. From what I saw on my way past the Ūṇa peak and the adjacent heights I believe that the expedient recorded by Aristobulos would probably nowadays also recommend itself if troops were obliged for a time to occupy that high ground and its southern slopes. The spring of the present year had been quite exceptionally belated. Yet at the time of my visit at the very end of April we found snow only in small sheltered hollows on the northern slopes of Mount Ūṇa and none at all on the south. The fine spring above "Little Ūṇa" and another at Adramār, about the same distance on the opposite side of the peak, would scarcely suffice for a large force encamped on this part of the range. Hence a thoughtful commander, faced by uncertainty as to the length of his stay on those heights, would only act wisely if he took steps to conserve whatever remained of the winter's snowfall. We thus see that this fragmentary reference also perfectly accords with that combined evidence of texts, topography, and name which has led us to locate Aornos on that rock-girt site by Mount Ūṇa.

The notices left to us of Alexander's movements after the capture of Aornos are too brief and too divergent in their details to permit us to trace his route with certainty on the map. Arrian tells us that Alexander moved from the rock into the territory of the Assakēnoi, having been informed that the brother of Assakēnos, with elephants and a host of neighbouring barbarians, had taken refuge in the mountains of that region.* When he reached there the town of Dyrta he found it, together with the surrounding district, abandoned by its inhabitants. Thereupon he detached certain commanders to examine the localities and to secure information from any barbarians captured, particularly about the elephants. We have seen above that Assakēnos was the ruler whose capital Massaga was taken on the Macedonians' first entry into Lower Swāt. Hence the mountain region in which his brother had taken refuge, and which was reckoned as part of the territory of the Assakēnoi, might well have been Bunēr; for this, as the records of the Chinese pilgrims clearly show, was in ancient times included in Swāt territory, just

* See 'Anabasis,' IV. xxx. 5.

as it is now again.* But as the position of Dyrta has not been identified and no other indications are furnished, the above remains uncertain.

Bunēr can be reached from the side of Pīr-sar and Chakēsar by several routes leading through Pūran and the Mukhozai and Chagharzai country. And to Bunēr seems to point what we are next told about Alexander having marched on the Indus: "and the army going on before made a road for him, as those parts would otherwise have been impassable." This description would well apply, as first suggested by General Abbott, to the most direct route leading from the central parts of Bunēr to the Indus along the Barandu river; for the lower valley of the latter, as yet unsurveyed and in part inaccessible owing to the colony of "Hindustānī fanatics" at present settled there, is reported to be a narrow gorge in places impracticable for traffic.

From captives Alexander learned that the Indians of that territory had fled to Abisares, *i.e.* to the ruler of Hazāra, having left the elephants behind by the river.‡ Alexander's successful capture of these elephants is then related. Finally we are told that, serviceable timber having been found by the river, this was cut by the troops and the ships built with it taken down the Indus to where a bridge had long before been constructed by the other portion of the army. At the present time the lowest point on the right bank of the Indus where something like forest can be found is a few miles above Amb, where the half-inch map sheet No. $43\frac{B}{S.E.}$ marks the "Palāli Rakh." But conditions may have been different in ancient times.†

Diodorus' account of what followed the capture of Aornos is very brief.‡ We are told by him that Aphrikes, an Indian chief, was hovering in that neighbourhood with 20,000 soldiers and 15 elephants. The chief was killed by his own men, who brought his head to Alexander and thereby purchased their own safety. The elephants wandering about the country were secured by the king, who then arrived at the Indus, and finding it bridged gave his army a rest of thirty days before crossing to the left bank. Curtius' account, evidently taken from the same source, supplements the above by some details, which however do not furnish any clear topographical guidance.§ Alexander is said to have marched from the "rock" to Ecbolima. Having learned that a defile on the route was occupied by 20,000 armed men under Erix, he hurried forward, dislodged the enemy with his archers and slingers, and

* Cf. 'Serindia,' I, p. 9.

† There is also a possibility, first indicated by General Abbott, to be taken into account, viz. that the original record referred to logs of timber such as are nowadays cut in high side valleys up the Indus, particularly in Tangīr and Kandia, and allowed to drift down the river for sale in the Yusufzai plain. At Darband, on the left bank some miles above Amb, an eddy helps to arrest such drift timber, which then is dealt with by traders.

‡ 'Bibliotheca,' XVII. lxxxvi. 2–3.

§ 'Historiæ,' VIII. xii.

thus cleared a passage for his heavy-armed troops behind. Erix was killed in flight by his own men and his head brought to Alexander. Thence he arrived after the sixteenth encampment at the Indus, where he found everything prepared by Hephaistion for the crossing.

