Photogravure. Survey of India Offices, Calcutta, 1914.

Plate 1.—On the Russian East Station of Sarblock, 17,284 feet.

RECORDS

OF THE

SURVEY OF INDIA

Volume VI

COMPLETION OF THE LINK

CONNECTING THE TRIANGULATIONS

OF

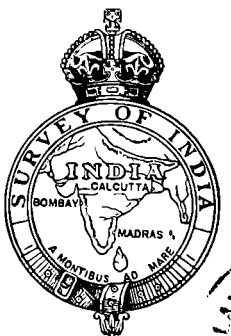
INDIA AND RUSSIA

1913

PREPARED UNDER THE DIRECTION OF

Colonel Sir S. G. BURRARD, K. C. S. I., R. E., F. R. S.,

Surveyor General of India



DEHRA DUN
PRINTED AT THE OFFICE OF THE TRIGONOMETRICAL SURVEY
1914

Price Four Rupees or Six Shillings

To the

MEMORY

of

HENRY GORDON BELL

Lieutenant Royal Engineers

Assistant Superintendent Survey of India

Who lost his life on the Taghdumbash Pamir on June 25th 1912

THIS ACCOUNT

of the

COMPLETION OF THE TRIANGULATION

between

INDIA AND RUSSIA

with which his name will ever be associated

is

DEDICATED

by

THE AUTHORS

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LIST OF ILLUSTRATIONS.

ERRATA.

P. 2, line 4 from top, *for* 1896 *read* 1895.

P. 3, line 21 from bottom, *for* Kashmir *read* Gilgit.

P. 7, line 11 from top, *for* Survey *read* Service.

P. 33, line 24 from top, *for* 1896 *read* 1895.

PREFACE.

The immense advantages that are derived from the existence of such bodies as the International Geodetic Association have seldom been better exemplified than in the work which is described in this volume.

Many Geodesists and Surveyors may have looked at the map and thought how fine an arc of meridian would be obtained if the triangulations of India and Russia could be connected; but the difficulties in every direction are so stupendous that scarcely anyone can have thought that it would be possible to face and overcome them.

Zeal on one side might be met by apathy on the other. political considerations might make either Government unwilling to take the first step. It is one thing for a man whose interests lie in the study of Geodetic questions to feel a conviction of the importance of effecting the link, and quite another thing to convince other people whose training has been different that the objects in view are worth any great effort; that a great effort would be required was clear at the first glance. An individual might well despair of ever making any headway, and here it is that the great momentum of corporate opinion able to express itself is felt.

The simple proposition "That it would be very advantageous if a connexion were made between the Indian and Russian systems of triangulation", is put before the International Geodetic Association at one of its triennial conferences. It commands immediate approval, is passed as a resolution, and conveyed through the proper official channel to the Governments of the two countries, and immediately all preliminary difficulties are cleared away.

Where the individual would have to argue, and possibly argue in vain, in support of his idea, the *ipse dixit* of the Conference passes unchallenged. All such delicate questions as that of who should move first are avoided and the officers on each side of the frontier face the problems that lie before them with the knowledge that the instructed opinion of the world is behind them in their enterprise.

The decision to make the attempt having been come to, the first part of the problem was the choice of the route to be followed.

For a distance of about 160 miles between longitudes 72° and 75° the British and Russian dominions are separated by a strip of Afghan Territory not exceeding 40 miles in width. The Gilgit Series of Principal Triangulation executed in the years 1909–1911 had carried the Indian system from near Rawal Pindi to Gilgit, and thus an excellent base to take off from lay within about 100 miles in a straight line from the nearest point of the Russo-Afghan boundary, and this nearest point was at or near Salisbury Peak (18,462 feet) of the Nicholas Range, which the work of the Pamir Boundary Commission of 1895 had shown to be perfectly accessible from the north. If therefore the Russian officers brought their triangulation to two peaks of the Nicholas Range and if the Survey of India established a pair of stations on the Indian side of the Afghan strip, which consists of the Oxus Valley, it would be easy to make the connexion without entering Afghan territory. But the difficulty of extending the triangulation from Gilgit to the Afghan boundary was obviously very great. The high Karakoram Range runs from E. S. E. to W. N. W. and crosses the meridian of Salisbury Peak about 12 or 15 miles south of this boundary, thus cutting off the possibility of a direct advance; for the gigantic height of this range, the peaks of which vary between 22,000 and 26,000 feet, renders it insurmountable.

In the west, the Sakiz Jarab Range offered a slightly more hopeful point of attack. Failing this it seemed that it would be necessary to have recourse to the Hunza Valley

as a means of passing the Karakoram barrier, though it did not in the least follow that the remainder of the route in this direction would prove possible, and to adopt this line would involve a reconsideration of the plans for the triangulation on the Russian side.

As the narrative that follows will show the Hunza Valley route was found to be the only feasible one, and its adoption inevitably entailed a departure from the wide and well conditioned figures that are essential to triangulation of the first order. When the enormous difficulties of this tract of country are borne in mind, it is a matter for congratulation that it was found possible to make the connexion with so comparatively small a number of triangles, for at one time it had been feared that so many of the peaks would prove unclimbable that it would only be possible to construct a chain of tiny triangles in the gorge itself opening out to something a little larger as the passes were approached. Such a connexion would have contained the possibility of a great accumulation of error and would have gone but a short way towards satisfying the needs of Geodesists. The link that has been forged, though no doubt it falls a good deal below the standard that would have been attained under less difficult conditions, is, nevertheless, a very great improvement on a chain running up the gorge. The narrative and the illustrations must be consulted by those who wish to form an idea of the arduous labour by which this measure of success was attained.

Is there any prospect of a still better connexion being made in the future? In this region, No. If anything more is to be done it must be further west. If conditions in Afghanistan were to change it would be easy to throw a fine chain of triangles across that country, but there seems but little prospect of that route being opened.

Another direction is diagonally across Persia to the Caucasus from Koh-i-Malik Siah, the present terminus of the Indian Triangulation, to Mount Ararat, where Persia, Russia and Turkey meet. On this line there would be formidable natural difficulties in the westward extension of the Indian Series from Koh-i-Malik Siah (lat. 29° 50′, long. 60° 50′), difficulties of exactly opposite character to those met with in the Karakoram —namely, drought, heat and flatness. But once the first 200 miles had been accomplished the remainder of the country to be crossed would probably prove quite easy. With the extension of railways into Persia opportunities for the extension of the triangulation are sure to arise and will be turned to account, but in the meantime the link which this volume describes will be of immense value, as soon as the triangulation on the Russian side is connected with the network of Europe, and enables us to express the coordinates of Kalianpur, the origin of the Indian Survey, in terms of those of Pulkova, the Greenwich of Russia.

Of previous geographical work in this region only that of the Pamir Boundary Commission in 1895 was executed by trained surveyors. Their work was necessarily carried on by the approximate methods and expedients which rapidity of movement dictates. In skilled hands however even these are capable of producing results of surprising accuracy, so surprising as to have the appearance of lucky accidents were it not that the luck always seems to accompany those who know their art and whose unremitting attention allows no chance of a check observation to pass them by. Three peaks which had been fixed by the Boundary Commission were intersected by the triangulators of the Indo-Russian Link, a comparison of the resulting coordinates is given below :—

Peak	Year	Latitude	Longitude	Height
		° ′ ″	° ′ ″	
Pk. 15 42 K	1895	37-34-40	74-49-11	17171 feet
	1913	34-38	49- 7	17348 ,,
Pk. 16 42 K	1895	37-32-28	74-58- 0	not observed
	1913	32-23	57-58	18011 feet
Pk. 3 42 O	1895	37-33-56	75- 9-48	20722 ,,
	1913	33-48	9-45	20898 ,,

The agreement is very striking, all the more so when it is remembered that the Boundary Commission Triangulation, executed by Major Wahab R.E. (now Colonel Wauhope, C. B., C. M. G., C. I. E.) was based on rays to peaks 40 to 50 miles distant.

This preface would not be complete if it failed to allude to the great loss that the Survey of India sustained in the death of Lieutenant H. G. Bell, R. E. who died on the 25th of June 1912 at Lup Gaz, close to the Mintaka Pass. He had made his way to the terminus of the Russian Triangulation and had met Colonel Tcheikine of the Russian Topographical Service and his detachment. Parting with them he began observations on his portion of the work, and had completed three stations when he was taken ill and died in a few days. He was an officer of high character and ability and his untimely death cut short a career which gave promise of distinction.

The whole undertaking from its beginning, after the passing of the Resolution by the International Geodetic Conference of 1909, to its completion in the autumn of 1913 has been under the direction of Colonel Sir Sidney Burrard, K. C. S. I., R. E., F.R.S., and all who have taken part in it have to thank him for wise counsel, friendly interest, hearty encouragement and firm support.

Dehra Dun,
July 1914.

G. P. LENOX CONYNGHAM.

CHAPTER I.

INTRODUCTION

by

Lieut. K. Mason, R. E.

Assistant Superintendent, Survey of India.

It is difficult to trace back the inception of any scheme that has taken more than a lifetime to accomplish, or to discover who first conceived the possibilities that may be the outcome of that scheme. If we look back into the early annals of the Survey of India, we find that it was Major William Lambton, of the 33rd Regiment, who first proposed the measurement of an arc of the meridian, by which geodesists would be able to determine the figure of the earth. With infinite trouble, Lambton collected from various sources the necessary instruments, and the measurement of the original base began on the 10th April 1802, near Madras. Subsequently Colonel Lambton became first Surveyor-General of India, and died while on tour at the age of 70.* Colonel Sir George Everest succeeded him as Superintendent of the Great Trigonometrical Survey of India and Surveyor-General, and he conceived the great gridiron system of triangulation in India and carried it to the foot of the Himalaya. Sir Clements Markham, in "A Memoir of the Indian Surveys", writes, "He had completed one of the most stupendous works in the whole history of science. No scientific man ever had a grander monument to his memory than the Great Meridional Arc of India. Everest's was a creative genius. The whole conception of the survey, as it now exists, was the creation of his brain." It would be very interesting if we could now know whether either Lambton or Everest ever contemplated the possibility of triangulation extending from the ninth parallel to the sixtieth. During the years that followed, work was commenced and carried on in the mountainous regions to the north, and we find Captain Montgomerie commencing, in the spring of 1855, the triangulation of the mighty mass of mountains between the plains of India and the frontier of Tibet. He used a 14-inch Troughton and Simms theodolite, and carried this heavy and cumbersome instrument up many rocky peaks, some of which were 16,000 feet in height. The location of his series was across Kashmir to Baltistan as the regions to the west were not then under British control, and were inhabited by slavedealing and robber tribes.

In the summer of 1888, Major Durand's Mission was sent to Gilgit, to enquire into the causes of an outbreak of hostilities between Kashmir and the tributary states of Hunza and Nagar; this resulted in the permanent establishment of a British Agency at Gilgit. In the winter of 1891, the Indian Government were forced by the intrigues of the rulers of Hunza and Nagar with our powerful neighbour across the border, to interfere, and the territories of these two mountain states became part of the Indian Empire.

* The Government Gazette of the time gave his age at 75.

During the year 1892, Sir Martin Conway led an exploration party in Nagar subsequently crossing into Baltistan, while smaller parties of officers on leave and duty have also increased our knowledge of the frontier in these parts. In 1896, the Pamir Boundary Commission commenced its labours, and settled the boundary between Russia on the north and the province of Wakhan in Afghanistan; but I do not think that the survey work accomplished in connexion with this Commission was done with any view to linking up the great systems of Russia and India. The only connexion between it and the Indian triangulation was by means of rays to very distant peaks, which had been intersected from the existing triangulation on the south; while an enormous gap separated it from any Russian work.

In 1903, Mr. James de Graaff Hunter, of the Survey of India, was deputed to commence a Principal Series* near Rawal Pindi emanating from the base Nerh-Khagriāna of the North-West Himalaya Series and this triangulation had reached the neighbourhood of Shardi by the end of 1910. The work was of the highest order of accuracy. It was intended to complete this series to Gilgit and thence by following the Indus valley to make a connexion with Colonel Montgomerie's series in Baltistan.

At the same time, Colonel Tcheikine, of the Russian Survey, had begun a series from the base Ourtak-Tchoucour-Machali-Goudour, (latitude 39° 33′, approximately), on the Trans-Alai Range, and had reached the neighbourhood of Pamirski Post.

During the International Geodetic Conference of 1909, which met in London, the possibility of a link of accurate triangulation between the Indian and Russian systems was discussed. It was suggested that the connexion might be effected across the northern boundary ranges of India to the Chinese or Russian Pamirs, and a Resolution to this effect was proposed and passed. This appears to be the first occasion on which a connected and accurate system of triangulation from the south of India to the north of Russia was contemplated, and the possibilities discussed. The complete series would be far the largest in the world, and it was anticipated that the results would yield matter of the greatest scientific interest. The Surveyor-General of India received this proposal in the early part of the year 1911.

Lieutenant H. G. Bell, R. E., who succeeded Mr. Hunter, carried the Principal Series as far as Gilgit during the summer of 1911. Great difficulty was experienced owing to an early start after a late winter, as the snow lay as low as 8,000 feet. On one station the portable lightning conductor was struck, and the detachment was greatly delayed by inclement weather, while in the Indus Valley, a severe earthquake caused a cliff to be precipitated into the river, destroying the road and thus adding to the difficulties of the work.

Having reached Gilgit, Lieutenant Bell and his assistant, Mr. Wainright, left that place on the 1st August, to reconnoitre the Darkot route and the Hunza Valley respectively with a view to finding the best means of effecting a junction with the Russian triangulation. Marching *viâ* Yasin, Bell reached the Darkot Pass and examined the peaks in the vicinity. He found the extensive glacier, rising on the pass, much intersected by crevasses, and only passable in the very early morning. The highest peak, about 19,370 feet, west of the pass, was found to be quite inaccessible for triangulation purposes, and the neighbouring peaks, though lower, were useless owing to high

* The co-ordinates of the stations and intersected points of this series are included in Appendix A.

unclimbable peaks to the south and south-east. From Darkot, Bell visited the approaches of Garmush, 20,564 feet; here also he found that the glaciers in the neighbourhood were extremely dangerous, and the slopes very liable to avalanches. The Darkot-Askuman Pass was crossed, and a peak ascended with a view to obtaining a more extensive reconnaissance of Garmush and the other peaks of the Sakiz Jarab Range, but the term "Glorified Matterhorns", which has been applied to the Karakoram peaks further to the east, was found to be equally applicable here. In a letter, written from hereabouts, Bell mentioned that he doubted whether the peaks would be accessible for an experienced party of climbers, and that it was a physical impossibility to take an instrument up any one of them. A move was then made to the Karumbar Valley, in the hope of finding a possible connexion by this route. But again the difficult nature of the obstacles encountered caused at any rate the temporary abandonment of this line.

Mr. Wainright meanwhile made a reconnaissance up the Hunza Valley towards the Kilik Pass. The settled condition of the country lightened his work to a great extent, and he reported that it would be practicable to run a series as far as the village of Misgar, but that from there it would be advisable to follow the general line of the Khūnjerab Valley and Kharchanai Pass. He also advised the use of a smaller instrument in place of the 12-inch, which had been used as far as Gilgit. This latter advice was followed and a six-inch micrometer theodolite was used for the subsequent triangulation.

During the summer of 1911, the Russian triangulation had been extended to the Russian frontier, and two stations in the neighbourhood of Beyik and Taghramansu, on the Russo-Chinese border, had been fixed. But, owing to the results of Bell's reconnaissance, the sites of these stations had to be slightly altered.

Lieutenant Bell was again in charge of the detachment during the summer of 1912, and it seemed possible that the end of the season would see the completion of the link. The detachment arrived in Gilgit by the 31st May and commenced work soon afterwards. It had been decided to base the connexion on a side of the Kashmir Principal Series, which had been completed the year before, in latitude 35° 55′ and longitude 74° 20′. Bell's plans were to go, accompanied by his assistant Mr. McInnes, *viâ* the Pamirs to the end of the Russian triangulation, arranging en route the work in the upper reaches of the Hunza Valley, and selecting the actual route north of Misgar. During this reconnaissance, he decided that the Khūnjerab mountains would be impracticable for accurate work, and that the Kilik would probably afford the only suitable route.

In the meanwhile, a second detachment under Mr. Collins was to work up from the neighbourhood of Gilgit.

The year was a disastrous one for the Survey. From the very first, bad luck dogged the expedition. Early in June, the various detachments left Gilgit, but the weather was very unfavourable, and while on Yashochish hill-station, in the Great Himalaya Range, the camp of Mr. Abdul Hai was wrecked by lightning; his servant was killed, and his recorder was severely burnt, while he himself received a bad shock, which necessitated his return to Gilgit. This district is notoriously bad for electrical disturbances, and very different from the regions of the Karakoram, which, judging from the observations made by the Duke of the Abruzzi, are very free from storms. Collins carried the triangulation on from Gilgit towards Hunza, but on the 28th July, he had to take over charge of the detachment owing to Bell's death.

The latter, with McInnes, had crossed to the Taghdumbash Pamir. McInnes was detailed to reconnoitre towards the Kilik Pass, and Bell proceeded to the Russian stations on either side of the Beyik Pass, on the Russo-Chinese frontier, meeting the Russian party under Colonel Tcheikine on the pass. On his return journey he completed the observations at three stations, and ascended a fourth, but here he found some difficulty in observing to one of his stations (Lup Gaz). He therefore decided to move his camp to this station, with a view to finding out if the stations were inter-visible. He had not been very fit for the last few days, and had been over-exerting himself. On the 19th July, when in camp on Lup Gaz hill station, he awoke in very great pain, and becoming no better, he was carried down to his base camp in the Lup Gaz Jilga. He remained here a few days, and on the morning of the 24th, sent a note to McInnes asking him to come and take over the observations. McInnes received this note on the following morning at his camp near the Kilik Pass and at once proceeded to Lup Gaz. The same night Bell passed away. It is hardly necessary to add after what has been written above, that the ultimate success of the work, was to a large extent due to Harry Bell's untiring efforts. He never ceased to think of the link, and during his last interview with McInnes, he urged on him the importance of getting on with the work. On his death, I personally lost my dearest friend and I had known him intimately for many years; he was a daring mountaineer, and absolutely fearless, and his loss to the Service and to Geography is greatly to be regretted.

This disaster delayed the work very considerably, and by the end of the season, a short late one for this part of the world, the triangulation from Gilgit had only been completed to a point some little way below Hunza. McInnes reconnoitred the Pamir work, but the reconnaissance in the Hunza Gorge showed that a departure would have to be made near Misgar, in order to obtain suitable figures. As the crow flies, there remained about seventy or eighty miles to be traversed with triangulation, but the actual length of the work would have to be half as much again. Of this about two-thirds was more or less reconnoitred.

During the winter of 1912-13, the question of this connexion was again discussed at the International Geodetic Conference at Hamburg, and another Resolution was passed expressing the hope that the connexion would be carried on again in 1913. On my return from three months leave in Switzerland in February, I was given charge of the detachment to complete the work. Before going on leave, I had asked for the services of a member of the Indian Medical Service who would be able to assist in such subjects as Geology and Botany, and before leaving Dehra Dun, I had the pleasure of hearing that Lieutenant R. W. G. Hingston, I. M. S., with whom I was acquainted, had been appointed. The results of his work are included in this report. Almost the entire collection of fauna was made by him, many of the rock specimens and plants from the Pamir itself were collected by him; the completeness with which the observations were taken to cirrus clouds for the Meteorological Survey of India, and the hæmatological investigation are entirely due to his energy. In addition to this work, he very largely assisted me with the photographic survey, both by taking photographs, and by helping with the development in the evenings; and when my recorder went sick, Hingston undertook the work of recording. Since returning he has been engaged on the classification of his zoological collection, during his spare time.

The last week of February and the whole of March were spent in making preparations for the expedition, and in arranging the additional work to

be done. The whole programme had to be thought out, and any difficulties that could be foreseen guarded against, for when once on the way, every day, almost every hour, was valuable, and we could afford to take no chances. The question of rations had to be carefully considered, as the country in which we were to work, produces no crops of any kind, nor does it contain any villages. Transport had to be prearranged, for the whole journey from Rawal Pindi to Gilgit, and a preliminary estimate worked out as to the number of coolies required. Instruments and kit had to be weighed and packed into loads not heavier than 60 lbs., suitable to the many and varied forms of transport. In connexion with this, during the march up the road, there were a few loads that were somewhat heavier; in particular, the memorial stone to be erected in Gilgit to Harry Bell, which had come with me from England; but in every case where a coolie had the choice of carrying the excess load, plus a slightly increased wage, or of taking turns with a lightly laden coolie, he preferred the former. The three large cases of tea taken up for the coolies' consumption, came also under this category.

As regards our own rations, we did ourselves well. Cases were made self-contained, so that only one case was open at a time. The great thing to guard against was loss of appetite and consequent loss of energy, and it was hoped that a varied diet would contribute towards this end. The arrangement was as follows: Boxes labelled A/1, A/2, B/1, B/2, etc., were for ordinary consumption; those marked C and D, for cooking and special occasions, respectively. All the "As" and "Bs" were in wooden cases, with the exception of A/1, which was packed in a padlocked yakdan. All the "As" were similar and all the "Bs", but the "As" differed slightly from the "Bs". The contents of both types were estimated to last three men for a fortnight, two men for three weeks, or one man for six weeks. When "A/1" was finished, "B/1" case was opened, and its contents turned into the yakdan; when this was again empty, or, more strictly speaking, on the regulation date, "A/2" was opened and its contents turned into the yakdan; and so on. This system worked excellently.

Each officer took a forty or eighty-lb. doube-fly tent, and in addition, the Pamir detachment took two single-fly 16-lb. Whymper tents. These latter should be made of very fine material, a superior Willesden canvas, but the one made in Srinagar to the pattern used by the Duke of the Abruzzi, was not a success, and one is led to the conclusion that this special type of tent should only be purchased from the best makers at home. My own Whymper tent, which first saw service with the Duke of the Abruzzi in 1909, completed its fifth year of constant use in the hills on the Pamirs, and is still quite serviceable. In our high camps Hingston and I shared my 16-lb. Whymper tent and slept in sleeping bags on the ground; while the other was shared by the men. Khalassies and gurkhas were supplied with $10' \times 8'$ single fly tents, generally four men to each. Coolies were given a tent, known as "the wigwam", 20 to 25 men in each. This consists of a light central umbrella-shaped structure, supporting a form of bell-tent. The height of the central part is about four feet; I once, and only once, inspected one of these after a cold night, and ascertained that 25 Balti coolies find no difficulty in maintaining a good temperature. This tent is exactly the right type for coolies; it was, I believe, invented by an officer in the 5th Gurkhas.

Khalassies were clothed on the scale known in the Survey of India, as the "Arctic". It consists of

1 Balaclava cap.
1 warm coat.

1 pair warm *paijamas*.
1 woollen jersey.
1 warm puggrie.
1 pair puttees.
1 pair woollen gloves.
2 pair woollen socks.
4 thick blankets.
1 pair boots.

In addition, a waterproof sheet was issued with each tent. A point which I consider of great importance, is the personal fitting of the boots; and Hingston and I saw to this ourselves. Each man was given a pair of boots one size larger than his ordinary size, to allow him to wear two pairs of socks within each boot, so that his circulation would not be impeded. No cases of frostbite occurred amongst the men so booted. The whole of this warm clothing was purchased from the Supply Depôt, Rawal Pindi, and wore very well. As regards my own footgear, I found that the most comfortable for snow and rockwork was the ordinary ski-ing boot packed with at least two pairs of ski or goat hair socks.

The date fixed for departure from Dehra Dun was the 10th April, and on this day everything was as ready as possible, and the detachment left by train for Rawal Pindi. Besides Hingston and myself, the detachment consisted of two assistants, Messrs. V. D. B. Collins and C. S. McInnes, who were each to have charge of sections of the work. Collins was to work up from the neighbourhood of Hunza, my own detachment was to work back from the Russian end, while McInnes was to reconnoitre the country in between, and observe there if he had time.

During the season the Link was completed, and now the triangulation, commenced over a century ago by the originator of the Survey of India, has reached and crossed the most northerly point of the Indian Empire. The Russian work in Asia has come down and joined on with this, and the whole series is practically complete from the ninth parallel on the south to the sixtieth parallel on the north.

I should like to take this opportunity of thanking all those who rendered assistance to the expedition. I am extremely indebted to Sir George Macartney, K.C.I.E., His Britannic Majesty's Consul-General at Kashgar, through whose kindness and personal influence any political difficulties on the Pamirs were avoided; to the Taotai of Kashgar and Amban of Tashkurghān who sent representatives to the Sarikōli Begs, instructing them to help us in every possible way; and to the latter for their invariable kindness and hospitality.

We met with the greatest assistance from the Hon. Mr. Stuart Fraser, C. S. I., C.I.E., Resident in Kashmir, and from Major A. D. Macpherson, Political Agent at Gilgit, who smoothed out our way to a large extent, and it will be impossible for us ever to forget the generous hospitality extended always to us at Gilgit—hospitality which has been recorded by every traveller in these parts, but which could never have surpassed that which we encountered.

It is here, too, that I must preface any account of the operations by a grateful reference to my fellow workers; to those indefatigable two gurkhas of the 5th, Kulbir and Hastabir Rana; to Naik Bulnar Singh, 9th Gurkha Rifles and his hard working signallers; to my guide, Abdulla; and lastly to the long-suffering and much maligned coolies, whose admirable qualities were never

marred by those mutinous tendencies which may be expected from any followers if treated with a total lack of consideration and tact.

In connection with the writing of this report, Captain Hingston and I are indebted to Mr. H.H. Hayden, C.I.E., Director of the Geological Survey of India and to Mr. J. Coggin Brown, M.Sc., of the same department for their interest and for the classification of the rocks brought back by the expedition, which are now in their museum at Calcutta; to Dr. Gilbert Walker, C.S.I., F.R.S., Director-General of Observatories, and Mr. W.A. Harwood, M.Sc., Assistant Director Aerological Observatory, Agra; to Mr. M.S. Ramaswami, M.A., Royal Botanic Gardens, Sibpur, Calcutta, for his classification of the flora and to Mr. R.N. Parker, Imperial Forest Survey, for his arrangement of this section*; to Mr. N.D. Riley of the Insect Department, British Museum, to Mr. W.M. Tattersall, of the Manchester Museum, and to Mr. N. B. Kinnear of the Bombay Natural History Society, for assistance in classifying a few species of the fauna collected; and lastly to Major H. Wood, R.E., Survey of India, for many suggestions and corrections.

With reference to the triangulation, I would add my conviction that the final success of the British contribution to the link would never have been so fully attained but for the devotion of my friend Harry Bell. He it was who reduced the possibilities of the connexion to the only feasible route across the mountains, and who devotedly gave his life when almost within sight of the completion of the link.

In a recent letter to me, Hingston wrote "I shall always look back on my experience on the Pamirs as one of the most fascinating of my life"; to those of us who were permitted to take a share in the work, the memory of those days spent in the high camps of those vast empty spaces and the recollection of the gigantic scale to which nature has built the mighty barrier wall of this great Empire will always bring back the fascinating days and nights spent among the silent Lords of the Mist-Mountains.

* Since writing the above, and before the final publication of this report, Mr. Ramaswami has rearranged the whole of the chapter on the Pamir flora, and has written an introduction to his classification.

CHAPTER II.

THE JOURNEY TO THE PAMIRS

by

Lieut. K. Mason, R. E.

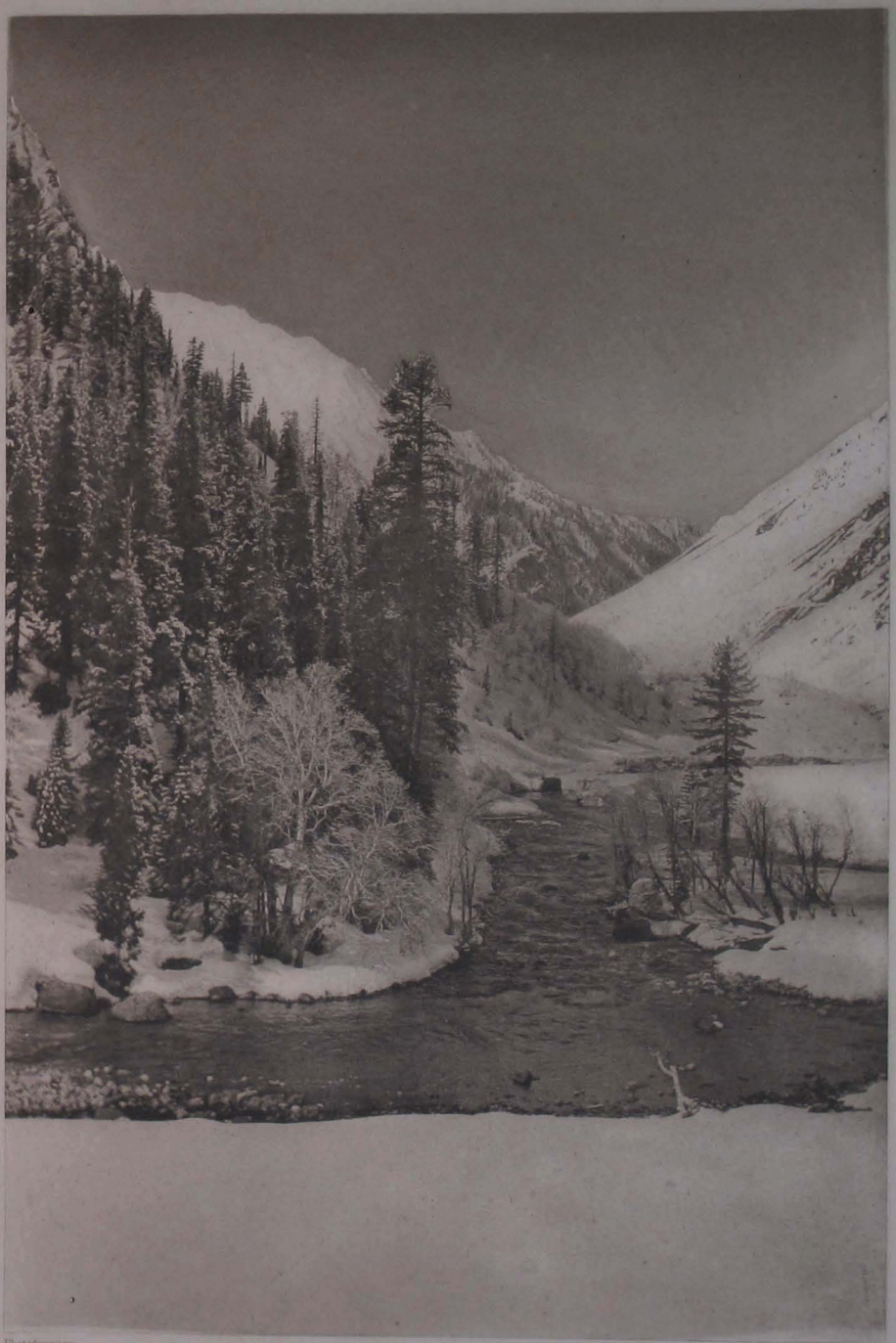
Assistant Superintendent, Survey of India.

Though the route to Gilgit is well known, it will be perhaps not out of place to describe our journey which was made at a very early time of year when the conditions were very different to those generally experienced in July. We were compelled to start at the earliest possible date so as to take every advantage of the short season during which triangulation is possible and to ensure the due completion of the work.

The detachment may be said to have commenced its journey to the Pamirs from Rawal Pindi, where it left the railway, and took to the road. The party was not yet fully concentrated as Messrs. Collins and McInnes had permission to join at Bandapur and delay had occurred in obtaining sanction for the employment of military signallers from the 9th Gurkhas stationed at Dehra Dun. The morning of the 13th April was spent in loading up the six bullock carts of kit and equipment, and the carts were despatched on their journey of 164 miles to Baramula the same evening.

The next morning we followed by motor, and completed the 198 miles to Srinagar in two days, halting for one night at Domel. The road is too well known to need description, but the luxury of a motor is a great improvement on the old uncomfortable method of travelling by tonga and adds a great charm to one's appreciation of the scenery.

The days which passed in Srinagar while waiting for the heavy transport were busy ones. There were still many things to be bought, and most of my warm and mountain kit had to be gone through, as I had left it in Srinagar in 1912, and it was an anxious time waiting for sanction for the signallers. On the evening of the 19th, the detachment was joined by two Gurkhas on furlough belonging to the 5th Gurkha Rifles at Abbottabad, kindly placed under my orders by Colonel Bruce. Once before, in 1911, I had had two of this famous regiment of mountaineers with me, Kulbahadur and Logbahadur Gurung, and had always found them indefatigable and untiring, and I had learnt to appreciate their fine qualities. The two men who now joined me, Kulbir and Hastabir Rana, whom owing to their outstanding characteristics I always connected in my mind with a "rugger" half back and forward respectively, were extremely good and energetic and never once showed the slightest signs of distress or weariness. I can testify that they left an impression of cheerfulness on the whole camp under the most adverse circumstances. Like the men from the 9th Gurkhas, they never failed to set an example of cleanliness and discipline to the motley crowd of mixed races that generally comprised the camp, and one retained the impression throughout, that they were fellow workers and comrades, and that one could treat them as such.



Photogravure

Survey of India Offices, Calcutta, 1914

Plate 2.—Near Peshwāri.

Photo. Engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Plate 3. The Burzil Pass.

During our stay in Srinagar, Drs. Arthur and Ernest Neve were exceedingly kind in giving us hints, and Mr. Mitchell, who probably knows better than any one living of the joys and otherwise of the Gilgit road, having helped to make it some twenty-five years ago, very kindly made suggestions as to the time we ought to cross the Burzil Pass. We were also the recipients of much kind hospitality from the Resident and Mrs. Stuart Fraser, the former of whom had officially written through to the local authorities requesting them to lend us every support. Without this consideration, it is hardly necessary to add that the progress of the detachment would have been impossible.

On the 25th April, we embarked on *doongahs* and made our way down the Jhelum and across the Wular Lake to Bandapur, which we reached on the following afternoon. Bandapur is the southern terminus of the Gilgit Road, and here all the kit had to be weighed, and arranged into coolie loads. That some forethought was necessary at the start may be gathered from the fact that during the expedition the following methods of transport, ranging from the most modern to the most primitive were employed; (1) train to Rawal Pindi; (2) bullock carts and ekkas to Baramula (3) boats to Bandapur; (4) coolies to Gudai; (5) ponies to Gilgit; (6) mules, donkeys, ponies and coolies to Murkushi; (7) yaks over the Mintaka Pass; and (8) yaks, camels and coolies on the Pamirs.

On arrival at Bandapur, we found that our heavy baggage had arrived the same day, and on the following morning we unpacked and laid out everything at the ghât and arranged loads. The same day we were able to send off the heaviest loads in advance, and during the evening Messrs. Collins and McInnes arrived and we made final arrangements for the journey. It had been decided that the detachment should proceed in two main squads, in order to give more room in the huts and bungalows en route where the accommodation was very limited and to make it easier to obtain the necessary transport, which was abnormally heavy. The two squads were to be separated by an interval of six days; this would give time for the dismissed coolies returning empty, to help with the transport for the second squad. The deciding factor in the fixing of the interval was the length of the Gurais to Gudai stages, as the Gurais district is only sparsely inhabited. The other alternative was to take coolies through from Bandapur to Gudai which would have meant rationing them; and it must be remembered that coolies who live within easy reach of a pass like the Burzil are infinitely better than any who come from a distance, and to whom the districts of the Gilgit road when under snow recall the miseries of the days so well described by Knight in "*Where Three Empires Meet*". Hingston and I were to go with the first detachment and McInnes was to bring along the other. Collins was to go on ahead as fast as possible with only his necessaries to Hunza, to commence the purchase of rations for the whole party.

On the 28th, the first detachment left Bandapur. Lieut. R. Blandy of the 9th Gurkhas had obtained permission to accompany us as far as the Pamirs, where he intended to shoot ovis poli, and he kindly undertook the charge of the messing during the journey. We were also lucky in being able to engage Abdulla, a Kashmir shikari, who has had great experience in handling coolies. He was trained by Dr. Neve, and is now fairly conversant with rope work on snow and rock. In 1909 he was chief coolie jemadar to the Duke of the Abruzzi and since then had been with me for three years. He was one of the party on the first ascent of Kolahoi, and a man one could trust.

For some three weeks the weather in the north of Kashmir had been very bad, and we had reports and expectations that the passes would be deep in snow. The evening of the 28th found us at Tragbal, and though ready to start at 2. 30 a. m. the next morning, we did not get away behind the last coolie until 4 a. m. We were caught in bad weather on the Rajdiāngan Pass, "The Dancing Hall of the Kings", about 12,000 feet above sea level and reached Gorai in the afternoon. Owing to the thickness of the falling snow and the impossibility of seeing far ahead on the Pass, I was compelled to take off my skis and one was lost by the gurkha who carried them. He apparently slipped and fell, and the ski disappeared down the snowy slope, where it would have been useless to follow it as it would have been covered up by the snow and lost before anyone could have found it; it had therefore to be abandoned. Being one of my best pair from Switzerland, it was rather a disaster, and I had to fall back on my spare English pair which was much heavier. These afforded some pleasant running down the valley to Gorai, but though I had crossed the pass on six previous occasions, the uncertain and misty light made small inequalities in the ground impossible to define, and I took a fair number of tosses.

On the 30th April, the weather was fine, and we had a very pleasant march to Gurais. After reaching the Kishenganga River and crossing it at Kanzalwän we turned eastwards up the valley. The scenery here was exquisite; the dark pine forests on the opposite side of the valley were slashed with white streaks of avalanche snow. Every bend in the road brought some fresh loveliness in view, and the idea created in the imagination was the perfect harmony of the lights and shades, the colours of the trees and snow.

On reaching Gurais, we called at the telegraph office for any telegrams that might have arrived, and here learnt that the Gilgit mails had been held up for six days on the Burzil Pass. Shortly after arriving at the bungalow, Lieut. H. Whitaker of the Rifle Brigade came in. His intention was to shoot in the Astor district, but he was held up for want of coolies. We arranged to move on together, and now our leading detachment numbered over 180 all told. Before starting on the 1st May, a load which had been left behind in the dark at the Tragbal bungalow, arrived. The coolie's performance is worth recording. The load was not missed till our arrival at Gorai, and one of the coolies was sent back to bring it up. Between the hours of 4 a.m. on the 29th April, and 4 a.m. on the 1st May, he had crossed the Rajdiāngan Pass three times, and marched 54 miles in 48 hours, of which 41 miles were accomplished with a load of 60 lbs.—an admirable performance. Surely this is sufficient testimony that even the despised Kashmiri can rise to an occasion when required.

On this day we marched to Peshwāri, just before reaching which place Whitaker came across a four-horned sheep. I was unfortunate in breaking my thermos flask on this march, which I rather treasured as a memory of gay days at Mürren. In stooping to examine a rock the flask which was slung on my back slipped round and struck the ground.

It snowed most of the night we spent at Peshwāri, and as there was very little room in the rest-house buildings some of the coolies preferred to go to a village some two miles away. In the early morning the hills wore a mantle of cloud, and the coolies at first refused to stir. By 5-20, however we were away behind the last coolie load. The clouds had cleared, and everything promised a gorgeous day; the new snow of the night before left an exquisite covering on the trees in the valley, and the delicate softness of the snow-stunted birches called forth our admiration. In the early hours of

a perfect day, the sublime loveliness of the lacelike tracery of snowladen birch and pine and the filmy transparency of the ghostly vapour clouds, rising on the opposite side of the valley were indescribably beautiful.

Rounding a bend and glancing back, the eye was caught by a small flame-coloured cloud, tinted with the first rays of the rising sun. Suddenly a snow-covered mountain seemed to rise up behind us, rose-coloured, holding us spellbound. Higher the sun rose, and each glance in every new direction seemed to create new sensations. Never had I seen such an exquisite softness, and never, I hope, shall I lose the impression that it made on me.

We had numerous dead avalanches to cross before reaching Minimarg telegraph station, the highest in the world kept open all the year round. A mile before this the coolies had a narrow escape from an avalanche, which fell between them, cutting off the leading five from the remainder. Owing to our late start, the snow was now getting soft, and as it was deep, there was much plunging amongst the coolies before reaching the shelter of Burzil Chauki. On this occasion my skis were of the greatest assistance to me and prevented me from sinking in, but the numerous avalanche crossings were somewhat tiring.

A night crossing of the Burzil Pass was imperative at this time of the year, particularly as the huge Dam Singh Patthar Avalanche had not yet fallen; and after a short rest the coolies were again moved off at 11. 30 p. m. by lantern light. The presence of 180 souls in two huts was not conducive to the height of comfort, so we were all ready for the start. The summit was reached by dawn, the slow progress being attributable to the exhausted state of the coolies who often dropped off to sleep during their frequent halts; this necessitated going round at every halt with a lantern to wake them up and make certain that none were left behind.

My descent of the Pass on ski left a lot to be desired, and I came to a bad end at the foot, mainly I prefer to think owing to the hard icy surface of the snow at this early hour. We marched to Chillam Chauki about midday, and most of the coolies arrived the same evening, while the remainder spent the night at Sirdarkōti Dāk Hut. On the 4th we continued the march to Gudai, through a wilderness of white loveliness. Shortly before reaching the bungalow, and after the most impressive scenery imaginable, we had an exquisite glimpse of Nanga Parbat, a sweep of the frailest azure, which even at this distance appeared Lord of the landscape, supreme and unchallenged. On arrival, Hingston attended about twenty cases of minor frostbite among the coolies, the result of crossing the pass with wet feet.

At Gudai we changed transport to ponies and took a day's halt to pay off the coolies and rearrange loads; and on the 6th marched to Astor. After about three miles the road crosses to the left bank of the river, and some five miles further on recrosses to the right. Up to now the formation had been granite, but just before recrossing we passed some very soft sand rock, finely grained and stratified, evidence of a former life of the Astor River. There were some remarkable alluvial terraces after this, and after again recrossing to the left bank at Gurikōt, we reached Astor about 4 p. m.

The formation here is on a grand scale. Everything is thrown back so that the view is taken in from an immense distance. Astor itself and several patches of cutivation are situated on old levels of the river. The scenery is grand,—grander and more rugged and unforgiving than any we had passed till now;—savage where before it had been soft. The people, too are in agreement, harder featured and less tame than on the Kashmir side of the Burzil,—in fact

the passage of the Pass had brought us to a new country, different in scale, in beauty and in its inhabitants.

