KARAKORAM

AND

WESTERN HIMALAYA

1909.

PUT INTO ENGLISH BY CAROLINE DE FILIPPI *née* FITZGERALD
AND H. T. PORTER.

THE ILLUSTRATIONS FROM PHOTOGRAPHS TAKEN BY
VITTORIO SELLA, MEMBER OF THE EXPEDITION.

KARAKORAM

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1909

AN ACCOUNT OF THE EXPEDITION

OF

H.R.H.

PRINCE LUIGI AMEDEO OF SAVOY

DUKE OF THE ABBRUZZI

BY

FILIPPO DE FILIPPI, F.R.G.S.

WITH A PREFACE BY

H.R.H.

THE DUKE OF THE ABRUZZI

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TRANSLATOR'S NOTE.

The thanks of the translator are due and are here gratefully expressed to Cesare Foligno, M.A., J. S. Gamble, C.I.E., F.R.S., F.L.S., and Capt. Howard Knox, who have been so kind as to read various parts of the translation.

H. T. P.

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PREFACE.

Once more I entrust to Cav. Filippo De Filippi, my travelling companion, the complete account of my late expedition. I am grateful to him for undertaking the task, and I hope that his revived memories of our journey may have rendered his labour less burdensome.

The detailed history of our wanderings will explain better than I was able to do in my short lectures before the Italian Alpine Club and the Italian Geographical Society, the difficulties and obstacles which the expedition encountered. The map of the Baltoro glacier which accompanies this volume was planned and executed at the Military Geographical Institute of Florence from photogrammetric panoramas assisted by tacheometer observations taken during the campaign by Ship's Lieutenant Marchese Federico Negrotto Cambiaso. I am glad of this opportunity to express my warm thanks to Ing. Comm. Pio Paganini, the inventor of the photogrammetric method, who has been at all times most generous with aid and advice; to Major-General Ernesto Gliamas, Director of the Military Geographical Institute of Florence; to Lieut.-Colonel Prospero Baglione; to Captain Nicola Vacchelli; to the topographers Fortunato Senno and Giuseppe Galli; and to all others who co-operated in the construction of the map.

Professor Domenico Omodei has once more taken upon himself the wearisome task of calculating and collating the statistics gathered from my meteorological observations, thus increasing the debt of gratitude already incurred by me for his help in former expeditions.

I am likewise most grateful to Ing. Vittorio Novarese, of the Regio Ufficio Geologico, for the geological survey he has written, based upon the observations made by the expedition; and to Professor Romualdo Pirotta and to Dr. Fabrizio Cortesi for their botanical notes upon the plants collected by Dr. De Filippi.

I hope that this book, together with the beautiful photographs taken by Cav. Uff. Vittorio Sella, will succeed in conveying to the reader some portion of the profound impression made upon us by our months of sojourn in the Karakoram. Our work will not have been in vain if it prove to be of assistance to future explorers of that distant and majestic region.

Luigi di Savoia

INTRODUCTION.

NOTE.

The nomenclature and geographical spelling adopted in this book are those of the Indian Survey and of the English Royal Geographical Society. As a matter of fact the native names have not always been transcribed with fixed rules of transliteration, owing to the impossibility of finding in the European alphabet signs which correspond to the Indian vowels. Short *e* is sometimes transcribed by *u* and sometimes by *a*, whereas *u* is transcribed at times as *oo* and at times as *u*. Thus we find written indifferently *Jhelam* and *Jhelum*, *Jammoo* and *Jammu*, etc.

Despite these and a few other uncertainties, it is better to preserve the more usual names as they are spelt on all European maps. By writing, as some authors do, *Dschelum* for *Jhelum*, *Setledsch* for *Sutlej*, *Dschemmu* for *Jammoo*, and so, we can only succeed in perplexing the reader even by the best-known names. Colonel Burrard, the well-known Director of the Indian Trigonometrical Survey, rightly observes that for geographers, uniformity of spelling is more important than accuracy.

With a few exceptions, vowels have the same sound as in the Latin languages.

The words *right* and *left*, with reference to rivers and valleys, are to be taken in the true geographical sense, independent of the direction of march; whereas upon cols and passes they are given with reference to the position of the observer.

INTRODUCTION.

ORIGIN AND NATURE OF THE EXPEDITION.

His Royal Highness Prince Luigi Amedeo of Savoy, Duke of the Abruzzi, was induced to set out upon this new expedition chiefly by his desire to contribute to the solution of the problem as to the greatest height to which man may attain in mountain climbing.