That by Ecbolima the same place is meant as Arrian's and Ptolemy's Embolima is scarcely subject to doubt; also that the chief Erix is the same whom Diodorus calls Aphrikes. But both authors fail to give any clear indication as to where the defile held by this chief lay. If the sixteen marches to the Indus crossing have to be reckoned, as Curtius' wording implies, from that defile, this certainly could not be looked for on the Barandu river; for thence the march to Ūnd (Uhand), the ancient Udabhāṇḍa, where the passage of the Indus in all probability took place,* could not have taken more than four or five marches. The defile held by Erix may have lain far away from the Indus, and hence been distinct from the difficult route by which Arrian makes Alexander reach the Indus. In this case Curtius has erred in indicating Ecbolima as the immediate goal of Alexander's move after Aornos was taken. However this may be, Curtius' reference to those sixteen marches, if considered together with Arrian's account, shows that Alexander's operations after the taking of Aornos must have been fairly extensive. In this we may well recognize a fresh proof of the importance which was attached by him to the complete subjugation of the Assakēnoi.† The reason obviously was the need to secure the flank of the main line of communication towards India against interference from the hills northward.

We have now accompanied the great conqueror right up to the starting point for his invasion of India proper, and here we must leave him. Alexander's triumphal progress through the wide plains of the Panjāb has, owing to the fascination exercised at all times by strange distant India, attracted most interest on the part of his historians, ancient as well as modern. But only those who are familiar with the natural difficulties of the territories beyond the present North-West Frontier and with their military history in recent times can fully appreciate the greatness of the obstacles which Alexander's genius as a leader and the extraordinary pluck and toughness of his hardy Macedonians faced and victoriously overcame during their preceding long campaign in those mountains.

* Cf. Vincent Smith, 'Early History of India, 2, p. 55.

† Arrian, V. xx. 7, mentions a report which Alexander, while on his way to the Akesines or Chenāb, received from Sisikottos, the Satrap of the Assakēnoi, about their subsequent revolt, and records the measures taken by Alexander to quell this.

Grabau's recently published 'Stratigraphy of China' (*Geol. Surv. China*). In parts there is evidence that some of the matter is ill digested and the author seems rather to misrepresent the views of the authorities he quotes. He does not, for instance, deal with sufficient care with the vexed question of Siberian glaciation, tending rather to confuse glaciation by ice-caps and the work of valley glaciers. These minor points do not, however, detract from the undeniable value of the work as a whole. The very instructive tectonic map is worthy of particular mention. L. D. S.

Bei den Urwaldzwergen von Malaya.— Paul Schebesta. Leipzig: F. A. Brockhaus. 1927. 9 × 6, pp. 278. 150 *Illustrations and a Map.*

The Semang of the Malay Peninsula are among the least known peoples of the world. Living in the remotest and densest parts of the forest they are shy of strangers, and Herr Schebesta is the first European to have lived amongst them and to have made a comprehensive first-hand study of their customs and mode of life. His expedition, which was financed by Pope Pius XI., lasted from January 1924 to September 1925. He was well received by the Semang and travelled with them through the forests, sharing their life, accompanied only by one Malay servant, and taking with him the barest necessaries of life.

The Semang are the oldest inhabitants of the Peninsula. They are nomadic, and their numbers are estimated at about 2000. Civilization is thrusting them into increasingly smaller regions of the forest; there is a scarcity of women, and they are gradually dying out. They have learnt opium-smoking, but fortunately syphilis is still unknown among them. Their own weapon is the bow and poisoned arrow, but to-day this is little used, as they have learned to use the blowpipe of the Sakai. The forest cannot support a large number of them in one place, consequently they are found in small groups without any tribal organization, the father in each family being the only authority; but each group has its hereditary region to which it returns after free wandering. Men and women have equal rights, and polygamy, although permitted, is seldom practised. They believe in a future life, and their deity is the god of Thunder.

Herr Schebesta has produced a work which is a serious and valuable contribution to social anthropology, and he is to be congratulated on having been able to gather much valuable information about these primitive and interesting folk before it was too late. The book is well illustrated and indexed, with a good map showing distribution, and it is to be hoped that it will be translated into English. O. R.