On the 9th we marched to Dashkin, and on the next day reached Doyan. The road, after Dashkin, winds up a spur, and on rounding it, we had a fine view of the road keeping to a gentle gradient for some miles. The scale was immense, and it was hard to become accustomed to it. Shortly after this, the road entered the Mishkin Forest, which, with its thick shade and breeze of "softest influence" reminded one of Dante's celestial forest on the way to Paradise. The extraordinary contrast of this charming stretch to the barrenness which we had been passing through, made one realize the truth of Colonel Durand's eulogy in "*The Making of a Frontier*". Here, too, I heard a pheasant call.

Suddenly a thunderous roar on our right was heard, and on looking across the valley, an immense cloud of dust and débris was seen to rise. A huge fall of rock had occurred, caused by the sun's rays thawing the ice in the rocks. The southern faces of all these mountains must be eroding very fast, as such falls occur very frequently. Later a smaller fall occurred. The roar of these echoes and re-echoes for fully a minute. A little further on our attention was rivetted on a very fine peak, a true peak it seemed, in the sense that even Ruskin would have allowed. We were told that its name was Ditzil.

On crossing a spur, the vastness of the landscape fairly staggered one. Far away to the west one could see the Indus shimmering in a heat-haze. Winding down our side of the river ran our road, with the Doyan bungalow some three miles away. This, owing to the immense scale, seemed but a mere stone's throw. One could imagine in the purple distance the great knee bend of the Indus, cutting its way through the Ladakh Range, and far, far away one could faintly trace the Gilgit Valley approaching its giant neighbour. Away to the right of this, suddenly the summit of Rakaposhi or Dumāni, the Mistmaker, came into view, with her perpetual cloud of snow dust,—the only cloud on this perfect day.

It is 18 miles from Doyan to Bunji, but some of this is avoided by going straight down to the Astor River and omitting the zig-zags of the road. Some five miles after leaving the bungalow, the road cuts into the cliffs of the famous Hatu Pir,—one of the most expensive portions of the whole route. By a series of seven zig-zags, it ascends a nearly perpendicular cliff over this outlying spur of the Nanga Parbat massif, and on the west side again descends in wide sweeping zig-zags to the river at Rāmghāt. A fine view is obtainable from all this part of the road, but to appreciate fully the vastness and grandeur of the landscape, and as Major Bruce writes, "to educate one's sense of scale" one should ascend to the top of the hill behind Doyan, a trek of about three hours on a hot day.

Knight, in "*Where Three Empires Meet*", gives an awful picture of the miseries of this portion of the road, before it was completed. He writes of the skeletons he passed and of the terror of the coolies. These days are over now, and a ten-foot road, the masterpiece of the whole route, takes the place of this Golgotha, and makes the journey as near as possible a pleasure.

Colonel Montgomery mentions that in December 1840, part of the Hatu Pir fell into the Indus, west of Nanga Parbat and formed a dam 1000 feet high. A lake formed behind this dam reaching almost to Gilgit forty miles away. The lake rose 300 feet, and for six months continued to rise, being held back by this natural dam, which it finally burst, and emptied itself in one day, doing an immense amount of damage down the course of

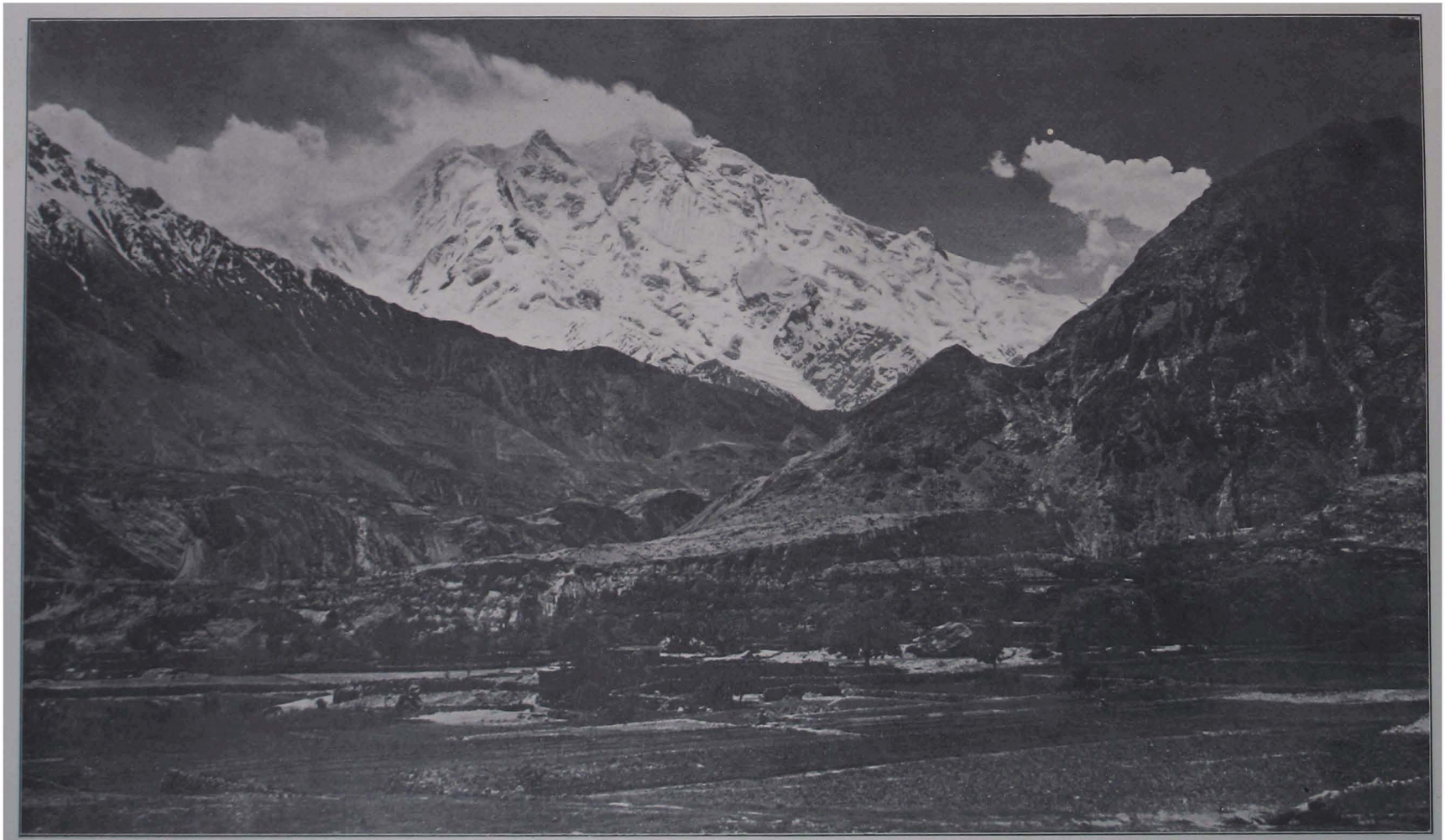


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914

Plate 4. Rakaposhi or Dumāni, the Mistmaker, 25,550 feet, from Aliabad (Hunza).

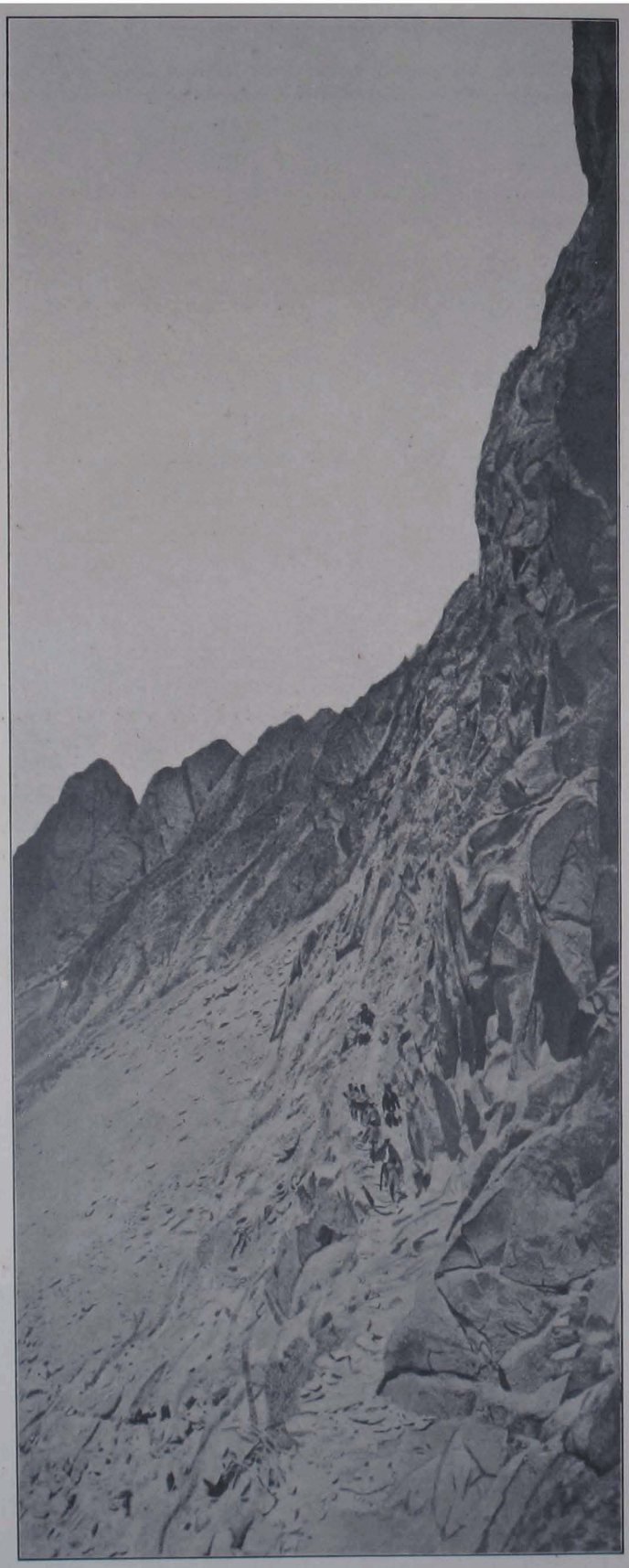


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta. 1914

Plate 5. The cliff route in the Karakoram Gorge of the Hunza River.

the river. A Sikh army in camp as far down the river as Attock was wiped out, "as an old woman with a wet cloth sweeps away an army of ants"; whole villages were destroyed, and all down the Indus the country was laid desolate.

The gorge of the Astor River where it debouches from the mountains to its confluence with the Indus is very striking, and one crosses it by a fine suspension bridge above Rāmghât or Shaitan Nāra, the Devil's Bridge.

From here to the oasis of Bunji is nothing but a waterless waste,—a "crumpled Sahara" as Sir Martin Conway not inaptly calls it. But a fine and wonderful Sahara. Owing to the terror caused by raiding and slave dealing Indus Valley tribesmen, the Bunji Plain has never been repopulated since the disaster of 1841. The new scheme, being carried out by Captain J. F. Turner, R. E., for bringing a *kul* to irrigate the plains higher up, will turn that part near Safed Parri into a green and fertile land, and if, as has been suggested, the same is done between Bunji and Pertab Pul, and State aid is allowed to returning families, even this stretch of magnificent desolation will become a thing of the past. None of us could grudge a day or two of this, a change in the wonderful scenery of this wonderful road. At Bunji we were handsomely entertained by Lieut. Cole. R. A., who was stationed there.

It was more like the beginning of a good hot weather in the plains than anything else on earth, and we all slept out of doors. Later in the year the Bunji Plain becomes a frightful furnace of almost red-hot sand, which hardly cools at night and on which one cannot bare to rest the hand. On the 10th May, Cole again invited us to breakfast, after which we rode some six miles to the Pertab Pul, where we crossed the Indus. Here we said good-bye to Whitaker, as the road to his shooting grounds left our route. He was a great loss to us, and we missed his advice and cheerfulness very much in the days that followed. I could not help wishing that he could have stayed with us for the whole trip, for he is an ideal traveller, and one who can always see humour in any situation.

We spent the night in the white bungalow of Parri, and on the next day marched to Gilgit. The last few miles which passed through an avenue of willows were very pleasant travelling, and on arrival we found that Major Macpherson, the Political Agent, had kindly pitched tents for us in the Agency Gardens. We halted some days at Gilgit and these were full of work. Collins went on and McInnes came through and also passed on. Equipment, which had been left in store here from last year, had to be taken over, tents and kit repaired and finally a depôt and office established here. A point in the arrangements which we had overlooked, but which was remedied on the suggestion of a local tailor, was the necessity of one of his trade to accompany us to repair tents, etc. We engaged one Shukra, who carried a light load on the march, and about every other day or so kept the tents in repair. This is the only method of keeping them fit for habitation in the sort of climate we had to expect.

We had to dismiss our ponies as Gilgit could not support them even for so short a period as a week, and difficulties were met with in obtaining fresh transport. However, with a mixture of mules, ponies, donkeys and Balti coolies, we moved away on the 17th. Major and Mrs. Macpherson were very kind and hospitable during our stay in Gilgit, but much of their hospitality we were obliged to decline owing to the necessity of pushing on. Our detachment was in camp near the graveyard, below the Treasury, in a delightfully shady garden known as Hayward's Bagh, and we took the opportunity of visiting Harry Bell's grave. He is buried next to Hayward, the intrepid Himalayan traveller, who was murdered in Yasin and finally brought in to Gilgit and buried there. Captain J. F. Turner, R.E., kindly took charge of the

memorial stone, which I had brought from England and undertook to build the monument desired by his people.

On the 17th May we spent the night at Nomal, and the next day reached Chalt. The road is still wonderful,–"a knife-scratch across the harsh face of desolation, whose dominant features of rock and stone and sharply jutting spurs were unredeemed by the least suggestion in outline and tint". Perhaps so, but though slightly wearisome there was always the splendour of some wild crag, or some fascinating virgin peak to engage the attention. It is between these places and in the desolate gorge through the Kailas Range, that the Hunza River cuts its way across the main axis. And now one could realize the extraordinary achievement accomplished during the Hunza-Nagar campaign when a field force was taken through this defile, before this road was completed. One had only to see the road and the numerous discarded remnants of road to realize the anxiety of having to keep this kind of country open for communications, with enemies on all sides and in rear, and only to glance at the famous Chaichar Parri to realize the key to this defile on the north.

The 19th was another perfect day, and another which will be difficult to forget. Not half a mile from Chalt the attention is rivetted by the spear shaped summit of Rakaposhi, or Dumāni as it is called on the Kanjūt side. It was unearthly, ethereal, sublime. Miles of glittering ice and snowclad slopes, leading to its sunlit crest, seemed ready to thunder down destruction on anyone daring enough to attempt an ascent.

"Such things are not to be seen lightly, nor would one wish that the toil and the trouble could have been abated. The memory of these wonders of the earth is a priceless possession, none the less precious because one has waited and endured somewhat to obtain it. A lasting regret there is,—that one has seen these things, and must remain for ever inarticulate. It is one thing to see a pale white shape, faintly gleaming against the blue sky, and quite another thing to express the grip it takes of the heart and of the imagination. A stony, colourless plain, and, far beyond, a dim shaft of light like a broken spear projecting above the horizon. Yet how much is suggested;—a vast bulk hidden from view, long miles of snow-clad slopes, immeasurable cubic yards of green ice, the covering the accumulation of centuries, the thing itself a monument to some convulsion of Nature, dating back into years beyond comprehension. A thing of perfect serenity, looking down on a world with placid calm; yet one knows how the wind rages among its pinnacles, and how the storms of winter howl like wild beasts in its ravines. The mother of rivers that nourish millions of humanity, the progenitor of floods that wipe out human endeavour as if it were writing on a slate. A jewel in the sunlight, and a terror in the darkness. Its head poised in the uttermost limits of the air we breathe, its feet in the bowels of the earth, where are generated the catastrophes that shake the world".

Thus writes David Fraser, and no lines could better apply to the entrancing vision we beheld that morning.

It is difficult to believe that until some twenty years ago this romantic valley was the scene of perpetual strife and petty wars, Hunza and Nagar always at war with each other or combined against some common foe, in protection of their lands. If only the Mistmaker could tell us of the horrors, of the murders, and of the miseries of the old slave days, we should hear a history of tears and weeping. Then came the Russian tentacles, Captain Gromchevtsky and his Cossacks, and the "slamming of the door"; the British advance, the storming and taking of Nilt fortress and of the almost impregnable position beyond.

We made a long detour up the Burdelas Nala and down again by its left bank. For a time our "jewel in the sunlight" was hidden and then we had one perfect view as the mistladen vapours rose and covered her.

Crossing the river at Sikanderabad to the Nagar side, one immediately enters the land of forts. That of Sikanderabad itself crowns the *parri* guarding the bridge. Under the shadow of this we passed, and some three miles further on came suddenly on the historic fortress of Nilt.* Kulbir and Hastabir were very interested in the deeds of their fathers, and I tried to explain to them the part the 5th Gurkhas took in the capture of the stronghold. The remains of the blown-up gate are still visible and the rabbit warren of dwellings within still inhabited. After Nilt fortress came Thôl Fort, and then Gulmat,—every village a regular stockade. Yâl Fort and that of Pisan follow in close succession, both at the foot of glacier valleys sweeping down from Rakaposhi. Lastly we arrived at Minapin after a march of twenty-one miles, and put up at the bungalow.

The 20th was a busy day. After sending off the camp to Aliabad, we visited the Minapin Glacier, which had been measured by Mr. H. H. Hayden of the Geological Survey in 1906. This was remeasured and the results will be found in chapter VII. The march on this day rather lacked shade until we crossed the Hunza River to the right bank, after which the views became indescribably beautiful. Shortly before reaching Aliabad, we diverged up the Hassanabad Valley and examined the snout of this glacier and Mr. Hayden's marks†.

The Mir of Hunza and his retinue of scallywags were awaiting us at Aliabad, where for the first time the whole detachment was concentrated. Two busy days followed, sorting out the various kit, and distributing the equipment to the three detachments, and on the 22nd a visit was paid to the Mir in his castle at Baltit.

The enormous amount of energy and skill spent on the original laying out of the cultivable terraces of Hunza strikes the traveller at once, the whole consisting of small fields ot land, built up and retained by carefully made and picturesque walls. It must have taken centuries to retrieve all this land for cultivation, and an engineer of no mean powers to lay out the fields and plan their irrigation. Two canals were originally made, but that which took off from the Hassanabad Glacier below Aliabad, and which was brought back some miles along the cliff, has been put out of action by the sudden advance of the Glacier some years ago, ‡ and it is almost heartrending to see the remains of the old terraces, built up with such care, now lying desolate.

The Hunzakûts were very short of agricultural implements, and I was tempted to write for sanction to sell our large stock when the work was finished, as their actual worth would not really balance the cost of their carriage down the road, while if left here they would be of great use and highly appreciated.

At Aliabad we decided on the strength of each squad, and enlisted the permanent coolies. Amongst those I took with me to the Pamirs, I included twenty-five Baltis, selected men, whom I knew I could trust. The Balti, being Shiah Mahomedan, does not employ the Ladakhi custom of polyandry to check the increase of his population, but on the other hand has decided polygamous tendencies, with the result that his poor country cannot afford to support the entire population, and emigration is the only alternative. They are the most faithful and trustworthy coolies in the world, will do

* For an official history of this compaign, see *Frontier and Overseas Expeditions from India*, Vol. I.
† See Chapter VII. ‡ For an account of this advance, see *Records Geol. Survey of India*, Vol. XXXV, p. 135.

anything they are told to do, unless fear takes hold of them; and they are extremely hardy and can withstand an enormous amount of cold. They are a race of children, and look on their employer as their father; and it is easiest to get them to work well if one treats them as such and looks after them carefully. The Kashmiri coolie requires a totally different treatment; he is a servant, knows he is a servant, and must be treated as a servant, or else he will impose on his master, sham illness on every possible occasion, and will give endless trouble. Again, the Kanjūti of Hunza has to be treated differently. He believes in Liberty, Equality, and, if it pays him, Fraternity. He requires it to be known that his master places implicit trust in him, admires his manly qualities and bearing, and treats him as one on a higher social plane than the rest. He will then live up to the standard required of him; he is a wonderful mountaineer on rock, and the best of them would probably never own defeat in this particular form of climbing, though they are not so reliable on snow and ice.

On the 23rd, after some preliminary troubles, the Pamir squad moved off. As has been mentioned in Chapter I, the arrangement was that I should travel straight to the Russian stations, and from there work back to the Kilik Pass; for Collins to work up the Hunza and Chapursān valleys while McInnes commenced by reconnoitring the country between us. The road ceases at Hunza; beyond it degenerates into a rough track impassable to ponies. In places it consists of stones laid on pegs driven into the face of the cliffs, but after passing Mahommedabad, we found that we were still able to use the winter route and to come down to the river bed. The gorge is very grand and rugged, and we occasionally had to climb *parris* or cliffs to avoid stretches of the river. A few of these with which to finish the march brought us again to the river bed below Atabad, where camp was pitched for the night.

The next day the detachment marched to Gulmit. For part of the way we were able to keep to the valley, as the Hunza River had not yet risen to its summer dimensions, and we were able to avoid the appalling *parri* at the beginning of this march, which greeted us on the return journey. Several of the strips of the "road" were however distinctly interesting, but none quite so nerve-shattering as we had been led to expect. Near Bulchidas and opposite the Brondibār Nala, the track rises steeply over the Salāmitas Parri, and in places barely exists; from the summit of this *parri*, a very imposing view was obtained of the Shoonuk Mountains beyond Pasu.

At Gulmit I was able to obtain Harry Bell's ovis poli head, which had been brought down during the cold weather, and which I eventually despatched to his father in England. Here also the Mir had a large store-house, where we had arranged to take over sixty maunds of *ata*. After weighing out and sealing up the bags, we left on the 25th for Pasu, and passed the snout of the Sasaini Glacier, which at present approaches to within about three hundred yards of the left bank of the Hunza River*. The track here climbs on to a tongue of land on which is situated the village of Sasaini, and then crosses a broad belt of slates at the top of which is Baurit. From here one sees a long lateral moraine placed high on a solid cliff foundation, which must have been formed when the Pasu Glacier advanced far into the bed of the Hunza River †.

The next day's march took us across the large Batūra Glacier, which is said to be about 20 miles long and $1\frac{1}{2}$ miles broad. We did not have time to

* A short description of this glacier and its moraines will be found in Chapter VII. † A description of the snout and moraines of this glacier appears in Chapter VII, with a photograph showing the position of the snout.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914

Plate 6. The 'road' on pegs and props north of Hunza.

Photogravure

Survey of India Offices, Calcutta, 1914.

Plate 7.—Pasu and the Shoonuk Mountains.

go down to the snout, which we were told runs well down into the Hunza River. The track crosses it about three-quarters of a mile from the snout and the glacier is here cut up somewhat by transverse crevasses, which, however, were closed up and presented no difficulties. *

Almost directly opposite the Batūra Glacier the famous Shingshal River meets the Hunza. This was one of the main raiding routes of the Kanjūtis in the days when they used to raid for slaves into the Valley of Raskam, which they completely depopulated. We reached Khaibar about 3-15 p. m., and found the lumbadar and his very old father awaiting us. The latter, who gave his age at 100, was easy to draw out on the subject of his wild youth. Four times, he said, he had raided for women, but though his eyes glistened at the memory of the good old days, he admitted that he was glad of the Pax Britannica in his old age.

The village of Khaibar is seemingly quite impregnable. A stream has cut its way down the mountain side to the south, and a zig-zag path winds up to the fan on which the village is situated. At the top of this track, there is a gate with a mud citadel called the "*Darband.*" In former days the garrison used to drop down rocks from here on to the heads of intrepid attackers below. This is the defence on the south side. On the east the fan drops sheer down to the river beneath, forming an unscaleable wall on this side. On the west the hillside is fairly difficult, and on the north there is a *darband* similar to that on the south. Our centenarian friend said that he could not remember on how many people's heads he had rolled stones, as he had not kept a *hissab*, but certainly very many. Here we managed to purchase six more maunds of *ata*.

On the following day we marched to Gircha. About a mile after leaving Khaibar we crossed to the left bank of the Hunza River by a fairly substantial bridge. The march from here to Gircha was easy, a total of only ten or eleven miles. During the afternoon the signallers showed their mates how to show a steady light for observations, and I put in some time cleaning and adjusting the theodolite. Hingston went off to look for fossils, but without success, and in the evening we weighed out and sealed up another sixty maunds of *ata*.

On the 28th May the march was somewhat more tiring. After an easy march to Sōst, we dropped down to the river bed, and were able to avoid some bad *parris*. Here the Chapursān River joins the Hunza, which above the junction is much smaller. Between here and Misgar, we had to ford the river ten times in all. The men of Hunza and Little Gujhāl are the most powerful forders I have ever met. I was not a little surprised that the men, though Mahommedans, "girt up their loins" to above the waist, took off their bifurcated habiliments and crossed very nearly in a state of nature; but I see in Colonel Durand's "*The Making of a Frontier*" that the Chitrali footmen shocked his Pathans very much "by rolling up their voluminous skirts, taking off their *paijamas* and fording stark naked." Colonel Durand adds that they are the only Mahommedans he has ever met with, who will do so unashamed.

The first seven fords were comparatively simple, though one pony fell and gave a Hunza levy a ducking. The eighth was more difficult, the Hunza River running swiftly through vertical walls, the gorge being cut by the combined influence of the Kilik and Khūnjerab Rivers which join

* See note in Chapter VII.

just above. Two more easy fords after this, with the intermediate road near the river bed brought us to a large conglomerate flat, after traversing which the track wound down to the river and crossed by a bridge a mile short of Misgar. It then winds up to the corresponding flat on the other side, and on this is situated the village. The level of these flats evidences the top of the deposit laid down formerly by the Kilik River, which has since been rejuvenated, and has cut its bed down again through a depth of some 360 feet.

Shortly after our arrival in camp, we were visited by a cyclone of terrific violence. One double fly tent and two of the khalassie's tents were levelled and one coolie 'wigwam' in the course of being erected was blown inside out, and the framework was smashed. The cyclone was followed by heavy rain.

High up in the cliffs above Misgar, there are some curious old caves. Hingston visited these by being hauled up on the rope; he found them to be of artificial construction, and though he dug up the floor he could find nothing of any interest. They were of enormous size and were capable of containing a hundred men with ease. They appear to have been used as hiding places during the old inter-tribal raids. Anyone trying to reach the entrance had a stone flung at his head, and they were probably quite impregnable so long as rations lasted.

On the 29th May we marched to Murkushi, the road gradually descending to near the river bed. A very cold wind was blowing as we reached Tōpkhāna, near which place the Derdi stream enters by the right bank. Tōpkhāna consists of a single small square look-out, again reminiscent of the old fighting days.

Strictly speaking, the Chapursān River, and not the Kilik or Mintaka should be considered as the head-waters of the Hunza. The Chapursān lies in the longitudinal trough between the Karakoram and the Northern Hindu Kush, which latter range has been cut back into by the Kilik and Mintaka, and the Chapursān is longer by many miles than either of these two streams, which should be properly considered as only subsidiary tributaries. The Ghūjerab and Khūnjerab, though only very imperfectly explored, lie also in this trough to the east. A curious point about the nomenclature of the rivers in this district must be mentioned to avoid confusion. On both sides of the Kilik Pass, the rivers flowing from the watershed are called the Kilik River, that on the Pamir side being generally designated "Jilga". Similarly at the Mintaka, Kharchanai, and Khūnjerab Passes.

Considering the Chapursān as the source of the Hunza River, geographically speaking it possesses one of the most curious attributes of all rivers of the globe. Its waters cut through seven ranges. Rising south of the Northern Hindu Kush and Northern Karakoram Ranges it flows eastwards in a longitudinal trough till it meets the Khūnjerab, flowing in the opposite direction, and in the same trough. At this point it bends southwards at right angles, and the combined waters attack the great Karakoram and cut their way successfully through the solid granite of this stupendous range, in one of those magnificent gorges so typical of this great barrier scenery. South of the Karakoram axis, on being joined by the Hispar, which drains the longitudinal trough between this range and the Kailas Range to the south, the river flows westwards of Chalt, where it again bends south through a right angle, and attacks the Kailas Range, cutting it at the striking gorge of Chaichar, nine miles west of Rakaposhi, 25,550 feet, the bed of the river

being at a height of only 6,000 feet above sea-level. The Hunza River continues southwards through this range to within a few miles east of Gilgit, where it is joined by the river of that name, which has drained the westerly trough between the Kailas and the Ladāk Ranges. The combined waters of these two rivers now flow for some thirty miles in an easterly direction, where they meet the great Indus, which, as becomes a river of this magnitude, has undergone two successive struggles with the Ladāk Range already, and which now, with the aid of the Hunza and Gilgit Rivers, attacks the range for the third time. South of the Ladāk Range, and below Bunji, the Indus is joined by the Astor River, draining the Ladāk—Himalaya trough, and cutting its tortuous way through the Himalaya, west of the mighty Nanga Parbat, and through the lesser ranges to the south, it flows unconcernedly to the sea.

The march to Murkushi was desolate in the extreme. A few—very few—trees, and for the rest, huge granite boulders and river-cut conglomerate, possibly the remains of an ancient Pamir. At Runhil, 11,680 feet above sea-level, another oasis of trees near the river bed was passed, which scarcely merits a place on the map. Murkushi itself is more deserving of honour, though one scarcely realizes this fact on the outward journey, but only when one has been without the sight of a tree for a couple of months.

At this place we had the pleasure of renewing our acquaintance with M. Reweliotty, the Russian Consul-General, who was passing through on his way to Russia by way of the Pamirs, and with whom we had a hare shoot. Here we were delayed by trouble with the yak-transport, and on the 30th May spent the day paying off coolies and making up accounts to the end of the month.

The following day, we completed the short half march to Boihil, while our permanent coolies made the journey from Murkushi twice to bring up the remainder of the equipment. At last some very tired yaks arrived and took some of our kit another short half march to Gulquāja, at the snout of the Gulquāja Glacier, where there is a stone dâk hut. Some of the kit had already gone on here by coolies, but some of the *ata* had still to be left at Boihil.

On the 3rd June, at last we crossed the Mintaka Pass on to the Taghdumbash Pamir. As we ascended the pass, Mahomed Beg, the British representative, accompanied by more yaks was met with, descending on our side, and with these animals, most of the remaining kit could be brought up, only leaving some loads of *ata* to be brought up later.

The crossing of the easy Mintaka Pass, some 15,000 odd feet, marked the end of the first stage of the work; and nothing could have been more pleasant than the wonderful scenery we had passed through. It appeared as though Nature had been asserting herself for some final and supreme effort of magnitude, and had failed, and the desolation of the Pamirs was her revenge. We completed the longish march to Mintaka Akhsai, where Mahomed's camp was located, and were soon comfortably installed in his guest khourga,—a substantial building of skins and mats laid on a framework of wood, the floor being spread with carpets from Yarkand.

On the following day we established a depôt here, and ascended our first station to reconnoitre.

CHAPTER III.

THE TRIANGULATION UP THE HUNZA RIVER AND GORGE

by

V. D. B. Collins

Extra Assistant Superintendent, Survey of India.

After the departure of the Pamir detachment on the 23rd May under Lieut. Mason and of Mr. McInnes' detachment on the 27th, my own squad, the southern one, was ready to leave Aliabad on the 28th. My idea was to begin the observations at Atabad station, and in order to get everything ready to commence, I sent two helio squads away with McInnes with orders to post themselves on the two stations on either side of the Hunza River, a little to the south of Khaibar; meanwhile I visited Hachindar and Zangiaharar stations, the last two hills on which observations were taken in 1912, in order to see whether the mark-stones had moved during the winter, and to post the helio squads.

From both these stations I was able to see a good deal of the Atabad hill and I noticed that the winter snow still lay for a distance of some 2000 ft. from the summit. Atabad peak is not at all an easy one to climb at the best of times as the one and only route lies for a great part of the journey over piles of old boulders with some very nasty rock work for the last thousand feet. A couple of feet of new snow had defeated me on this hill in September 1912, and the prospects of getting up now with several feet of snow lying on the ground were not very bright. I attempted the climb on the 1st June but had to abandon the effort at about 14, 500 ft.

On the 3rd June, I crossed the Hunza River by the suspension bridge just below Baltit, the capital of Hunza, and reached Booriharar station, which is situated on the left bank of the river almost opposite Atabad, at about 9 p. m. the following day. We were forced to make a very long march, as no water was obtainable from the time we left the river until we reached the snow line. The suspension bridge below Baltit and the one near Gulmit have been erected by the Hunzakūts directed by the Mir and are quite creditable pieces of work. The bridge at Baltit is thrown across the river at a place where it narrows considerably, and is a short one and quite easy to cross. Not so the one at Gulmit, but I shall have more to say about this later.

I had hoped to see the pole, which I had erected on Atabad station in 1912 from Booriharar, but the closest examination of this hill for two whole days failed to disclose any sign of it, though the summit was scanned under almost every condition of light and shade. Later in the season, when eventually I reached Atabad hill station, I found that the pole had been carried away by the winter's snow, and was lying several hundred feet below the station, under piles of débris. On account of the lack of any mark on Atabad station to which I could observe, I had subsequently to revisit three of my stations.

The detachment left Booriharar on the morning of the 7th, and camped

for the night at Gulmit, after crossing the suspension bridge there at about 2 p. m. This bridge is a very frail affair and not at all a nice one to cross. I managed to get across successfully as did most of my men, but I must own to having a fairly dry mouth by the time I reached the far side.

The bridge consists of five $\frac{1}{2}$-inch wire ropes slung across the river. Three of these run side by side, about two feet apart, through which narrow laths of wood, and in many places simply rough boughs of trees, are interlaced at every yard, more or less. The first lath lies over the centre wire and under the two outside ones, while the next runs under the centre wire and over the other two; and so on alternately, the laths being kept in position merely by the strain on the three ropes. This forms the footway. About four feet above this, the other two wires are slung and these serve as handrails, being connected to the footway by fairly thick wire, and in some places merely by rough pieces of woollen rope. These are spaced about twenty to thirty feet apart. The whole structure is 218 yards long and hangs about 150 feet above the stream at its middle point. As it sways in the slightest breeze, and as the movements of a man crossing it set it swinging, one has to proceed very gingerly. The handrails are by no means a fixture, and tend to spread out to an alarming extent. Their distance apart is regulated solely by the inclination of the person crossing, so that, if one does not constantly keep in mind the necessity of keeping a strong inward pull on then, one suddenly finds them widened out to the extreme limit of the arms. The transverse laths of the footway make matters worse by being unequally spaced, and this often necessitates a good deal of feeling about with the foot for the next lath, because if one looks down, the aspect of the water swirling past far below, is apt to give one the sensation that one's legs are being swept upstream, and to cause one to lose one's nerve.

The natives never venture on this bridge without performing a certain amount of *poojah*, which mostly takes the form of kissing the ropes and pressing them to their foreheads, and they would not hear of my crossing until I had done likewise. So I fell in with their wishes and did exactly as I was told. However on the second occasion on which I crossed the bridge, and on the third, I neglected this precaution, with no very evil results. Once on the bridge the natives are wonderfully confident, and some of them will cross scarcely touching the handrails at all.

From Gulmit we made a double march into Khaibar, and on the morning of the 9th after sending the coolies away with the instruments very early, I followed them about three hours later. It is a fairly easy climb of 4500 feet from Khaibar to Shanoz, and we were all at the survey station on the top of the hill by noon. By commencing work at once, I was able to complete almost all the observations before sunset. The height of this station was 13688 feet.

After completing the work on this hill between 6 and 8 a.m. the following morning, I marched down to Khaibar, and arrived there about 11 a.m., where I had a change of coolies. Leaving again at 2 p.m. I determined to push on part of the way towards the next station.

After marching some three miles upstream, we crossed to the left bank of the Hunza river by the Galapan bridge. The going from this point to the foot of Shoonuk was very bad indeed, for the normal route in the river bed was now useless owing to the swollen river. The result was that we had to scramble along at the edge of the river as best we could. The banks are very precipitous, and the going was consequently very tiring and painfully slow. However, we managed to reach the point for which I was aiming by 8 p.m.,

and camped near the riverside for the night.

The next morning, after again sending the coolies away at a very early hour, I followed about 5-30 a.m. The climb was only about 4300 feet, but the route took us over loose slates and shales for more than 3000 feet of the total distance, and fast climbing took it out of us tremendously.

There was just one tiny red cloud in the sky and scarcely any wind when we started from camp, but by the time we reached the station, 13,191 feet, at 8-45 a.m., the breeze had freshened considerably, and there was quite a bunch of cloud low down in the south-west. Unfortunately the helios did not show up for some time, and over an hour was wasted in waiting for them. By 2 p.m. I had completed more than half the horizontal angles, and was about to begin the observations for heights, when two of the helios disappeared, having been overshadowed by cloud. By this time there was an ominous looking bank of cloud moving up at a great pace from the south-west, and it was blowing a small gale. At 4 p.m. I had to dismount my instrument and take down the observatory tent, as there was every chance of it being blown off the hill any moment. By six o' clock we were in the thick of a heavy snowstorm which continued throughout the whole night. There was no sign of a break at 3 p.m. the following day, so I packed up the camp and moved down to Murkun, and arrived there at 7 p.m. This bad spell of weather lasted till the 17th, during which time we had three feet of new snow at 14,000 feet.

On the morning of the 18th there was great promise of better weather and I went up Sirsar station, arriving there late in the afternoon. On the 19th I began work, and after completing the observations by midday on the 20th, marched part of the way to Kirilgoz, my next station, which was 15,738 feet high. Observations were completed at this hill on the 22nd and I returned to Khodabad on the following day, where I had a day's halt. On the 25th we marched to Misgar. The road from Khodabad to Misgar when the river is in flood is about the worst stretch on the whole route from Hunza to the Pamirs. It is one continuous labour of climbing several hundreds of feet away from the river-bed, only to come down to the river again a few hundred yards further on. The track itself is absolutely the last word in villainous goat-tracks, and I should imagine that all the minor climbs on the march in this stretch must add up to at least four thousand feet. From Misgar I next visited Tehri Sar station, which is situated on a hill lying a few miles to the north-east. The climb is a long one but fairly easy, and the going over fair ground all the way; observations were finished on this hill on the 27th and on this day I returned to Misgar. The height of Tehri Sar h. s. is 16,503 feet.

I next visited Gamohar station,—the last station built in 1912 and one of the stations which McInnes had to revisit again in order to carry on his reconnaissance this season. When I reached the station I found that neither Spandrinj Sar nor Sumayar Sar stations, which were the two new forward stations reconnoitred by McInnes, were visible, being shut out by a higher hill about four miles north-west of me. This hill was very similar to Gamohar in appearance, and McInnes evidently mistook it for Gamohar in his reconnaissance. During his work at his forward stations McInnes experienced very bad weather, which, besides causing him some anxiety about completing the work in time, undoubtedly added to the difficulty of identifying the signals. McInnes' reconnaissance was carried out in the face of great difficulties and in very severe country, and only those who know the country in which he had to work, can realize the obstacles encountered in laying out the stations.

This unfortunate error left me no choice but to change the position of this station, thereby adding a considerable amount to the work still remaining in this section of the triangulation. All my forward observations, of course, had been taken to this rejected station, and by altering it I was compelled to revisit Tehri Sar, Sirsar and Kirilgoz.

The weather cleared again about the 9th July, and I recommenced work by building a new station, Raminj Sar, in place of Gamohar on the 10th. Between that date and the 25th July, I revisited and finally completed all observations at Tehri Sar, Sirsar, Kirilgoz, Shoonuk and Shanoz. On the 18th I had been able to get a helio detachment on to the summit of Atabad station, and was therefore enabled to take the remaining observations to this point from Shoonuk and Shanoz.

Four days of bad weather now kept me at Gulmit, and on the 30th July I marched up to Atabad village, while on the following day I camped below the station which is 17,011 feet above sea level. Atabad station is built on the summit of a pinnacle of rock, and is the nastiest place from which I have ever observed. The rock stands up from the main range and can only be scaled with great difficulty. The flat portion at the summit is only about four feet by five; on one side the approach is in the form of large loose rocks resting at a very steep angle, while on the other three sides there is a sheer precipice of a thousand feet and more. There is just room enough for the theodolite stand, and I had to erect a temporary platform about a foot wide, on beams of wood, in order to enable me to move round the instrument. The observations were completed by the afternoon of the 2nd August.

We had a good deal of bad weather during the first few weeks of August, and I was not able to complete at Booriharar, my last station, till the 14th. From Booriharar I went over to Gulmit, crossing the suspension bridge once more, and then up the valley to Khaibar, as I understood that there was some doubt about completing the stations in the Chapursān Valley within the time at our disposal.

However, on reaching Khaibar, I had a note from Lieut. Mason saying that McInnes had nearly finished his observations, and that there was no need for me to go any further. I therefore turned back from Khaibar, and reached Aliabad, near Baltit, on the 22nd August, where I awaited the arrival of the other two detachments.

CHAPTER IV.

THE TRIANGULATION ON THE TAGHDUMBASH PAMIR TO THE RUSSIAN STATIONS

by

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A word is necessary on the subject of the country over which the triangulation had to be carried and on the climate. Colonel Tcheikine of the Russian Triangulation had completed his work in 1912, finishing up on two stations, one on either side of the Beyik Pass on the Russo-Chinese border. Reconnaissance was carried out in 1912, which showed that it would be impossible to utilize either the Kilik or Mintaka routes for connection to the Indian work, and anyone who has been along these "roads" will readily understand the reason of this. It is extremely difficult to get out of the Upper Hunza gorge, owing to the precipitous nature of its walls; and it was therefore hoped to take the series up the Chapursān and connect across country at the head of the Derdi and Hark Nalas; the only alternative to this was a system of very small triangles along the bed of the Hunza River, which would have accumulated a large error.

The general idea taught at school is that the Pamirs are a tableland. But anything more unlike a tableland, which seems to imply something level, could not be imagined. I have tried to bring into line the general idea with the actuality, and if one is to call the Pamirs a plateau or tableland, one may liken them to a table with a rough cloth over which the gods amuse themselves by playing "blowing the feather" from one end of the table to the other. The cloth becomes crumpled and torn, the wind cold, and the unfortunate human feather leads a most unenviable existence.

Lord Curzon estimates that the plains or valley portion of the Pamirs constitute less than one-tenth of the whole mass*.

However this may be, triangulation on the Pamirs cannot be considered uncommonly difficult, provided the detachment remains healthy. This is the whole crux of the matter. The mountains are generally high, the summits of those suitable for survey stations averaging somewhere between 17000 and 19000 feet. Their ascents are not difficult when once the observer comes to look on laid snow as a friend and not a foe. Handholds are rarely required, and in my opinion there is much more pleasure to be derived from climbing in June on snow than later in the season when the slates and shales are exposed and make the going very tiring. Many of the detachment who did not care for the snow at first would have given anything for a hard snow climb later in the year. Provided one

* Geog. Journal, Vol. viii, 1896.