Physiologists have long given their attention to a study of the effects of reduced atmospheric pressure upon the human system, whether in balloon ascents to great heights or by confinement in rooms contrived for the artificial diminution of the pressure of the air. The result of these experiments appears to show that life is possible under atmospheric pressure reduced far below the limit marked by the barometer on the highest summits of the earth.

The very nature of the scientific experiment, however, which is to reduce each phenomenon to its simplest terms, deprives this conclusion of all possible value as a forecast of the solution of the problem which interests the mountaineer and the geographer.

For this problem is complicated for us by the length of the sojourn at low atmospheric pressure; by the severe physical exertion inevitable in high ascents, and often protracted for days or weeks; by extremes of temperature and other special conditions of climate, whose action upon the organism is still obscure. And all these are factors which influence the physical and mental condition of the explorer in varying degrees. The solution cannot, therefore, be based upon scientific reasoning, but only on direct experience. Up to the present time the result of experiment has been a slow but uninterrupted progress toward the attainment of the greater heights; and there is nothing to show that we are reaching a final limit. From the first ascent of Mont Blanc (15,780 feet above the sea level) at the end of the eighteenth century up to the present day we have gained 8,820 feet. It is not much; but we must remember that most of the expeditions in question had for their object rather the exploration of distant and unknown regions than the ascent of the high peaks which those regions might contain. Again, such undertakings are possible to very few men. They require profound technical experience of geographical exploration and long and costly preparations, since they are made in uncivilized or uninhabited regions where it is necessary to carry a complicated and heavy equipment to a great distance; where it is not possible to find natives who are expert in glacier and rock work; and where, on account of these drawbacks, it is very difficult, even impossible, to transport camp material and the necessaries of life above a certain height.

The result is that explorers often deprive themselves of comforts needful to ensure due rest from fatigue, to protect themselves from cold, or even sometimes to furnish sufficient or suitable bodily nourishment. Thus they reach the spot where the maximum effort is required of them with their forces already diminished by overstrain and suffering from the lack of everything beyond the mere necessities to which they have reduced their equipment. In the end the highest peaks may turn out to be very difficult to climb, or even entirely inaccessible, because of the condition of the rock or glacier. All these material obstacles, combined with bad weather and the shortness of the seasons, have up to now done far more than diminished atmospheric pressure to limit the activity of mountaineers in this special field of great altitudes.

The giant ranges into which His Royal Highness the Duke of the Abruzzi led his expedition were not kind to him, nor was the weather favourable. Nevertheless, he succeeded in making a step forward toward the conquest of the greatest heights after such a struggle as is perhaps unexampled in the history of mountaineering. This was, however, but the last stage of a campaign which was rich in mountaineering and exploring work for the purpose of collecting data for the more accurate knowledge of a system of ranges that, taken all together, is perhaps the grandest in the world. The expedition lived for over two months on the Karakoram glaciers. It brought back a large number of photographs of the group, a topographical survey of a portion of the high glacier basins, many new altimetric measurements and meteorological data systematically collected, and new glaciological and geological observations, as well as the experience of a long sojourn at low atmospheric pressure on the part of both Europeans and natives.

To reach the Karakoram the expedition had to cross the vast mountainous region which lies between Kashmir and Chinese Turkestan, taking a different route each way. The country through which they passed is known only in its general outlines, and its ethnological, climatic and geological characteristics are peculiar to itself. In the course of my narrative I shall mention the principal problems which this strange region propounds to the traveller.

Let me close my brief account of the objects of the expedition by a word of thanks in my own name and that of my companions to His Royal Highness the Duke of the Abruzzi, to whose energy, will, decision and power of organization we are indebted for the rich memories of new experiences we have brought back with us from our journey.

FILIPPO DE FILIPPI.

Rome. *October*, 1911.

CHAPTER I.

THE HIMALAYA.

Dimensions and Geographical Limits. — Inhabitants. — Work of the Trigonometrical Survey of India. — Statistics of Peaks. — The Sikkim Himalaya. — Kabru and Kinchinjunga. — The Expeditions of Rubenson and Monrad Aas and of Freshfield. — The Nepaul Himalaya. — Mount Everest. — The Himalaya of Kumaun and Gahrwal. — The Nun Kun Peaks. — The Expedition of the Workmans. — Nanga Parbat and the Mummery Catastrophe. — The Karakoram and the Hindu Kush. — The Five Glacial Basins of the Karakoram. — Previous Explorations of the Karakoram: Vigne, Falconer, Thomson, Schlagintweit, Conway and the Workmans. — The Baltoro Glacier. — From Godwin Austen to Eckenstein–Pfannl–Guillarmod. — K². — Nomenclature.