The Revolt of Asia: The End of the White Man's World Dominance.— Upton Close (J. W. Hall). New York: G. P. Putnam's Sons. 1927. 9 × 6, pp. xiii. + 325. 10*s.* 6*d. net.*

The rise of nationalism in the countries of Asia is a subject of vital importance to the world, and one deserving the closest sympathetic study. It is difficult, however, to regard the present volume as a serious contribution to that study. Written in extravagant, journalistic language, the interests of strict accuracy tend to be sacrificed to the fullest possible justification of the sub-title. The author is probably correct in his main thesis, but many of his observations are superficial and his deductions of doubtful validity. Thus rubber-planters' bungalows represent "the British-hope of a 'White Malaya'"; "British business conservatism and inefficiency and demand for huge dividends make petrol in Burma twice the usual cost of 'gas' in the U.S.A." (p. 36); "that great imponderable, British Prestige, of which men once spoke with

awed voices, went out of existence when Hongkong was brought to its knees by striking coolies and boycotting hongs" (p. 181). Nevertheless "as Japan and Great Britain are doing, America too must find her particular line of 'enlightened imperialism' to follow in dealings with Asia" (p. 300).

L. D. S.

AFRICA

France, Spain and the Rif.— Walter B. Harris. London: E. Arnold & Co. 1927. 9 × 5½, pp. xii. + 338. *Maps and Illustrations.* 21*s. net.*

In this book the *Times* correspondent in Tangier gives an impartial and eminently readable account of events in the Jibala and the Rif from the signing of the 1912 treaties down to the end of 1926; a succinct introductory chapter includes a concise statement of the status of the Tangier zone, and is followed by a brief sketch of the origins and previous history of the Berbers of the Rif.

A life-long observer of Moroccan affairs and the friend or acquaintance of most of the protagonists of the period, Mr. Harris writes with authority. The book is illustrated by excellent photographs.

East Africa: A New Dominion.— Major A. G. Church, D.S.O. London: Witherby. 1927. 9 × 5½, pp. 315. *Illustrations and Sketch-map.* 18*s. net.*

Major Church was a member of the Parliamentary Commission which visited East Africa in 1924, and thus had unusual opportunities for observation and investigation. He has also studied the problems of East Africa in various other ways. His conclusions therefore deserve careful consideration.

The geographical factors which to a very large extent must mould, though they may also in degree be made to serve, future development are set forth. and there is insistence on the need of increased transport facilities. For the most part, however, Major Church is concerned with what may be called moral questions, as may be gathered from the sub-title of his book: 'A Crucial Experiment in Tropical Development and its Significance to the British Empire.' His standpoint is that of the Kenya White Paper of 1923, namely, "the interests of the African natives must be paramount." He seems to think that that object can be best attained under the searchlight which the mandatory system affords, and he would like to see that system extended to all the East African territories. He also looks forward to the creation of a single East African Dominion, with its capital in Tanganyika. There is much in praise of the white settlers, and much in criticism of them; the claim of the white settlers in Kenya for self-government means, he says, a claim by 10,000 whites to dispose of the destinies of over 2,000,000 Africans, besides the Indian settlers, and he dismisses the claim as fantastic. His own solution is that in Kenya and in the other territories the whites, the blacks, the Arabs, and the Indians should each have "community self-government. The four communities would raise their own taxes and disburse them . . . contributing their quota to the general expenses of administration of the whole territory." The encouragement of "home rule" among the Africans—under official superintendence—is a well-known feature of British colonial policy, and in Kenya a community franchise for the other races has already been introduced. Whether Major Church's solution is either desirable or practical is a question we need not discuss here.

In one respect Major Church and Lord Delamere—the leader of the whites in Kenya—whose views differ on many points, are agreed. Both believe that the belt of high land extending from Northern Rhodesia to Kenya is a proper

Through Tibet to Everest.— Capt. J. B. L. Noel. London: Edward Arnold & Co. 1927. 8½ × 5½, pp. 302. *Illustrations.* 10*s.* 6*d. net.*

So much has been written on the Mount Everest Expeditions that Capt. Noel is faced with the difficulty of having to repeat an old story. He has done so, however, with considerable success. His narrative is very readable, sometimes dramatic. It is essentially human and of the kind likely to arouse popular interest. He sees things from a new angle; he gives us his own particular view-point, and he is not afraid to criticize others. His book is eminently fitted to stimulate adventurous youth.

There is much that is new in Capt. Noel's volume. We have a full account of his own preliminary exploration when in 1913 he reached within 40 miles of Mount Everest and was turned back by armed Tibetans. Then we have many points of interest on Tibetan customs, given us, in the main, on first-hand information. We see the author attending funeral ceremonies, trying to photograph the butchers smashing up the corpses and the vultures gorging themselves on human flesh. Then we find him searching through monastic institutions and their stores of wonderful books. Capt. Noel had a way with the Lamas. We think that his capacity for their revolting food must have been a help to him in that respect. Then, scattered through the book are legends and folklore which give us an interesting insight to the most extraordinary people in the world.