Photogravure. Survey of India Offices, Calcutta, 1914.

Plate 8.—View towards the Northern Karakoram Mountains from Mintaka Akhsai h. s.

Pk. 56 | Pk. 19 | Pk. 57 | Pk. 32 | Pk. 24

42 L | 42 P | 42 L | 42 L | 42 L

19,100 | 32,891 | 31,013 | 25,540 | 23,434

Photogravure

Survey of India Offices, Calcutta, 1914.

Plate 9.—The distant Karakoram Range from Tomtek h. s., 18,608 feet.

(Pks. 56, 57, Northern Karakoram; Pks. 19, 32, 24, Karakoram.)

can keep warm and fit, get enough to eat, and has luck with the weather, the rest is more or less plain sailing. Above all else, the necessity of sufficient and suitable food is overwhelming; it keeps one warm, healthy and cheerful, and stores up the essential energy. It is easy to keep warm, even without fires, though I am told that it freezes every night on the Taghdumbash. We never indulged in fires or stoves, as fuel was scarce and only consisted of yak-dung, and a sufficiency of warm clothing was a far better substitute. But the food question was a more difficult one to solve, with our limited experience.

The Pamir detachment consisted of Hingston and myself, 10 gurkhas, about the same number of servants, orderlies, native guides and interpreters, and some 70 or 80 permanent coolies. To keep roughly 100 men rationed in a country that only produced milk was a constant source of anxiety. We bought *ata* from Hunza territory and more was promised later. Once on the Pamirs we wrote to and had a promise from the Amban of Tashkurghān for any amount of *ata* up to 8000 lbs, but owing to failure on the Hunza side and the arrival of Chinese troops at Tashkurghān, we were for a time reduced to half rations. I had then to dismiss some coolies and this cramped our action to a certain extent, necessitating lighter and more uncomfortable camps, with their attendant consequences. The signallers were each supplied with a mate for cooking purposes and two coolies for collecting yak-dung for fuel, &c; this was a minimum for them. The main lesson learnt from the work in 1912 was the futility of trying to carry on in these parts with insufficient men.

The ration for all men was two lbs. of *ata* per day, and they could sometimes supplement this with sour curds and milk, an occasional sheep, goat, ibex or *poli*. While this ration could be maintained, there was never any sickness, except in the case of one khalassie who suffered from mountain sickness the whole time and had to be left in the depôt camp at Mintaka Akhsai; besides this there were a few cases of local mountain sickness amongst the men. It was noticeable that one district was far worse than the rest in this respect; this was Kilik East h. s., which was particularly bad just before the beginning of a week of very vile weather. I think everyone was distressed when breathing on this occasion, even the Sarikōli interpreter with us, and a Sarikōli dog was actually sick.

Whether this was "regional" or "seasonal" sickness, I cannot say; possibly the latter, as on two later ascents of the same station the distress was not so great. One of the party quite lost his appetite towards the end of the season, but this may have been due to the unappetising nature of the fuel, which though serviceable when dry, caused an unpleasant odour and *taste* to pervade cooked food during bad spells of weather.

The signals used were in nearly all cases, helios, and I should here like to pay a tribute to the signallers and khalassies, who had a very hard time of it on the whole, and suffered much discomfort.

The Pamir detachment began work on June 4th, the day after our arrival on the Taghdumbash. Helio men were sent out to Dastur and Lup Gaz, and a reconnaissance was made from Mintaka Akhsai h.s. Helio communication was established with Dastur, but the men sent to Lup Gaz, failed to reach the summit owing to soft snow, and a reserve party, quickly put through their paces by Naik Bulnar Sing, 9th Gurkhas, was sent in their place, and ordered up the next day. On the 5th, we marched to below Takhtakhūn, and on the following day took a light camp halfway up the hill and camped at about 16,000

feet*. The route led up a left bank tributary of the Karachukor and was quite easy. On the 7th, sending our light camp down with orders to pick up the base camp on the Karachukor and march round *viâ* the Chinese post of Beyik to a point in the valley of that name east of Takhtakhūn h.s., we ascended the latter, and found Bell's signal and mark intact. The tent signal had fallen slightly over to one side, and was partly buried under snow. We had only intended to reconnoitre from here on this occasion, but the climb had taken us less time than we had expected. The route led up a steep snow couloir to some gendarmes and then followed the ridge for about a mile, and the early start made the way quite easy. The day was brilliant, and we were able to do some observations, while Hingston carried on the photographic survey. Abdulla meanwhile reconnoitred for a way down into the Beyik Valley, but as it was getting late when we left the station, and his route was on snow with a tendency to avalanche, we selected a better route later in the day. The triangulated height of Takhtakhūn is 17,595 feet.

On the 8th, two Cossacks visited our camp and after inaugurating a new *entente cordiale*, with not a little success, we marched to below Sarblock h. s., the Russian East station, and made our plans for the next day. One signaller had been despatched to Tongder h.s., with orders to expect a call on the 9th, and after a very early start owing to the presence of a large number of ibex in the neighbourhood, one of which was bagged, we ascended Sarblock, height 17,284 feet, and found the Russian signal and Bell's mark intact. The station was an easy one to climb, but unfortunately the day was none too fine and towards evening slight snow fell. For a time, however, we had a fine view of the Russian Pamirs and of the Sarikōl Range, the latter trending away northwards. I think that the summit of Mustagh Ata, "the Father of Ice Mountains", 24,388 feet in height, might have been visible from here if the view in this direction had not been spoilt by the heavy clouds. The Russians used an opaque signal and as such it was a very good one. Four inclined poles met above the mark, and at their junction there was a fifth and vertical one carrying the remains of a flag. This admits of a theodolite being placed over the mark and under the signal without disturbing the latter. A similar mark was observed on Kukhtek, (Russian West) h. s. (height 17,031 feet), the observations from which were completed in 1912 by Bell. The signaller who had been sent to Tongder signalled to us from a spur that he had been unable to reach the summit of the station, so we had to make up our minds to follow him on the 10th.

At this time our camp contained a curious variety of races and religions. Besides the Cossacks and their Chinese servants, there were men from Hunza, Baltis, Gilgitis, Kashmiri Mahommedans and Hindus, Sarikōli Tajiks, Gurkhas, one Englishman, one Irishman, and a down country Mahommedan cook. On only one occasion did I ever notice the slightest unfriendliness between any two men of different races, and this was between a Hunzakūt and a Sarikōli headman who had given him an order. With this one exception which was quickly settled, the most cordial relations existed in the whole camp.

The Survey detachment had now been in the three biggest empires of the world, the most complex, the most ancient, and the most autocratic. After a journey lasting exactly two months since the day of leaving Dehra Dun, we had reached the Russian stations, and were ready to begin observing on the way back. Everything seemed to promise well; there had been no sickness,

* The mean of two aneroids gave 16,350, but varied so much on different ascents, that the heights by this means are unreliable.

it seemed as though we had nothing to worry about as regards food; the Sarikōlis were most friendly and hospitable, and the weather had given us the most promising indications.

On the 10th, however, we awoke after a dismal windy night to find the whole place a dreary white wilderness of snow, and snow was still falling with a silent steady monotony that gave us the impression of a glimpse into eternity. With scarcely a break, this continued throughout the 11th and 12th, but an apology for a clearance occurred on the 13th, and we were able to move camp a few miles to the mouth of the Tongder Jilga. But snow came down on us again about midday, and we were forced to pitch camp.

On the next day we left camp at 5 a.m., and went up Tongder h. s. (17,611 feet). The going was not difficult; in fact we did not have a piece of really interesting climbing the whole season; but the snow was new and soft, so that we sank in places up to our thighs. Even so I think we were better off on this occasion than we should have been later in the season, when the route would have been either on loose rocks or shale. I observed to a few intersected points, as Bell had completed the stations the previous year, but the weather was vile, and snow constantly fell at intervals. The wind was also very strong and I used the observatory tent. I afterwards gave this up as I found much time was wasted by not having the right window open when wanted. It was more unpleasant without it, but I do not think the observations suffered, and when in the tent in a high wind I was always in a mortal terror that the tent would be carried away. On this occasion as on several occasions later, the ink froze, so that we had to record in pencil. We took the signaller up with us, but he suffered from slight mountain sickness, as did one other of the gurkhas. About 12-30, we decided to return, and we had a great "Joy Ride" on the snow on the way down. The snow was in excellent condition for a plunging glissade, and of just the right consistency to make the pace exhilarating.

Having deposited our signaller in a low camp about 15,000 feet, we marched in the gloom of another snowstorm down the Beyik, to below Takhtakhūn h.s. *En route* we received reports from our signallers of the joys of the camps at high altitudes, but could do no more than rave against the fates, the gods, and the weather. On the 16th, it really seemed that our curses had had some effect and we started off for Takhtakhūn, but only made some 2000 feet before the snow came down again. The next day we were away before 5 a. m. hoping against hope the weather would change for the better, but on reaching the summit, it turned as bad as ever, so we pitched our 16 lb. Whymper tent, packed a few people in another, and sent the rest down. Towards evening, we were able to get some observations completed as the weather cleared and one sportsman in the 9th Gurkhas had returned as soon as it was possible.

"..... The delighted spirit
"To bathe in fiery floods, or to reside
"In thrilling regions of thickribbed ice."

We then dined off ram-chukors' eggs, a rare occurrence and one which, incidentally, we regretted afterwards, as we did not come across any more. As we had had a message that the helio men had been unable to find the Tomtek mark we decided not to wait, but to push on and return when we were certain that this station was correct, and in the meanwhile we sent our Sarikōli interpreter, Arzu, an excellent man in every way, to help the helio squad. Early on the 18th, we sent word down to our

low camp for a double march up the Karachukor to Kuss Kussu, and ourselves marched there, arriving at nightfall below our next Survey station, Dastur. Our bedding did not turn up, so we slept in hope and our clothes.

The 19th deserves a new paragraph, for it was cloudless throughout. We were, however, a little late in getting off, because the march on the 18th had been rather too severe on the coolies, but we reached the station of Dastur by 2-30 p. m , and called up most of the stations, the gurkhas turning out of their tents, like marmots after winter. The Lup Gaz helio did not show, so we had to return on the 20th, when we had more luck and were able to finish off the work. The return journey, which afforded a pleasant glissade for nearly 3000 feet was accomplished in about half an hour. On the 21st we took a light camp up Mintaka Akhsai h.s., completed about half the observations, and the next day finished off and came down to our depôt, where we had a wash and brush up, which we were sorely in need of. Perhaps it is nothing to be proud of, and not quite the thing in civilized countries, but it is a fact that we rarely undressed for the night, had a bath, or were able to change our clothes. It was either too cold or we had no time. In this we more or less followed the prevalent custom of the country. But as regards washing our faces there was no skin to wash, for the snow and wind were already playing havoc with the raw flesh beneath.

After a short march on the previous day, on the 24th we left camp at 5-30 and, taking a light camp, went up Tomtek; we completed all the observations to those stations on which helios had been placed, were able to send the camp back again, and follow in the evening. This was our highest station up to date, 18,608 feet, and it was very tiring keeping on one's feet for five hours on end after a somewhat strenuous climb.

Tomtek is one of the highest mountains in this part of the Pamir and everything appeared spread like a carpet crumpled beneath us. It was indeed a magnificent sight and the mountains we had already been up seemed almost insignificant. The station mark-stone was let into the icecap, which we eventually found to be a cornice.

From here we saw a literal waste of mountains, which for ever rooted out any idea of a tableland that may have been lurking anywhere in our thoughts before. In every direction there was the same interminable range upon range, the same stupendous desolation, planned without any apparent form or thought. It was the Earth of B. C. 4004, and a sight to stagger the imagination. The three greatest Empires of the world lay at our feet, and whichever way we looked, they appeared desolate, uninhabited, and uninhabitable, a seeming maze, as though Nature had tired of method and cast the surplus of the earth's crust down here, hoping that no one would find her out.

On the 25th we divided the detachment, and while Hingston kept on with the photography, I doubled back with a squad to Takhtakhûn h. s., and owing to a very early start on the 26th, we finished the work to Tomtek and Dastur, and on the following day returned to our depôt While on Takhtakhûn h.s. on this occasion, a khalassie, while building the cairn, dropped a boulder on my knee and lamed me for a day or two.

We now intended to take a rest, as we had been up four stations in eight days, often with long marches between, and while at Mintaka we had an

opportunity of observing our surroundings more closely, and I extract the following note from the doctor's journal.

"The fat-tailed sheep which the nomads tend are interesting. In the winter, when food is scarce, the fat in the tail disappears, and in the summer accumulates to such an extent as to form a large rounded mass projecting from the hinder extremity of the animal. Thus does Nature convert that mysterious animal appendage—the tail,—into a storehouse for food, which in time of need, the creature can burn up and use for fuel in its economy. The shearing season has just passed and most of the sheep are bare of their wool, with the exception in many cases of a large area over the buttocks, which has not been deprived of its natural covering. I was unable to understand clearly why that portion of the animal had not been shorn. The animal's great enemy seems to be the wild dog, which is also said to cause much havoc amongst the *ovis poli*. The Sarikōli uses the domesticated dog for protecting their flocks against its wild cogener".

We had a little trouble with one yak owner on this day. Most of these people have a very poor idea of the value of money. They can get very little in Tashkurghān, and so, when one pays for anything in cash, one has to realize that to be a fair exchange, one must pay for time wasted in getting things the ten marches from Kashgar. Bell realized this, and produced a wonderfully fair rate for everything he or any of his men might want, and himself insisted on these rates being paid. The rate for yak transport is well known,—one rupee per day for any march whether for half a mile or thirty miles. This is quite fair, because a yak needs no tending when halting, and he will go apparently all day without worrying. Bell also used to pay the same rate for a milking yak. One beg, Kumalik, however, had a very fair idea of the value of ready money, and besides being quite incapable of counting above ten, he could see no reason why we should not pay a rupee a day for a milking yak and a rupee *for each of her two calves*, though the latter were actually fattening on our milk. We eventually gained our point, but during the negotiations, he had been rechristened "Bukhwassie Beg"—the bukhstick. I was afterwards told by a Sarikōli that the name had stuck to him and would remain with him till his dying day.

On the afternoon of this day the camp presented quite a gala appearance, all the gurkhas getting hold of Sarikōli wedding garments (mostly feminine attire) and coming to us to be photographed. The kit may be described aptly by the word "loud", but detailed description is quite out of the question.

On the 29th, we had intended to move camp, but early in the morning a Chinese officer came to call on us, having as he told us lost his camp. So we remained one more day to entertain him. Yung Chung Lun was still in possession of his pigtail and quaint kit with his absurd little straw hat, but the Republican *hukm* had arrived and he told us that pigtail and kit had all to be changed within the month. He rather liked our brandy, and we toasted a new entente to "*Askola*". Conversation was carried on through two interpreters,—through the medium of Turki. After tiffin, when the fact that he had had enough was made known to us by the expressive remark that his head was going "*hulla-pulla*", we found that it was nearly tea time.

We had arranged to meet McInnes about the 1st on the Kilik Pass, so on the 30th, we marched to Taghramansu, westwards up the Pamir, and on the following day reached the Kilik Pass, after a halt in Tulboy's hospitable

khourgas, where after much *kow-towing* and *askolas* we bade adieu to Yung Chung Lun, who asked us to stay with him at Tashkurghān. On the way we had an interesting experience in the shape of hunting. Arzu's dog entertained us by stalking and killing a marmot, much to the admiration of my dog Smiler, an optimistic enthusiast, but one who had no idea of hunting for his own food. At the top of the pass we heard that McInnes was in camp at Bun-i-kotal, and sent word to him to meet us on the pass the next day. His chief trouble was the link between the Chapursān and the Kilik, and I believe he had by far the most difficult country. His climbs were worthy of the name, and he was near enough to the Pamirs to get most of the bad weather. He looked thoroughly worn out and from now onwards his health caused us all an extra anxiety. But he stuck to it like a Trojan, and was the last to finish work.

Our food question was now beginning to cause us some fears, as the promised convoy from Hunza was a fortnight overdue and all the men were on half rations; we fell back on the Amban's promise, but as bad luck would have it, a regiment of Chinese troops had arrived in Tashkurghān and commandeered all supplies. The local Begs then came to the rescue and supplemented the small ration with "*lassi*", or sour curds, and I can never be grateful enough to them for all the help they gave me during this time. At the same time I had to reduce my squad and send some men back.

It was bitterly cold on the pass and I believe the wind is always the limit here. It defies description. Heavy dark ominous snow clouds were gathering towards evening, and on the 3rd July after ascending the new station of Kilik East (height 18,203 feet), we commenced to clear the cornice away; we soon found this was too much of a task, and would have taken us days; so we had to build a large platform from which we could see over the cornice to the north.

Our camp was not with us so we came down some 2000 feet for the night. The following morning it was distinctly dismal when we woke up. The country had again become a vast white desolation, and snow was silently falling. Dark threatening clouds loaded with misery rolled overhead, and we remained in our sleeping bags all day.

On the 5th, we again went up Kilik East h. s. The new snow had completely changed the aspect of the country, but the day seemed as though it intended to be more obliging. It was weary work ploughing through the freshly-fallen snow, and when we reached the summit, and set up the observatory tent, the weather had again changed for the worse, and we had nothing to do but crawl back into our sleeping bags, and listen to the *thud-thud* of the snow outside. We were immensely cheered towards evening by the arrival of news that the Hunza *ata* was only two marches off, and it seemed to give us a new hope. The next day was the same monotony redeemed by one faint glimmer of a sun. Twice we left our sleeping bags and cleared away the snow from the observatory tent, and set up the theodolite. But almost at once we had to pack up and crawl disconsolately back into comparative comfort. A coolie, one of the best, arrived in the evening through the blizzard, and found his way to our high camp on the top of the hill with a dâk, the most welcome we had ever received. But there was bad news. McInnes and Collins were having greater trouble than they had expected, owing to a fault in the reconnaissance, and I was asked to observe from the two Kilik stations to the south. This meant that I should anyhow have to revisit Kilik East h. s., so there was little further use in my remaining on the station now, and on the 7th, after again experiencing the same snowy weather, we decided to leave and complete the work on the Pamirs itself. Desolate as the pass seemed under its white pall

of snow, it seemed a veritable paradise after the discomforts of the last few days, but we did not linger and made our way to Tulboy's khourgas, where we were the recipients of his generous hospitality. We exchanged presents, and then had our first bath for over a week.

In the morning the weather was brilliant, and we marched to the Jalung Jilga, and on the following day ascended the hill station of that name (17,510 feet). It was a perfect day, and all the lights showed except one. This we afterwards found was due to both the signaller and his mate being temporarily unwell, and luckily we did not wait. We came down the same day, and followed with an evening march to a spot below our next station, Karakokti (17,708 feet). On the 10th, we went up this station in fine weather, observed to all stations and points, and returned to our low camp.

On waking up the following morning, I found I was snow blind, as was Kulbir, of the 5th Gurkhas. Observing in a snowy land is rather hard on the eyes, and from now onwards till the end of the season my eyes gave me trouble, particularly after a long day's observations. On this occasion I made someone lead my yak to our next camp below Tomtek, from which station we were now going to observe to the forward stations. We met Blandy on the way, who gave us an account of his shooting luck, and he camped with us for the night. He had examined many of the minor valleys in search of *ovis poli*, and had secured some of the best heads in the district. In addition he was able to add to our scanty knowledge of some of the outlying parts of this Pamir. My recorder, Pandit Aftab Bhan, had an accident during this march, and was put *hors de combat* for a month and Hingston very kindly offered to undertake the duties instead. I can never be sufficiently grateful to him for this, and undoubtedly he saved me by this means a large amount of trouble.

We had a great day on the 12th. At the first streak of dawn we did a long trek up Tomtek. There was less of the winter snow than on our former visit, and the new snow had cleared away by now. Again we had the perfect view from the top. Somehow one felt that this one view was worth any amount of discomfort. My eyes were causing a good deal of trouble, and owing to the constant rests that I had to take from this cause, observations were very slow. But all the lights were showing up well and we were lucky in getting the work completed; we were thus able to return to our low camp the same day, arriving just before dark, after a glorious and exhilarating "breeches glissade" for some 3000 feet. We collected a good many specimens of the flora on our way back to camp, for the side valleys were by now enjoying their spring, and, comparatively speaking, the land near the waters of a tributary stream was really almost fertile.

On the 13th we marched to Lup Gaz Jilga, halting *en route* at our depôt for lunch. We camped on the spot where Harry Bell had died almost exactly a year ago. Harry had endeared himself to all these people during his stay on the Pamirs; Arzu told me he had never met anyone who had set such a high example. He refused to contemplate that he was near death, and when Mc Innes arrived after a long day's ride, Harry had told him to go and get some rest. This was the brave spirit that could think of others, when at death's door, and the impression that this act had on the people, was only equalled by the calm resignation with which he faced the end alone. Those who knew Harry best, knew his sterling worth and his splendid qualities, and to some extent can gauge the loss. But it needs a visit to the lonely spot where he died, to get a glimpse of what his thoughts must have been, and get a true answer to "cui bono". A man more unselfish and unconcerned for

his own estate, it would be hard to find, and a more conscientious observer is an impossibility. In a letter Colonel Tcheikine wrote to me from Tashkent, he said "Quant à moi, je suis fort heureux d'avoir pris part au travail universel, avec nos amis les Anglais, mais mon bonheur fut assombri par la mort soudaine du jeune, intelligent et sympathique compagnon de travail, que fut Monsieur le Lieutenant Bell."

At Lup Gaz we built a large cairn to his memory, with a suitable inscription cut in granite, the work of some hours. It is not often perhaps that Mahommedans will apply for permission to build a shrine to the memory of a Christian, but it was so in this case, and I found that the Sarikōlis already knew this valley as the "Bell-Sahib-i-Jilga". His example will remain in the memories of these people for many years to come.

We completed the observations from Lup Gaz, 17,695 feet, on the 14th, and on the next day did a short march to our depôt. It snowed slightly during the day, but nothing to speak of. We had found that the helio men on Lup Gaz had been unwell and we had left a squad to relieve them; so now that we were certain of a light there we returned to below Jalung Jilga h.s. and camped in the Kara Jilga. On the 17th after sending our camp on to Kukturuk, we climbed the station by a ghastly route on shale, finished the observations and followed on yaks to our camp below Kukturuk h. s., arriving about nightfall.

My eyes were rather strained again, but we finished Kukturuk off the next day, being able to ride yaks up the greater part of this, one of our lowest stations. We had been expecting a dâk for nearly three weeks now, and since the bad news from Collins and McInnes on the 6th we had heard nothing, and were getting anxious; a helio message came in from the signallers on Kilik East that they had been watching to the south for some days and had seen no flash from McInnes' helios. I was suffering from an attack of rheumatism, so we decided to remain here for two or three days. Five stations had been ascended and observed from in ten days, which of course had meant very early starts, and late arrivals into camp of an evening. There was always heaps to be done in the evening after dinner, developing the survey photographs, checking means, and writing up a duplicate angle book and notes of the day's work. Hingston generally had in addition to helping me with this, his birds to classify, the flowers to press, and on colder nights, a good deal to say on such subjects as Home Rule, the suffrage question, and Mr. Lloyd George. We both heartily disagreed on these subjects, and found it an admirable way of getting warm. It snowed and blew most of the night of the 20th and we expected another bad spell, but this time it passed off without doing us any harm. I felt very rotten for two days, but was much better after a rest, and on the 22nd, we went back to the Kilik Pass. We went up Kilik East h.s. again on the next day and camped there, but I was not fit enough to take any observations. The following morning, however, Bulnar Singh was out early getting in touch with the various stations, and we were relieved to hear that McInnes had finished observing from Tong-i-tuk, (the old Hark station), which he had ascended from the south, after a very hard time. After finishing the observations we came down to our Kilik Pass base camp, where we remained for some days because McInnes sent us word that he wanted the helios. Helio communication was maintained with Kilik East, so that we could know when McInnes had finished. Hearing no news, on the 28th, we went up Kilik West (18,020 feet), to try and find out what had caused the delay. The Pamir observations were finished off the next day, and those to Tong-i-tuk on the south, but McInnes had not yet signalled through from Lupjangal hill station, and we afterwards found he had mistaken the hills. A cutting snow storm made

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Plate 10. View towards Tong-i-tuk h.s., 19,135 feet, and Hunza from Kilik West h.s., 18,020 feet.

(The V-depression on the left is the Hunza Gorge at Murkushi.)

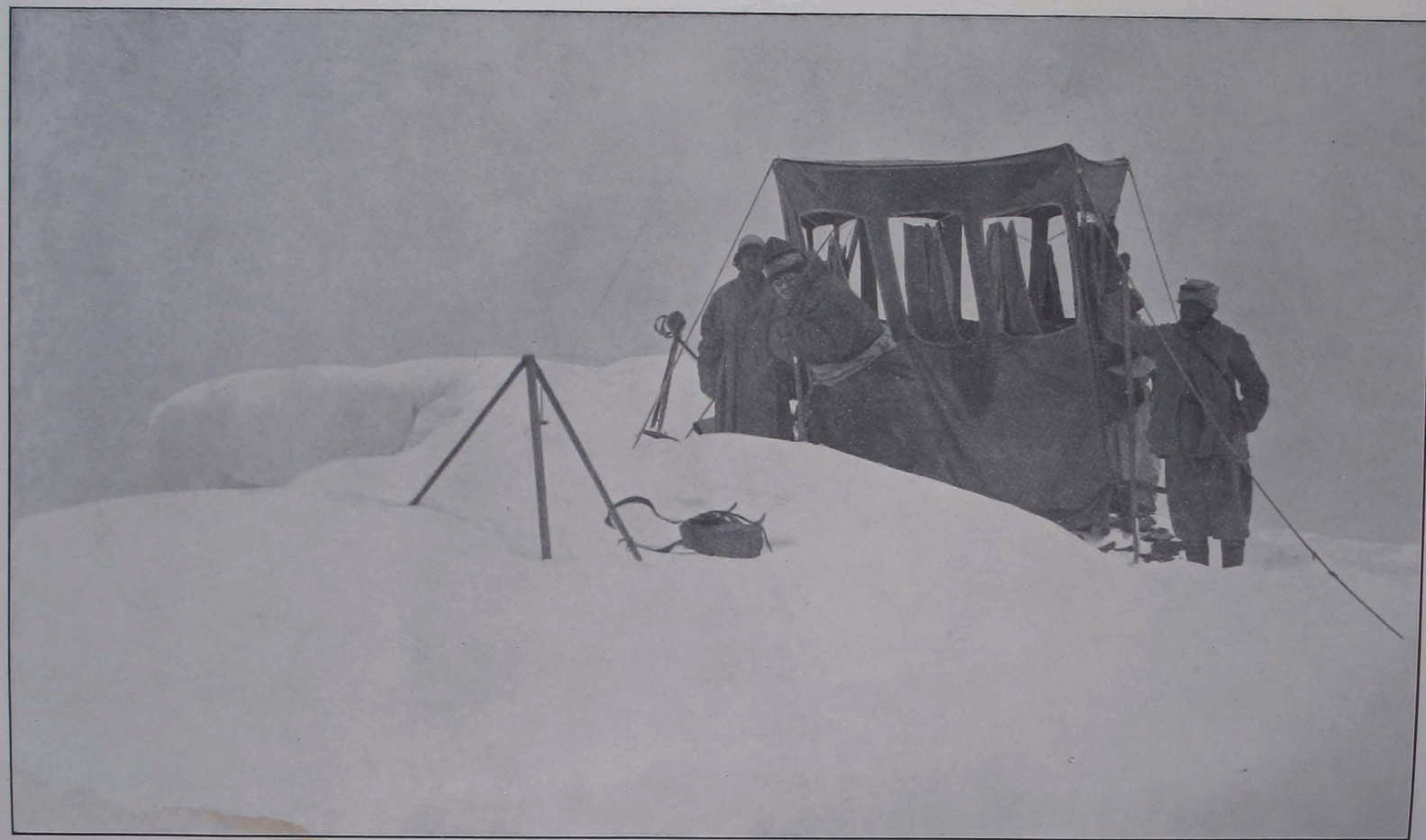

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Plate 11.—On the Summit of Kilik East h. s., 18,203 feet.

things unpleasant in the afternoon and we returned to the more congenial atmosphere of the pass. We were again running short of food, owing to the failure of the Chinese supply. McInnes was also in difficulties for want of food, and expecting every day we should be able to finish off our work, we sent him 800 lbs. of *ata*, again went on half rations, and sent out a foraging party under our Hunza havildar; again we were helped by the generosity of the Sarikōlis. A few sheep were bought at ruinous prices.

On the 30th, it was decided to go to Mc Innes and lend him some help. Some Khirgiz had come in from the Russian Pamirs for medical treatment and Hingston attended to them. Though there was very little medical work for Hingston in our camp, scarcely a day passed that some nomads or tribesmen did not come in for treatment, and Hingston at all hours of the day was to be found busy healing their infirmities. He gained a great reputation, and men would come as much as ten marches for his cures. This left a great impression on the people, and to no small extent contributed, by the good effect it produced on them, to their kindness to us.

These Khirgiz were a very different type from the Sarikōli Tajik we had been accustomed to. All the Mongolian nomads have left the Taghdumbash, and trekked to the sphere of Russian influence. They possess no land or houses in Tashkurghān, and so are quite free to travel from one country to another and become the subjects of any Power, without fear of losing anything by so doing. The fact that the Khirgiz were liable to taxes to both the Chinese and to Hunza, was the primary cause of their removal to Russian territory. Colonel Sir Thomas Holdich, after the Pamir Boundary Commission of 1896, wrote as follows:—"There being but a shadowy line of distinction drawn between the Khirgiz tribal divisions, all of which appear to follow their yearly migrations in search of pasturage on lines which are quite irrespective of national frontiers, we may expect that the whole Khirgiz population will soon be under the domination of the strongest power, possessing the largest share of Pamir. According to information obtained by General Gerard when personally investigating the subject, the Chinese taxation of the Khirgiz is of the most nominal description. All skins of wild animals killed (except *ovis poli*) are given up as tribute to the Amban of Tashkurghān, but no money payment whatsoever. To their own Begs, they pay one per cent annually of all their flocks. Such easy terms are no doubt attractive, but will not suffice to keep Khirgiz nomads permanently from Russian influence"*.

Sir Thomas Holdich's prophesies have come about, and there are now no Khirgiz living on the Taghdumbash. It is possible that this was hurried by the fear of a money tax, such as the one imposed this year by the Amban of Tashkurghān on the Sarikōlis, and which they have flatly declined to pay. From what we could find out by questioning, the grazing on the Russian side appears to be far richer than that on the Sarikōl. Sir Thomas Holdich records that the grass on the Great and on the Little Pamirs is extremely rich; this is certainly not the case on the Taghdumbash, where the only grass suitable for grazing exists near water and the snow line. Again, in the days of the Commission, it is recorded that the Russians had created a very high rate of payment for all sheep and livestock purchased from the nomads, and had insisted on the strict compliance of this order; and one officer was given a week's arrest for disobedience in this respect. They do not appear to be so particular nowadays.

* Report on the Proceedings of the Pamir Boundary Commission, 1896.

The reason that the Sarikōlis have not followed suit, appears to be from the fact that they possess houses and land in Tashkurghān, and they seem to be unwilling to give these up, as they would undoubtedly have to do if they were to migrate to the Russian sphere of influence. But it is just possible they too will leave the Taghdumbash if the Amban insists on a money tax.

On the 31st July we marched down to Murkushi, and after our average height of over 15,000 feet for the last two months, it was like getting down to sea level again. How can I describe the joy of seeing real trees again? Murkushi, which on our arrival two months before had seemed the end of the world, now appeared a regular harbour of civilization. The dwarf willow forest gave us more delight than a walk in Greenwich Park, and I shall always connect willows with this part of the Empire. We camped there for the night and on the 1st August moved out with a very light camp to meet McInnes. After going, however, a couple of miles we received a note from him, saying he was on his way to a forward station, and would be connected through to the Pamir work by the time we could reach him, and that there was no object in our going to him. We therefore left our heaviest kit at Murkushi, and on the 2nd returned to the Kilik Pass, and camped there for some days, anxiously waiting for news. On the 4th we had a helio message from McInnes, through our signaller on Kilik East h. s., to the effect that he had climbed a peak from which he could see Kilik East, and that he intended to connect from this; also that he would observe if fine on the following day. The weather again turned bad during the evening, but the 5th was better, and we went up Kilik East h. s. and found that McInnes was observing to that station. We pitched our 16 lb. Whymper on the summit, and the weather drove us into our sleeping bags early; it was very cloudy all night and a violent snow squall threatened to keep us there for some days.

At last however, on the 6th we got into touch with Murkushi h. s., and were able to complete the observations and come down, before the clouds obscured the hills. Duffadar Beg put us up for the night, and presented the coolies with a sheep to celebrate the success of the work. We now had no doubt that the work would be finished, for the worst had been done, and there only remained the Chapursān stations.

We now hoped to get in ten day's work with the survey camera, and fill in the blanks that had necessarily to be left out during the more important work of completing the link. But we were caught in bad weather near Taghramansu, on the 7th, and on the following morning we awoke to find the ground right down to the Karachukor under a white mantle of snow, while clouds hung very low on the hills. Morning after morning the outlook was the same, the worst spell we had had since our arrival. The clouds seemed to be driven backwards and forwards, up and down the valley, each time the snow being driven almost horizontally, so that it was impossible to see anything. We had now been on half rations for nearly a fortnight, and two maunds of *ata* foraged for by Humayun had been left the other side of the passes, as soon as the weather turned bad. Our ten days' work with the camera had to be abandoned on the 12th, on the morning of which day we only had four days half rations left, and still the day's ration to issue. The wind was very biting and cold on our way to our depôt at Mintaka Akhsai, and we sheltered from the storm at Faqir Shah's encampment. We bought two sheep at ten rupees each at Mintaka, as the Sarikōlis were in the same straits as ourselves as regards *ata*, which had gone up to prohibitive prices at Tashkurghān, and was now being refused to them at any price. In the evening, however, three maunds arrived from the forag-

ing party in Hunza, and we felt more comfortable. Early the next day we started to pack up our depôt, and were able to cut down our kit to a large extent, by the distribution of warm clothing, tins, old bottles, etc., to the Sarikôlis. These latter were immensely appreciated, as were old kerosine oil tins, and it is a useful thing to know that these men almost prefer them to any other form of bakhshish. In the evening a little more *ata* arrived, and I was even able to repay Mahomed Beg for some of his kindness with a present of *ata*, of which he had run out. It was the same dreary day, similar to the previous fortnight, and our last day on the Pamirs was scarcely better.

On the 14th we returned over the Mintaka, a snow squall driving us to shelter in the dâk hut on the summit of the pass with most of our coolies. Now that we were leaving the Pamirs for good, one could not help doing so with a feeling almost akin to regret. It is a desperately inhospitable country where hospitality amongst the tribesmen is a religion. We took away with us memories of a wonderful land, and of a wonderful people, whose kindly characteristics and generous help had lightened our work to a very considerable extent.

CHAPTER V.

THE LINK BETWEEN THE CHAPURSAN AND THE KILIK PASS

by

C. S. McInnes

Extra Assistant Superintendent, Survey of India.

By the end of the 1912 season, an approximate series had been carried from Hunza northwards as far as Khodabad village in the Hunza Valley, and a reconnaissance had also been effected from the Russian stations on either side of the Beyik Pass to the Kilik Pass. It remained to reconnoitre the country between Khodabad and the Kilik.

Khodabad is situated at the junction of the Kilik River, flowing from the pass of that name, approximately from north to south, and the Chapursān River, which flows from the Afghan border on the west. This latter is the main branch of the Hunza River. During the previous season it had been found impracticable to carry the series by the direct route *viâ* Murkushi and the Kilik Valley to the Kilik Pass, and it had been decided to try and force a connexion westwards up the Chapursān and then to strike northwards across the mountains and join up with the Kilik stations.

I shall here give a very brief description of the lower Chapursān, between Khodabad and Spinje, which was the only portion of this valley over which we worked. On leaving the former place, one enters a valley more open and less striking than the Hunza Gorge, and it is pleasing to find that instead of steep pathways hung on galleries and pegs driven into the cliffs, a comparatively smooth and level track over which ponies can travel, is met with. Sixteen miles from Khodabad there is a small jungle of willows, which is known by the name of Spandrinj; the whole of these sixteen miles are extremely barren, and almost unbearable in the summer months owing to the heat. Between Spandrinj and Spinje, a distance of some fifteen miles, there are two small villages, Kil and Reshit, the only two in the whole valley. The combined population only amounts to thirty-five inhabitants. On either side of the river the banks are thickly clothed with willows, but the hillsides on either hand are bare to the last degree throughout the entire length of the valley. The height of the River at Reshit is about 10,000 feet and the mountains on both sides rise to a height of some 20,000 feet, the ascent being gradual for the lower portions, after which the mountains become precipitous and rocky.

In order to carry out the reconnaissance, a detachment was formed in Hunza, consisting of the writer, Gobarayah Havildar of the Hunza levies, six Garhwali khalassies, who were to carry instruments, and who had been enlisted in Dehra Dun, and one levy who was in charge of fifty permanent coolies enlisted in Hunza. Besides this permanent establishment, a hundred extra

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914

Plate 12. A log bridge over the Chapursān.

temporary coolies were engaged to carry rations as far as Khodabad, which had been decided on as our depôt during the season. All arrangements were completed by the 25th May and early the next morning, my whole detachment left Hunza for the first march up the valley, and arrived at Khodabad five days later.

On the 1st June I made my first ascent to a peak due west of Khodabad, accompanied by the havildar and a local guide obtained in the village, and after deciding on the first figure with which to extend the series, we returned to Khodabad. On our way back we came across the tracks of a snow leopard on the snow, and further down the hill we found the remains of a large ibex, which had evidently been killed the previous night. On the following day I set out for a peak on the Kilik-Chapursān watershed, due north of Khodabad, and sent my camp to the foot of the peak. After a very fatiguing climb, mostly over shale and lasting eight hours, I arrived at the summit and made a station, after which I returned to camp. The following day the detachment marched to Spandrinj, and from here on two consecutive days, I visited the two peaks called Spandrinj Sar and Sumayar Sar, situated above the right and left banks of the river respectively; on both these hills stations were built, their heights being 15,640 and 17,249 feet respectively. We started for Sumayar Sar at 6 a. m., and after fording the Chapursān River ascended the Kermin Pass and, continuing westwards along the ridge, reached the peak at about 2 p.m., after having been climbing for five hours over snow in a bitterly cold wind. I may here remark that the high winds for which the Pamirs are noted, terminate at the ridge above the left bank of the Chapursān.

We had been very curious to see what the country north of the valley was like, and from Sumayar Sar we had an extensive view of this land of peaks, which lay between us and the Kilik Pass. The scene was anything but reassuring. We saw numerous peaks ranging to over 18000 and 19000 feet, and shaped like a series of pinnacles. The more rounded and lower ones were under a thick layer of permanent snow, and the approaches to these seemed to be blocked by much-crevassed glaciers which appeared to render them inaccessible. Below us flowed the Derdi, a large stream which enters the Kilik River above Misgar, and the sides of the mountains above and beyond the Derdi looked inaccessible in most places. We returned to camp below the station at 8 p. m. and on the following day made a short march to Reshit, from which place I ascended on the 9th June a peak south of the village, built a station and returned.

The weather which had up till now been brilliant, suddenly changed, and we awoke on the morning of the 10th to find that it was raining heavily, and all the hills round hidden by low clouds. This spell of vile weather lasted for nine days, with brief intervals of fine weather which continued for a few hours, and which I utilized by attempting to climb a peak north of Reshit, but without any success. On the 19th, however, the weather at last cleared, and accompanied by Goharayah, the levy and several coolies, I set out determined to fix my last station in the Chapursān valley before rain came on again, of which there appeared every prospect. For the first 1500 feet the climb was simple, and there was only a little snow on the ground, but beyond this the ascent became stiffer, for about two feet of new snow had fallen. The wind had risen considerably, so that we had to climb from this point in a cloud of snow dust. The coolies, too, began to complain, although the heaviest load was only a planetable, and after every five hundred yards an argument ensued between the havildar and levy on one side and the coolies on the other. How-

avoid a spell of bad weather which set in the following morning and which continued beyond the 5th September, which was the date of my departure from Hunza on the return journey to Kashmir.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta. 1914.

Plate 13.—The Russian Pamirs from Sarblock h.s., 17,284 feet.

CHAPTER VI.

SOME GEOGRAPHICAL IMPRESSIONS OF THE PAMIRS AND THE NORTHERN KARAKORAM MOUNTAINS

by

Lieut. K. Mason, R. E.

Assistant Superintendent, Survey of India.

Perhaps it is wrong to get geographical impressions of a district. But when one is dealing with a complicated puzzle like the Pamirs, it is so difficult to be certain of anything, that practically the only way to set about unravelling the puzzle is to let impressions strike one on the spot and then try and find proof or otherwise. To illustrate the initial difficulty one has only to quote the following passage:—

"Humboldt's conception of the Pamir was a great meridional range connecting the Tibetan and Thian Shan systems, and this view was supported subsequently by Hayward; but Severtsoff and Fedchenko contended that the fundamental mass of the Pamir Plateau was a series of parallel ranges running from east to west. From the plains of Kashgar, Hayward saw a snowy range on the east of the Pamir running north and south. Fedchenko argued that this so-called range consisted only of the ends of the parallel ranges which were running east and west." *

When opinion is so divided as to the *direction* of ranges one is inclined to hesitate with an impression.

Undoubtedly the range that Hayward saw from the plains of Kashgar, was what is now generally known to geographers as the "Kashgar Range", and on Stolickza's authority, this range is a continuation of the Kuen Lun. This Kashgar Range is a higher one than the Sarikōl, which rises behind it and which Hayward therefore could not see. Severtsoff and Fedchenko were more acquainted with the Russian Pamirs, which consist of high glacial valleys, running approximately east and west, and connected on the east with the Sarikōl Range.

We did not have the opportunity of visiting the Great or Little Pamirs, and so our impressions of these have been largely borrowed from the Report on the Proceedings of the Pamir Boundary Commission, 1896, and we started out with the idea that the Sarikōl or Kashgar Ranges were the eastern boundary of the Pamir mass and that the former somehow or other joined up with Sir Francis Younghusband's Aghil Range†. Owing to the decided advantage of high trigonometrical stations, we hoped to be able to get a continuous series of points on this supposed continuation of the Sarikōl Range to show at any rate some present-day range connection with the Aghil. We

* Burrard and Hayden: "*Geography and Geology of the Himalaya Mountains and Tibet*," page 68.
† *Op. Cit.*, page 69.

were met by a difficulty almost at once. All the main spurs and mountains are so much the same height that it was extremely hard to recognize the same point from different stations, and to separate in one's mind the different spurs from ranges. And one's first impression was of a gigantic game of noughts and crosses or of a jig-saw puzzle upset in the toy department of the Army and Navy Stores.

Gradually, however, impressions began to grow, and the first point one became aware of was the apparent termination of the Sarikōl Range on the northern side of the Taghdumbash. There appeared to be no continuation or connection on the southern side. From the Russian station of Sarblock, and from our high station of Tomtek we could see the so-called Sarikōl Range trending more or less northwards, but there appeared to be no continuation to the south. From Takhtakhūn hillstation and from Tomtek we could see far to the south the main Karakoram Range in all its snowy beauty,* and much nearer and a good deal lower there appeared due south of Takhtakhūn another range, less grand and imposing, since it seemed lost in the magnificence of the vast waves of this sea of mountain splendour. This appeared as a line of snow-capped peaks, with depressions between them; but still it seemed to us undoubtedly a distinct range, whose highest slopes and peaks were clothed with eternal snow. This range seemed to trend roughly east and west, but how far in the former direction we were unable to estimate, as the view in that direction was cut out by a series of peaks and spurs of about the same height as our station of observation. The photographic survey has since indicated that these peaks lie on a snowcovered range of which the highest points are between 19000 and 21000 feet.

It seemed to us then that this southern boundary range of the Pamir Plateau was the possible extension of the Northern Hindu Kush on the west, and later in the season we saw what we assumed to be the latter range approaching the country south of the Kilik Pass, and from our stations on each side of this pass we tried to follow a connexion between the two. The country between the Kilik and the Chapursān is a mass of granite peaks; there is a high peak, $\left(\frac{\text{Pk. 31}}{42\ \text{K}}\right)$, south-east of the Kilik Pass, and south of the Mintaka there is a huge dome shaped peak over 21000 feet in height, $\left(\frac{\text{Pk. 57}}{42\ \text{L}}\right)$†. Between Misgar and the Kilik and Mintaka Passes practically the whole structure is granite, excepting some striking recent river terraces between Misgar and Murkushi. It appeared to us that there had been an original connexion between the range we had seen from Takhtakhūn h.s., and the Northern Hindu Kush, and that this connexion used to run south of the present watershed. It seems too, that this idea would be caused by the forces of denudation at work. Assuming that the Taghdumbash Pamir was at a comparatively recent date covered with a glacial cap,‡ the lower depth to which the Hunza River has cut its bed to the south would give the latter great power to cut its course back into the dividing range, which would be practically protected by its ice-covering on the northern side. The glaciers on this side would have no chance of equalizing matters and of keeping the watershed true to its axis. This seems to have been the case, and it seems that the connexion between the ranges mentioned above extended to a point about five miles east of the Mintaka Pass, and then practically followed the present watershed, and possibly joined on to the Aghil Range.

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* See plate 9.

† For the coordinates and heights of these peaks see Appendix A.

‡ See Chapter VII.

In connection with this southern alignment, we again had an opportunity of observing the neighbourhood of the Mintaka Pass on our return journey. During our march up the Mintaka River on the Pamir side, we came on many erratic boulders of granite which could never have been brought down by the present river, and it seems doubtful whether any Pamir *river* could have transported them. They could not have fallen from the neighbouring hills, which are composed of shales and slates, and therefore they must have been derived from the old Northern Karakoram Range. On leaving the Mintaka River, opposite the snout of the Mintaka Glacier, which may be taken as the present source, one ascends a moraine which appears to be a terminal one, formed by the retreating Mintaka Glacier when it reached the bend and changed its direction from south-east to north. At the top of this moraine near the dâk hut, appear a series of what seem to be the lateral moraines of a glacier which originally came from the direction of the pass. Large granite boulders appear in this moraine, but the formation on either side is still shale. These glaciated granite boulders continue to the summit of the pass, which is now much covered by granite blocks which appear to have fallen from the granite cliffs above, which now line the summit of the pass on either side. These cliffs are extremely steep and the pass is very narrow. From near the top of the pass on looking up the Mintaka Glacier, the crest of the watershed at its head seems to run back in a south-westerly direction, and to join on to the main lines of higher granite peaks, south of the Gulquāja Glacier, which is one of the sources of the Hunza River; it looks as though the present watershed between the Mintaka and the Gulquāja Glaciers is only a spur from this original range, and that the latter glacier originally drained through the gorge which is now the Mintaka Pass. This pass has been formed by the retreat of the Gulquāja glacier and the closing of its outlet to the north by the granite débris fallen from the cliff walls. Certainly the Gulquāja Glacier must have been at some higher level than it now is; but it seems that this is the only solution that will account for the polished nature of the granite and the high lateral moraines near the top of the pass, which could never have been formed by any diminutive glacier descending from the present pass. This glacier must have been the Gulquāja; the forces at work in these regions are colossal, and one has only to watch the Hunza River in autumn with its thick pea-soup-like whirl of waters to realize where the cutting power comes from. When the old outlet became choked, the river had a tremendous task before it, but it is probable that by this time the Hunza River had nearly cut its way back and captured the waters of the Gulquāja. The present watershed, as mentioned above, has still on its northern side a covering of shales, while this rock is not met with on the south till below Misgar, and though there is little now in the alignment of ridges and spurs that can be designated by the term *range*, which denotes length and continuity, the high granite peaks south of the passes, one of them rising to over 21,000 feet, seem to confirm the original axis of continuous elevation.

It is perhaps more difficult to trace the width of this range than its continuity, and it now appears more in the nature of a big step on to the Pamir mass. But the fact that the slates on the north of the passes dip approximately to the S.W., at a very high angle, may mean that the original fold was in the form of an inverted anticline to the north-east. It may be a solution that the Sarikōl Range is a long southerly extension of the Trans-Alai or Thian Shan and that with the "rucking up" of the mountains, the crust has become highly compressed in the angle between the Sarikōl and Trans-Alai. If this were so, it would be natural to assume the crust as "bunded up" against this

angle and one would expect the long parallel systems of drainage running from east to west, which is a feature of Pamir topography.

A possible extension of this idea might account for the Kashgar Range to the east. Suppose the Pamir crust to be exerting its pressure against the Sarikōl-Trans-Alai angle, a pressure in the Sarikōl crust from the west would be induced, and this would stand as a buttress in the way of advancing waves of crust from the north or north-east. The Kashgar Range would be the result. There is some evidence that the Sarikōl is older than the Kashgar in the fact that the Tashkurghān River has kept its channel open through a gorge in the Kashgar Range, during the elevation of the latter.*

Appearance of a portion of the Karakoram Range from the North.

Only a small length, comparatively speaking, of the Karakoram or Hindu Kush Range could be seen at one time from any one station on the Pamir, and this portion lay in the extension of the Karakoram Range, west of the Hunza Gorge. Perhaps the best station of observation was Kilik East h. s., though we seldom had a day clear from haze or clouds from here.

The easternmost point triangulated on this range was $\frac{\text{Pk. 33}}{42\ \text{L}}$†. This appears from the north as a large detached peak, the highest thousand feet or so being scarred with rock precipice too steep for much snow to rest upon. Two main arêtes are visible and these meet at a right angle at the summit of the peak and appear to carry slopes of névé on the southern faces. A smaller northern arête abuts the scarred northern face but does not reach the summit. The eastern arête appears to throw out a long buttress towards the north some 3000 feet from the top.

Between this peak and $\frac{\text{Pk. 55}}{42\ \text{L}}$ there is a marked depression. $\frac{\text{Pk. 55}}{42\ \text{L}}$ appears from the north to be a snow pyramid situated on an extensive field of névé, which is almost level, but has a slight gradient upwards to the south-west, where it appears to culminate in a massive dome of eternal snow, which is probably higher than $\frac{\text{Pk. 55}}{42\ \text{L}}$, but which offered no point for triangulation. The névé field finishes abruptly on the northern side in an extensive icefall, from which the range appears to fall steeply into the Batūra Glacier valley.

To the west of this dome, the range is depressed to a saddle and then rises and forms a huge massif for which I could as usual obtain no name. The whole was covered with a glittering icecap and presented very few outcrops of rock for many thousands of feet, and contained few points suitable for triangulation. $\frac{\text{Pk. 32}}{42\ \text{L}}$, 25,540 feet, is on this massif and appeared approximately the highest point, but there were several rounded domes of snow some nearer, some further off, which made distinction impossible. I considered it advisable to make certain of what appeared to be approximately the highest point of this massif, rather than confuse at so great a distance the work with useless observations.

$\frac{\text{Pk. 31}}{42\ \text{L}}$ lies some two miles north-west of $\frac{\text{Pk. 32}}{42\ \text{L}}$ but was not reobser-

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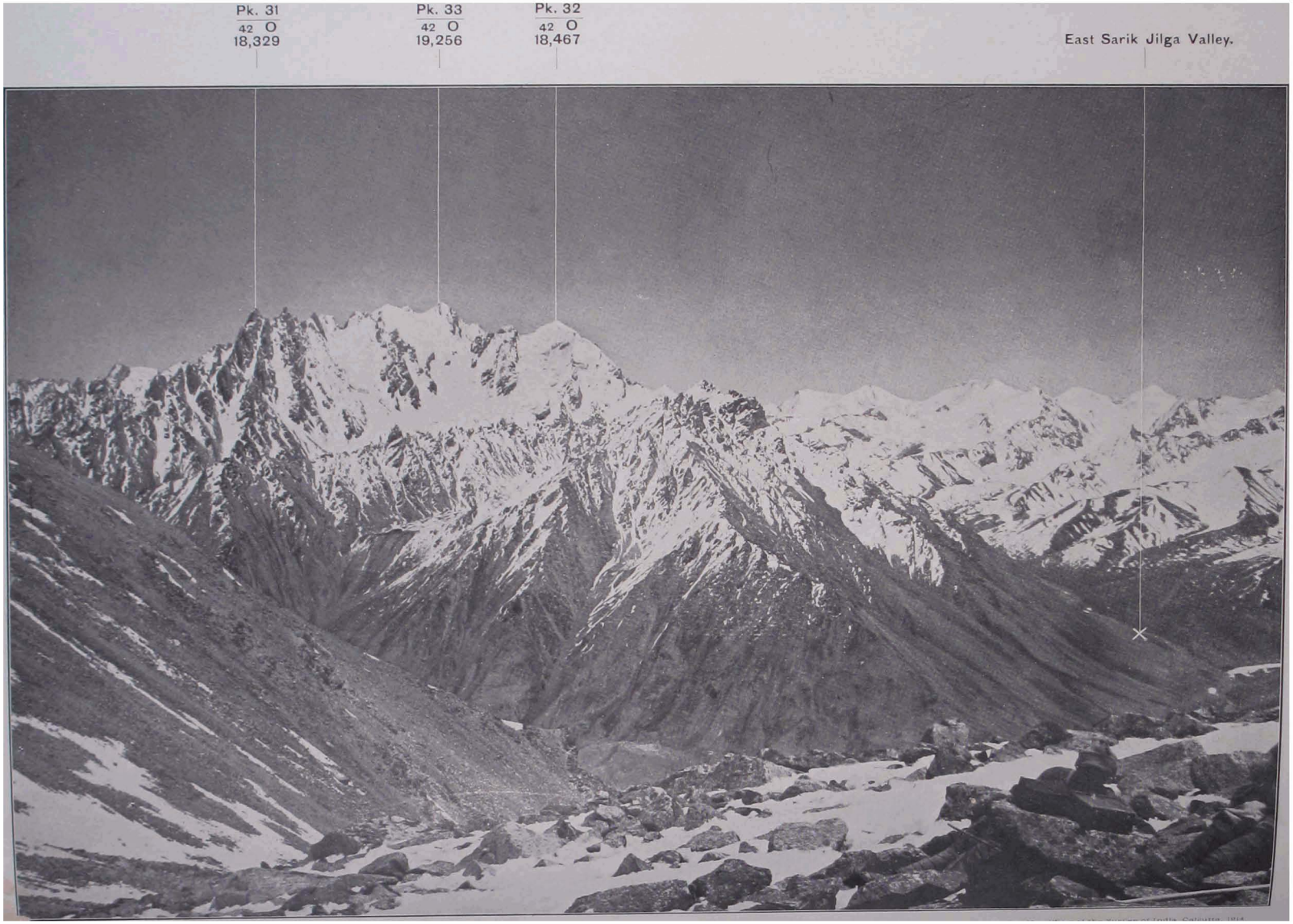
* *Manual of the Geology of India*, 1st edition. 676.(1870).

† For the coordinates and heights of these peaks see Appendix A, Table III.


Pk. 31
42 O
18,329
Pk. 33
42 O
19,256
Pk. 32
42 O
18,467
East Sarik Jilga Valley.

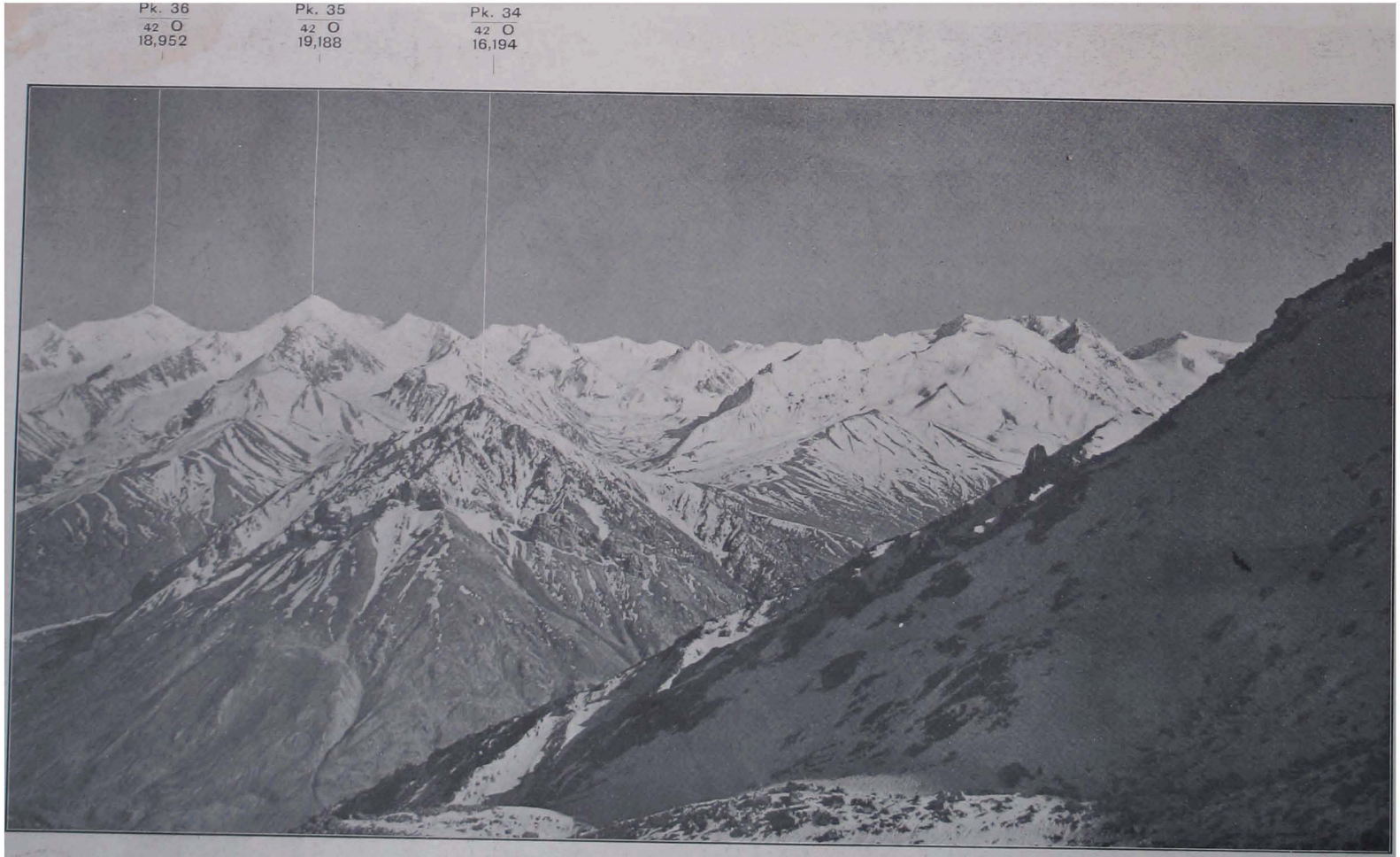


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914.

Plate 15. The Northern Karakoram. Western continuation of plate 14.

ved, and west-north-west of this another peak, $\frac{\text{Pk. } 48}{42\ \text{L}}$, was observed by Mr. McInnes.

$\frac{\text{Pk. } 24}{42\ \text{L}}$ is still further to the west and is a true peak, with an outline somewhat similar to Rakaposhi, except that it presented a series of alternate rock arêtes and snow couloirs. This peak could be likened to a head placed on two fairly symmetrical shoulders, the latter being represented by two long sloping arêtes, east and west respectively.

This line of peaks $\frac{\text{Pks. } 24,\ 25,\ 48,\ 31,\ 32,\ 55,\ 33,\ 34,\ 35,\ 67}{42\ \text{L}}$ indicates the axis of the Hindu Kush or westerly extension of the Karakoram Range, for a distance of some 35 miles.

CHAPTER VII.

SECTION A.

NOTES ON THE GEOLOGY OF THE PAMIRS

by

Lieut. K. Mason, R. E.

and

Capt. R. W. G. Hingston, I. M. S.

The first thing that strikes one on crossing the Mintaka Pass, is the sudden and marked change from sheer and rugged peaks and deep gorges to comparatively undulating hills and valleys. On either side of the Mintaka Valley, as one descends from the pass, the hills are composed of dark coloured slates and shales now undergoing rapid denudation, and capped at their summits by a covering of permanent snow. The impression one receives is that the ice-covering has but in recent geological times left the lower slopes of these hills, as the side nalas can be seen in the very commencement of their formation, and are noticeable by the number of talus shoots, slipping down the mountain side. There is one large shoot which has reached such a size, and has extended so far across the valley, as to have completely diverted the stream from its original course. Looking down on this shoot from above, one is struck by the curious wave-like ripples of the surface, which give the idea of a *flow* and seem to indicate that the mass is creeping downwards.

In this valley, as all over the Taghdumbash, the extreme regularity of the way in which the country has been carved by glacial action is remarkable. Sir Thomas Holdich writes of the Sarikōl Range that "Glacial action has had the effect of wearing the buttresses of this range into an almost architecturally regular succession of gigantic square-cut spurs, each facing the plain with a broad triangular-shaped abutment and each pair in succession embracing a glacier."*

This is true of the Northern Karakoram Range and its spurs. Glacial action could alone have produced this uniformity, and the comparative absence of the denuding effects of rain and rivers, which must have been in force since glaciation retreated, seems to indicate that this retreat is of a tolerably recent date. In fact, the whole Taghdumbash Pamir and its surrounding mountains appear to have been in modern geological times completely covered with an immense ice-cap somewhat similar to the Greenland and Spitzbergen of the present day. This ice-cap was the feeder of the huge main glacier of the Karachukor or Tashkurghān River, and it has now retreated to the summits of the highest mountains.

Further evidence of glaciation exists all over the Pamir in the form of old moraines, (plate 16), some of which are enormous, and are composed

* *Report on the Proceedings of the Pamir Boundary Commission, 1896*, p. 39.

Photolyncure

Survey of India Offices Calcutta, 1914.

Plate 16.—The old moraines of the Taghdumbash Pamir from Karakokti h. s

mainly of facetted granite blocks varying in size from pebbles to huge boulders, and hidden under a scanty layer of soft alluvium which in places is covered with a thin saline efflorescence.

These moraines in places give an extraordinarily false impression. Close to the junction of the Kilik and Karachukor Rivers they appear in the form of a series of terraces rising one above another at regular intervals and reaching hundreds of feet up the mountain side. In one place we counted as many as twelve of these terraces, which at first appeared to be the ancient beds of the river before it had cut its course down to the present level. But on closer examination we were surprised to find that these terraces were composed to a large extent of huge granite boulders, polished and facetted, and showing no signs of having been *rolled* into their present position by water action, nor any regularity in their deposition. They are without doubt the products of glacial action and must have been left in the form of terraced moraines by an enormous glacier at regular intervals during its retreat.

One can conceive the whole valley filled with a large glacier and the hills bordering it covered with a glacial cap. Should a *permanent* change of climate occur, and it become warmer with a diminution of snowfall, the glacier would necessarily retreat. After the climatological cycle is complete, one can again conceive the glacier as tending to re-advance, but owing to the *permanent* change in climate, the *secular* advance is more or less balanced by the *permanent* tendency to retreat, and the glacier either remains stationary, or else slowly advances or retreats, leaving lateral and perhaps terminal moraines. After the period for advance of the glacier, (during which it has remained practically stationary), the secular period of its retreat begins, and in this retreat it is again aided by the permanent change in climate; the glacier rapidly retreats leaving no moraine, until the semi-cycle of retreat is complete, when for a period the glacier again becomes practically stationary, and again deposits moraine. In this way, by a permanent general change of climate and a succession of secular variations of the glacier, these terraced moraines may be explained. And their remarkable regularity in size seems to indicate periodicity.

The great majority of peaks and ridges over 18000 feet are still ice-capped, and on the northern and eastern slopes this cap generally extends down in the form of a hanging glacier or field of névé, terminating in an impassible icefall, which in the distance gives it the appearance of clotted cream pouring over the lip of a jug.

Many of the hills, especially those spurs ascended on the northern side of the Pamirs, were composed of granite, and it is probable that owing to the more direct nature of the sun's rays on the southward facing slopes, the ice-covering was here removed earlier than on the northward facing ones and that the denudation of the deposits here is practically complete.

Careful search was made for fossils amongst the shale, but none were found. The dip of the slates measured on Mintaka h.s. was 70° W.S.W., but this was by no means constant, and on Kilik East h.s. it would vary between 30° and 70°. It seems curious that these slates should have, on what appears to be the northern slopes of the granite range of the Northern Karakoram, a tendency to dip to the south, but the extreme irregularity of this dip may indicate that they have suffered from later compressions and contortions since the elevation of the range, or that the whole has been inverted to the N. E. This again would be a curious feature as most of the great anticlines of the south are inverted to the south.

CHAPTER VII. (*Continued*).

SECTION B.

EXAMINATION OF CERTAIN GLACIER SNOUTS OF HUNZA AND NAGAR

by

Lieut. K. Mason, R. E.

THE MINAPIN GLACIER (NAGAR)

(Observed 20th May, 1913).

This glacier was observed by Mr. H. H. Hayden, Director of the Geological Survey of India in 1906, and his sketch map and report taken as the basis of observation.* The new position of the snout was mapped on Plate 35 of his report, and is shown on plate 17 of this.

As will be seen from this, the glacier has advanced about 700 feet since 1906, and appears now to be heading due north, after having piled and banked up an immense pack of black ice, down which rocks are constantly falling. The snout now falls rapidly with a series of minor transverse crevasses and there are no surface streams.

As regards 1906 marks; A is buried by the advancing ice, and B and C are also covered. E, P, and D, were all found and made use of; a photograph was taken from E (plate 18) according to Mr. Hayden's suggestion for comparison with his which is reproduced in plate 23, Vol. XXXV, Records of the Geol. Survey of India. A photograph was also taken from P across the glacier and another of the snout from a point about Z.

There is no sign of any terminal moraine and it may be that the glacier is still advancing, or that the torrent is carrying away the débris. The upper part still agrees exactly with Mr. Hayden's description and its icefall remains in the same position, and appears to have very similar features.

A cross was cut at X, (see plate 17) above the snout on the left side and painted $\overset{X}{\underset{\oplus}{13}}$ in black. Bearings to the snout:– from P, 24°; from X, 61°; from E, 158°. X is beside the same path leading to the summer grazing grounds mentioned by Mr. Hayden. The bearing from E to X is 163°. There were no signs of any of Mr. Hayden's cairns, which have probably been swept away by snow, but the paint had remained in fairly good condition. Mr. Hayden's marks were all repainted with black enamel.

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*Records Geol. Survey of India, Vol. XXXV. Pl. 23, 24, 35, and p. 131.

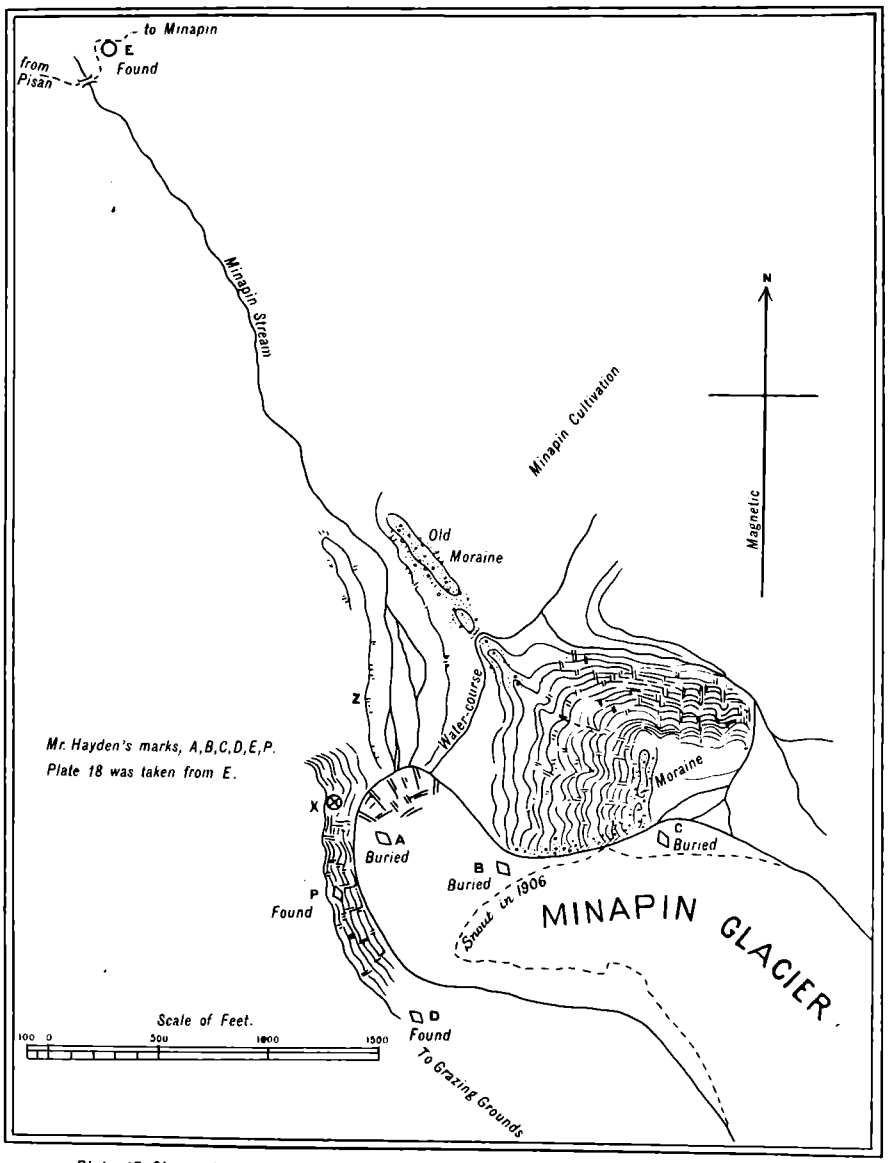

Plate 17. Chart showing the Advance of the MINAPIN GLACIER between 1906 and 1913.

Photo. Engraved & printed at the Offices of the Survey of India, Calcutta, 1914

Plate 18. Photograph of Minapin Glacier from Mr. Hayden's Station E; X, Snout of Glacier.

THE HASSANABAD GLACIER, (HUNZA).

(Observed 20th May, 1913).

This glacier was also measured and marked by Mr. Hayden in 1906.* On the 20th May 1913, the snout appeared in practically the same position. Of Mr. Hayden's marks– "2" was easily visible on the granite-veined cliff east of the glacier and could be read through field glasses, from "3". The latter mark has apparently slipped some 50 feet down the hillside and is now a little below the Garukin irrigation channel. A photograph was taken from here which gives a precisely similar position of the snout to Mr. Hayden's, reproduced in plate 32 of his report. Mr. Hayden's mark "1" has been carried away and lost down the slope. Station "3", described by Mr. Hayden as "near the last (most northerly) group of bushes" is now slightly incorrect, as a few more bushes have sprung up along the channel to the north. But the position of the boulder is fairly well known, and should serve as an excellent position for photographic comparisons at some future date. Mr. Hayden's marks '2" and "3" were repainted in black.

†Mr. Hunter Workman visited the snout of this glacier in 1908, and found that the glacier had remained stationary since 1906, and it may be safely assumed that there has been no advance or retreat since that date.

THE SASAINI GLACIER.

LITTLE GUJHAL, (HUNZA).

(Observed 25th May, 1913).

This glacier feeds the Hunza River from the west about $2\frac{1}{2}$ miles north of the village of Gulmit and just south of the village of Sasaini.

The snout approaches to within about 300 yards of the left bank of the Hunza River. There is a small icecave at the snout, and the ground is littered with massive blocks of black ice, much intermingled with boulders and débris. There are several moraines, impossible to distinguish from one another, and it is even impossible to say of many of them whether they are laterally or terminally formed.

At the present time the north side of the glacier (left bank) is bunded up against a well marked lateral moraine, and towards the village of Sasaini there are several old lateral moraines, which tend to show that the glacier at one time met the Hunza River further north than at the present time.

The inhabitants told me that this glacier has never been known to block the Hunza River, but that it is now slowly advancing; and that the snout annually varies to a certain extent laterally. Owing to the instability of this glacier, it was impossible to make any accurate observations or to mark any rocks, as all are moraine material in the neighbourhood of the snout‡.

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* *Records Geol. Survey XXXV.* p. 135.

† *The Call of the Snowy Hispar*, p. 25.

‡ This glacier varies so much that on our return visit late in August, many of the large blocks seen in May, had been carried down by the torrent which now rushed from a much larger ice-cave quite 50 feet in height.

THE PASU GLACIER.

LITTLE GUJHAL, (HUNZA).

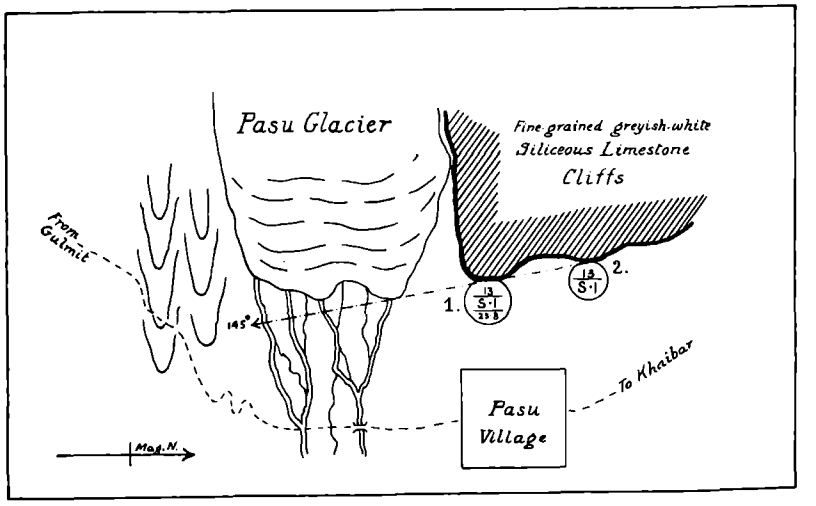
(Observed 25th May, 1913).

At the top of the terrace on which is situated Baurit, one sees a long lateral moraine placed high on a solid foundation of cliff. This moraine must have been formed when the Pasu Glacier had advanced far into the Hunza River bed. Looking down from this moraine, there were two further lateral moraines visible on this side of the glacier, so it appears that the top one was laid down first, and that the glacier then suddenly retreated. It then appears that the glacier remained stationary while the second moraine was being formed and then retreated again. Another halt and another moraine was formed and this is above the present level of the glacier. It seems too that this glacier has retreated of recent years, for on the map it is shown as right across the Hunza River. But all absence of terminal moraine seems to argue that the glacier has retreated too fast for any bank to form.

Plate 7 shows the position of the snout fairly well. This was taken from the top of the highest southern moraine.

Observations on 23rd August.

On August 23rd some further observations were made of the present position of the snout. Owing to the moraines on the south side it was considered inadvisable to put any marks on that side, but the limestone cliff on the northern side offered a good place for marks. The sketch below is only rough and not drawn to scale, as there was no time to make an accurate survey. Two marks were painted in black on the cliff as sited roughly in the sketch, so that the line joining them and produced passes through the foremost and northernmost of the two noses, the whole snout being cleft, as shown



Diagrammatic Plan of the Snout of the Pasu Glacier 23rd August 1913.

Not drawn to scale

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta. 1914

Plate 19. View towards the snout of the Pasu Glacier from $\frac{13}{S\,1}$; Snout of glacier, X.

in the sketch. The lower one $\frac{13}{\frac{S.\ I.}{23.8}}$ is near the angle of the cliff, while the higher one, $\frac{13}{S.I.}$, above a talus fan, is some 100 yards further north on the cliff. The photograph, (plate 19) shows a view of the north nose of the glacier from (2), in a line with (1). The bearing of the indicating line was 145°.

The lumbadar knows the marks and their purpose, and scouted the idea of the glacier ever advancing again sufficiently to do any harm, but gave us the following interesting information about the Batūra Glacier, some two or three miles north of Pasu.

Note on the Batūra Glacier.

'About 40 years ago, the Batūra Glacier advanced and blocked the Hunza Valley, thereby causing a lake to form north of it. This finally burst its glacial dam, caused a flood and carried away part of the old village of Pasu. Near the edge of the river bed are still the remains of houses, and the whole of the bed corroborates this statement*. Opposite the snout of the Batūra Glacier are the remains on the left bank of the Hunza River of a continuation of the Batūra moraine; but these we were only able to view through field-glasses from a distance. After the deluge the village of Pasu was placed further back.

* It is, however, possible that this appearance of glacial floods is caused by the damming of a glacier in the Shimshal or Skingshal River, which joins the Hunza River between the Batūra snout and Pasu. This periodically happens, the last case recorded being in July 1906—*Vide* Frontier and Overseas Expeditions from India, Vol. I. p. 10.

SECTION C.

ROCKS FROM THE TAGHDUMBASH PAMIR AND FROM HUNZA.

Collected by Lieut. K. Mason, R.E., Survey of India, and Capt. R. W. G. Hingston, I. M. S.;

described by

J. Coggin Brown, M. Sc.

Geological Survey of India.

Rock No. 27/701 (*Col. No.* 1-4-6-13) — From S. side of hill on which is situated Mintaka hillstation; about 15,300 feet. *In situ. (Taghdumbash Pamir).*

Black, lustrous, phyllitic slate; somewhat contorted, with well-developed slaty cleavage.

Rock No. 27/702 (*Col. No.* 2-4-6-13) — From amongst shaly débris in the tributary stream descending S. E., from Mintaka hill station, to join the Mintaka stream. About 14,000. *(Taghdumbash Pamir).*

Crystalline vein quartz. One surface is partly covered with small but well-developed quartz crystals, stained light brown.

Rock No. 27/703 *Slide No.* 10308 (*Col. No.* 3-9-6-13) — From summit of Sarblock hillstation, *(Russo-Chinese border, Sarikōl Range, 3 miles E. of Bēyik Pass). In situ.*

Medium grained biotite granite. The rock possesses a speckled appearance due to the great abundance of small, well developed biotite crystals.

Under the microscope it is seen that felspar and mica make up the larger proportion of the mass. Clear quartz grains are present only in subordinate quantities, and minute grains of magnetite in smaller quantities still. The felspars consist of plagioclase (probably oligoclase), microcline and orthoclase. Kaolinization of the felspars, especially of the former two, has commenced to take place. The biotite is of two varieties, a brown kind in large idiomorphic crystals, and a green variety in smaller flakes, often intergrown with the former. Grains and small rods of apatite are the only accessory mineral.

Rock No. 27/704 *Slide No.* 10309 (*Col. No.* 4-25-6-13) — From left bank of Tomtek stream (west stream). This stream joins left bank of Karachukor opposite junction of Karachukor and Mintaka Rivers. *In situ. (Taghdumbash Pamir).*

Grey rhyolitic porphyry. A profoundly decayed grey and greenish-grey rock, in which small idiomorphic quartz crystals and grains can be detected with a lens, in a felsitic background.

Under the microscope, a section exhibits a uniformly opaque groundmass, in which a few clear idiomorphic quartz crystals, and outlines of felspar crystals entirely replaced by kaolin are seen. Patches of a greenish decomposition product represent a former ferro-magnesian constituent. The groundmass was probably felspathic, for it is now completely changed to greyish kaolinitic products with a good deal of calcite. The presence of the latter mineral is confirmed by the fact that the rock effervesces slightly with acid.

Rock No. 27/705 ....Grey felspathic rock, probably a quartz porphyry in the last stages of decomposition. Effervesces freely with acid.

Slide No. 10310

(*Col. No.* 5-25-6-13)

From right bank of Tomtek Stream, (west stream). *In situ. (Taghdumbash Pamir).*

Under the microscope, clear idiomorphic quartz crystals are seen to be the only unaltered mineral. Outlines of kaolinized felspars remain, and the greenish decomposition products of some ferro-magnesian silicate. These are set in a felsitic matrix now entirely changed and speckled with small particles of calcite.

Rock No. 27/706 .....Grey porphyry. A greenish-grey rock, speckled with white; small felspar crystals and cubes of pyrites are visible to the naked eye.

Slide No. 10311

(*Col. No.* 6-25-6-13)

From right bank of Tomtek Stream, close to entrance of main valley. *In situ. (Taghdumbash Pamir).*

Under the microscope the specimen is seen to be extensively decayed. The groundmass now consists largely of kaolinitic and chloritic decomposition products, with patches of a yellowish mineral, probably epidote. The phenocrysts are felspars now extensively decomposed; their outlines show smaller well developed crystals and larger rounded pieces, evidently corroded. A few quartz grains appear to be present. There are no structures visible, suggestive of glassy rhyolites, and the fresh rock evidently closely approached a true porphyry in composition and structure.

Rock No. 27/707 .....Basic agglomeratic ash (?) A dark greenish-grey, very decomposed specimen, flecked with minute patches of darker and lighter shades.

Slide No. 10312

(*Col. No.* 7-25-6-13)

From right bank of Tomtek Stream, (west stream), close to entrance of main valley. *In situ.* (*Taghdumbash Pamir*).

Under the microscope it shows remains of kaolinized felspars, usually of irregular outlines, angular fragments of quartz in small quantities, and brownish and yellowish-green alteration products largely composed of epidote. The groundmass consists of weathered felsitic and chloritic minerals sprinkled with specks of magnetite. Reddish grains of hæmatite and hæmatite dust are also present.

This rock may have been a basic lava, but it is so far changed that its original character is not quite evident though I am of the opinion that it approaches closest to a basic agglomeratic ash.

Rock No. 27/708 .....Massive, contorted, siliceous slate, greenish-grey in colour with shining grey contorted surface.

Slide No. 10313

(*Col. No.* 8-14-8-13)

From débris at base of talus shoot in Mintaka Nala. (*Taghdumbash Pamir).*

A section examined under the microscope shows that the exceedingly fine siliceous background is plentifully sprinkled with grains of a brown oxide of iron. The shape of some of these proves that they are derived from small crystals of pyrites. Minute cracks filled with the same material traverse the slide.

Rock No. 27/709 .....Biotite hornblende granite. Black crystals of biotite and hornblende embedded in a matrix of bluish quartz and white felspar impart a speckled appearance to this rock. The texture is medium fine and there is no banded structure visible on the small hand specimens. The felspars are orthoclase and albite (?) and both are much altered. Hornblende is more abundant than biotite and occurs as green, well developed crystals showing the prismatic cleavage and lamellar twinning parallel to the orthopinacoid. The crystals are markedly pleochroic. Small magnetite grains are a common inclusion. The brown biotite flakes are but little altered. Clear grains of quartz small light coloured garnets and rods of apatite are also present.

Slide No. 10314

(*Col. No.* 9-14-8-13)

Fragments from erratic boulder in Mintaka Valley. Similar to granite débris on Mintaka Pass. (*Taghdumbash Pamir*).

Rock No. 27/710..... Greyish-black slate, traversed by thin calcite veins.
(*Col. No.* 10-18-8-13)

From Kilik branch of Kanjut or Hunza river, right bank, 1½ miles above (N. W.) junction of Khūnjerab and Kilik rivers and 2½ miles S.E. of village of Misgar. Angle and direction of dip, very variable. Here measured 75° N.N.W., but sometimes practically vertical. (*Hunza*).

Rock No. 27/711..... Dark, bluish-grey limestone, traversed with small cracks and gashes filled with calcite.
Slide No. 10316
(*Col. No.* 11-18-8-13)

From about 1 mile N. of Chapursān and (Hunza) Kilik rivers, on right bank of latter river, sited in a "*parri*" and overlain with much later river conglomerate. The site is also about 2 miles S. of Belia Parri (marked Beliachur on 1/4" map). The dip was extremely variable and it would have been useless to measure it. *In situ*. Unfossiliferous. (*Hunza*).

Rock No. 27/712..... Fine, even-grained, greyish-white, siliceous limestone.
(*Col. No.*12-22-8-13)

From cliffs west of track on west side of Kanjut (Hunza) river, ½ mile N. of the village of Pasu. *In situ*. (*Hunza*).

Rock No. 27/713..... .... Dark, bluish-grey, siliceous limestone, with calcite-filled cracks. Appears to have developed an incipient slaty cleavage.
Slide No. 10318
(*Col. No.* 12 A)

From cliffs above southern moraine of Pasu glacier, near the track. Dip 65° N. E. Covered on the S. side by shale on which is situated Baurit. (*Hunza*).

Rock No. 27/714..... A fine grained biotite gneiss forming a speckled black and white rock, very friable and full of biotite mica.
Slide No. 10319
(*Col. No.* 13-24-8-13)

A section shows that the rock is entirely composed of brown biotite, green amphibole, clear quartz and some plagioclase felspar which has undergone little alteration.

From "*parri*" about 3 miles south of Gulmit. This rock was seamed in all directions by light coloured and often white granite veins. (Spec.14). Karakoram Gorge. *In situ*. (*Hunza*).

Rock No. 27/715..... Very coarse white granite, with large crystals of quartz, felspar and muscovite mica. Small red garnets are also present. Some of the quartz has a curious light-green tint. The specimen shows a contact with fine biotite gneiss.
Slide No. 10320
(*Col. No.* 14-24-8-13)

Specimens of the white veins intersecting the previous specimen, from "*parri*", 3 miles S. of Gulmit. (*Hunza*).

CHAPTER VIII.