Of the expeditions themselves we have many details not to be found in the previous records. Of these one of the most attractive is the author's account of his own work. Life at high altitudes is no easy matter: it is one continual battle with inertia. But a photographic recorder has no time for inertia. He must always be in readiness, always on the spot, and all the time carrying on a struggle with a complicated apparatus that demands the utmost grit and determination.

Capt. Noel does not refrain from criticism. Moreover, his criticism is highly constructive. He puts forward his own proposals as to how a future expedition should be run. These proposals are contained in an appendix, and, from the point of view of climbers and explorers, are bound to meet with interest and attention. What strikes us about them is their elaborateness. Some authorities regard the previous expeditions as being in themselves much too elaborate. They believe that a small party with a few porters would stand a greater chance of success. Capt. Noel goes to the other extreme. For him they have not been elaborate enough.

Here are some of his most striking proposals: He would transfer the base camp up the glacier to near the present site of Camp III. He would build huts there on Polar methods. He would construct a yak-road up the glacier to this camp, and have an aerial rope-line up the North Col. By this means all transport up to 23,000 feet would fall either on animals or on machinery. Then he asks for an improved oxygen apparatus, a wireless communication between the expedition and India, and wireless intercommunication between the camps on the mountain. He would prefer Tibetan to Sherpa porters, would have the expedition purchase a special herd of yaks and feed them on compressed grass from India. He would bring out a competent European cook, would improve food and cooking arrangements, would give the porters special cooks and have them under the care of one particular member of the expedition.

These proposals are so vast and so far-sweeping that they cannot be discussed in the space of a review. A few of them, we think, will meet with

general acceptance. The majority, we fear, will be turned down. One thing, however, we do say: they must be considered very seriously. Capt. Noel is in every sense a pioneer. His photographic work on the previous expeditions was a masterpiece of pioneering effort. When we remember the thorough efficiency of his organization, the careful forethought in every detail, and the splendid record which resulted from his work, we feel at least that he can speak with authority, and that those who criticize must not criticize lightly even so revolutionary a scheme. R. W. G. H.

AFRICA

Religion and Art in Ashanti.— R. S. Rattray. With chapters by **G. T. Bennett, Vernon Blake, H. Dudley Buxton, R. R. Marett, C. G. Seligman.** Oxford: Clarendon Press. 1927. 9 × 6, pp. xviii. + 414. *Illustrations.* 30*s. net.*

This book is the second volume on Ashanti produced by Capt. Rattray, that is to say, the second instalment of his great monograph which, unless he alters his plans, will be complete when the volume on which he is now working is published.

The present volume, which contains both more and less than its title suggests, deals with that part of religion not treated in 'Ashanti' (1923), *i.e.* broadly with the lower-grade spiritual powers, including fairies and monsters, with the life and death of the individual, the funeral rites of both commoners and kings, and with the chief arts and crafts; while nearly a hundred pages are given over to the views of outside authorities on the problems raised in the preceding chapters.

Of the many matters of general interest reference may be made to the *odwira* ceremony or "Yam Custom," which since Bowdich's description, written over a hundred years ago, has passed as the very type and ensample of West African bloodthirst. If it was bloody, Capt. Rattray has shown that it was but the logical application of the ideas of ancestor-worship: "The *Odwira* or *Apafram* was an annual ceremony held in September in honour and propitiation of the Ashanti kings who 'had gone elsewhere,' and for the cleansing of the whole nation from defilement." Such was the definition given by an Ashanti. It was also a feast of the dead, very closely associated with the crops and the firstfruits; indeed, to Europeans this has been the most noticeable part of these rites; hence the name "Yam Custom" generally applied to the ceremony, while it was also the occasion for the purification of shrines of ancestral spirits, of the gods, and of lesser non-human spirits. Mention must also be made of the ceremonies—hitherto undescribed—connected with the bodies of dead kings, the articulation of their skeletons with gold wire, and the existence of a great reserve of gold treasure, stored in the mausoleum where the skeletons were kept and guarded by a corps of 1000 armed men. "This wealth belonged to the 'ghosts,' but could be 'borrowed' from them in cases of great national emergency and also to finance national festivals."

Of the contributions by "outsiders" that by Mr. Vernon Blake is easily the most important, and the reviewer, though he does not accept the validity of Levy Bruhl's thesis of savage pre-logical thought and mystic participation as does Mr. Blake, would like to express his appreciation of and agreement with almost all that the latter has written in the chapter entitled "The Æsthetic of Ashanti"; he would especially commend the remarks on pp. 372–373 as to what is likely to happen to Ashanti art submitted to European influence.

C. G. S.