ZOOLOGY

by

Capt. R. W. G. Hingston, I. M. S.

SECTION A.

NOTES ON THE FAUNA OF THE TAGHDUMBASH PAMIR.

A bleak and barren country, in which the deepest valleys lie at an altitude of 13000 feet and the highest mountains reach to 18000 and 19000 feet, cannot be expected to possess any but the very scantiest of Fauna. Moreover, when it is borne in mind that, save for a short Alpine summer of three or four months, the whole country, mountains and valleys alike, is concealed in a thick mantle of snow, there seems less reason for wonder at the scarcity of the animal life than for amazement at its very existence.

The fauna of the Taghdumbash Pamir is, therefore, essentially poor. During a period of almost $2\frac{1}{2}$ months, from the 3rd June to the 14th August, only 47 species were obtained, and, though this collection will seem exceedingly small, it may be considered as fairly representative of the animal life in those barren regions.

The one mammal that may be regarded as in any way common is the Golden Marmot. In the bed of every valley, along the bank of every river, and on the mountain sides up to an altitude of 15000 feet, this interesting little creature was continually seen. One of the few sounds heard in the silent desolation of the Pamirs was the prolonged scream of the marmot followed by a series of shrill bird-like chirps. When alarmed, it sits erect on its hind quarters, presses its fore limbs firmly to its chest and, continuing to utter its sharp piercing cry, peers about in all directions and then, suddenly espying the cause of its alarm, gives a last scream of defiance and plunges swiftly into its burrow. It usually lives singly but, occasionally, small communities in favourable situations suggested a gregarious nature. A position frequently selected by the Golden Marmot for the construction of its burrow lies beneath the shelter of one of the large erratic granite boulders which lie strewn in such profusion along the bed of almost all the valleys. The burrow is about 10 inches in diameter and opens on the surface at an angle of about 30 degrees. It supports an arched roof so that a cross section of the burrow would be represented by a segment of a circle in which the base of the segment would correspond to the floor and the arc to the roof of the burrow. The greatest enemies of the marmot are the brown bear and the domestic dog of the Sarikōli nomads. The former, deprived of its vegetable diet, digs the marmot from its burrow, and the dog, after stealthily creeping on its prey, dashes suddenly on any marmot which has happened to wander dangerously far from the mouth of its retreat. At the entrance to many of the burrows were observed the deep claw-marks of the bear, and one burrow, seen uprooted throughout its whole length, was found to measure 21 feet. On two occasions a marmot of a much darker colour was seen and it may possibly have belonged to a different species.

Herds of Ibex haunt the shaley slopes of all the mountains. Each herd usually comprised about 10 or 15 individuals but occasionally a large herd of many hundreds covered the whole hill-side. From a sportsman's point of view, these animals proved disappointing, as the size of the heads was as small in proportion as their numbers were great.

Of all the animals in Central Asia, there are few more eagerly sought for by the sportsman and of more interest to the naturalist than the Great Pamir Sheep (*Ovis poli*). This magnificent creature, the noblest of its kind, appears to be approaching rapidly towards ultimate extinction. Sportsmen, of a generation ago, tell of the great herds which browsed upon the mountains and frequented every valley. The traveller is now made aware of its presence by the countless skulls and horns, in all stages of decay, which everywhere strew the ground. In the large majority of cases the horns are those of fully developed males, and this is somewhat surprising, as the cause of such destruction is due to the numbers killed by the nomads in winter with hunting-dogs, and one would expect that the younger males and females would be captured more easily than the older and stronger males. On one occasion a dilapidated head, of which the horns measured 65 inches, was found in the Kukturuk Valley but it had apparently lain there for many years. The Beyik and Kukturuk Valleys are those most frequented by the *Ovis poli* and it is there that the sportsman will most probably be rewarded. In the early mornings and in the evenings the *poli* descend to the low feeding grounds, sometimes to the bed of the valley, and in the heat of the day they retire to the shaley slopes high up the mountain side. The manner in which the Sarikōlis pursue them with dogs is of interest. One or two hunting-dogs are put at a herd and, on reaching it, they single out one individual which they bring to bay. It is stated that the *poli* chooses a prominent rock or other exposed position and, with head low, endeavours to drive off its attackers. Meanwhile the Sarikōli, armed with an antiquated matchlock, creeps stealthily towards the animal, whose whole attention is diverted to the dogs, and reaching within a range of about 50 or 60 yards, is able to shoot it without difficulty.

In the year 1896 the Tibetan Hare was described as being as common on the Taghdumbash Pamir "as rabbits in an English warren". It is now, however, but seldom seen and occupies the small sheltered glens rather than the more exposed and open valleys. On the Little Pamir it is described as being gregarious and occupying burrows, but, according to the Sarikōli nomads who inhabit the Taghdumbash Pamir, it never enters burrows and we certainly never saw any sign of them.

An animal which causes much destruction amongst the *Ovis poli* and also the domesticated flocks is described by the nomads as the wild dog. In all probability they refer to the common wolf, (*Canis lupus*). The herds of goats and sheep have to be continually under protection to save them from this pest. Throughout the day they remain in charge of their owner and at night they congregate around the encampment and are guarded by a number of lank and semi-domesticated dogs. One unfortunate Sarikōli had six of his flock destroyed by wolves in a single night.

A shy and wary animal, which was noticed on the Taghdumbash Pamir at an altitude of 16000 feet, was the common fox. When alarmed, it became most distrustful and curious, and remained gazing at us from long distances but never permitted us to approach to close quarters. Another common little mammal is a species of Mouse-hare. It haunts the narrow and sheltered valleys, frequents the great piles of moraine débris and, when alarmed, hides itself in the clefts of the rocks or beneath the shelter of large boulders.

Of birds, by far the most common is the Red-billed Chough. It might be considered as almost ubiquitous. It frequents all the valleys and, in large flocks, feeds on the pasture grounds; it ascends the slopes of the hills high above the snow line and was often attracted to our camps at 18000 feet. But this is by no means its limit of altitude, for it may often be seen soaring far above the highest mountains. It associates freely with the Yellow-billed Chough. The Horned Lark and Gould's Chat may also be considered as common species. The former nests freely in the exposed valleys during the months of July and August. Güldenstadt's Redstart was seldom obtained below 14000 feet; the banks of the mountain torrents and the sides of the old moraines are its favourite haunts. It nests in the months of June and July. The prolonged whistle of the Himalayan Snow Cock was almost as common as the shrill cry of the Marmot. They frequent some valleys in large numbers keeping to the snow line, while other valleys were completely deserted. Nests of the White-bellied Dipper and the Siberian Martin were obtained in the month of July; the former was only partially built and the latter, though placed in an inaccessible situation, was believed to contain young.

No Reptilia or Batrachia were seen, and, in all probability, they do not exist at such high altitudes.

The main rivers, their tributaries, and the isolated pools along their margins teem with fish of the species *Nemachilus stoliczkæ*.

Seventeen species of butterflies were taken on the Pamirs, of which by far the most common was *Pieris glauconome*. One specimen was obtained at 17000 feet and a solitary specimen of *Parnassius epaphus* was captured in the snow at one of our camps, the altitude of which was over 18000 feet. An ant of the genus *Lasius* was extremely common in all the valleys and a bee was taken on the Kilik Pass at 15600 feet.

All creatures in these bleak altitudes live in a continual struggle with Nature in her fiercest and sternest moods. In winter the domestic animals dig deep down into the snow in the search of a scanty pasture or seek the most exposed and the wildest valleys which the biting winds have swept clear of snow. And though few are the hardy creatures that can wage a successful war with these rough elements, yet it is their presence that brightens the landscape and their voices that break the silence of that land of desolation.

CHAPTER VIII *(Continued).*

SECTION B.

A SYSTEMATIC ACCOUNT OF A ZOOLOGICAL COLLECTION MADE ON THE TAGHDUMBASH PAMIR

by

Capt. R. W. G. Hingston, I. M. S.

Many of the heights given in the following account were taken with an aneroid barometer and therefore must be considered as only approximate though, in no case, probably is the error more than a few hundred feet. Triangulated heights have been used wherever available.

With the unavoidable exception of a very few cases, suitable references have been given, especially those relating to previous expeditions into Central Asia.

MAMMALS.

Order *RODENTIA.*

Family SCIURIDÆ.

1. ARCTOMYS AUREUS.—The Golden Marmot.

Arctomys aureus, Blanford, Mammalia of 2nd Yarkand Mission, pp. 33 to 36; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 59.

The most common mammal on the Pamirs. It ascends the slopes of the hills to about 16000 feet.

Family MURIDÆ.

2. MICROTUS BLANFORDI.—The Gilgit Vole.

Arvicola blanfordi, Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 60.
Microtus blanfordi, Blanford, Faun. Brit. Ind. Mammals, p. 432.

A single specimen, the only one seen, was taken on the Kilik Pass at 15600 feet. Mr. N. B. Kinnear, of the Bombay Natural History Society, very kindly identified this species for me, but, owing to the absence of the skull, he cannot give quite a definite opinion. The species has also been taken in the neighbourhood of the Little Pamir so that, presumably, his opinion is correct.

Family LEPORIDÆ.

3. LEPUS TIBETANUS.—The Hare of Little Tibet.

Lepus pamirensis, Blanford, Mammalia of 2nd Yarkand Mission, p. 67; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 60.

Very uncommon. A few specimens were obtained early in July.

Order *UNGULATA*.

Family BOVIDÆ.

4. CAPRA SIBIRICA.—The Himalayan Ibex.

Capra sibirica, Jerdon, Mammals of India, p. 292.

Large herds frequent the hill sides. The horns of all specimens shot were very small.

5. OVIS POLI.—The Great Pamir Sheep.

Ovis poli, Jerdon, Mammals of India, p. 299; Blanford, Mammals of 2nd Yarkand Mission, p. 83.

Three specimens were obtained by members of the party; the horns of these measured between 50 and 53 inches.

BIRDS.

Order *PASSERES*.

Family CORVIDÆ.

1. CORVUS MACRORHYNCHUS.—The Jungle-Crow.

Corvus culminatus, Sharpe, Cat. B. M. 3, p. 20.
Corvus macrorhynchus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 17.

The Jungle-Crow was seen occasionally on the Taghdumbash Pamir, but never at an altitude above 14500 feet.

2. GRACULUS EREMITA.—The Red-billed Chough.

Graculus graculus, Sharpe, Cat. B.M. 3, p. 146; id. Birds of 2nd Yarkand Mission, p. 21; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 62.
Graculus eremita, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 43.

This is the most common bird on the Pamirs. It frequents all the pasture-grounds and ascends to the summits of the highest hills. It was attracted, on many occasions, to our camps at 18000 feet and over and was seen soaring above the mountains at an altitude which could have been no less than 20000 feet. In snowy weather large flocks descend from the hills into the more sheltered valleys.

3. PYRRHOCORAX ALPINUS.—The Yellow-billed Chough.

Pyrrhocorax alpinus, Sharpe, Cat. B. M. 3, p. 148; Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 44.

The Yellow-billed Chough associates freely in flocks with the Red-billed Chough. Both species appear to possess similar habits and to occur at the same stations. In the stomach of one specimen were found fragments of slate half an inch in diameter.

Family SYLVIIDÆ.

4. PHYLLOSCOPUS INDICUS.—The Olivaceous Willow-Warbler.

Luscinia indica, Seebohm, Cat. B. M. 5, p. 126.
Phylloscopus indicus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 404.

A solitary warbler, resembling in every way the description by Oates of this species, was obtained amongst the rocks at an altitude of 14500 feet.

Family TURDIDÆ.

5. SAXICOLA ISABELLINA.—The Isabelline Chat.

Saxicola isabellina, Seebohm, Cat. B. M. 5, p. 399; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 77.

A single specimen, the only one seen, was shot in the end of June.

6. SAXICOLA MONTANA.—Gould's Chat.

Saxicola montana, Seebohm, Cat. B. M. 5, p. 384; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 78; Sharpe, Birds of 2nd Yarkand Mission, p. 85; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 62.

A common bird which frequents the stony wastes and the banks of the mountain streams.

7. RUTICILLA HODGSONI.—Hodgson's Redstart.

Ruticilla hodgsoni, Seebohm, Cat. B.M. 5, p. 344; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 95.

From the north side near the summit of the Mintaka Pass. Altitude, 15000 feet.

8. RUTICILLA ERYTHROGASTER.—Güldenstadt's Redstart.

Ruticilla erythrogastra, Seebohm, Cat. B.M. 5, p. 347.
Ruticilla erythrogaster, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 97; Sharpe, Birds of 2nd Yarkand Mission, p. 88; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 62.

This redstart was seen far more frequently on the barren ground and rocky hillsides than in or alongside the mountain torrents. It was found usually above 15000 feet, but in snowy weather it descended into the more sheltered valleys as low as 13000 feet.

The nest of this species was found on the 21st July in the Kukturuk valley at an altitude of 14000 feet. It was situated about 30 feet above the level of the stream on the side of an old moraine and well protected beneath an overhanging mass of rocky débris. It was about 4 inches in diameter and was composed of a lower thin layer of hay with a few roots, on the surface of which was a much thicker layer of yak's hair intermingled with feathers. The nest contained three young, fully fledged, and almost ready for flight. The male alone was seen to take part in feeding the nestlings.

According to Oates (*Faun. Brit. Ind. Birds, Vol. 2, p. 97*) the nest of this species has not hitherto been found.

9. CINCLUS LEUCOGASTER.—The White-bellied Dipper.

The dipper which frequents the streams of the Taghdumbash Pamir has the lower parts of the body completely white.

It is usually found between 13000 and 14000 feet but was, on one occasion, seen in a mountain torrent at 15500 feet. The nest was found on the 21st July at an altitude of 14000 feet. It was situated on a rocky cliff about 12 feet immediately above the level of the stream. It was a large and bulky nest, composed of roots, moss and a little grass and was about 10 inches in diameter. It lay in a deep cleft between two rocky strata and was completely roofed over with the materials of which the nest was built. It was entered by a small, circular, lateral aperture. The nest was not fully constructed and the birds were busily occupied in completing it. They were frequently seen diving from the position of the nest into the stream below, a distance of about 12 feet.

Family FRINGILLIDÆ.

10. FRINGILLAUDA SORDIDA.—Stoliczka's Mountain-Finch.

Montifringilla sordida, Sharpe, Cat. B. M. 12, p. 266.
Fringillauda sordida, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 248.

Numbers were seen feeding in the short grass on the northern slopes of the Mintaka Pass. Altitude, 14000 feet.

11. Frigillauda brandti.—Brandt's Mountain-Finch.

Montifringilla brandti, Sharpe, Cat. B. M. 12, p. 269; id, Birds of 2nd Yarkand Mission, p. 32; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.
Fringillauda brandti, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 248.

Obtained in July on the summit of the Kilik Pass. Altitude, 15600 feet.

Family HIRUNDINIDÆ.

12. Chelidon lagopus.—The Siberian Martin.

Chelidon lagopus, Sharpe, Cat. B. M. 10, p. 93; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 270.

Not uncommon in the open valleys of the Taghdumbash Pamir. In the Tomtek valley, on the 12th July and at an altitude of about 14000 feet, a colony of nine nests was found in an inaccessible position beneath the shelter of an overhanging rock, about 30 feet above the bed of the valley. It was impossible to reach the nests but from the frequent visits of the parents and the egg remains on the ground beneath, it was evident that they contained young.

Family MOTACILLIDÆ.

13. Motacilla citreoloides.—Hodgson's Yellow-headed Wagtail.

Motacilla citreoloides, Sharpe, Cat. B. M. 10, p. 507; Oates, Faun. Brit. Ind. Birds, p. 299; Sharpe, Birds of 2nd Yarkand Mission, p. 60; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.

Found along the banks of the rivers between 13500 and 14500 feet.

Family ALAUDIDÆ.

14. Otocorys penicillata.—Gould's Horned Lark.

Otocorys penicillata, Sharpe, Cat. B. M. 13, p. 530; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 319; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.
Otocorys pallida, Sharpe, Birds of 2nd Yarkand Mission, p. 49.

This lark is common on the Pamirs. It frequents the grassy pasture lands, the banks of the rivers, and the old moraines, and ascends to the summit of the passes. It was found on the Kilik Pass at an altitude of 15000 feet.

In one specimen the black ear-coverts on the right side were fused with the black throat-band while on the left side they were completely separate.

The nest of this species was found on the 21st July in the Kukturuk valley at an altitude of 14000 feet. It was composed of dried grass situated in a depression on the ground and sheltered from the sun by an overhanging grassy tuft. It contained two eggs, recently laid.

15. Alaudula persica.—Sharpe's Sand-Lark.

Alaudula persica, Sharpe, Cat. B. M. 13, p. 590, (1890); Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 531.

Not infrequently seen on the Taghdumbash Pamir between 13000 and 14000 feet.

The colours of the soft parts of this lark, which do not appear to have been before recorded, are as follows. Legs, fleshy; feet, dark fleshy; claws, brownish fleshy; upper mandible, brown with yellow margin; lower mandible, yellow with dusky tip; iris, brown. Length of culmen, 0·4 inch.

Order *ANISODACTYLI*.

Family UPUPIDÆ.

16. Upupa epops.—The European Hoopoe.

Upupa epops, Salvin, Cat. B. M. 16, p. 4; Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 160; Sharpe, Birds of 2nd Yarkand Mission, p. 110; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 64.

During the months of June and July this bird was never seen. It first appeared in the beginning of August and soon became almost common on the Pamirs.

(Order *MACROCHIRES*)

(Family CYPSELIDÆ)

(CYPSELUS SP.).

(A number of swifts, possibly belonging to the species *Cypselus apus*, were seen crossing the Pamirs early in August).

(Order *ACCIPITRES*)

(Family FALCONIDÆ)

(GYPAETUS BARBATUS).

(The Lammergeyer is not uncommon on the Taghdumbash Pamir. Unfortunately no specimens were obtained. On one occasion the Lammergeyer was seen swooping after a hare. As it swept downwards a loud humming sound was produced, heard nearly a mile away).

(AESALON REGULUS).

(A hawk, believed to be the Merlin, was seen, on one occasion, swooping unsuccessfully after choughs).

Order *COLUMBÆ*.

Family COLUMBIDÆ.

17. COLUMBA RUPESTRIS.—The Blue Hill-Pigeon.

Columba rupestris, Salvadori, Cat. B.M. 21, p. 250; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 30; Sharpe, Birds of 2nd Yarkand Mission, p. 116; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 67.

Not uncommon. It frequents many of the pasture grounds and is often seen feeding amongst the stones at the margin of the mountain streams.

18. COLUMBA LEUCONOTA.—The White-bellied Pigeon.

Columba leuconota, Salvadori, Cat. B.M. 21, p. 249; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 32; Sharpe, Birds of 2nd Yarkand Mission, p. 116.

This species is met with in small flocks. It is less numerous than *C. rupestris* and the two species appear never to intermingle.

Order *GALLINÆ*.

Family PHASIANIDÆ.

19. CACCABIS CHUCAR.—The Chukor.

Caccabis chukar, Ogilvie Grant, Cat. B.M. 22, p. 113.
Caccabis chucar, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 131.

The Chukor was seen only on one occasion early in June. Two were shot on the shaley hillside at an altitude of 13500 feet.

20. TETRAOGALLUS HIMALAYENSIS.—The Himalayan Snow Cock.

Tetraogallus himalayensis, Ogilvie Grant, Cat. B.M. 22, p. 106; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 143; Sharpe, Birds of 2nd Yarkand Mission, p. 123; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 67.

Very numerous near the snow line. A nest, containing two recently laid eggs, was found by one of our camp-servants on the 16th June.

Order *LIMICOLÆ*.

Family CHARADRIIDÆ.

21. AEGIALITIS GEOFFROYI.—The Large Sand-Plover.

Ochthodromus geoffroyi, Sharpe, Cat. B.M. 24, p. 217.
Aegialitis geoffroyi, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 237.

Uncommon. Only one specimen obtained.

22. AEGIALITIS MONGOLICA.—The Lesser Sand-Plover.

Ochthodromus mongolus, Sharpe, Cat. B.M 24, pp. 223, 226.
Aegialitis mongolica, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 238.
Aegialites mongolicus, Sharpe, Birds of 2nd Yarkand Mission, p. 137.
Charadrius mongolicus, Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 66.

Frequently seen in the narrow grassy marshes which, in many places, skirt the Pamir rivers.

In specimens obtained in the month of June the black ear coverts were extremely variable in coloration.

23. TOTANUS OCHROPUS.—The Green Sandpiper.

Helodromas ochropus, Sharpe, Cat. B. M. 24, p. 437.
Totanus ochropus, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 262; Sharpe, Birds of 2nd Yarkand Mission, p. 141.

Occasionally met with along the banks of the streams and in the marshy areas bordering the rivers.

Order *ANSERES*.

Family ANATIDÆ.

24. MERGANSER CASTOR.—The Goosander.

Merganser castor, Salvadori, Cat. B. M. 27, p. 472; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 469.

A pair were seen in June on the Beyik stream at an altitude of 13150 feet. The male was shot.

FISHES.

Order *PHYSOSTOMI*.

Family CYPRINIDÆ.

1. NEMACHILUS STOLICZKÆ.

Nemachilus stoliczkæ, Day, Fishes of 2nd Yarkand Mission, p. 14; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 92; Day, Faun. Brit. Ind. Fishes, Vol. 1. p. 235.

Very common in the Pamir rivers and their tributaries from 13000 to 14000 feet. This species has also been described from the rivers of the Little Pamir.

INSECTS.

Order *LEPIDOPTERA*.

Family NYMPHALIDÆ.

1. KARANASA HUEBNERI.

Hipparchia cadesia, Moore, Butterflies of 2nd Yarkand Mission, p. 1.
Karanasa huebneri, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 39; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 69.

This species has been said to be "the commonest butterfly of the Great

Pamir" (*Alcock, Nat. Hist. Report of Pamir Boundary Commission*, p.69). Only three specimens were taken on the Taghdumbash Pamir, two in the valleys at an altitude of 14000 feet and one on the summit of the Kilik Pass at 15600 feet.

2. VANESSA CARDUI.

Pyrameis cardui, Moore, Butterflies of 2nd Yarkand Mission, p. 2; Lep. Ind. 4, 1899-1900, p. 105; Alcock Nat. Hist. Report of Pamir Boundary Commission, p. 69.
Vanessa cardui, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 365.

A solitary specimen of the Painted Lady was taken in the Kilik valley on the 22nd July.

3. ARGYNNIS VITATHA.

Argynnis vitatha, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 431; Moore, Lep. Ind. 4, 1899-1900, p. 239; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 69.

An uncommon species. Two specimens were obtained in August. Altitude, 14000 feet.

4. MELITÆA SINDURA, *race* BALBITA.

Melitæa sindura, race *balbita*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 452; Moore, Lep. Ind. 5, 1901-1903, p. 3.

This butterfly was very common on the summit and slopes of the Kilik Pass as high as 16000 feet. It did not appear before the middle of July.

5. MELITÆA DIDYMA.

Melitæa robertsi, Moore, Lep. Ind. 5, 1901-1903, p. 8.
Melitæa didyma, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 453.

Two specimens were taken in July at an altitude of 14000 feet.

6. MELITÆA MINERVA, *var.* PALLAS.

Melitæa minerva, var. *pallas*, Stand. Stett. Ent. Zeit: 1886, p. 235.

Mr. N. D. Riley of the Insect Department, British Museum, has kindly compared our two specimens with a short series of this variety in the Museum from the Trans-Alai and Hindu-Kush mountains. They were both obtained in the Lup Gaz valley between 15000 and 15500 feet.

Family PAPILIONIDÆ.

7. PAPILIO MACHAON, *race* SPHYRUS.

Papilio asiatica, Moore, Lep. Ind. 6, 1913, p. 39.
Papilio machaon, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 36.

Not an uncommon species in the month of July. One specimen was taken at 15000 feet.

8. PARNASSIUS EPAPHUS.

Parnassius epaphus, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 120; Moore, Lep. Ind. 5, 1901-1903, p. 109; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 70.
Parnassius jacquemonti, Moore, Butterflies of 2nd Yarkand Mission, p. 5.

Numerous on the Kilik Pass at an altitude of 15000 feet. A single specimen was obtained in the Mintaka valley as low as 14000 feet, and, on two occasions, this butterfly came near one of our camps in the snow at 18,200 feet, to which it was probably carried by ascending air-currents. This species has also been taken on the Great Pamir.

9. Parnassius delphius, *race* hunza.

Parnassius delphius, race *hunza*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 134.

A solitary specimen, the only one seen, was caught on the ascent to the Kilik Pass at an altitude of 14000 feet.

10. Parnassius simo, *ssp.* avinoffi.

Parnassius simo, ssp. *avinoffi*, Verity, Rhopalocera Palearctica, p. 316. Florence, 1905-1911.

Mr. N. D. Riley has very kindly compared our specimens with the type of *Parnassius simo* from Tibet and a cotype of this subspecies in the British Museum. He considers that they undoubtedly belong to the latter subspecies. Our three specimens were obtained in the month of July between 15600 and 16500 feet.

Family PIERIDÆ.

11. Baltia shawi.

Baltia shawi, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 159; Moore, Lep. Ind. 6, 1904, p. 144; id. Butterflies of 2nd Yarkand Mission, p. 3.

This butterfly was taken on the shaley mountain side between 15000 and 17000 feet. It was frequently observed alighting on the snow.

12. Pieris deota.

Pieris deota, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 171.
Mancipium deota, Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 70; de Niceville, Journ. Asiatic Soc. Bengal, p. 82.

A few specimens were caught early in June but none were seen latter. This butterfly was noticed feeding on yak-dung at an altitude of 14000 feet.

13. Pieris glauconome.

Pieris glauconome, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 176.
Pontia glauconome, Moore, Lep. Ind. 6, 1904, p. 139.

This is the most common butterfly on the Taghdumbash Pamir. It was very numerous near the Kilik Pass at 15000 feet and one specimen was obtained on the summit of Kukturuk hillstation at 17200 feet.

14. Colias dubia.

Colias dubia, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 239; Elwes, P.Z.S. 1906, p. 481.

A single specimen was taken near the Kilik Pass at 15000 feet.

15. Colias eogene.

Colias eogene, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 241; Grum-Grshimailo, Faun. Lep. Pamir, p. 329; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 70.

A single specimen was taken on the Kilik Pass. This species has also been found on the Great and Little Pamirs.

Family LYCÆNIDÆ.

16. Lycæna stoliczkana.

Polyommatus ariana, Moore, Butterflies of 2nd Yarkand Mission, p. 66.
Lycæna stoliczkana, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 341.

Three specimens were caught near the Kilik Pass at 15000 feet.

17. Lycæna pheretes, *race* lehana.

Polyommatus lehanus, Moore, Butterflies of 2nd Yarkand Mission, p. 6.
Lycæna pheretes, race *lehana*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 352.
Lycæna lehana, Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 70.

Two specimens from near the Kilik Pass. Altitude, 15000 feet. This species has also been taken on the Great Pamir.

CRUSTACEA.

Order *AMPHIPODA*.

Family GAMMARIDÆ.

1. GAMMARUS PULEX.

This species has been identified by Mr. W. M. Tattersall of the Manchester Museum. Dr. N. Annandale, who kindly sent the specimens to England for identification, informs me that the record is interesting as it makes the highest altitude from which this species has ever been taken, being 5000 feet higher than any previous record. The species was common in a large pool on the summit of the Kilik Pass. Altitude, 15600 feet.

CHAPTER VIII. (*Continued*).

SECTION C.

A SYSTEMATIC ACCOUNT OF A ZOOLOGICAL COLLECTION MADE ON THE ROAD TO AND FROM THE PAMIRS

by

Capt. R. W. G. Hingston, I. M. S.

BIRDS.

Order *PASSERES*.

Family CORVIDÆ.

1. CORVUS MACRORHYNCHUS.—The Jungle-Crow.

Corone macrorhyncha, Sharpe, Cat. B. M. 3, p. 38.
Corvus macrorhynchus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 17.

Common at all the villages and cultivated districts as far north as Gilgit.

2. PICA RUSTICA.—The Magpie.

Pica pica, Sharpe, Cat. B. M. 3, p. 62; Birds of 2nd Yarkand Mission, p. 19; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 87.
Pica rustica, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 24.

The Magpie was not seen south of the Burzil Pass. To the north, however, it is abundant and nests freely at Hunza. At the village of Minapin almost every tree contained a nest, from one of which seven newly-laid eggs were taken on May 19th.

3. NUCIFRAGA MULTIPUNCTATA.—The Larger Spotted Nutcracker.

Nucifraga multipunctata, Sharpe, Cat. B. M. 3, p. 55; Oates, Faun. Brit. Ind. Birds, p. 41; Sharpe, Birds of 2nd Yarkand Mission, p. 20; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

Numerous in the Astor valley in September. Large flocks of these birds were seen feeding on the pine seeds in the forest between Dashkin and Doyan.

4. GRACULUS EREMITA.—The Red-billed Chough.

Graculus graculus, Sharpe, Cat. B. M. 3, p. 146; Birds of the 2nd Yarkand Mission, p. 21; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 62.
Graculus eremita, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 43.

The Red-billed Chough was first noticed near the summit of the Burzil Pass at about 12000 feet. It was the most common of all birds north of Hunza.

5. LOPHOPHANES MELANOLOPHUS.—The Crested Black Tit.

Parus melanolophus, Gadow, Cat. B. M. 8, p. 28.
Lophophanes melanolophus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 57.

A solitary specimen was obtained near the village of Gurais. Altitude, 8000 feet.

6. LOPHOPHANES RUFINUCHALIS.—The Simla Black Tit.

Parus rufonuchalis, Gadow, Cat. B. M. 8, p. 29; Alcock, Nat. Hist. Report of the Pamir Boundary Commission, p. 88.
Lophophanes rufinuchalis, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 58; Sharpe, Birds of 2nd Yarkand Mission, p. 100.

Frequents the pine forests between Doyan and Astor. Altitude, 7000 to 8000 feet.

Family CRATEROPODIDÆ.

7. TROCHALOPTERUM LINEATUM.—The Himalayan Streaked Laughing-Thrush.

Trochalopteron lineatum, Sharpe, Cat. B. M. 8, p. 377.
Trochalopterum lineatum, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 101; Sharpe, Birds of 2nd Yarkand Mission, p. 100; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

A single specimen obtained in the neighbourhood of Astor. Altitude, 8000 feet.

8. MYIOPHONEUS TEMMINCKI.—The Himalayan Whistling-Thrush.

Myiophonus temminckii, Sharpe, Cat. B. M. 7, p. 7.
Myiophoneus temmincki, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 178.

Astor valley. Altitude, 8000 feet.

Family CERTHIIDÆ.

9. CERTHIA HIMALAYANA.—The Himalayan Tree-Creeper.

Certhia himalayana, Gadow, Cat. B. M. 8, p. 327; Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 329.

A solitary specimen was obtained in the Kishenganga valley between Gorai and Gurais. Altitude, 8000 feet.

Family SYLVIIDÆ.

10. PHYLLOSCOPUS INDICUS.—The Olivaceous Willow-Warbler.

Lusciniola indica, Seebohm, Cat. B. M. 5, p. 126.
Phylloscopus indicus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 404.

A single specimen obtained near the village of Gulmit in Hunza. Altitude, about 7500 feet.

Family LANIIDÆ.

11. LANIUS ERYTHRONOTUS.—The Rufous-backed Shrike.

Lanius caniceps, Gadow, Cat. B. M. 8, p. 265.
Lanius erythronotus, Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 464.

Gilgit valley. Altitude, 5000 feet.

Family ORIOLIDÆ.

12. ORIOLUS KUNDOO.—The Indian Oriole.

Oriolus Kundoo, Sharpe, Cat. B. M. 3, p. 194; Oates, Faun. Brit. Ind. Birds, Vol. 1, p. 504; Sharpe, Birds of 2nd Yarkand Mission, p. 24; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.

Seen occasionally in the orchards of the Gilgit valley up to 7000 feet.

Family TURDIDÆ.

13. PRATINCOLA MAURA.—The Indian Bush-Chat.

Pratincola maura, Sharpe, Cat. B. M. 4, p. 188; Oates, Faun. Brit. Ind. Birds, p. 61.

This species was common at Tragbal and was found at Hunza as high as 8000 feet.

14. SAXICOLA PICATA.—The Pied Chat.

Saxicola picata, Seebohm, Cat. B. M. 5, p. 367; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 71; Sharpe, Birds of 2nd Yarkand Mission, p. 83; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

Numerous along the banks of the Indus, Gilgit and Hunza rivers.

15. SAXICOLA PLESCHANKA.—The Siberian Chat.

Saxicola morio, Seebohm, Cat. B. M. 5, p. 372.
Saxicola pleschanka, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 73.

A chat obtained between Doyan and Dashkin I believe to be of this species. Altitude, about 7500 feet.

16. CHIMARRHORNIS LEUCOCEPHALUS.—The White-capped Redstart.

Chimarrhornis leucocephala, Sharpe, Cat. B. M. 7, p. 47.
Chaemorrhornis leucocephala, Sharpe, Birds of 2nd Yarkand Mission, p. 86.
Chimarrhornis leucocephalus, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 89; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

Frequents the banks of all the streams and rivers between the Burzil Pass and Astor. It was extremely common in September on the northern ascent to the Kamri Pass.

17. RUTICILLA FRONTALIS.—The Blue-fronted Redstart.

Ruticilla frontalis, Seebohm, Cat. B.M. 5, p. 349; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 91.

Common at high altitudes on each side of the Burzil Pass and obtained in Hunza at 8000 feet.

18. RUTICILLA RUFIVENTRIS.—The Indian Redstart.

Ruticilla rufiventris, Seebohm, Cat. B.M. 5, p. 342; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 95; Sharpe, Birds of 2nd Yarkand Mission, p. 87; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

Common in the Hunza gorge and ascends the slopes of the Mintaka Pass to an altitude of 13000 feet.

19. RUTICILLA ERYTHROGASTER.—Güldenstadt's Redstart.

Ruticilla erythrogastra, Seebohm, Cat. B.M. 5, p. 347.
Ruticilla erythrogaster, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 97; Sharpe, Birds of 2nd Yarkand Mission, p. 88; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 62.

Frequents the moraines and banks of the river on the southern ascent of the Mintaka Pass. Altitude, from 12000 to 14000 feet.

20. ADELURA CÆRULEICEPHALA.—The Blue-headed Robin.

Ruticilla cæruleocephala, Seebohm, Cat. B. M. 5, p. 353.
Adelura cæruleicephala, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 108.

A single specimen was obtained in the pine forest between Doyan and Dashkin. Altitude, 7500 feet.

21. PETROPHILA CYANUS.—The Western Blue Rock-Thrush.

Monticola cyanus, Seebohm, Cat. B. M. 5, p. 316; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.
Petrophila cyanus, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 146.

Common along the Gilgit valley and in the Hunza gorge. Altitude, 5000 to 10000 feet.

Family FRINGILLIDÆ.

22. PYRRHOSPIZA PUNICEA.—The Red-breasted Rose-Finch.

Pyrrhospiza punicea, Sharpe, Cat. B. M. 12, p. 431; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 211.

This species frequents the grassy patches and camping-grounds on the south side of the Mintaka Pass. Altitude, about 12000 feet.

23. CARPODACUS SEVERTZOVI.—Severtzoff's Rose-Finch.

Carpodacus severtzovi, Sharpe, Cat. B. M. 12, p. 400; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 220.

One specimen was obtained at the village of Khaibar in the Hunza valley. Altitude, 8800 feet.

24. PASSER DOMESTICUS.—The House-Sparrow.

Passer domesticus, Sharpe, Cat. B. M. 12, p. 307; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 236.

Common in the neighbourhood of Gurais dâk-bungalow. Altitude, 7800 feet.

25. FRINGILLAUDA SORDIDA.—Stoliczka's Mountain-Finch.

Montifringilla sordida, Sharpe, Cat. B. M. 12, p. 266.
Fringillauda sordida, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 248.

Large flocks of these birds were numerous in September on the northern ascent of the Kamri Pass. Altitude, 10000 to 12000 feet.

26. FRINGILLAUDA BRANDTI.—Brandt's Mountain-Finch.

Montifringilla brandti, Sharpe, Cat. B. M. 12, p. 269; and Birds of 2nd Yarkand Mission, p. 32; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.
Fringillauda brandti, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 248.

One specimen obtained early in May in the Kishenganga valley. Altitude, 8000 feet.

27. EMBERIZA STRACHEYI.—The Eastern Meadow Bunting.

Emberiza stracheyi, Sharpe, Cat. B. M. 12, p. 539; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 257.
Emberiza cia, Sharpe, Birds of 2nd Yarkand Mission, p. 47; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 88.

Very common on both the northern and southern slopes of the Burzil Pass.

Family HIRUNDINIDÆ.

28. PTYONOPROGNE RUPESTRIS.—The Crag-Martin.

Cotile rupestris, Sharpe, Cat. B. M. 10, p. 109.
Ptyonoprogne rupestris, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 274.

Frequents the precipitous cliffs on either side of the Hunza gorge.

29. HIRUNDO RUSTICA.—The Swallow.

Hirundo rustica, Sharpe, Cat. B. M. 10, p. 128; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 277.

Numerous in May at all the villages north of Hunza.

Family MOTACILLIDÆ.

30. MOTACILLA PERSONATA.—The Masked Wagtail.

Motacilla personata, Sharpe, Cat. B. M. 10, p. 479; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 290; Sharpe, Birds of 2nd Yarkand Mission, p. 56; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.

This species was very common at Hunza and the neighbouring villages in the month of September. On two occasions it was observed perching on trees. It is known by the people of Hunza as "*Buyachin*."

One specimen obtained on the 13th September was in typical winter plumage.

31. MOTACILLA HODGSONI.—Hodgson's Pied Wagtail.

Motacilla hodgsoni, Sharpe, Cat. B. M. 10, p. 486; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 291; Sharpe, Birds of 2nd Yarkand Mission, p. 57; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 89.

Numerous along the banks of the rivers and streams in both Gilgit and Hunza. It was exceedingly common in September.

32. MOTACILLA MELANOPE.—The Gray Wagtail.

Motacilla melanope, Sharpe, Cat. B. M. 10, p. 497; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 293.

Obtained at Hunza. Altitude, 7500 feet.

33. MOTACILLA BOREALIS.—The Grey-headed Wagtail.

Motacilla borealis, Sharpe, Cat. B. M. 10, p. 522; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 294.

Large flocks were seen congregating in the cultivated fields at the village of Minapin near Hunza. Altitude, about 7000 feet.

34. MOTACILLA CITREOLOIDES.—Hodgson's Yellow-headed Wagtail.

Motacilla citreoloides, Sharpe, Cat. B. M. 10, p. 507; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 299; Sharpe, Birds of 2nd Yarkand Mission, p. 60; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.

Very numerous in large flocks at Hunza. These birds were probably migrating to the southern slopes of the Himalaya and the plains of India, after breeding in Central Asia.

35. ANTHUS MACULATUS.—The Indian Tree-Pipit.

Anthus maculatus, Sharpe, Cat. B. M. 10, p. 547; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 304; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 89.

A single specimen obtained on the northern ascent of the Kamri Pass. Altitude, 13000 feet.

36. ANTHUS CERVINUS.—The Red-throated Pipit.

Anthus cervinus, Sharpe, Cat. B. M. 10, p. 585; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 310.

Obtained in the Hunza valley between Chalt and Minapin. Altitude, about 7000 feet.

Family ALAUDIDÆ.

37. ALAUDA ARVENSIS.—The Sky-Lark.

Alauda arvensis, Sharpe, Cat. B. M. 13, p. 567; Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 324.

Sky-Larks were numerous in the cultivated fields at the villages of the Hunza district.

38. GALERITA CRISTATA.—The Crested Lark.

Galerida cristata, Sharpe, Cat. B. M. 13, p. 626.
Galerita cristata, Oates, Faun. Brit. Ind. Birds, Vol. 2, p. 337; Sharpe, Birds of 2nd Yarkand Mission, p. 55; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 89.

This bird is one of the few living creatures found in the desert waste between Bunji and Gilgit.

Order *PICI.*

Family PICIDÆ.

39. IYNX TORQUILLA.—The Common Wryneck.

Iynx torquilla, Hargitt, Cat. B. M. 18, p. 560; Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 78; Sharpe, Birds of 2nd Yarkand Mission, p. 110; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 63.

This species was obtained about five miles north of Astor. Altitude, 8000 feet. It was seen clinging to the trunk of a low pine tree in a manner resembling that of a wood-pecker.

Order *ANISODACTYLI.*

Family CORACIADÆ.

40. CORACIAS GARRULA.—The European Roller.

Coracias garrula, Sharpe, Cat. B. M. 17, p. 15; Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 106; Sharpe, Birds of 2nd Yarkand Mission, p. 113; Alcock, Nat. Hist. Report of Pamir Boundary Commission, pp. 64 and 89.

Gilgit and Hunza valleys. Altitude, 5000 to 8000 feet.

Family UPUPIDÆ.

41. UPUPA EPOPS.—The European Hoopoe.

Upupa epops, Salvin, Cat. B. M. 16, p. 4. Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 159; Sharpe, Birds of 2nd Yarkand Mission, p. 110; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 64.

Seen occasionally in May at Astor and Bunji, but very numerous in September at all the fertile districts from Kashmir to the Indo-Chinese frontier where it ascends to an altitude of 12000 feet.

Order *MACROCHIRES.*

Family CYPSELIDÆ.

42. CYPSELUS APUS.—The European Swift.

Micropus apus, Hartert, Cat. B. M. 16, pp. 442 to 444.
Cypselus apus, Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 165.

Numbers were seen hawking for insects in the Astor valley. Altitude, 8000 feet.

Order *COCCYGES.*

Family CUCULIDÆ.

43. CUCULUS MICROPTERUS.—The Indian Cuckoo.

Cuculus micropterus, Shelley, Cat. B. M. 19, p. 241; Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 210.

This bird is called by the people of Hunza "*Kapoo*" and by the people north of Hunza "*Kupoo*".

A young bird in the second stage of plumage was obtained at Minapin. Altitude, 7000 feet.

Order *ACCIPITRES.*

Family FALCONIDÆ.

44. MILVUS MELANOTIS.—The Large Indian Kite.

Milvus melanotis, Sharpe, Cat. B. M. 1, p. 324; Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 377; Sharpe, Birds of 2nd Yarkand Mission, p. 8.

Hunza valley. Altitude, 8000 feet.

45. TINNUNCULUS ALAUDARIUS.—The Kestrel.

Cerchneis tinnunculus, Sharpe, Cat. B. M. 1, p. 425; Birds of 2nd Yarkand Mission, p. 12; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 89.
Tinnunculus alaudarius, Blanford, Faun. Brit. Ind. Birds, Vol. 3, p. 428.

Numbers were seen early in May in the Astor and Gilgit valleys.

Order *COLUMBÆ*.

Family COLUMBIDÆ.

46. COLUMBA LIVIA.—The Blue Rock-Pigeon.

Columba livia, Salvadori, Cat. B. M. 21, p. 252; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 30, Sharpe, Birds of 2nd Yarkand Mission, p. 115.

Common amongst the high cliffs and in the neighbourhood of the many mud forts along the route. This species was rarely obtained at a higher altitude than 8000 feet.

47. COLUMBA RUPESTRIS.—The Blue Hill-Pigeon.

Columba rupestris, Salvadori, Cat. B. M. 21, p. 250; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 30; Sharpe, Birds of 2nd Yarkand Mission, p. 116; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 67.

Frequents the rocky cliffs along the Hunza river and its tributaries from 8000 to 12000 feet. This pigeon associates so closely with *Columba livia* that, on two occasions, a specimen of *C. rupestris* and *C. livia* were obtained with one shot.

48. COLUMBA LEUCONOTA.—The White-bellied Pigeon.

Columba leuconota, Salvadori. Cat. B.M. 21, p. 249; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 32; Sharpe, Birds of 2nd Yarkand Mission, p. 116.

Small flocks haunt the steep cliffs of the Kilik gorge from 10000 to 12000 feet.

49. TURTUR FERRAGO.—The Indian Turtle-Dove.

Turtur ferrago, Salvadori, Cat. B.M. 21, p. 401; Blanford, Faun. Brit. Ind. Birds. Vol. 4, p. 41.

A common bird on the forest-clad slopes of the Tragbal Pass. A solitary specimen was obtained near the Indo-Chinese frontier at an altitude of 11000 feet.

Order *GALLINÆ*.

Family PHASIANIDÆ.

50. CACABIS CHUCAR.—The Chukor.

Caccabis chukar, Ogilvie Grant, Cat. B.M. 22, p. 113.
Caccabis chucar, Blanford, Faun. Brit. Ind. Birds. Vol. 4, p. 131.

Numerous in the Astor and Gilgit valleys.

Order *LIMICOLÆ*.

Family CHARADRIIDÆ.

51. TOTANUS HYPOLEUCUS.—The Common Sandpiper.

Tringoides hypoleucus, Sharpe, Cat. B.M. 24, p. 456; id. Birds of 2nd Yarkand Mission, p. 141.
Totanus hypoleucus, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 260; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 66.

From the river bank close to Astor. Altitude, 7500 feet.

52. TOTANUS OCHROPUS.— The Green Sandpiper.

Helodromas ochropus, Sharpe, Cat. B.M. 24, p. 437.
Totanus ochropus, Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 262; Sharpe, Birds of 2nd Yarkand Mission p. 141.

Common about the pools and streams in Kashmir, Gilgit and Hunza.

Order *ANSERES*.

Family ANATIDÆ.

53. QUERQUEDULA CIRCIA.—The Garganey or Blue-winged Teal.

Querquedula circia, Salvadori, Cat. B. M. 27, p. 293; Blanford, Faun. Brit. Ind. Birds, Vol. 4, p. 449; Sharpe, Birds of 2nd Yarkand Mission, p. 131; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 65.

Flocks were frequently seen at Hunza early in September. Our specimens included one female captured alive in an exhausted state.

REPTILES.

Order *SQUAMATA*.

Family AGAMIDÆ.

1. AGAMA TUBERCULATA.

Stellio tuberculatus, Blanford, Reptiles and Amphibia of 2nd Yarkand Mission, p. 25.
Agama tuberculata, Boulenger, Faun. Brit. Ind. Reptilia and Batrachia, p. 148.

Common amongst the rocks in the Astor, Gilgit and Hunza valleys. Altitude, 7000 to 8000 feet.

2. AGAMA HIMALAYANA.

Stellio himalayanus, Blanford, Reptiles and Amphibia of 2nd Yarkand Mission, p. 3.
Agama himalayana, Boulenger, Faun. Brit. Ind. Reptilia and Batrachia, p. 149.

Very numerous in the Hunza gorge. Altitude, 8000 to 9000 feet.

Family SCINCIDÆ.

3. LYGOSOMA HIMALAYANUM.

Mocoa himalayana, Blanford, Reptiles and Amphibia of 2nd Yarkand Mission, p. 19.
Lygosoma himalayanum, Boulenger, Faun. Brit. Ind. Reptilia and Batrachia, p. 200.

Very common on the southern ascent of the Kamri Pass. Altitude, 12000 to 13000 feet.

BATRACHIA.

Order *ECAUDATA*.

Family BUFONIDÆ.

1. BUFO VIRIDIS.

Bufo viridis, Blanford, Reptiles and Amphibia of 2nd Yarkand Mission, p. 26; Boulenger, Faun. Brit. Ind. Reptilia and Batrachia, p. 504.

Common about the streams and gardens at Gilgit.

FISHES.

Order *PHYSOSTOMI.*

Family CYPRINIDÆ.

1. SCHIZOTHORAX ESOCINUS.

Schizothorax esocinus, Day, Fish, India, p. 533: Faun. Brit. Ind. Fishes, Vol. 1, p. 254.

Numbers were taken from a small tributary of the Hunza river. Altitude, 10000 feet.

INSECTS.

Order *LEPIDOPTERA.*

Family NYMPHALIDÆ.

1. SATYRUS MENAVA.

Lasiommata menava, Moore, Lep. Ind. 1893-96, p. 9; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 95.

Satyrus menava, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 111.

This species was not uncommon in Hunza. Numbers were seen in the end of August amongst the old moraines near the snout of the Hassanabad glacier. Altitude, 7000 to 8000 feet.

2. NYTHA BALDIVA, *race* LEHANA.

Eumenis baldiva, Moore, Lep. Ind. 2, 1893-96, p. 18; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 95.

Hipparchia lehana, Moore, Butterflies of 2nd Yarkand Mission, p. 1.

Nytha baldiva, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 114.

Hunza district. From 7500 to 9450 feet. In one of our specimens the black subtornal spot, characteristic of *N. baldiva*, is present but the pale ground colour and broad postdiscal band resemble that of the race *lehana*.

3. NYTHA PERSEPHONE.

Philaveta persephone, Moore, Lep. Ind. 2, 1893-96, p. 23.

Nytha persephone, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 115.

Three specimens were taken, early in September, in the Astor valley. Altitude, 8000 feet.

4. NYTHA PARISATIS.

Nytha parisatis, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 117; Moore, Lep. Ind. 2, 1893-96, p. 24.

Astor valley and Hunza districts from 7000 to 8000 feet.

5. MANIOLA DAVENDRA.

Maniola davendra, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 119; Moore, Lep. Ind. 2, 1893-96, p. 45.

A common species in the Hunza gorge up to 10000 feet. It was not obtained below 7500 feet.

6. MANIOLA CHEENA.

Maniola cheena, Moore, Lep. Ind. 2, 1893-96, p. 50; Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 120.

A single specimen was obtained in the Astor valley. Altitude, 8000 feet.

7. MANIOLA PULCHELLA.

Maniola pulchella, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 121.
Chortobius pulchella, Moore, Lep. Ind. 2, 1893-96, p. 54.

Not uncommon on the southern slopes of the Mintaka Pass. Altitude, 13000 to 14000 feet. One specimen was taken in the Astor valley. Altitude, 8000 feet.

8. MANIOLA COENONYMPHA.

Chortobius coenonympha, Moore, Lep. Ind. 2, 1893-96, p. 54.
Maniola coenonympha, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 122.

A solitary specimen was taken on the Kamri Pass at an altitude of about 12000 feet.

9. KARANASA HUEBNERI.

Karanasa huebneri, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 124; Moore, Lep. Ind. 2, 1893-96, p. 39; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 95.

Numerous in the month of August on the southern slopes of the Mintaka Pass. Altitude, 13000 to 14000 feet.

10. KARANASA DIGNA.

Kanetisa digna, Moore, Lep. Ind. 2, 1893-96, p. 42.
Karanasa digna, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 125.

Two specimens. One from the Astor valley at 8000 feet and one from the neighbourhood of Hunza at 7500 feet.

11. AULOCERA PADMA.

Aulocera padma, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 127; Moore, Lep. Ind. 2, 1893-96, p. 32.

Two specimens were taken at the village of Minapin in the Hunza district. Altitude, about 7000 feet.

12. VANESSA CARDUI.

Pyrameis cardui, Moore, Butterflies of 2nd Yarkand Mission, p. 2; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 69.
Vanessa cardui, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 365.

The Painted Lady was common at Gilgit and throughout Hunza. Two specimens were obtained in August at an altitude of 10000 feet, and one in May on the ascent of the Burzil Pass, well above the snow-line.

13. VANESSA CASHMIRENSIS.

Aglais cashmirensis, Moore, Lep. Ind. 4, 1899-1900, p. 87.
Vanessa cashmirensis, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 367.

Specimens were taken on the slopes of the Burzil Pass and in the Astor valley.

14. VANESSA RIZANA.

Aglais rizana, Moore, Lep. Ind 4, 1899-1900, p. 89.
Vanessa rizana, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 368.

Not uncommon in June near the foot of the Mintaka Pass. Altitude, 13000 feet. One specimen was taken in Kashmir on the Kamri Pass at about 13500 feet.

15. VANESSA VAU-ALBUM.

Vanessa vau-album, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 369.

A solitary specimen was obtained in the Kishenganga gorge at the end of April. Altitude, 8000 feet.

16. VANESSA C-ALBUM.

Polygonia cognata, Moore, Lep. Ind. 4, 1899-1900, p. 98.
Vanessa c-album, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 372.

Three specimens. One from the Kishenganga gorge at an altitude of 8000 feet, and two from the gorge of the Astor river, north of the village of Gircha, at an altitude of 10000 feet.

17. ARGYNNIS VITATHA.

Argynnis vitatha, Moore, Lep. Ind. 4, 1899-1900, p. 239; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 96; Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 431.

Two specimens. One taken on the southern ascent to the Mintaka Pass at 13500 feet. The second taken in July on the southern ascent to the Kilik Pass at 14000 feet.

18. ARGYNNIS JAINADEVA.

Argynnis jainadeva, Moore, Lep. Ind. 4, 1899-1900, p. 238; id. Butterflies of 2nd Yarkand Mission, p. 2; Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 433.

A single specimen from the village of Doyan in Kashmir. Altitude, 7800 feet.

19. MELITÆA SINDURA, *race* BALBITA.

Melitæa balbita, Moore, Lep. Ind. 5, 1901-03, p. 3; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 96.
Melitæa sindura, race *balbita*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 1, p. 451.

From the southern ascent to the Kilik Pass. Altitude, 14000 feet.

Family PAPILIONIDÆ.

20. PARNASSIUS EPAPHUS.

Parnassius epaphus, Moore, Lep. Ind. 5, 1901-03, p. 109; Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 120.

This species was extremely common near the foot of the Mintaka Pass and along its southern ascent from 13000 to 14500 feet. A single specimen was taken on the southern ascent to the Kilik Pass at 15000 feet.

Family PIERIDÆ.

21. APORIA NABELLICA.

Pieris nabellica, Moore, Lep. Ind. 6, 1904, p. 151.
Aporia nabellica, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 163.

A single specimen obtained in Kashmir about 1000 feet below the summit of the Kamri Pass.

22. PIERIS RAPÆ.

Danaus rapæ, Moore, Lep. Ind. 6, 1904, p. 131.
Pieris rapæ, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 169.

This butterfly was very common at Gilgit and throughout the Hunza district. In one specimen, obtained at an altitude of 10000 feet, the coloration of the dark markings was unusually intense.

23. PIERIS BRASSICÆ.

Danaus brassicæ, Moore, Lep. Ind. 6, 1904, p. 127.
Pieris brassicæ, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 170.

Throughout Gilgit and Hunza up to 8000 feet.

24. PIERIS DAPLIDICE.

Pontia daplidice, Moore, Lep. Ind. 6, 1904, p. 137.
Pieris daplidice, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 175.

Two specimens from the Hunza gorge. Altitude, 8000 feet.

25. PIERIS GLAUCONOME.

Pontia glauconome, Moore, Lep. Ind 6, 1904, p. 139.
Pieris glauconome, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 176.

Two specimens were taken near the foot of the Mintaka Pass. Altitude, 12000 to 13000 feet.

26. COLIAS HYALE, *typical*.

Colias hyale, Moore, Butterflies of 2nd Yarkand Mission, p. 4; Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 234; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 97.

Common in the Hunza valley. Altitude, 8000 feet.

27. COLIAS HYALE, *var*. ERRATE.

Colias hyale: var. *errate*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 235.

Two specimens from the Hunza valley. Altitude, 8000 feet.

28. COLIAS HYALE, *var*. CHRYSODONA.

Colias hyale, var. *chrysodona*, Bingham, Faun Brit. Ind. Butterflies, Vol. 2, p. 235.

Not uncommon in the Hunza gorge. Altitude, 7000 to 8000 feet.

29. COLIAS DUBIA.

Colias dubia, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 239.

A solitary specimen was obtained on the southern ascent to the Mintaka Pass. Altitude, 14000 feet.

30. COLIAS EOGENE.

Colias eogene, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 241.

A single specimen from the southern ascent to the Mintaka Pass. Altitude, 14000 feet.

31. COLIAS CROCEUS: *race* FIELDI.

Colias fieldii, Moore, Butterflies of 2nd Yarkand Mission, p. 4; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 97.
Colias croceus: race *fieldi*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 243.

Throughout Kashmir and Hunza up to 8000 feet.

Family LYCÆNIDÆ.

32. LYCÆNA ASTRARCHE.

Lycæna astrarche, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 337.

A single specimen taken in the Astor valley. Altitude, 8000 feet.

33. LYCÆNA STOLICZKANA.

Polyommatus ariana, Moore, Butterflies of 2nd Yarkand Mission, p. 6.
Lycæna stoliczkana, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 341.

Throughout the Hunza gorge. Altitude, 7000 to 9000 feet.

34. LYCÆNA CHRISTOPHI: *race* SAMUDRI.

Lycæna christophi: race *samudra*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 346.

Two specimens from the Hunza valley. Altitude, 8000 feet.

35. LYCÆNA OMPHISA.

Lycæna omphisa, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 347; Alcock, Nat. Hist. Report of Pamir Boundary Commission, p. 96.

Common on the southern ascent to both the Kilik and Mintaka Passes. Altitude, 13000 to 14000 feet.

36. LYCÆNA PHERETES: *race* LEHANA.

Polyommatus lehanus, Moore, Butterflies of 2nd Yarkand Mission, p. 6.
Lycæna pheretes: race *lehana*, Bingham, Faun. Brit. Ind. Butterflies, Vol. 2, p. 352.

One specimen from the southern ascent to the Kilik Pass. Altitude, 14000 feet.

37. CHILADES TROCHILUS.

Chilades trochilus, Bingham, Faun. Brit. Ind. Butterflies. Vol. 2, p. 367.

Not uncommon in the Hunza valley. Altitude, 8000 feet.

Order *HYMENOPTERA*.

Family FORMICIDÆ.

1. LASIUS HIMALAYANUS.

Lasius himalayanus, Bingham, Faun. Brit. Ind. Hymenoptera, Vol. 2, p. 340.

Obtained on the slopes of the Tragbal pass and throughout Gilgit and Hunza up to 8000 feet.

2. LASIUS ALIENUS.

Lasius alienus, Bingham, Faun. Brit. Ind. Hymenoptera, Vol. 2, p. 342.

Numerous in the Hunza Gorge. Altitude, 8000 feet.

3. CAMPONOTUS BASALIS.

Camponotus basalis, Bingham, Faun. Brit. Ind. Hymenoptera, Vol. 2, p. 352.

A single specimen obtained at Doyan in Kashmir. Altitude, 7800 feet.

CHAPTER IX.

THE FLORA OF THE TAGHDUMBASH PAMIR

by

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I. INTRODUCTION.

The botanical collection forwarded by Lieut. Kenneth Mason, R. E. to the Calcutta Herbarium for determination, consists entirely of flowering plants and comprises forty-four species of which three are probably undescribed, or at least unrepresented in this Herbarium, besides a few which indicate an interesting extension of geographical range. Apart from these however, this is a highly interesting collection, representing as nearly as possible, as Lieut. Mason very kindly informs me, the complete Phanerogamic Flora of the region explored at altitudes of 13000 to 16000 feet and chiefly above 14000 feet.

Judging from the specimens, it is obvious that the vegetation of this Pamir consists largely of exceedingly dwarf herbaceous perennials with wonderfully strong and bulky root stocks evidently often of considerable age. Further, most of the plants suggest a compact habit of growth, sometimes giving a moss-like appearance, while a fair percentage of them possess very strong and resistant seed capsules. An intense degree of Pilosism is also markedly pronounced in some of them.

The above peculiarities are more or less generally taken to be the characteristics of the Alpine vegetation and have been explained as the direct results under Natural Selection of a climate, the principal feature of which, is a short and sudden summer following on a long and severe winter. Of the forty-four species represented in this collection quite a large proportion (*i. e.* 38, or 86 per cent of the whole) do not seem to rise more than six inches above the surface of the soil and some of them not more than an inch and a half. But the roots of nearly all of them, besides being perennial, are remarkably tenacious to the soil, well protected and intensely woody. This dwarfing in size coupled with the woody nature of the root system is eminently well adapted to store up a reserve of nutriment in a protected root rather than in an exposed stem. Effective resistence to the severe winter is afforded by the toughness and persistence of the seed vessels. This character is remarkably seen in the plants mentioned below under the Natural Orders *Cruciferæ*, *Primulaceæ*, and *Leguminosæ* and to a certain extent in such species as *Viola thianschanica*, *Lagotis globosa* and others.

In addition to these contrivances for the effective propagation of species there is reason to believe that vegetative reproduction appears to be the rule in several species. Among the plants which undoubtedly increase vegetatively are the species of *Lloydia serotina*, from bulbs; the cushion-like plants, such

as *Erysimum altaicum* and *Smelowskia calycina*, by successive branchings or offsets; and the trailing plants like *Androsace villosa*, *Stellaria graminea*, *Allardia glabra* by runners or rooting of the new branches. Doubtless most of the grasses and *Polygonum viviparum* increase in this way by the production of bulbils.

As regards the distribution of the species, the most noteworthy point is the great preponderance of the Himalayan element in the Flora of this Pamir. Nearly 30 out of the 44 species are West Himalayan. It is also interesting to note that the following species forming part of the collection are common to the Alps of Europe and the Pamirs:—

Draba fladnitzensis, Oxytropis lapponica, Leontopodium alpinum Androsace villosa, Pedicularis Oederi, Polygonum viviparum, Avena subspicata and *Poa annua.*

The above facts lead us to the conclusion that the composition of the Flora of this Pamir is so largely Himalayan that there can be little doubt as to its origin. It is quite probable that the greater migration might have proceeded from the Western Himalaya.

II. SYSTEMATIC CENSUS OF SPECIES.

(The plants here classified were collected during the work on the Pamir, by Lieut. K. Mason and Capt. R.W.G. Hingston, in the months of June and July 1913. A specimen of every plant noticed was collected, but the flora is not numerous. The collection has been presented to the Royal Botanic Gardens, Calcutta).

Throughout the accompanying list references have been given to Hooker's *Flora of British India* and the distribution of the species is taken, except when otherwise stated, from specimens in the Calcutta Herbarium. New species or species not previously recorded from this area and those not mentioned in the *Flora of British India* are distinguished by an asterisk(*) prefixed to them.

The sequence of Bentham and Hooker's *Genera Plantarum* is followed and the species are arranged alphabetically under the genera.

DICOTYLEDONES.

POLYPETALÆ.

THALAMIFLORÆ.

I. Ranunculaceæ.

1. Ranunculus *Linn.*

1. Ranunculus pulchellus *C.A.Mey.*–F. B. I. i, p. 17.
Bank of Beyik river, 14300 ft., No. 1.
Distr. Western Himalaya, Kashmir and the Pamirs.

2*. Ranunculus rufisepalus *Franch.*
Kilik stream, 13000–14000 ft., No. 16.
Distr. The Pamirs.

2. Delphinium *Linn.*

3. Delphinium cashmirianum *Royle.*–F. B. I. i, p. 26.
Var. Jacquemontianum (*Camb*).
Mintaka stream, 14000 ft., No. 42.
Distr. Western Himalaya.

II. *Papaveraceæ.*

3. Papaver *Linn.*

4. Papaver nudicaule *Linn.*–F.B.I. i, p. 117.
Var. rubro-aurantiaca *Fischer.*
(P. croceum *Ledeb*).
Tomtek Jilga (west), 13500–14500 ft., No. 18.
Distr. Kashmir, Western Tibet.

III. *Cruciferæ.*

4. Parrya *Br.*

5* Parrya sp.– aff. P. exscapa *C. A. Mey.*–F. B. I. i, p. 131.
Kukturuk Jilga, 14000 ft., No. 39.
Not quite the Tibetan plant but undoubtedly nearest to it. The scapes are not shorter than the leaves. I am unable to examine the pods as they are not available.

5. Draba *Linn.*

6. Draba fladnitzensis *Wulf.*–F. B. I. i, p. 143.
Tomtek Jilga (west), 13500–14500 ft., Nos. 24, 30.
Distr. Western Himalaya, Western Tibet.

7. Draba incana *Linn.*–F. B. I. i, p. 143.
Tomtek Jilga (west), 13000–14500 ft., No. 33.
Distr. Western Himalaya, Western Tibet, Turkestan and Siberia.

6. Smelowskia *C. A. Mey.*

8*. Smelowskia calycina *C. A. Mey.*
Tomtek Jilga (west), 14000 ft., No. 44.
Distr. Mongolia, Altai Mts.

7. Erysimum *Linn.*

9. Erysimum altaicum *C. A. Mey.*–F. B. I. i, p. 154.
Near Kilik Pass, 14000–15000 ft., No. 14.
Distr. Western Himalaya, Western Tibet and Altai Mts.

8. Chorispora *DC.*

10. Chorispora sabulosa *Camb ?*–F. B. I. i, p. 167.
Kilik Pass, 15600 ft., No. 40.
Distr. Western Himalaya, Kashmir and the Pamirs.
I am unable to be absolutely certain of the specific name as the specimen is without siliqua.

IV. *Violaceæ.*

9. Viola *Linn.*

11*. Viola thianschanica *Maxim.*
Mintaka stream, 13300 feet, No. 6.
Distr. Turkestan. Central Asia.
This is an interesting new record for this area. As far as examples in the Calcutta Herbarium show, it was never before known from the Pamirs.

V. *Caryophylleæ.*

10. Stellaria *Linn.*

12. Stellaria graminea *Linn.* – F.B.I. i, p. 233.
* *Var.* brachypetala *Rgl.*
Tomtek Jilga, 13000–14500 feet, No. 31.
Distr. Northern Mongolia, Eastern Turkestan.

DISCIFLORÆ.

VI. *Geraniaceæ.*

11. Geranium *Linn.*

13. Geranium Tuberaria *Camb.* – F.B.I. i, p. 431-432.
Tomtek Jilga, 13000–14500 feet, No. 17.
Distr. Western Himalaya, the Pamirs.

CALYCIFLORÆ.

VII. *Leguminosæ.*

12. Astragalus *Linn.*

14*. Astragalus lydius *Bois.*
Tomtek Jilga (west), 13000–14500 feet, No. 29.
Distr. Asia Minor.
A very interesting extension of geographical range as regards the distribution of this species.

15. Astragalus rhizanthus *Royle* – F.B.I. ii, p. 131-132.
Near Kilik Pass, 14000–15000 feet, No. 15.
Distr. Western Himalaya, Kashmir and Western Tibet.

13. Oxytropis *DC.*

16. Oxytropis lapponica *Gaud.*
Var. humifusa – F.B.I. ii, p. 137.
Mintaka stream, 13300 feet, No. 8.
Distr. Kashmir, Western Tibet.

17. Oxytropis tatarica *Jacq ?* – F.B.I. ii, p. 138-139.
Tomtek Jilga, 14000 feet, No. 12.
Distr. Ladak, Western Tibet.
Too near to be considered distinct. The flowers are somewhat larger and the peduncles longer than those of some of the types in the Calcutta Herbarium.

14. Cicer *Linn.*

18. Cicer soongaricum *Steph.* – F.B.I. ii, p. 176.
Lup Gaz Jilga, 15700 feet, No. 36.
Distr. Western Himalaya, Yarkhand and Afghanistan.

VIII. *Rosaceæ.*

15. Potentilla *Linn.*

19. Potentilla sericea *Linn.* – F.B.I. ii, p. 354-355.
Tomtek Jilga (west), 14000 feet, No. 5.
Kukturuk Jilga, 14000 feet, No. 38.
Distr. Western Himalaya, Afghanistan.

GAMOPETALÆ.

IX. *Caprifoliaceæ.*

16. Lonicera *Linn.*

20. Lonicera spinosa *Jacq.* – F.B.I. iii, p. 13.
Tomtek Jilga (west), 13000–14500 feet, No. 26.
Distr. Kashmir, Tibet and E. Himalaya.

X. *Compositæ.*

17. Aster *Linn.*

21*. Aster alpinus *Linn.*
Tomtek Jilga, 13500–14500 feet, No. 20.
Distr. Turkestan, Altai Mts.

22. Aster Heterochæta *Benth.* – F.B.I. iii, p. 250-251.
Mintaka stream, 13300 feet, No. 47.
Distr. Alpine Himalaya, Tibet and Altai Mts.

23*. Aster obovatus *C. A. Mey.*
Tomtek Jilga, 14000 feet, No. 43.
Distr. Altai Mts., Siberia.

18. Erigeron *Linn.*

24*. Erigeron uniflorus *Linn.*
Lup Gaz Jilga, 15700 feet, No. 35.
Distr. Turkestan.
This is, at any rate, a new record for the Pamirs.

19. Leontopodium *Br.*

25. Leontopodium alpinum *Cass.* – F.B.I. iii, p. 279.
Bank of Beyik river, 14300 feet, No. 3.
Distr. Mountains of Europe, Central Asia and Himalaya.

20. Allardia *Dcne.*

26. Allardia glabra *Dcne.* – F.B.I. iii. p. 313.
Rocky slopes above Kilik Pass, 16000 feet, No. 41.
Distr. Western Himalaya, Eastern Himalaya, Kashmir and Tibet.

21. Senecio *Linn.*

27*. Senecio sp. nov ? aff. S. altaicus *Schultz-Bip.*

A pretty looking plant about 6 in. high. *Roots* tufted, fibrous. *Radical leaves* obovate, 3 in. long, 1·5 in. broad at the broadest part, acute, base cuneate and narrowed down towards the petiole, very obscurely dentate otherwise quite entire, glabrous above, pubescent beneath, coriaceous. *Cauline leaves* 2, sheathing, oblong or obovate. *Peduncle* 1 in. long. *Bracts* lanceolate or subulate about ½ in. long. *Panicle* very compact. *Heads* ½ in. long and about 1 in. diameter. *Involucral bracts* 10-14, one-seriate, lanceolate or linear-lanceolate, acute, ¼ in. long, pubescent without and ciliolate towards the apex. *Ligules* 12-16, lanceolate. *Anthers* ecaudate. *Achenes* 1/16 in. long, 1/24 in. broad, 5-6 striate. *Pappus* ¼ in. long, scabrid.

This species belongs undoubtedly to the section Ligularia and differs from S. altaicus *Sch. Bip.* in its dwarfish habit, more compact panicle and much smaller peduncles. The leaves are quite different from any species under Ligularia described in Hooker's *Flora of British India.*

Tomtek Jilga (West), 13500–14500 ft., No. 28.
Pamir region, alongside water courses, 14000–15000 ft.
Alcock, No. 17715 (Pamir Boundary Commission 1895).

XI. *Primulaceæ.*

22. Primula *Linn.*

28. Primula farinosa *Linn.?* – F.B.I. iii, p. 486–487.
Near Kilik Pass, 14000–15000 ft., No. 13.
Distr. Western Tibet.

29. Primula purpurea *Royle?* F.B.I. iii, p. 490.
Near Kilik Pass 15000 ft., No. 48.
Distr. Western Himalaya.

30. Primula sibirica *Jacq?* F.B.I. iii, p. 487–488.
Mintaka stream 13400 ft., No. 46.
Distr. Western Tibet.

23. Androsace *Linn.*

31*. Androsace sp. nov. – aff. A villosa *Linn.*
Tomtek Jilga, 14500 ft., No. 7.

The above four identifications have, at present, to be regarded as tentative as they have been determined with the aid of descriptions only. The Calcutta Herbarium material is on loan at present and hence comparison with authentic types was not made.

XII. *Boragineæ.*

24. Eritrichium *Schrad.*

32. Eritrichium strictum *Done.* – F.B.I. iv, p. 164.
Mintaka stream, 13300 ft., No. 9.
Tomtek Jilga, 13000–14500 ft., No. 21.
Distr. Western Himalaya, Kashmir and Tibet.

25. Myosotis *Linn.*

33. Myosotis sylvatica *Hoffm.* – F.B.I. iv, p. 173.
Tomtek Jilga 14500 ft., No. 32.
Distr. Alpine Himalaya, Western Asia.

XIII. *Scrophularineæ.*

26. Pedicularis *Linn.*

34. Pedicularis versicolor *Wahlb.* – F.B.I. iv, p. 316–317.
Mintaka stream, 13300 ft., No. 45.
Distr. Alpine Himalaya, Central Asia.

An Alpine condition of P. Oederi *Vahl.*

XIV. *Selagineæ.*

27. Lagotis *Gaertn.*

35. Lagotis globosa *Kurz ?*—F.B.I. iv, p. 558–559.
Kukturuk Jilga, 14000 ft., No. 37.
Distr. Western Tibet.

XV. *Polygonaceæ.*

28. Polygonum *Linn.*

36. Polygonum viviparum *Linn.*—F.B.I. v, p. 31–32.
Tomtek Jilga, 13000–14500 ft., No. 25.
Distr. Alpine Himalaya, Western Tibet, Central Asia and Northern Europe.

29. Oxyria *Hill.*

37. Oxyria digyna *Hill.*—F.B.I. v, p. 58.
Tomtek Jilga, 14500 ft., No. 11.
Distr. Alpine Himalaya (Sikkim to Kashmir), Western Tibet.

MONOCOTYLEDONES.

XVI. *Liliaceæ.*

30. Lloydia *Salisb.*

38. Lloydia serotina *Reichb.*—F.B.I. vi, p. 354.
Lup Gaz Jilga, 15700 ft., No. 34.
Distr. Alpine Himlaya.

XVII. *Cyperaceæ.*

31. Carex *Linn.*

39. Carex melanantha *C. A. Mey.*—F.B.I. vi, p. 733.
Bank of Beyik River, 14300 ft., No. 4.
Distr. Kashmir, Central Asia.

XVIII. *Gramineæ.*

32. Deschampsia *Beauv.*

40. Deschampsia kœlerioides *Regel.*—F.B.I. vii, p. 273–274.
Tomtek Jilga, 13000–14500 ft., No. 22.
Distr. Kashmir, Turkestan.

33. Avena *Linn.*

41. Avena subspicata *Clairv.*—F.B.I. vii, p. 278.
Tomtek Jilga, 13000–14500 ft., Nos. 19,27.
Distr. Alpine Himalaya, Tibet.

34. Poa *Linn.*

42. Poa annua *Linn.*—F.B.I. vii, p. 345–346.
Bank of Beyik river, 14300 ft., No. 2.
Distr. Temperate Asia, Europe.

43. Poa attenuata *Trin.*—F.B.I. vii, p. 340–341.
Tomtek Jilga, 14500 ft., No. 10.
Distr. N. Kumaon, Kashmir and Asia Minor.

35. Elymus *Linn.*

44. Elymus sibiricus *Linn.*—F.B.I. vii, p. 373.
Tomtek Jilga, 13000–14500 ft., No. 23.
Distr. N.W. Himalaya, Tibet etc.

The following table gives a synoptic view of the systematic character of the collection :—

PHANEROGAMS.

	Natural Orders			Genera			Species		
Dicotyledons	...	..	15	...	...	29	...	...	37
Polypetalæ	...	8	...	...	15	...	...	19	...
Thalamifloræ	5	...	...	10	...	...	12	...	...
Discifloræ	1	...	...	1	...	...	1	...	...
Calycifloræ	2	..	...	4	...	...	6	...	...
Gamopetalæ	...	6	...	...	12	...	...	16	...
Incompletæ	...	1	...	...	2	...	...	2	...
Monocotyledons	...	...	3	...	...	6	...	...	7
Totals—Natural Orders 18	Genera 35			Species 44.					

The collection comprises only 18 Natural Orders, 35 genera and 44 Phanerogamic species. The Natural Order Compositæ comes first with seven species, next Cruciferæ with six species, Leguminosæ and Gramineæ with five species each and Primulaceæ with four species. Of the remainder, Polygonaceæ, Boragineæ and Ranunculaceæ contain 2 species each, while the rest of the Natural Orders are represented by only one species each.

CHAPTER X.

BLOOD OBSERVATIONS AT HIGH ALTITUDES AND SOME CONCLUSIONS DRAWN FROM THIS ENQUIRY IN RELATION TO MOUNTAIN DISTRESS

by

Captain R. W. G. Hingston, I.M.S.

It has long been known that, during an ascent from sea level to a high altitude, a remarkable group of phenomena in the nature of a severe throbbing headache, mild fever, breathlessness, insomnia, giddiness and vomiting were very liable to manifest themselves. The nature and intensity of these symptoms appeared to vary greatly in different individuals, but there was, undoubtedly, a distinct relation between the severity of the phenomena and the height of the ascent.

Of all the physical changes which take place during the ascent to any great altitude, the reduction in atmospheric pressure is, undoubtedly, the most important; and the human body is compelled to adapt itself to the increased rarefaction of the air and the lessened oxygen percentage which is associated with the diminished pressure. Should no such adaptation take place and should the whole vascular and respiratory mechanism perform its functions at high altitudes with the same power and the same regularity with which it works at sea level, then the greatly diminished supply of oxygen would produce an extreme anæmia and account for that group of symptoms usually described as "mountain sickness" and which seem to be nothing more than the result of a diminished aëration of the blood.

Theoretically it appears evident that the body might accommodate itself to a diminished oxygen supply in one of three ways or by any combination of these ways. *Firstly*, the respirations might so increase in depth or in frequency as to result in so much greater a bulk of the rarefied air entering the interior of the lung as to obtain a supply of oxygen equal to that received at sea level under the influence of less energetic respiratory movements. *Secondly*, the cardiac mechanism might act with greater force and frequency and produce an increased vascularity of the lung tissue and a corresponding increase in oxygen absorption. *Thirdly*, and this I consider to be the chief, if not the sole, means of accommodation, the actual oxygen carrying power of the blood stream may be increased by a multiplication of its oxygen carriers, the red blood corpuscles, or by an increase in the amount of hæmoglobin which each corpuscle contains, and thus result in the greater power of a unit volume of blood to convey oxygen from the lungs to the tissues of the body at high altitudes than at sea level. The body becomes adapted to a rarefied atmosphere not by any increase in the power of the vascular and respiratory mechanism, but by a greater richness of the fluid driven and purified by that mechanism and made manifest by an increase in the red blood corpuscles.

The unpleasant symptoms experienced at high altitudes appear to be due to a failure on the part of the body to create red corpuscles in sufficient numbers to produce adaptation to the more rarefied air and diminished oxygen;

Photogravure. Survey of India Offices, Calcutta, 1914.

Plate 20.—Blood observations at 16,900 feet.

and, though this failure is usually of a temporary nature owing to the ascent being made too rapidly and the blood forming mechanism not having time to complete its work, yet, in one case which came under my notice at 14,000 feet, the failure was almost permanent; the blood forming mechanism seemed to have reached the full extent of its creative power, the blood with extreme slowness reached the standard normal at that altitude and the individual suffered continually from the characteristic symptoms. Normal blood at sea level, i.e. under a pressure of 760mm. of mercury, contains 5,000,000 red blood corpuscles per cubic millimetre. During a gradual ascent, the number of the corpuscles increases until at an altitude of 18,203 feet, the highest point at which I was able to make an examination, the blood contains 8,320,000 corpuscles per cubic millimetre; this estimation was made after camping for two days at that height and it was sufficient to adapt the body to the diminished oxygen supply, if not completely, at any rate to such an extent as to obviate any symptoms of mountain distress.

The first unpleasant symptoms were experienced at an altitude of 11,000 feet, after a rapid ascent from a height of 5,000 feet. A blood examination at this altitude gave a count of only 5,200,000 which was much below the normal for such an altitude as, on a subsequent occasion, at a slight-lower elevation of 10,500 feet reached by a slow and gradual ascent for many days along the course of the river, the blood count was as high as 6,624,800 and no symptoms of mountain distress were noticeable.

On all occasions the headache, insomnia, breathlessness and palpitation, from which some of our party suffered, were experienced only after ascents which were associated with a rapid increase in altitude and tended to pass away completely after a residence of some days at the higher altitude. It seems as though the cardiac and respiratory mechanisms were compelled to work with more energy at an increased altitude only when that altitude has been reached by a rapid ascent and before the blood forming tissues have been able to produce a greater number of red corpuscles. The breathlessness, dyspnœa and palpitation are the manifestation of the increased cardiac and respiratory functions and the headache, giddiness, vomiting and insomnia are the results of the diminished aëration of the blood which the accelerated heart action and respiratory movements are unable to make good. But the increase in the pulse rate was, on no occasion, very noticeable even after a rapid ascent if a lapse of some hours' rest was allowed to take place after the termination of the ascent. Thus the highest of a large number of records gives a pulse rate of 99 and this was taken at the end of a quick climb to 11,000 feet and after an interval of some hours. The number of respirations also alter in a similar manner and though during exercise at high altitudes they increase to an amazing extent, yet after a long rest they decrease almost to normal and, after a residence sufficiently long to produce adaptation to the altitude, they often become sub-normal.

The altitude at which the largest number of observations were made was one between 13000 and 14000 feet (aneroid). Over a period of almost two months blood counts were continually estimated by the usual method of calculating with a Hæmacytometer the number of corpuscles in a minute volume of blood diluted with a known volume of saline solution, and multiplying the result thus obtained by the amount of the dilution. The mean of a number of counts made on a European at that altitude was 7,402,500 and this average was well maintained throughout the whole two months and had reached its maximum after a residence of 19 days at that altitude. After a rapid ascent to a height of

16,907 feet (triangulated height), the blood count rose to 7,640,000 and after a residence of two days at a height of 18,203 feet (triangulated height) the count had reached 8,320,000, and, with the exception of a slight insomnia, which may have been due to extraordinary conditions of discomfort, no unpleasant symptoms were then experienced.

The inhabitants of the Pamir Plateau live permanently at an altitude of over 13,000 feet and seldom descend much below that level. I considered it, therefore, a matter of interest to determine their normal blood count and to ascertain whether their blood corresponded in increased red corpuscles to that which was seen to have taken place in Europeans who had ascended to that height. The blood of seven Sarikōlis, all adult healthy males, was examined and the mean of a number of observations, all of which closely agreed, gave a blood count of 7,595,000. This, it may be noticed, agrees closely with the count of 7,402,500 obtained from the blood of a European who had ascended to that altitude. Thus the dweller of the plains, during an ascent to a higher altitude, is able to improve gradually the standard of his blood until it ultimately reaches that degree of richness which is normal to the permanent inhabitants of that altitude. And when that increased development of red corpuscles has been completed, all distressing symptoms due to altitude will disappear as full adaptation of the body to the new conditions will have taken place.

It is difficult to conjecture to what extent that degree of adaptation would continue; if the body can accommodate itself to the rarefied atmosphere of 18,000 feet, will it continue to accommodate itself, in a gradual ascent, up to 29,000 feet, the altitude of Mount Everest? There must be some limit to the degree of adaptation, and in one case which I examined that limit appeared to have been reached. One khalassie, who suffered from severe and continual symptoms of mountain sickness at an altitude of 13,300 feet, had a blood count of only 5,760,000 while the blood count normal at that altitude was over 7,000,000. His manufactory of blood corpuscles seemed to have been worked to its extreme limits and for weeks was unable to perform the increased functions demanded by the altitude; and it was not until a period of nearly two months had elapsed that the blood count had slowly improved to the amount normal at 13,300 feet, that the symptoms from which he suffered gradually disappeared.

If the individual who ascends from a low level to a high altitude gradually adapts himself to the new altitude by an increase in the number of his red blood corpuscles, he does so because the deficiency in oxygen acts as a continual and ever-increasing stimulus to the blood forming mechanism and ever compells it to a greater production in order to produce closer adaptation. Consequently it is by no means self-evident, in fact it might almost be contrary to expectation, that the permanent dweller at a high altitude would, during a descent to a lower altitude, undergo a reduction in the number of his red corpuscles; there would be no definite stimulus compelling such a reduction which, in the reverse case, compelled an increase, although the excess corpuscles might be expected to atrophy and disappear slowly as they would be no longer of any use.

I had an opportunity of putting this matter to the test. A Sarikōli accompanied the Expedition on its return journey as far as Gilgit and frequent examinations of his blood were made. He had spent almost his whole life at an altitude of about 13,000 feet and only on one occasion descended as low as 10,000 feet. The average blood count of the Sarikōlis has been stated to be 7,595,000 and the blood count of this man agreed closely with that average,

yet during his descent to lower levels his blood count gradually decreased; at 9,450 feet it had reached 7,320,000 and at 7,500 feet it had sunk as low as 5,960,000 and the rapidity with which it declined corresponded closely to the rate of decline in the blood of a European who had lived but two months at that altitude where the Sarikōli had passed his whole existence.

Thus increase in altitude means increase in the number of red blood corpuscles per unit volume of blood. The manufacture of those corpuscles takes time to develop and failure in that development either through insufficient time or inefficiency of the creative power means mountain sickness. The number of red corpuscles in the blood of a dweller at low altitudes can increase until it reaches ultimately the number normal in the dwellers at high altitudes and the converse is likewise true; and the method by which the body adapts itself to great heights is not by a greater energy on the part of the cardiac or respiratory mechanism but by a slow and gradual manufacture of the red blood cells which produce a greater richness of the blood stream and convey a normal supply of oxygen to all the tissues.

CHAPTER XI.

SECTION A.

SOME GENERAL NOTES ON THE CLIMATE AND SNOWFALL OF THE TAGHDUMBASH PAMIR

by

Lieut. K. Mason, R.E.

and

Captain R.W.G. Hingston, I.M.S.

On the suggestion of Dr. Gilbert Walker, C.S.I., F.R.S., Director General of Observatories in India, from the date of our stay at Gilgit on 16th May, to our return to Hunza on 25th August, a regular series of observations of the upper air currents were taken daily, as indicated by the movement of cirrus clouds.

Owing to the very variable weather, the sky was often so overcast that this was not possible, but the table at the end of the chapter gives the results obtained.

No barometrical nor thermometrical observations were recorded, as the camp was constantly on the move; the results could only have been fragmentary, and time was better employed on obtaining other results.

Previous to our start from Srinagar, the weather had been very severe, and the first detachment to cross the Rajdiāngan Pass experienced bad weather during the passage. But from the date of crossing the Burzil Pass, on the night of the 2nd May, the weather remained uninterruptedly fine till our arrival on the Pamirs on the 3rd June, with the minor exception of a very violent cyclone at Misgar on the 28th May; and we were informed on ascending our first few stations, that there was less snow this year than at the same period of last year. Incidentally it may be of interest to mention that at this time of the year (2nd May), snow is at its deepest on the Burzil Pass, (Punjab Himalaya), and that we were told by the telegraphists at Minimarg, that the heaviest snowfall occurs here in April.

The fine spell lasted on the Pamir till the 9th, when heavy clouds were experienced on Sarblock (Russian East) h.s., and on the morning of the 10th, snow was falling. A spell of bad weather set in, and lasted till the 18th, when again the weather turned fine. During this period, the cirrus clouds were very irregular and on the 17th were travelling northwards; on the 22nd, however, the first day on which they were observed after the renewal of the fine spell, the 19th to the 21st being practically cloudless, they were again travelling southwards.

This period of fine weather lasted till 3rd July, when it was noticeable on ascending Kilik East h.s., that everyone, including the Sarikōlis, suffered great distress in breathing. This was attributed to excessive moisture

in the atmosphere*, and on the 4th July the ground was again completely under snow. On the 3rd, the cirrus clouds were travelling south-eastwards, and the first day after the snow fell on which a glimpse was obtained of these clouds was the 6th; they were then going northwards.

On the 7th July snow covered the whole Pamir, and from the summit of Kilik East h.s., the whole panorama appeared under a white sheet of snow. Scarcely a black rock was visible anywhere.

On the 8th, however, the weather again cleared, and cirrus clouds were reobserved on the 10th, when they were again travelling south-eastwards. From now onwards the weather remained fine till the evening of August 3rd, when rain fell on the summit of the Kilik Pass, at an altitude of 15,600 feet, and snow on the hills over 16,000 feet. During this fine spell, there were exceptions in the form of snow squalls experienced on the tops of certain stations, but the snow from these either did not lay, or else cleared soon after falling. These though unpleasant, could scarcely be classified as wet days, and throughout this period the cirrus clouds when observed were travelling in a direction between south and east.

In August we hardly had a fine day, and morning after morning the ground, even in the valleys down to the Karachukor itself, was under new snow. This in the valleys generally cleared by nightfall, but heavy snow clouds remained low on the hills most of the day; and a biting wind blew alternately up and down the valley. We could hardly get a glimpse of the upper clouds during the whole of this month.

During the survey operations of 1912, the weather on the Pamirs was bad until about the 8th July, but August was brilliant; and it seems from reports that July is undoubtedly the finest month, and the only one that can be at all counted on, and that both June and August are very variable.

As regards the wind on the Pamirs, the detachment seems to have not been exceptionally unlucky. At times it was very biting and cold, and it would get up so suddenly that we could never take any risks with summer clothing. But on the whole it was not the rule in the valleys up to midday, and particularly during the last half of July, hot mornings with practically no breeze were common in the valleys. But there was always a breeze or high wind on the summits of stations, rising in violence in the afternoon often to a squall. Except for the wind and intermittent spells of bad weather, the climate of the Taghdumbash Valley cannot be said to be in any way particularly severe in summer time, especially in July.

The detachment tried to collect information as to when the maximum amount of snow falls in winter, and it appears from several accounts obtained that this is, generally speaking, about Christmas, though sometimes late winter falls occur. This seems to indicate that the currents, which carry and deposit snow in April on the Western Himalaya, do not to any large extent cross the watershed into Central Asia.

The average depth of laying snow in winter was said to be about $3\frac{1}{3}$ feet, and it appears probable that the cloud outlook is generally somewhat

*Some mountaineers have recorded that the effects of altitude are more noticeable on clear, cloudless, and dry days; this was not our experience, and it is possible that owing to these conflicting views, moisture has in reality very little bearing on the question of mountain distress.

dismal. A few Sarikōlis* only remain, those responsible to China and the British Government for the fortnightly mails between Gilgit and Kashgar.

The limit of permanent snow seems to be about 16,500 feet on northern slopes, and 18,500 on the southern. This was observed in the beginning of August. The permanent snow, or, more strictly speaking, *ice*, had then a darker colour, and was of a different character to the layer of winter snow, which had almost melted by this time.

A curious point was noticed with regard to the almost total absence of electrical phenomena. On one occasion, on the 27th July, we both thought we heard, when encamped on Kilik West h.s., the rumble of one distant peal of thunder, and our Kashmiri guide thought so too, but we may have mistaken an avalanche or sérac fall. The Sarikōlis then assured us that thunder was never heard on the Pamirs. On the 4th August however, there was no doubt, and though the storm seemed very severe over the Chapursān direction and thunder was distinctly heard, the storm did not burst on the Pamirs. The fact that "summer" lightning was also seen on the evening of the 4th shows how unreliable are the statements of the inhabitants.

Cav. de Filippi mentions a complete absence of thunderstorms in the Karakoram Range†. This is all the more remarkable considering the extreme sensitiveness of some of the mountains of the Punjab Himalaya and the ranges to the south. On one occasion in 1912, one of the Survey detachments was struck on Yashochish in the main Himalayan Range, one man being killed and another badly burnt, though it is rare that lightning is really dangerous on a mountain top. On another occasion in 1912, in the Punjab Himalaya, some 20 miles north of the Rajdiāngan Pass, the hill station of Lōsar and the triangulation party on it became highly sensitive, the theodolite and even the hand when held above the head emitting a buzzing sound. The author received a slight shock in the arm, which paralysed it for about a quarter of an hour. Major Bruce remarks on the comparative immunity from hurt from electrical shocks at high altitudes‡, though as will be seen from the detachment's experience on Yashochish, one is not always so lucky. On one other occasion the author has experienced a similar buzzing of the theodolite in the Punjab Himalaya, and this was the forerunner of a terrific thunderstorm at night. It seems curious that there is such a complete absence of electrical phenomena in the Karakoram, and so little in the regions to the north, and it will need further investigation to unravel the causes.

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* The Kirghiz is the wandering nomad of Chinese extraction; the Sarikōli is purely Aryan and never intermarries with the Kirghiz. The ancestors of the two biggest Sarikōli Begs, Mahomed and Tulboy, originally came from Nagar and most of the others are of Afghan origin much intermarried with these two families.

† F. de Filippi, "*Karakoram and Western Himalaya*", pp. 315, 316.

‡ Major the Hon. C. G. Bruce, "*Twenty Years in the Himalaya*", pp. 129, 130.

CHAPTER XI. (*Continued*).

SECTION B.

NOTE ON THE UPPER AIR CURRENTS OVER THE PAMIRS

by

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Lieut. Mason's short series of cloud observations taken between Kashmir and the Pamirs form a useful addition to our very limited knowledge of the movements in the upper layers of the atmosphere over Central Asia. They are interesting from two points of view; firstly, as regards the question of whether the Indian south-west monsoon is part of a cyclonic circulation round the heat depression of Central Asia, or a less extensive phenomenon concerning only India and the Indian Seas; secondly, as regards the general circulation of the atmosphere, theories of which have had to be largely modified in consequence of Hildebrandsson's analysis of cloud observations collected from the greater part of the earth's surface*.

The relation between weather south and north of the Himalaya, and its bearing on the nature of the south-west monsoon was already under discussion in the early years of expeditions into the Himalayan region, and the discussion was brought to a standstill rather through lack of data than because the question was satisfactorily settled. It is interesting now therefore to re-examine the points at issue, in the light of our further information.

In support of the first view of the monsoon mentioned above, it may be recalled that early observations of the upper clouds almost invariably showed south-west winds over Tibet, Kashgaria and the Himalaya†; while of later observations, those of de Filippi in 1909 showed strong and persistent damp south-westerly winds above 20,000 feet on the Upper Godwin Austen Glacier. An examination of the Indian daily weather charts of the period corresponding to de Filippi's observations indicates that they could hardly have been anything other than a continuation of the monsoon winds. Barometric gradients were then favourable for a current of moist air from the Arabian Sea in a northerly direction across the Punjab, and excessive rainfall was occurring along the western Himalaya. Some doubt as to the existence of such a southerly current might be induced by the north-westerly upper winds and calms indicated by pilot balloons during the same period at Jhang, in the Punjab, (about 400 miles south-west of the Godwin Austen Glacier), but, considered in conjunction with the accompanying deficiency of rainfall in the west of Kashmir, these winds at Jhang are quite consistent with the existence of southerly moist winds further to the east. It appears therefore that monsoon winds can and do on occasion penetrate beyond the Himalayan watershed.

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* See *Quarterly Journal, Royal Meteorological Society, 1904.* pp. 317—343, and *Meteorologische Zeitschrift, Hann Band, 1906,* p. 117.

† See Henderson, *From Lahore to Kashgar,* p. 357, also Blanford, *Indian Meteorological Memoirs, Vol. 1,* p. 59.

The evidence in support of the second view was formulated chiefly by Blanford who maintained that the monsoon could not penetrate far beyond the snowy ranges. From the consideration of average values, he showed that nearly seven-tenths of the marked seasonal pressure changes, which are associated with the development of the monsoon over India, are produced by changes of temperature and humidity in the layer between sea-level and 7000 feet*. He therefore concluded that the monsoon must be caused mainly by the pressure gradients in this layer south of the Himalaya, and not by the changes of pressure in the interior of Asia. Recent cirrus cloud and pilot balloon observations agree with Blanford's conclusion and show that during the monsoon period the upper currents are not as a rule directed across the Himalaya. Such directions are however fairly frequent during the period covered by the cloud and balloon observations, namely, clear weather and the early and late stages of disturbed weather; while during periods of continuous monsoon rainfall along the Himalaya, it is not unlikely that they are still more frequent. This latter point, however, we are not at present in a position to decide, since our methods of observation fail during such periods.

The wind roses showing the wind directions at the cirrus level over the Pamirs, Simla, and Lahore, during the period covered by Lieut. Mason's observations, and the roses given at certain north Indian stations by more extended observations, are plotted in the accompanying diagrams. The agreement between the short series of observations on the Pamirs and at Simla is well-marked. The predominant wind is in both cases from between north-west and west, but it is interrupted more frequently at Simla than on the Pamirs. At Lahore, which, as shown by the roses given for the period 1897-1900, is more affected by the upper easterly monsoon current from the Bay of Bengal than is Simla, the few observations available show no such predominance of winds from between west and north-west. The occasional incursions of the wind northwards across the Himalaya are clearly shown in the Simla observations, and from an examination of the Indian and Russian daily weather charts, it appears exceedingly probable that such an incursion, due to the disturbance which moved from the Arabian Sea into northern India in the early part of June and gave much rain in Kashmir, was responsible for the disturbed weather experienced by the expedition from the 9th to the 18th. The trajectories of pilot balloons sent up at Simla during the disturbed periods also show these incursions. For example, from the 15th to the 22nd June, when the cirrus cloud directions over the Pamirs were consistent with the advance of a depression from the south and its movement away eastwards, the pilot balloons at Simla showed a considerable flow from the south, which ceased on the 23rd. Similarly, winds above Simla changed from north-westerly to southerly between the 3rd and the 6th of July, when like changes were observed in the movement of the cirrus over the Pamirs. The cirrus direction from S. S. E. observed by Lieut. Mason on May 18th may have been due either to an anti-cyclone shown by the Russian reports as then situated north of Tashkent, or to the disturbed conditions which rendered pilot balloon observations impossible at Simla. This point we have no means of determining.

An examination of the Russian and Indian daily weather reports of the period, indicates a markedly closer relation of the weather on the Pamirs with that of Kashmir than with that of Tashkent. The effect of the Indian monsoon currents on the country north of the Pamirs was inappreciable, the

* Blanford. *Winds of Northern India*, p. 53.

PERCENTAGE FREQUENCY OF WIND DIRECTIONS

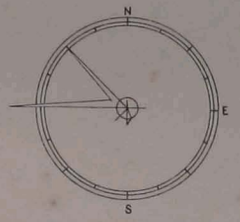
AT CIRRUS CLOUD LEVEL

Length of Radius Vector denotes percentage frequency of Winds blowing from the direction of the Vector.

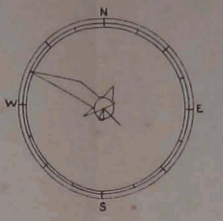
Scale 5 cm. = 100 %

PLATE 21.

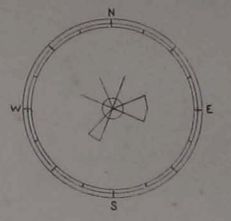
PAMIRS
May 16th — Aug. 24th
33 Observations



SIMLA
May 16th — Aug. 24th
25 Observations

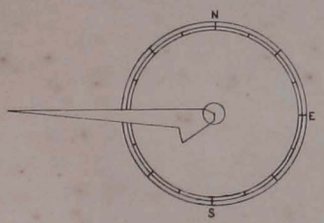


LAHORE
May 16th — Aug. 24th
8 Observations

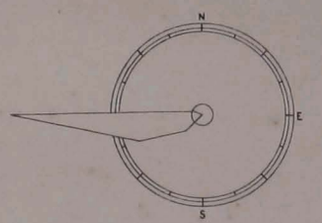


SIMLA 1897-1900

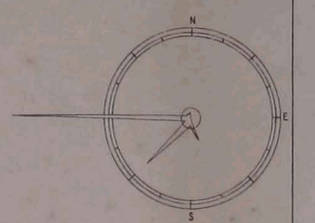
Oct. — Feb.
217 Obsns.



Mar. — May
267 Obsns.

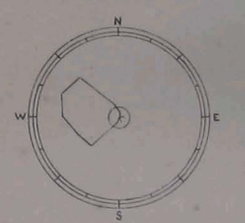


June — Sept.
40 Obsns.

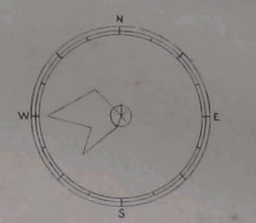


JAIPUR 1897-1900

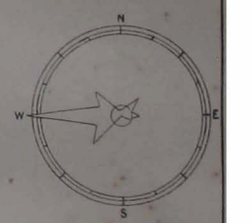
Oct. — Feb.
290 Obsns.



Mar. — May
179 Obsns.

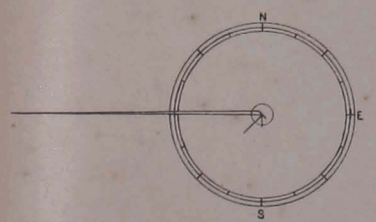


June — Sept.
117 Obsns.

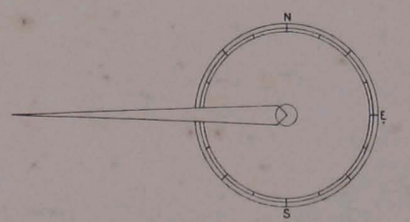


LAHORE 1897-1900

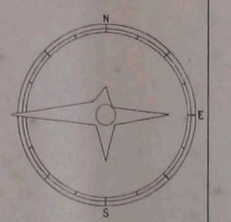
Oct. — Feb.
318 Obsns.



Mar. — May
211 Obsns.

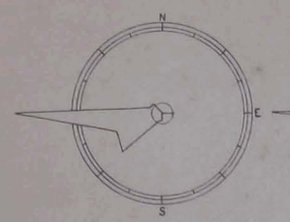


June — Sept.
57 Obsns.

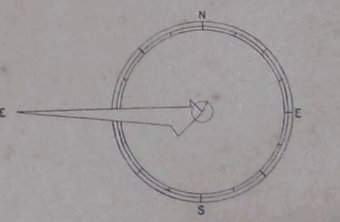


ALLAHABAD 1896-1900

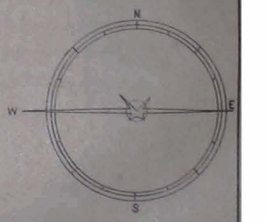
Oct. — Feb.
521 Obsns.



Mar. — May
211 Obsns.

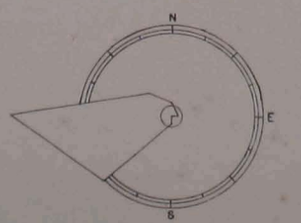


June — Sept.
474 Obsns.

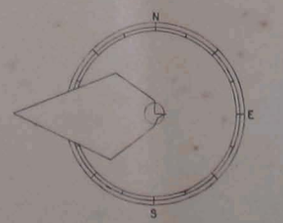


CALCUTTA 1881-86

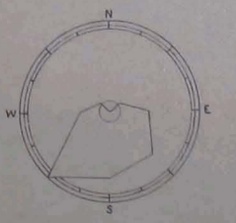
Oct. — Feb.
196 Obsns.



Mar. — May
62 Obsns.



June — Sept.
84 Obsns.



10 0 10 20 30 40 50 60 70 80 90 per cent.

conditions there being controlled by disturbances which advanced across Russia from the west.

To sum up, the view that the Indian monsoon currents form part of a circulation round a depression over Central Asia and are continued beyond the Himalaya, is no longer tenable. They are essentially currents of the lower atmosphere, and though from time to time they make incursions northwards across the Himalaya, the discharge from them does not as a rule cross the mountain barrier, but is carried eastwards in the general circulation of the atmosphere above the level affected by monsoon influences.

The second point of interest of the observations concerns their agreement with the general circulation of the upper winds described by Hildebrandsson. This circulation consists of east winds over the thermal equator and the region of equatorial calms; of the upper anti-trades in higher latitudes; and of westerly descending winds above the polar limits of the trades, (about latitude 30°). Between latitude 30° and the polar circle, the atmosphere moves in a cyclonic whirl round the depression in polar regions, the upper winds having a component away from the centre, and the lower winds a component towards the centre as in the case of ordinary cyclonic disturbances. The local cyclonic and anti-cyclonic movement shown at the earth's surface by weather maps, and also the monsoons of Asia, as a rule are not strong enough to affect the upper winds of the general circulation.

Lieut. Mason's observations and the corresponding observations at Simla agree with this circulation more closely than would be expected in view of the shortness of the period covered by them, and illustrate the remarkable steadiness of the westerly upper winds over the Himalayan region. Simultaneous pilot balloon observations at Darjeeling showed winds from almost due west, and it is probable that during the greater part of the period a massive current extended unbroken along the whole length of the Himalaya. It would appear that the monsoon invades the upper regions more frequently than was indicated by the data available to Hildebrandsson, but it may be noted that in accordance with Hildebrandsson's general conclusions, only three of the several disturbances which affected the Pamirs while the expedition was there, markedly affected the direction of drift of the cirrus cloud.

SECTION C.

SYNOPSIS OF OBSERVATIONS OF CIRRUS CLOUDS,
16th MAY—25th AUGUST, 1913.

Notes:—

1. The kind of cloud is indicated by the International abbreviations.

2. The direction of the cloud was obtained by its reflection on a plate glass painted black on its lower surface, and is always shown by the magnetic direction towards which the cloud is moving.

3. The density of cirrus banks is abbreviated as follows:—

0=Very thin and irregular.
1=Thin but regular.
2=Fairly thick.
3=Thick.
4=Very thick and of a dark colour.

4. Unless otherwise stated, where no cirrus clouds were observed, the weather was either fine with possibly cumulus clouds, or else lower clouds obscured the sky.

Date.	Hour.	Station.	Cloud.	Direction.	Rad. point.	Undulation.	Banks.	Remarks.
May.								
16	...	Gilgit	...		...	...	...	None.
17	3-20 p. m.	do.	Ci	East	0	0	0	Slow.
18	10-35 a. m.	Nomal-Chalt	Ci	N. N.-W.	0	0	0	Very slow.
19	...	Chalt-Minapin	...	...	...	...	...	None.
20	...	Minapin-Aliabad	...	...	...	...	...	do.
21	...	Aliabad	...	...	...	...	...	do.
22	...	do.	...	...	...	...	...	do.
23	7-35 p. m.	Aliabad-Atabad	Ci	S.-E.	0	0	2	Fairly fast.
24	...	Atabad-Gulmit	...	...	...	...	...	None.
25	...	Gulmit-Pasu	...	...	...	...	...	do.
26	11-25 a. m.	Pasu-Khaibar	Ci	S.-E.	0	0	0	Fairly fast.
27	...	Khaibar-Gircha	...	. .	...	...	...	None.
28	...	Gircha Misgar	Ci	E.S.E. × E.	0	0	0	Slow; cyclone and rainstorm about 6 p. m.
29	8 a. m.	Misgar-Murkushi	Ci	E.	0	0	0	Slow.
30	12-20 p. m.	Murkushi	Ci	E.S.E.	0	0	2	do.
31	10-15 a. m.	Murkushi-Boihil	Ci-S.	E.	0	0	2	Fairly fast.
June.								
1	4 p. m.	Boihil	Ci	E.	0	0	0	do.
2	...	Boihil-Gulquaja	...	...	...	...	...	Cloudless.

Date.	Hour.	Station.	Cloud.	Direction.	Rad. point.	Undulation.	Banks.	Remarks.
June.								
3	...	Gulquaja-Mintaka Akhsai	...	...	...	...	...	None.
4	...	Mintaka Akhsai (Pamir).	...	...	...	...	...	do.
5	2-30 p. m.	do.	Ci	E.	0	0	2	Slow.
6	...	do.	...	...	...	...	...	None.
7	...	do.	...	...	...	...	...	do.
8	2 p. m.	do.	Ci	E.	0	0	0	Slow.
9	...	Sarblock	...	...	...	...	...	No cirrus clouds visible and sky heavily overcast. Snow fell in the afternoon.
10	...	do.	...	...	...		...	Snow all day.
11	...	do.	...	...	...		...	do.
12	...	do.	...	...	...		...	do.
13	7 p. m.	do.	Ci-S.	S.E.	0	0	3	Very slow. Observed during a break in the snowfall. 4 feet snow since 9-6-13 at 16000 feet.
14	...	Tongder		...	...	...	...	None visible. Snow most of day.
15	3-30 p. m.	Takhtakhun	Ci	W. S. W.	0	0	0	Very slow; snow storms at intervals throughout day.
16	1-30 p. m.	do.	Ci	W.	0	0	2	Slow. Thickest to S. W. Snow storms at intervals.
17	4-35 p. m.	do.	Ci	N.	0	N.-S.	1	Very slow. Snow till 4 p. m.
18	...	do.	...	...	...	...	...	None visible. Snowed early.
19	...	Kusskussu	...	...	...	...	...	Cloudless all day
20	...	do.	...	...	...	...	...	None.
21	...	do.	...	...	...	...	...	do.
22	1 p. m.	Mintaka Akhsai	Ci	S.	0	0	0	Very slow.
23	...	Tomtek	...	...	...	...	...	None.
24	...	do.	...	...	...	...	...	do.
25	...	Mintaka Akhsai	...	...	...	...	...	do.
26	...	do.	...	...	...	...	...	do.
27	11-30 a. m.	do.	Ci	E.	0	0	0	Very slow.

Date.	Hour.	Station.	Cloud.	Direction.	Rad. point.	Undulation.	Banks.	Remarks.
28	...	Mintaka Akhsai	...	...	...	...	...	None.
29	5-30 p. m.	do.	Ci	E	0	0	0	Very slow.
30	...	Taghramansu	...	...	...	...	...	None.
July.								
1	...	Kilik Pass	...	...	...	...	...	None, but heavy nimbus clouds.
2	...	do.	...	...	...	...	...	do.
3	4 p. m.	Kilik East h. s.	Ci	S. E.	0	0	2	Very slow. Snowed towards evening.
4	...	do.	...	...	...	...	...	None visible. Snowed all day and heavy snow clouds low on the hills.
5	...	do.	...	...	...	...	...	Snow at intervals all through the day. Ci clouds seen for a short time, but not observed.
6	3 p. m.	do.	Ci	N.	0	0	0	Very slow. Heavy snow all day with one break.
7	...	Kilik	...	...	...	...	...	Snow all day.
8	...	Jalung Jilga	...	...	...	...	...	Cloudless.
9	...	Karakokti	...	...	.	...	...	None.
10	7-30 p. m.	do.	Ci	S. E.	0	0	1	Very slow.
11	5-30 p. m.	Tomtek	Ci	S. E.	0	0	1	Slow.
12	5 p. m.	do.	Ci	S. E.	0	0	1	Very slow.
13	5-15 p. m.	Lup Gaz	Ci	S. E.	0	0	1	do.
14	...	do.	...	...	...	...	...	None.
15	7 p. m.	Mintaka Akhsai	Ci	S. E.	0	0	1	Slow.
16	...	Kara Jilga	...	...	...	...	...	None. Cloudless.
17	...	Kukturuk	...	...	...	...	...	do. do.
18	...	do.	...	...	...	...	...	do. do.
19	2 p. m.	do.	Ci	N. E.	S. W.	S.W.-N. E.	2	Slow. Thickest in S. W.
20	...	do.	...	...	...	...	...	None.
21	...	do.	...	...	...	...	...	Cloudless.
22	...	Kilik Pass	...	...	...	...	...	None.
23	...	Kilik East h.s.	...	...	...	...	...	do.
24	...	Kilik Pass	...	...	...		...	do.
25	...	do.	...	...	...	...	...	do.

Date	Hour.	Station.	Cloud.	Direction.	Rad. point.	Undulation.	Banks.	Remarks.
26	5-30 p. m.	Kilik Pass	Ci	W.	0	0	0	Very slow.
27	...	do.	...	...	...	...	...	None. Snowed about 5 p. m.
28	...	Kilik West h.s.	...	...	...	...	...	None; snowed about 4 p.m.
29	3-45 p.m.	do.	Ci	E.S.E.	0	0	0	Very slow; snow squall about 3 p.m.
30	...	Kilik Pass	...	...	...	...	...	None.
31	...	Murkushi	...	...	...	...	...	do.
August.								
1	...	do.	...	...	...	...	...	do.
2	...	Kilik Pass	...	...	...	...	...	Very faint Ci clouds seen, but not observed.
3	...	do.	...	...	...	...	...	No Ci clouds; heavy low snow clouds collected in the afternoon.
4	...	do.	...	...	...	...		No Ci clouds. Heavy snow clouds. Slight snow, heavy hail & thunderstorm over the Chapursān.
5	...	Kilik East h.s.	...	...	...	...	...	No Ci clouds Heavy snow clouds. Snow squall in the evening.
6	...	Kilik	...	...	...	...	...	No Ci clouds; low clouds driving at intervals. No snow.
7	...	Taghramansu	...	...	...	...	...	No Ci clouds visible. Low heavy dense clouds covered the sky all day.
8	...	do.	...	...	...	...	...	do. Heavy snow at intervals throughout the day, and night.
9	...	do.	...	...	...	...	...	do. Snow during the day and night.
10	...	do.	...	...	...	...	...	do. Snow most of the day and night.
11	4-30 p.m.	do.	Ci	N.E.	N.	0	1	Slow. Thickest on N.N.E. Snow during morning.

Date.	Hour.	Station.	Cloud.	Direction.	Rad. point.	Undulation.	Banks.	Remarks.
12	12 noon.	Taghramansu-Mintaka Akhsai	Ci	E.	0	0	0	Very slow. Thickest on west. Snow during morning, and squall about 2-30 p. m.
13	...	Mintaka Akhsai	...	...	...	...	...	No Ci clouds visible. Sky generally overcast and snow showers throughout the day.
14	...	Over Mintaka Pass	...	...	...	...	...	No Ci clouds visible. Clear early. Snow at midday & about 3 p.m. from the south
15	...	Murkushi	...	...	...	...	...	No Ci clouds visible. Sky overcast. Heavy clouds settled on Pamirs, but cleared towards evening.
16	9 a. m.	do.	Ci-Cu	E.	0	0	3	Slow. Overcast towards north.
17	...	Murkushi-Misgar	...	...	...	...	...	Sky overcast.
18	...	Misgar-Khodabad	...	...	...	...	...	do.
19	...	Khodabad	...	...	...	...	...	No Ci clouds visible.
20	...	do.	...	...	...	...	...	do.
21	...	Khodabad-Khaibar	...	...	...	...	...	do. Almost cloudless.
22	...	Khaibar-Pasu	...	...	...	...	...	do Cloudless.
23	6 p. m.	Pasu-Gulmit	Ci	E.	0	0	0	Almost stationary.
24	5 p. m.	Gulmit-Atabad	Ci	E.	0	0	0	Very slow.
25	...	Atabad-Hunza	...	...	...	...	...	Overcast and rain fell in the afternoon.

CHAPTER XII.

A DESCRIPTION OF THE PHOTOGRAPHIC SURVEY

by

Lieut. K. Mason, R. E.

Assistant Superintendent, Survey of India.

During the progress of the triangulation, a number of photographs were taken with the object of making a reliable map of the district on our return to India. The great advantage of this method of survey is that, whereas by ordinary methods an accurate map, based on triangulation, is almost impossible to produce during the triangulation, yet by photography, material can be obtained from which a map can afterwards be drawn, based on carefully triangulated points.

The method employed was that known as the Stereo-Photographic; it had not been in use in India previous to 1913, but the method had been tested in Cumberland by its inventor, Captain F. Vivian Thompson, R. E., and the apparatus had recently arrived in India.

It must be remembered that the topographical survey carried out on the Pamirs had to be considered as of very secondary importance compared with the more important work of the triangulation link; no reconnaissance was possible, owing to lack of time; most of the photographs had to be exposed at or on the way to or from triangulation stations, which were often quite unsuitable; and Hingston, who took many of the photographs had had very little experience of reading topography, and none of surveying.

With any photographic survey a very careful reconnaissance is of the utmost importance. Whereas when surveying with a planetable the surveyor can see exactly how much ground he has covered, the use of photography introduces an element of uncertainty, and leaves a doubt as to whether the whole area has been mapped. In some negatives the same ground will be mainly a repetition of the topography obtained from other negatives, while without any reconnaissance some ground must inevitably be lost altogether.

Photographic survey is only suitable for mountainous country, and can never compete against planetabling in the plains. It is admirably adapted to the survey of inaccessible parts such as the Pamirs, where it would not be worth while to send a topographical party so far for so short a season. The almost total absence of vegetation and paucity of any artificial features render the natural features the only objects to be mapped, so that little is lost in this respect by the employment of photography.

The field equipment is very light, and with all developing materials and sufficient plates to take 60 pairs of photographs, can be arranged into three light coolie loads. For every additional 60 pairs and chemicals for their use, an extra coolie is necessary.

The camera is of the box pattern, similar to that in use in Canada, but adapted for the use of this method. It is arranged with a fixed focal length of approximately 6 inches, and has a telescope mounted on the top which is capable

of being moved into a position with its axis exactly at right angles to the axis of the camera. The camera is mounted similar to a theodolite, having a base-plate and foot screws, with a silver scale and vernier with which to read horizontal angles, while the telescope is fitted with an arc and vernier for determining the inclination of the stereoscopic base.

The apparatus is supplied with two tripods, which are set up at either end of a base approximately three hundred feet long, arranged roughly at right angles to the direction in which the photograph is to be taken. Having placed the camera at one end with its telescope aligned on an indicator which is mounted on the tripod at the other, a photograph is taken. The camera and the indicator are then interchanged on their tripods, the telescope is reversed in its supports, and after again carefully realigning the telescope on the indicator, another plate is exposed. By this means we have a pair of photographs taken on a base, which is measured by a subtense bar, and these two photographs may be placed in a stereoscope. Owing to the fact that the camera axes in both cases have been made parallel, stereoscopic accommodation is possible. By an instrument known as the "Thompson Stereo-Plotter", which consists of a stereoscopic microscope, with an indicator reading to $\frac{1}{100}$ inch, a system of levers to transmit automatically the direction of any point observed in the right hand photograph to a fixed drawing board, and a graduated drum which records the range of the point stereoscopically observed in the two photographs, which is a measure of the parallactic displacement of the two photographed positions of the point, a series of as many points as may be desired may be quickly plotted. This instrument also has another system of levers which give a reading of the heights of all points observed. It is perhaps unnecessary to go into any greater details of the instrumental adjustments and the plotting here, but it may be observed that while the accuracy of each point may suffer slightly in comparison with the Canadian system, yet by this almost automatic method, the far greater number of points that can be plotted without undue waste of time and with a due regard for the economy of the system, leaves the result more accurate and far quicker on the whole finished survey than the laborious plotting of points by the older intersection method employed in recent years. The theory of the plotting has been dealt with in a Survey of India departmental paper, and once the observer has become accustomed to the work, he can work rapidly and accurately, a pair of photographs taking on the average from 3 to 4 hours.

It should perhaps be mentioned that the plotter has been designed to record photographs which have been taken on an inclined base up to twenty degrees, so that the difficulty of obtaining a suitable base in any required direction is much less than might be at first expected. The adjustment for inclined bases is an extremely simple one. The length of the bases adopted for the survey varied between 50 and 150 yards, the greatest ranges of course being obtained from the longest bases.

As regards the field work, a few points may be mentioned. The plates employed were Kodak Orthochromatic (Green Label), and a high power ($\times 20$) orthochromatic screen was used in conjunction with them. Burrough's and Wellcome's Exposure Meter was used to indicate the correct exposure, and was found satisfactory. "Tabloid" Metol-Quinol developer was the developer employed and development was carried on almost nightly in the field in a double tank, in conjunction with a changing bag. This system was found to be highly serviceable. The "Time" method of Development was always used, and the negatives were taken out in subdued light and transferred to covered dishes containing a solution of hyposulphite of soda.

Plate 22. Photographic Survey Equipment packed.

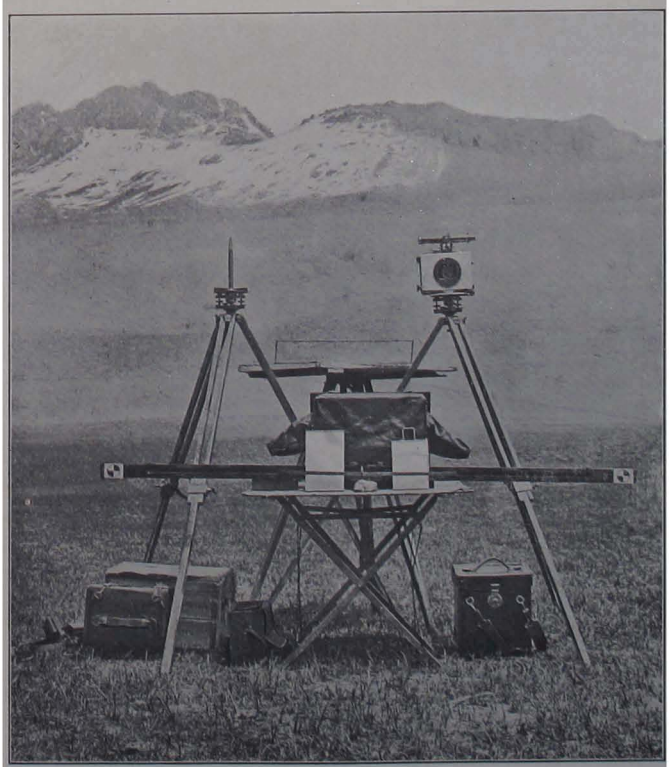


Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1914

Plate 23. Photographic Survey Equipment laid out.

Owing to the cold, there were a few practical difficulties which call for mention. The developer was as a rule dissolved and brought to a temperature of about 75° F. But this rapidly fell when, as was usually the case, the development was carried on at night, and a rough mean temperature taken for the calculation of the time. Again, it was found extremely difficult to give the fixed negatives a sufficient amount of washing. Frequent changes were made of the water, but on occasions the water froze before the negatives were changed.

On one occasion, too, drying the washed negative was attended by considerable difficulty, for before the surface water could evaporate, it had frozen to beautiful but unwelcome fern-crystals, and these had to be dissolved off by a very dilute solution of hydrochloric acid. The water was never pure, and during the drying, dust was in nearly every case blown on to the film, and had to be removed later by a gentle sponging with cotton wool and dilute hydrochloric acid.

The negatives after cleaning and drying, were carefully packed in their own boxes, and I may here mention that not one single plate or developed negative was ever broken from the time of packing in Calcutta, till they were safely stored in Dehra Dun after the return of the expedition.

Though the dark slides were of a good pattern, it was found very difficult to keep out all light from the orthochromatic plates which, as is wellknown, are extremely sensitive, especially when we had work to do on snow, and one cannot be overcautious in this respect. We found the Gurkhas after a little training, capable of assisting to set up the camera at one end of the base, and of mounting the indicator at the other.

In nearly every case where the photograph was not taken close to a station or triangulated point, the position was resected by a prismatic compass or with the camera itself, by using it as a theodolite. Most of the views were taken to include several intersected points, and in addition the base was always measured with a subtense bar and the camera telescope. The average time taken in setting up, levelling the camera, measuring the base, taking both photographs and repacking the equipment was about 50 minutes. Owing to inexperience with the method, in some cases the intersected points included in the views were too far away to be of any use in the plotting, except for azimuth, and it was then found that the map plotted did not join up with the neighbouring sections as well as when two near well-defined points appeared in the photographs. During the construction of the map it was also found that the chief mistake in the field work had been the failure of absolute levelment of the camera or absolute parallelism of the camera axis in its two positions. In these cases the photographs were adjusted by means of known points in the view, which gave accurate enough results and, though it sometimes happened that the views were projected on planes that were not exactly horizontal, the error from this cause was practically negligible. In one case, during the plotting it was found that the axes of the camera in its right and left positions had not been absolutely parallel; I can only imagine that the camera moved at the last minute before one of the photographs was taken, owing to unequal thawing of the snow under the legs of the stand. This pair of views was almost useless, and was only used to plot a small section, which was adjusted afterwards according to the country adjacent to it. During the field work one pair of photographs was rendered useless owing to the plates becoming fogged, and in another case a pair was temporarily lost through the right and left photographs being taken on the same plate. In both these cases, it was possible to repeat the exposures owing to

the fact that development was carried out almost at once and the errors discovered early.

Roughly speaking an average of about 10 square miles was plotted from each pair of photographs. In one favourable case, 24 square miles of complete map were obtained from one pair and this adjusted very well with the neighbouring section.

It was originally hoped that a fairly complete map would be obtained of the Taghdumbash Pamir, but the exigencies of other work and the breaking up of the weather at the end of the season rendered the completion of the work impossible. It was therefore decided to plot as much as possible on the 1-inch scale with contours at 200 feet vertical interval, and reduce the map to a smaller one, adding as much of the omitted portions by eye from the stereoscopic pairs. These omitted portions generally consisted of the bottoms of valleys, of which the boundary hills could be seen, or of portions of country too distant to be plotted by the method. In the plotting, heights were estimated to the nearest 50 feet, and in all cases where two or more triangulated points appeared in the view, the plotted height agreed with the triangulated height within this amount. The contours of adjacent plotted sections in almost every case agreed easily in height to within 200 feet, there being a few exceptions in very steep ground, where the contours were very close together.

One other difficulty which was very apparent during the subsequent plotting was the great contrast of the high lights on the snowy hills and the dark ground of the valleys, and I found that though we had anticipated this to a certain extent and over-exposed the hills in order to get the utmost value over the whole picture, yet it was almost an impossibility to get sufficient detail in the valleys for plotting, when there were great high lights in the picture.

The photographic survey has added to and corrected portions of the existing map of these regions. The accuracy obtained may be considered as at least equal to any that would have resulted from a $\frac{1}{4}$-inch planetable survey, though the one-inch plotted map is probably inferior to a detailed planetable survey on this scale, which would however have been far more costly in time and money. This inferior comparison may be referred to the length of some of the ranges employed, which in some cases amounted to over 10 miles. This range however was never employed unless a triangulated point appeared in the distance.

I do not think that the method would prove of any great value in India itself. It seems to me that the plotting must be done by a responsible officer and that the difficulties of adjustment of the pairs of photographs in the stereoscope for slight errors in the field work would not admit of the work being done by a surveyor. Undoubtedly the method is a feasible and accurate one, and in certain cases a very valuable one; but these cases are the exception and not the rule. A traveller in the Himalaya, who had but little time on his way to make a map, could bring back photographs which would supply definite information on a disputed point, for example, the drainage of certain valleys, or the location of an uncertain pass. An officer who reached the frontier of a neighbouring territory into which he had been forbidden to enter, could increase our knowledge of the transfrontier without violating his orders. Finally, in the case when an accurate map is required on a small scale of a distant country, which is entered for other than topographical objects, when weather or other considerations considerably

shorten the period available for topographical work, this method of photographic survey will be found economical; because a practically negligible increase of expenditure while in the country in question will ensure a far larger section of mapped country, and though the expense of plotting after the return is practically entirely additional, if one arrays against this the cost of sending another expedition to complete the survey, or the cost of the upkeep of the detachment in the country until the conditions become more favourable, one will find that the comparison is all in favour of the photographic method.

CHAPTER XIII.

CONCLUSION

by

Lieut. K. Mason, R. E.

Assistant Superintendent, Survey of India.

On the 14th August the Pamir detachment commenced its journey back from the Taghdumbash. Collins had finished the triangulation on the south, and assurances came in from McInnes that in a few days the Chapursān work would be completed. Even so it was with a feeling almost akin to regret that we said goodbye to our hospitable friends, the Begs, who came in to Mahomed's khourgas at Mintaka Akhsai to see us off. We distributed presents among them and Mahomed himself gave me his ancient sporting matchlock. Arzu, our invaluable Sarikōli guide and interpreter had come to me some days before and asked me to take him back to India "to see the world", and after some consideration I had agreed to do so. Hingston, the ardent hæmatologist, insisted on the condition that Arzu should supply samples of his blood on the way down to lower altitudes to complete his investigations into the behaviour of corpuscles with altitude, but by now, most of our friends had become used to his bloodthirsty tendencies, and agreed to be "stuck" without demur. However, when Arzu approached his father, Mahomed, the local Warden of the Marches, the latter refused to allow his son to accompany us further than Gilgit. Some hereditary distrust of the men of Hunza lurked in his bosom, and when we finally left his camp, the old man followed us some way, begging us to ensure his son's safe return.

Our last glimpse of the Pamirs was characteristically equal to the occasion. As we neared the summit of the Mintaka Pass, Hingston and I who had halted to take a few final observations for the photographic survey, were caught in a violent snow-squall which drove all of us who were near enough, Baltis, Hunzakūts and Gurkhas, into the stone dâk-hut, where we had to wait until the storm subsided. We pitched camp at Gulquaja Uwin and on the 15th arrived at Murkushi, where we halted for a day, owing to the non-arrival of the extra baggage coolies.

Two days afterwards we reached Khodabad, McInnes' base. After leaving Misgar, we found that the bridge by which we had crossed the river on our northward journey had been swept away, and the only path which remained was a goat-track, which ran for some distance along the east side of the river, and then crossed by a frail log laid on boulders in the stream. In places it had not been considered worth while to improve the track for mere mortals, as the river would soon subside and make the winter route again practicable. From the flat which we climbed on the right bank, we could see remains of old river terraces extending up to 2000 feet on the opposite side; this gives one some idea of the enormous cutting power of the Hunza River, and an interesting insight into the rejuvenation powers of mountain streams. There is a particularly formidable *parri* along this march on the summer route which we had to traverse; this is the one that avoids the long detour *viâ* the Kermin Pass.

It is a case of almost hanging on by the eyelashes, and in places the track merely apologizes for its existence. There is for the most part no roadway of any description, not even one large enough to be supported on props or pegs, and this for a country which has a maximum width of about two feet for its best hill roads is saying a good deal. Joints in crumbling shale, worn pockets in slippery granite, these constitute the alignment of this remarkable stretch.

We halted at Khodabad until the 21st, in order to make certain that McInnes would have no difficulty in finishing his work, and to assist in forwarding supplies to him. Here we received maps from Dehra of the Hispar-Biafo route into Baltistan. We had obtained permission to return by this way, but the lateness of the season, (we should not be able to start from Hunza till September), and the continual bad weather which was experienced all August, finally caused us to abandon the scheme.

All down the road, people were most hospitable; probably they were glad to see the last of us, for, however much we may have tried to lighten the burden of our existence in this country, it must be admitted that an expedition of such a size must cause a good deal of inconvenience to the inhabitants, however well paid they may be. At Khaibar, where we spent the night of August 21st, the lumbadar practically stripped his trees of apricots for us; and this kind of hospitality existed all the way to Hunza.

There is not much of interest to mention between Khaibar and Aliabad. The track at times ceases to exist, but the only really sensational portion is a three-mile stretch just north of Atabad. The path zig-zags up a cliff, which it traverses on pegs and props, about a thousand feet above the seething chocolate-coloured torrent. One cannot help feeling a distinct concentration of attention on footholds. Failing this concentration, the glance is apt to stray to the waters below, while the imagination commences to calculate distances and depths, which I believe causes the desire in some people to throw themselves down.

At Gulmit, I found a man who had been to Raskam in the old raiding days, and he was able to corroborate and amplify the information which I had received on two former occasions as to the Raskam route into Baltistan. Raskam has never been repopulated since the Hunza raids which ceased over twenty years ago. My informant explained that he did not follow the route which he described, but that the way was pointed out to him by a man who had accomplished the journey. Apparently it was not a summer or autumn route owing to the amount of water that fills the river during these periods. The details he gave me were as follows:—Pasu to Shingshal, 3 marches; from Shingshal onwards down the Raskam Shingshal River, 4 marches; here a *nala* enters the valley from the south which has to be followed to a pass at the head. The man was unable to give me any precise information as to where the route led to on the Baltistan side, but he was quite definite when he asserted that the *nala*, which was pointed out to him, left the Shingshal valley before the latter reached the Oprang. From this it appears that the route must either enter the Biafo or Punmah Glaciers. Apparently the route was occasionally used by men from the Pamirs en route to Baltistan, who travelled *viâ* the Pamir Oprang and the Raskam Shingshal.

The Pamir detachment reached Aliabad on August 25th. Collins had already arrived, and the paying off of permanent men and general settling up of the affairs of the expedition was commenced. McInnes arrived on the 30th, having completed the work in the Chapursân, and we all enjoyed a few days'

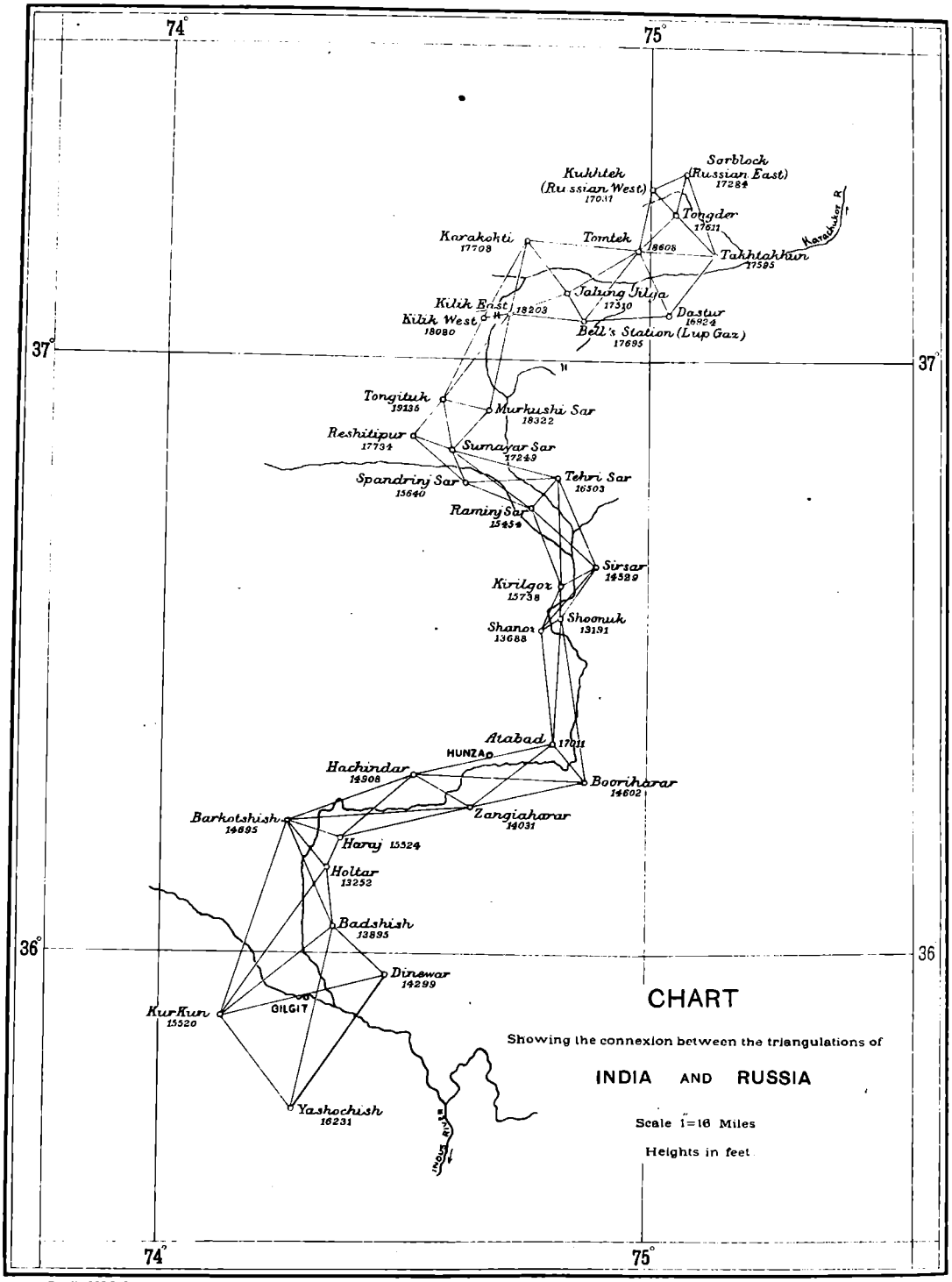
rest before leaving for Kashmir. On the 2nd, Hingston and I definitely abandoned the idea of returning by Baltistan owing to continued bad weather.

The detachment was again divided into two parts for the journey back, and the leading portion reached Gilgit on September 5th. Here we found that the Resident, the Hon. Mr. Stuart Fraser, had arrived the same morning, while all the British officials were in the station.

From Gilgit we travelled to Kashmir with Major Webb and Captain Moore, *viâ* the Kamri Pass, which gave us a variation from our previous route. All the way we had perfect weather until we reached Gurais, when a bad spell set in. The Rajdiāngan Pass was crossed in a snow blizzard and Bandapur was reached on the 15th.

While waiting for the arrival of the second detachment, Hingston and I went in to Srinagar, where we had the pleasure of meeting Dr. de Filippi and the other members of his expedition which was on its way to winter quarters at Skardo.

The detachment returned to Dehra Dun in October. Every man was in perfect health. During the whole of the time during which the expedition had been away, there had been only one casualty, which happened to a coolie on the road north of Hunza. This man apparently lost his nerve on a *parri* or bridge, became dizzy, fell into the river, was swept away and drowned. With this one exception, there were no accidents and no cases of more than very temporary sickness among any men connected with the expedition.



Reg No 708 D D D 1914 - S. I. - 570

Heliozincographed at the Survey of India Offices, Dehra Dun.

Published under the direction of Colonel Sir S.G., Burrard, K.C.S.I., R.E., F.R.S., Surveyor General of India.
1914

APPENDIX A.

Table I.

List of Latitudes, Longitudes and Heights of Trigonometrical Stations of the Gilgit Principal Series.

Name of Station		Latitude			Longitude			Height in feet	REMARKS
		°	′	″	°	′	″		
Nerh	H.S.	33	43	57·35	73	32	45·53	6,076	
Khagriānā	H.S.	33	44	11·66	72	57	37·90	3,939	
Kandi	H.S.	33	18	33·58	73	53	34·07	4,375	
Ganga Choti	H.S.	34	4	31·37	73	47	19·33	9,989	
Miranjani	H.S.	34	6	19·95	73	24	26·32	9,780	
Kafir Khan	H.S.	34	16	26·07	73	45	58·56	11,510	
Kakwa ka Pahar	H.S.	34	19	45·38	73	59	55·62	12,986	
Ismail Di Dori	H.S.	34	29	44·21	73	55	16·17	12,626	
Chotiwala	H.S.	34	53	31·38	74	16	30·48	16,124	
Ratta Pahar	H.S.	34	48	41·35	74	3	26·02	14,870	
Liowi	H.S.	35	10	5·08	74	14	47·32	17,491	
Zingi Shish	H.S.	35	8	28·05	74	5	28·84	14,931	
Chamuri	H.S.	35	34	25·32	74	32	12·13	15,315	
Gashushish or Yasho Chish	H.S.	35	44	4·14	74	16	31·43	16,231	
Dinewar	H.S.	35	57	42·37	74	28	2·72	14,299	

Table II.

List of Latitudes, Longitudes and Heights of Trigonometrical Stations of the Secondary Series connecting the triangulations of India and Russia.

Name of Station		Latitude			Longitude			Height in feet	REMARKS
		°	′	″	°	′	″		
Dinewar	h.s.	35	57	42·37	74	28	2·72	14,299	
Yashochish	h.s.	35	44	4·14	74	16	31·43	16,231	
Kur Kun	h.s.	35	53	30·81	74	7	42·89	15,520	
Badshish	h.s.	36	2	43·32	74	21	34·81	13,895	
Barkotshish	h.s.	36	13	22·01	74	15	42·50	14,695	
Holtar	h.s.	36	8	40·41	74	20	32·48	13,252	
Haraj	h.s.	36	11	41·67	74	22	19·85	15,524	
Zangiaharar	h.s.	36	14	57·07	74	38	13·06	14,031	
Hachindar	h.s.	36	18	3·40	74	31	19·34	14,908	
Booriharar	h.s.	36	17	30·30	74	52	25·04	14,602	
Atabad	h.s.	36	21	24·87	74	48	22·66	17,011	
Shoonuk	h.s.	36	33	44·44	74	49	9·69	13,191	
Shanoz	h.s.	36	32	34·87	74	46	41·50	13,688	
Sirsar	h.s.	36	39	2·46	74	53	38·45	14,529	
Kirilgoz	h.s.	36	36	57·45	74	49	30·50	15,738	
Raminj Sar	h.s.	36	44	58·38	74	45	28·24	15,454	
Tehri Sar	h.s.	36	47	56·15	74	48	35·76	16,503	
Spandrinj Sar	h.s.	36	47	14·38	74	37	9·82	15,640	
Sumayar Sar	h.s.	36	50	35·91	74	35	26·03	17,249	
Reshitipur Sar	h.s.	36	51	48·73	74	30	42·18	17,734	
Tong-i-tuk	h.s.	36	55	37·16	74	34	12·19	19,135	
Murkushi Sar	h.s.	36	54	44·86	74	40	0·23	18,322	
Kilik East	h.s.	37	4	39·27	74	42	28·09	18,203	
Kilik West	h.s.	37	4	12·80	74	39	3·74	18,020	
Karakokti	h.s.	37	12	8·96	74	44	31·01	17,708	
Jalung Jilga	h.s.	37	16	59·90	74	49	42·70	17,510	
Tomtek	h.s.	37	1	17·90	74	58	58·38	18,608	
Bell's Station (Lup Gaz)	h.s.	37	4	2·74	74	51	42·81	17,695	
Dastur	h.s.	37	4	38·04	75	2	30·40	16,924	
Takhtakhun	h.s.	37	10	49·45	75	8	24·13	17,595	
Tongder	h.s.	37	14	55·04	75	3	20·89	17,611	
Russian West (Kukhtek)	h.s.	37	17	32·97	75	0	12·19	17,031	or 5,190·9 metres.
Russian East (Sarblock)	h.s.	37	18	58·92	75	4	41·17	17,284	or 5,268·0 metres.
Subsidiary Stations.									
Kukturuk	h.s.	37	8	37·43	74	37	27·17	17,237	
Mintaka Akhsai	h.s.	37	4	59·94	74	57	46·68	16,907	

Table III.

List of Latitudes, Longitudes, and Heights of Trigonometrical Points, observed from the Indo-Russian Connexion Series.

Name of Point	Latitude			Longitude			Height in feet	Remarks
	°	′	″	°	′	″		
Pk. 26 / 42 K	37	13	59	74	44	50	18,060	On spurs of Sarikōl Range.
Pk. 27 / 42 K	37	13	21	74	41	59	18,675	On spurs of Sarikōl Range.
Pk. 28 / 42 K	37	7	46	74	41	14	16,943	On spurs of Northern Karakoram Range.
Pk. 29 / 42 K	37	5	56	74	41	33	17,702	On spurs of Northern Karakoram Range.
Pk. 30 / 42 K	37	3	38	74	37	24	18,755	On spurs of Northern Karakoram Range.
Pk. 31 / 42 K	37	2	13	74	43	29	19,394	On spurs of Northern Karakoram Range.
Pk. 15 / 42 K	37	34	38	74	49	7	17,348	Agree closely with Pamir Boundary Commission Peaks on spurs of Sarikōl Range.
Pk. 16 / 42 K	37	32	23	74	57	58	18,011	Agree closely with Pamir Boundary Commission Peaks on spurs of Sarikōl Range.
Pk. 32 / 42 K	37	13	48	74	48	5	18,390	On spurs of Sarikōl Range.
Pk. 33 / 42 K	37	11	52	74	54	32	18,845	On spurs of Sarikōl Range.
Pk. 34 / 42 K	37	5	51	74	49	41	18,172	On spurs of Northern Karakoram Range.
Pk. 35 / 42 K	37	2	9	74	55	15	17,926	On spurs of Northern Karakoram Range.
Pk. 36 / 42 K	37	0	25	74	57	54	18,171	On spurs of Northern Karakoram Range.
Pk. 47 / 42 L	36	53	54	74	18	53	20,424	On Northern Karakoram Range.
Pk. 21 / 42 L	36	40	8	74	25	18	22,751	Agrees with old point. On Karakoram Range.
Pk. 24 / 42 L	36	37	32	75	19	10	23,434	Agrees with old point. On Karakoram Range.
Pk. 48 / 42 L	36	33	20	74	25	50	22,409	
* Pk. 27 (Rakaposhi) / 42 L	36	8	37	74	29	22	25,526	On Kailās Range.
Pk. 49 / 42 L	36	57	54	74	32	30	19,557	On Northern Karakoram Range or its spurs.
Pk. 50 / 42 L	36	57	38	74	39	33	18,706	On Northern Karakoram Range or its spurs.
Pk. 51 / 42 L	36	56	51	74	40	5	18,875	On Northern Karakoram Range or its spurs.
Pk. 52 / 42 L	36	51	41	74	41	11	18,200	On Northern Karakoram Range or its spurs.
Pk. 53 / 42 L	36	46	2	74	31	4	19,321	
Pk. 54 / 42 L	36	45	46	74	37	41	19,098	
Pk. 32 / 42 L	36	30	39	74	31	26	25,540	Agrees with old point. On Karakoram Range.
Pk. 55 / 42 L	36	28	51	74	36	53	23,897	On Karakoram Range.
Pk. 33 / 42 L	36	26	30	74	40	53	24,970	Agrees with old point. On Karakoram Range.
Pk. 56 / 42 L	36	58	46	74	54	59	19,100	
Pk. 57 / 42 L	36	57	6	74	50	12	21,019	
Pk. 58 / 42 L	36	52	41	74	47	3	19,877	On Northern Karakoram Range or its spurs.
Pk. 59 / 42 L	36	50	42	74	45	4	19,204	On Northern Karakoram Range or its spurs.
Pk. 60 / 42 L	36	49	35	74	49	1	18,536	On Northern Karakoram Range or its spurs.
Pk. 61 / 42 L	36	44	32	74	55	54	19,253	
Pk. 62 / 42 L	36	41	57	74	56	48	18,943	
Pk. 63 / 42 L	36	40	13	74	56	9	17,960	
Pk. 64 / 42 L	36	37	48	74	47	51	17,890	
Pk. 65 / 42 L	36	34	49	74	54	18	19,864	
Pk. 66 / 42 L	36	33	21	74	50	52	17,870	
Pk. 67 / 42 L	36	23	10	74	46	55	19,061	On Karakoram Range.
Pk. 68 / 42 L	36	3	28	74	58	0	23,056	On Kailās Range. Pk. 46 / 42 L agrees closely with old point.
Pk. 46 / 42 L	36	0	13	74	52	34	24,467	On Kailās Range. Pk. 46 / 42 L agrees closely with old point.

Table III.—(Continued).

List of Latitudes, Longitudes, and Heights of Trigonometrical Points observed from the Indo-Russian Connexion Series.

Name of Point	Latitude	Longitude	Height in feet	REMARKS.
	° ′ ″	° ′ ″		
Pk. 3 / 42 O ...	37 33 48	75 9 45	20,898	Agrees approximately with Pamir Boundary Commission Peak on Sarikōl Range.
Pk. 24 / 42 O ...	37 33 15	75 0 56	18,513	On spur of Sarikōl Range.
Pk. 25 / 42 O ...	37 31 37	75 3 52	18,439	On spurs of Sarikōl Range.
Pk. 26 / 42 O ...	37 24 19	75 11 14	19,268	
Pk. 27 / 42 O ...	37 22 7	75 12 54	18,659	
Pk. 28 / 42 O ...	37 10 44	75 1 11	18,182	
Pk. 29 / 42 O ...	37 10 10	75 4 50	18,003	
Pk. 30 / 42 O ...	37 9 47	75 3 7	17,975	
Rock Pillar ...	37 8 42	75 13 44	17,425	On spurs of Northern Karakoram Range.
Pk. 31 / 42 O ...	37 8 32	75 13 54	18,329	
Pk. 32 / 42 O ...	37 7 37	75 13 40	18,467	
Pk. 33 / 42 O ...	37 7 29	75 14 54	19,256	
Pk. 34 / 42 O ...	37 7 15	75 9 42	16,194	
Spur Cairn ...	37 5 18	75 2 30	16,190	
Pk. 35 / 42 O ...	37 3 5	75 12 19	19,188	Snow Peaks on Northern Karakoram Range.
Pk. 36 / 42 O ...	37 3 5	75 13 16	18,952	
Pk. 37 / 42 O ...	37 14 30	75 16 31	18,336	On spur of Sarikōl Range.
Pk. 38 / 42 O ...	37 10 3	75 17 16	17,203	On spur of Northern Karakoram Range.
Pk. 39 / 42 O ...	37 18 29	75 34 17	18,737	Snow Peak on Kashgar Range.
Pk. 18 / 42 P ...	36 58 56	75 8 37	19,062	On Northern Karakoram Range.
Pk. 19 / 42 P ...	36 36 47	75 4 48	22,891	
Pk. 20 / 42 P ...	36 19 35	75 11 20	25,868	On Karakoram Range.

APPENDIX B.

A NOTE ON THE DEGREE OF ACCURACY OF THE SECONDARY LINK SERIES, TRIANGULAR ERRORS, MEAN ERRORS, ETC.

by

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From the primary stations of Dinewar and Yashochish in the neighbourhood of Gilgit, the Link series consists of seven quadrilaterals, with the diagonals observed; two tetragons with central points;and eleven single triangles. The quadrilaterals and tetragons have been reduced by the method of minimum squares, and the errors have been distributed in accordance with the results, while in the case of the triangles, the error has been distributed equally.

The whole of this series has been observed with six-inch Troughton and Simms' theodolites, it being found impossible to carry up to the stations larger instruments than these, owing to the difficulties of the country. Except in the case of one station on the Pamirs, and in the very difficult country just to the south of the Kilik Pass, observations were made to helios; in the exceptional cases mentioned, opaque signals were employed. In all cases observations were taken on six zeros.

As far north as Sumayar Sar h.s. on the mountains bordering the Chapursān Valley, the 19th station of the link, the mean triangular error was only 2·18 seconds per triangle (23 triangles); then for a short distance the error rose, owing to the use of opaque signals, and to the very difficult conditions existing at the stations, the average height of which was 17,750 feet approximately, and the error here was 7·27 seconds per triangle (6 triangles). On the Taghdumbash Pamir, the mean triangular error again fell owing to the employment of luminous signals, to 3·59 seconds (11 triangles), though the height of the Pamir stations averaged 17,650 feet.

The whole series, including the base stations near Gilgit and the two final Russian stations, Kukhtek and Sarblock, comprised 33 points of observation, the highest of which was Tong-i-tuk, 19,135 feet or 5832 metres, and the average height of which was 16,222 feet. The mean triangular error of the whole series was 3·33 seconds, the greatest being −13·77. The mean side of the triangulation was 8·637 miles, or 13·897 kilometres.

The mean error, m, of the value of an angle, obtained from the formula*

$$m = \pm\sqrt{\frac{\Sigma\Delta^2}{3n}}$$

(where $\Sigma\Delta^2$ = the sum of the squares of triangular errors, and n is the number of triangles),

* Association Géodésique Internationale. Rapport sur les Triangulations présenté à la Dixième Conférence Générale à Bruxelles, en 1892, par le general Ferrero.

amounts to ... $\pm 2''\cdot 79$.

The distance between the Russian West (Kukhtek) h.s., and the Russian East (Sarblock) h.s. is 23,403·8 feet, or 7,133·414 metres; the height of Kukhtek is 17,031 feet or 5,191 metres, and of Sarblock 17,284 feet or 5,268 metres. The azimuth at Kukhtek of Sarblock is 248° 10′ 29″·05, and at Sarblock of Kukhtek, 68° 13′ 12″·06.

The secondary series is extended from a side of the Gilgit Principal Series, and is consequently in the same terms as the whole triangulation of India, in which the coordinates of Kalianpur, the origin of the Survey, are as follows:—

Lat. ... 24° 7′ 11″·26

Long. ... 77° 39′ 17″·57

Azimuth of Surantal ...190° 27′ 5″·10.

The longitude is that determined by electro-telegraph from Greenwich to Kalianpur. The whole of the triangulation has been worked out on the Everest Spheroid.

To reduce the coordinates of Sarblock, Russian East h.s., to the terms of the most recent value of the origin of the Survey of India, viz:—

Lat. ... 24° 7′ 11″·57

Long. ... 77° 39′ 17″·57

Azimuth of Surantal ...190° 27′ 6″·39.

and to express them on the spheroid defined by the following:—

Semi-major axis 6,378,200 metres

Compression 1/298·3,

approximate corrections in latitude of $-4''\cdot 9$

in longitude of $+1''\cdot 9$

and in azimuth of $+2''\cdot 1$

are required. These corrections have been provisionally worked out by Mr. J. de Graaff Hunter, M. A., Mathematical Adviser to the Survey of India.

APPENDIX C.

JONCTION DE LA TRIANGULATION RUSSE A LA TRIANGULATION DES INDES

by

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Chef de la Section topographique de l'Etat-major.

Pour la réalisation de la jonction de la triangulation russe à la triangulation des Indes à travers le Pamir, il a été tracé du côté russe, une serie de triangles partant de la ville d'Oche au lac Cara-coul et plus loin par la vallée de la rivière Ac-sou jusqu'à la jonction de la triangulation des Indes par son côté Couktek-Serblok.

Ce travail consistait, du côté russe, en ce qui suit:—

(1). A l'est de la ville d'Oche la base d'Oche a été mesurée à l'aide de fils d'invar par la methode de Jæderin, la longueur obtenue de la base est $8322^{m} \cdot 116 \pm 0^{m} \cdot 010$.

(2). A l'extrémité nord-ouest de la base d'Oche (pyramide de la base N 2) des observations astronomiques ont été obtenues: la latitude $40° 37' 16'' \cdot 67 \pm 0'' \cdot 10$ et l'azimut de pyramide de la base NI est égal à $151° 54' 1'' \cdot 86 \pm 1'' \cdot 26$ (du nord à l'est).

(3). A peu près à la distance de 30 verstes vers le nord-ouest du côté Couktek-Serblok la base de Kisil-Rabate, a été mesurée comme la base d'Oche, à l'aide du même appareil; la longueur obtenue est de $8395^{m} \cdot 683 \pm 0^{m} \cdot 002$.

(4). A l'extrémité ouest de la base Kisil-Rabate des observations astronomiques ont été obtenues: la latitude $= 37° 26' 40'' \cdot 28 \pm 0'' \cdot 42$ et l'azimut de l'extrémité est de la base (du nord à l'est) $= 75° 45' 22'' \cdot 72 \pm 0'' \cdot 60$.

(5). Entre la base d'Oche et la base de Kisil-Rabate et plus loin jusqu'au Couktek-Serblok de la triangulation des Indes il à été tracé une triangulation, contenant 85 triangles (87 points).

Les angles ont été mesurés à l'aide de l'instrument universal de Hildebrand avec la précision de 10″: à chaque station les angles ont été mesurés six fois.

L'écart moyen de l'angle d'un triangle obtenu de tous les triangles de la série par la formule

$$m = \pm \sqrt{\frac{\Sigma\Delta^2}{3n}}$$

(ou $\Sigma\Delta^2$ représente la somme carrée des écarts des triangles, n-le nombre des triangles) est ègal à $\pm 2'' \cdot 89$.

Comme la triangulation entre la base d'Oche et le côté Couktek-Serblok représente une simple chaîne de triangles, dont deux bases, celle d'Oche et celle de Kisil-Rabate, ont été mesurées, on a fait attention pendant la compensation à ce que les conditions des angles et de la base soient remplies.

L'ecart des logarithmes de la base mesurée et calculée s'exprime par 0·000158. Pour faciliter les calculs, tous les angles des triangles qui ont dû être corrigés pour la concordance des bases, ont subi la même correction de 0″·51.

Le côté Couktek-Serblok, calculé après la compensation de la série des triangles, s'exprime par 7134^{m}·938, tandis que conformément aux données de la triangulation anglaise, ce côté est égal à 7133^{m}·414, c'est à dire que l'écart entre les deux résultats s'exprime par 1^{m}·524.

Actuellement la série des triangles en question n'est reliée ni aux travaux de triangulation de la Russie d'Europe ni aux travaux analogues près de Tachkent.

La jonction des travaux près de Tachkent sera exécutée dans un court délai: une triangulation de la ville de Tachkent est déjà tracée dans la direction du nord-ouest jusqu'à l'extremité sud des monts Ourals.

Comme données fondamentales pour le calcul des latitudes, des longitudes et des azimuts ont été prises, déterminées astronomiquement, la latitude et la longitude* du point nord-ouest de la base d'Oche et l'azimut d'un autre point de la base, observé du premier point.

Latitude	=	40°	37′	16″·670	± 0″·10
Longitude de Poulcovo	=	42	36	32 ·625	± 1 ·380
Azimut	=	151	54	1 ·860	± 1 ·26.

Toutes les coordonnées de tous les points de la triangulation citées dans la liste, ont été obtenues aves ces données, en adoptant pour le sphéroïde les valeurs de Bessel.

Ces coordonnées doivènt être considérées comme préliminaires. Quand la triangulation en question sera jointe à Tachkent et par tant à toutes les autres parties de la Russie, d'autres coordonnées seront calculées pour les points de triangulation à l'aide de nouveiles données fondamentales.

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* La longitude a été obtenue par expédition chronométrique de la ville d'Oche, et la longitude d'Oche par télégraphe de Tachkent.

CATALOGUE

des points de la série de triangulation de la base d'Oche jusqu'à col Beïk.

N N	Noms des points	Latitude			Longitude de Poulcovo		
		°	′	″	°	′	″
1	Pyr. de la base II ...	40	37	16·67	42	36	32·62
2	Pyr. de la base I ...	40	33	18·62	42	39	19·25
3	Imam-ata	40	31	23·50	42	30	24·31
4	R. d. g.	40	29	33·50	42	40	41·30
5	Atchina-beli	40	25	0·02	42	39	25·68
6	Langar	40	25	18·26	42	49	38·70
7	Oi-coul	40	22	35·61	42	44	6·78
8	Chamal-bel	40	13	34·14	42	56	5·85
9	Coungourte-tau	40	23	31·33	42	59	49·77
10	Cara-boulac	40	15	20·50	43	6	38·47
11	Ac-pachate	40	23	35·35	43	13	11·20
12	Sary-tache	40	12	52·49	43	14	58·05
13	Ob-ke-bachi	40	3	37·13	43	7	38·61
14	Tastar-ata	40	7	42·52	43	14	11·38
15	Coul-douc	39	59	46·38	43	14	59·19
16	Irgaïli-bachi	39	59	5·59	43	7	19·70
17	Guetchga	39	51	5·15	43	2	57·60
18	Nasik-bachi	39	57	49·28	43	4	55·26
19	Catta-caracol	39	55	7·06	42	59	46·61
20	Artchate-davane	39	45	55·95	42	58	18·99
21	Cara-tepe	39	43	59·63	42	52	28·04
22	Machale-goudour	39	38	59·46	43	0	1·81
23	Ourtak-tchocour	39	36	50·43	42	49	14·29
24	Ourtak-tchoucour-bachi ...	39	31	41·20	42	54	36·86
25	Bor-doba-goudour ...	39	32	34·95	42	57	16·80
26	Bek-couli-tau	39	26	54·77	42	55	42·88
27	Djan-aïdar-iouni	39	26	32·74	42	52	53·62
28	Kisil-arte-tau	39	25	8·10	42	58	40·17
29	Kok-say du sud	39	21	53·31	42	57	56·26
30	Kisilcoul de l'est	39	17	52·33	43	3	9·33
31	Djanaïdar	39	18	37·60	42	57	48·72
32	Kisil-coul de l'ouest ...	39	15	44·67	43	1	5·65
33	Oui-boulac de l'est ...	39	14	52·19	43	5	36·41
34	Oui-boulac de l'ouest ...	39	12	18·17	43	5	18·37

CATALOGUE—(*Continued*).

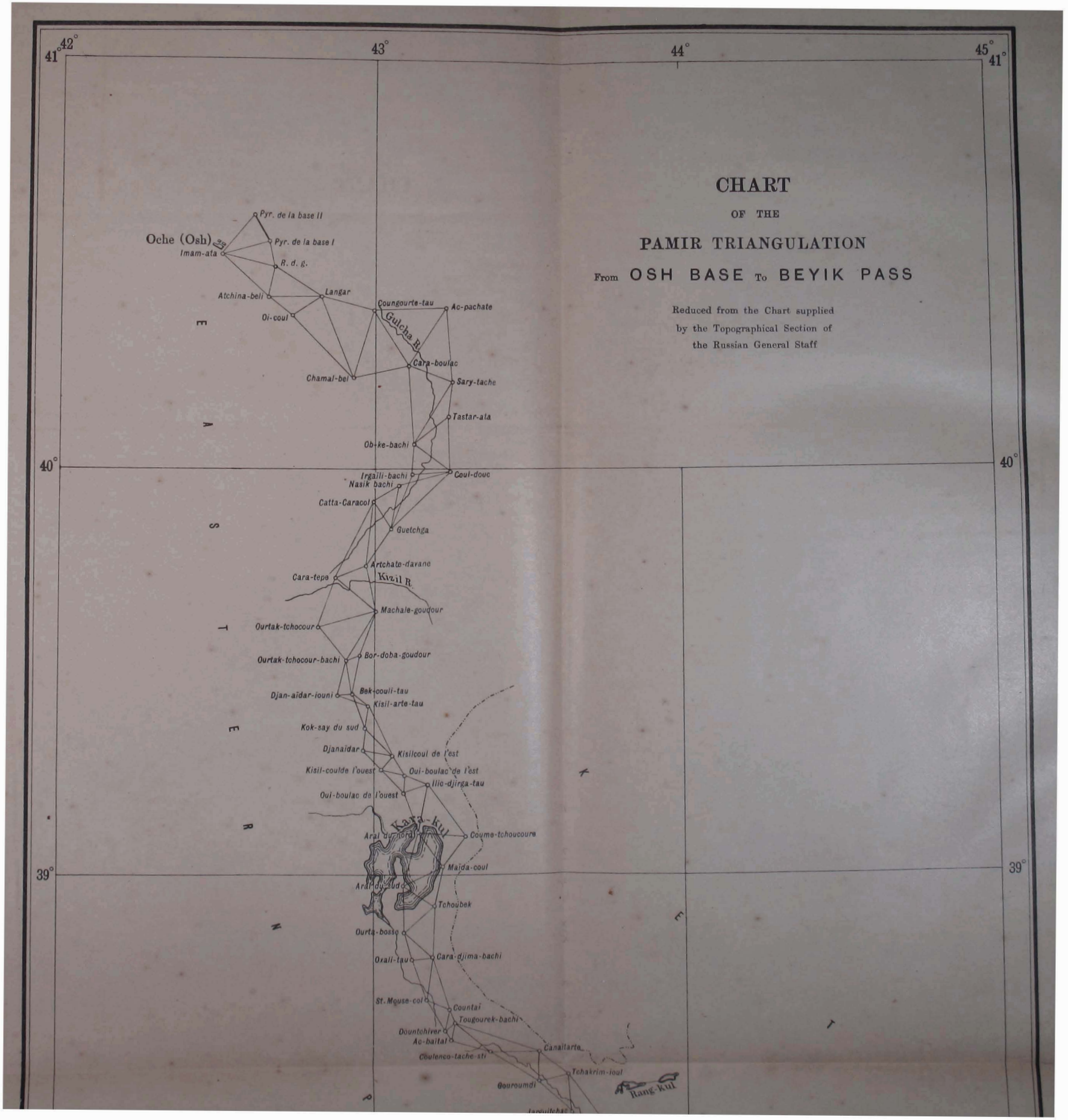
des points de la série de triangulation de la base d'Oche jusqu' à col Beïk.

N N	Noms des points	Latitude			Longitude de Poulcovo		
		°	′	″	°	′	″
35	Ilic-djirga-tau	39	13	19·99	43	9	47·25
36	Aral du nord	39	6	22·56	43	8	10·94
37	Coume-tchoucoure ...	39	5	51·19	43	17	7·51
38	Maïda-coul	39	1	28·19	43	13	0·21
39	Aral du sud	38	58	33·79	43	5	14·15
40	Tchoubek	38	55	32·83	43	11	40·81
41	Ourta-bosse	38	51	32·50	43	5	50·28
42	Cara-djima-bachi	38	47	57·76	43	11	13·73
43	Oxali-tau	38	47	30·55	43	7	5·39
44	St. Mouse-col	38	41	18·26	43	10	5·92
45	Countaï	38	39	53·74	43	14	56·48
46	Dountchiver	38	36	45·00	43	13	58·63
47	Tougourek-bachi	38	37	44·54	43	15	28·07
48	Ac-baïtal	38	35	9·05	43	14	59·63
49	Coulenco-tache-sti ...	38	33	22·65	43	22	44·79
50	Canaïtarte	38	33	27·70	43	31	39·32
51	Gouroumdi	38	28	32·51	43	31	46·24
52	Tchakrim-ioul	38	29	28·06	43	37	5·77
53	Jarguitchac	38	23	31·91	43	37	38·35
54	Tache-matik	38	20	48·65	43	45	48·40
55	Tchitchecti-bachi	38	18	29·43	43	40	48·80
56	Itchke-touchegan ...	38	14	11·07	43	44	16·36
57	Kankri	38	9	38·12	43	41	27·25
58	Mingue-hadjir-tau ...	38	8	12·20	43	52	14·13
59	Kisil-belèce-tau	38	6	9·77	43	46	6·21
60	Mouse-dic-bouac	38	3	13·37	43	47	50·32
61	Cara-belèce-bachi ...	37	59	8·72	43	49	58·94
62	Bouddha	37	59	22·53	43	55	33·95
63	Chour-boulac	37	53	44·10	43	53	20·68
64	Chour-boulac-bachi ...	37	52	40·75	43	50	4·87
65	Ac-boura-bachi	37	49	40·36	43	55	40·61
66	Coutatore	37	47	29·74	43	49	48·49
67	Outch-djima	37	44	13·06	43	56	14·18
68	Chour-djima	37	46	44·23	43	58	15·98
69	Costanate-ausi	37	43	22·51	44	2	13·13
70	Tchalkir	37	36	36·54	44	2	9·77

CATALOGUE—(Continued).

des points de la série de triangulation de la base d'Oche jusqu' à col Beïk.

N N	Noms des points	Latitude			Longitude de Poulcovo		
		°	′	″	°	′	″
71	Bosse-maïdan	37	40	19·26	44	5	5·60
72	Oulan-djima-tau	37	34	27·98	44	7	58·26
73	Salantchour-coul	37	30	12·93	44	6	57·82
74	Cara-djima-cri	37	30	26·86	44	10	37·73
75	Darbasi-cri	37	33	29·78	44	10	20·95
76	Belek-kir	37	31	54·93	44	17	42·39
77	Teschik-tache	37	28	49·02	44	15	18·78
78	Djoul-belèce	37	27	53·25	44	16	27·65
79	Initchca-djima-bachi ...	37	30	0·29	44	22	46·03
80	Pyr. de la base S. W. ...	37	26	49·55	44	24	28·72
81	Pyr. de la base N. O. ...	37	27	56·44	44	29	59·90
82	Kisil-rabate	37	27	34·32	44	24	39·51
83	Ac-belèce	37	21	59·52	44	30	6·33
84	Ouou-tache	37	24	32·06	44	35	6·25
85	Tchapac-tache	37	21	4·68	44	36	44·30
86	Beïk (Sarblock)	37	19	9·93	44	44	46·01
87	Ac-tourouc-tau (Kukhtek) ...	37	17	43·94	44	40	16·98



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OF THE

PAMIR TRIANGULATION

From OSH BASE To BEYIK PASS

Reduced from the Chart supplied
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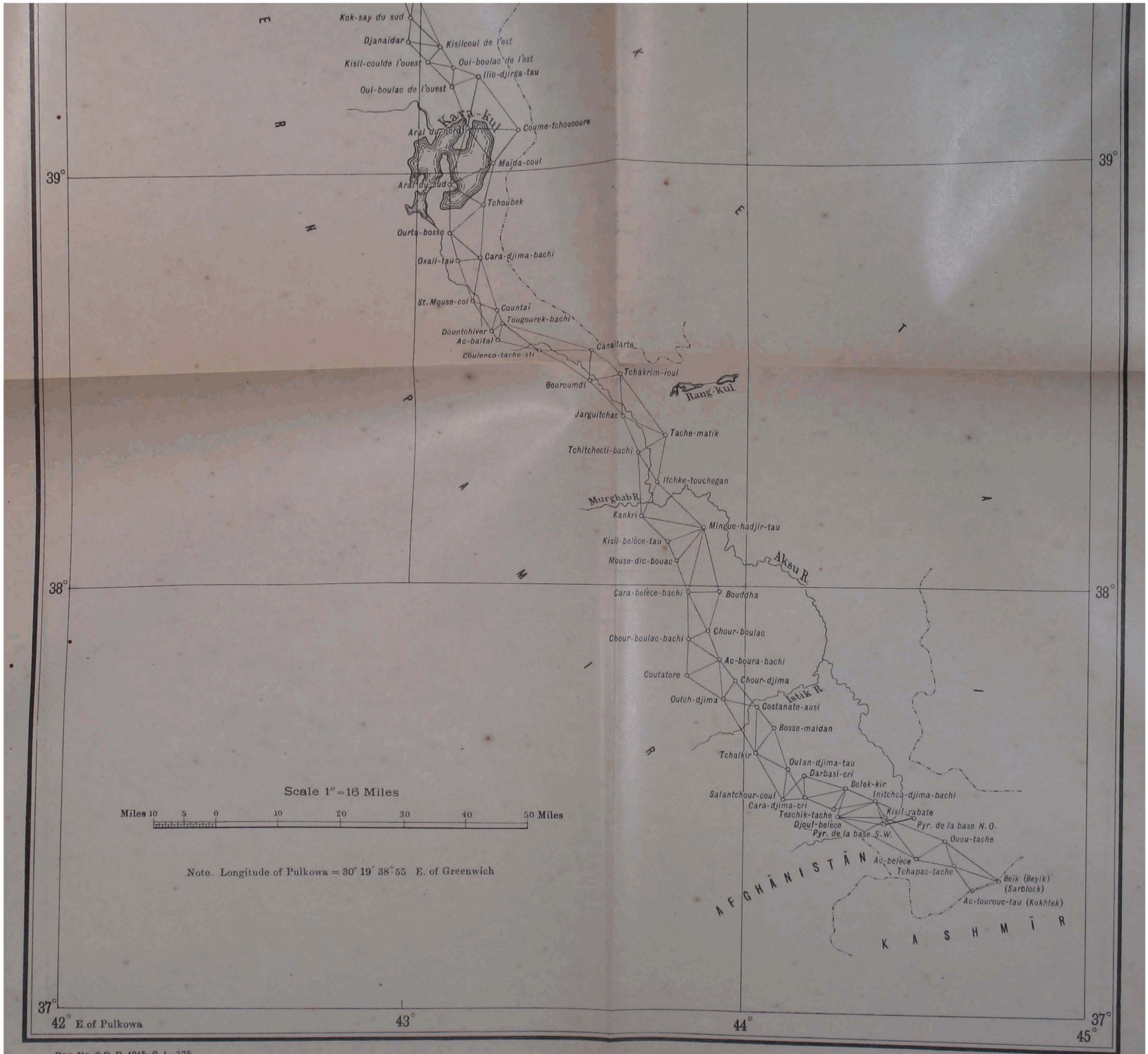

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