It is difficult without a certain degree of acquaintance with geography to form a clear idea of the relative sizes of different regions of the globe. This is especially true as regards those remote countries known to most of us through the atlas only, in which they are rendered on a far smaller scale than the familiar countries of our own civilization. Probably few people guess how vast and how varied is the portion of the earth to which we assign the name Himalaya.

I suppose that to most minds this word suggests the image of a lofty mountain range, rearing up to the sky a series of peaks covered with everlasting snow, which overlook the torrid plains of India.

But the name Himalaya denotes no mere chain of mountains, however high and however long we may imagine it. It denotes a complex system of ranges, of immense table-lands, of intricate valleys and of mighty rivers, that has no rival upon the face of the earth. Put together all the mountain ranges of Europe, great and small, including the Caucasus, and the result is not even comparable in size to the giant backbone of the Asiatic continent.

Most modern geographers include in the term Himalaya the whole of the mountainous region about 500 miles wide, which forms a barrier between the Indian peninsula and Central Asia from Afghanistan to Burma,—a distance of over 1,500 miles, equivalent to that between Naples and St. Petersburg. This barrier is formed by a series of approximately parallel ranges running mainly from north-west to south-east, and increasing in height northward up to the giant peaks which bound the table-land of Central Asia. Here the mighty rivers of India spring from the feet of mountains as famed in legend as the streams whose sources they shelter—worshipped like them, and like them objects of pilgrimages on so vast a scale as to seem like migrations of entire peoples.

The western end of this group of ranges reaches about the same latitude as the south coast of Sicily, while the eastern end runs down as far as the Red Sea. Thus the valleys gradually rising towards the north-west along an oblique line present every conceivable variety of climate, vegetation and produce. They contain whole nations with various political organizations, tribes of diverse races and origins: Aryans, Turanians, primitive aborigines, at every stage of civilization, speaking an endless number of different tongues, professing every religion of Asia—Hindu, Mohammedan, Buddhist and Animist—and exemplifying social customs which range from polygamy to polyandry. The future undoubtedly has historical evolutions in store for this region which cannot fail to exert an influence upon the nations of Europe.

There will be work enough for many generations of geographers, geologists, ethnologists and naturalists before we come to know the Himalaya in its details. And what of the mountaineer? It scarcely seems possible that man should ever succeed in completely exploring that forest of peaks. Thousands of them probably reach up to 20,000 feet; hundreds of them are over 23,000 feet. In the glacier basin explored by the Duke of the Abruzzi's expedition there are more than twenty-five peaks above 23,000 feet.

A great part of the Himalaya is shut in by territories which are closed to the European. Other parts of the highest chains are at a great distance from human habitation, secluded in a wilderness where no assistance or supplies are to be had. Many of the valleys are nearly desert for hundreds of miles, with sparse and squalid villages, where a scanty population just contrives to wrest a bare living from the arid stony waste. The topographical work of the Trigonometrical Survey of India was carried out in the face of these obstacles. The history of privations endured, dangers faced and difficulties daily encountered and surmounted in solitude by the brave officers who carried out this work has never been written. The work itself was not and could not be definitive or complete. The vast region is only known to us in its main outlines, nor is there one single mountain group where the mountaineer, if possessed of the knowledge befitting an explorer, may not fill up blank spaces in the map, complete it with fresh data and correct its approximate outline.

Colonel S. G. Burrard and H. H. Hayden, the Directors of the Trigonometrical and the Geological Surveys of India, have published in recent years a brief summary of the geographical and geological knowledge which we now possess with regard to the Himalaya.[1] Here we find a list of mountains whose position and height have been accurately fixed by triangulation. Seventy-five of them are above 24,000 feet, forty-eight are above 25,000 feet, sixteen are above 26,000 feet, five are above 27,000 feet and three above 28,000 feet.

We are not likely to discover a higher peak than Mount Everest, but there certainly exist in the Himalaya a great many peaks which have not yet been measured and which are between 25,000 and 27,000 feet in height. Every exploring party brings a new one under our notice. The expedition of the Duke of the Abruzzi took the altitude of a mountain which reached to over 27,000 feet, in addition to fifteen peaks, now measured for the first time, all above 23,000 feet and all included in the upper basin of the Baltoro and Godwin Austen glaciers.[2]

The principal peaks, those of 27,000 feet and over, are not grouped together in one range, but are dispersed along the whole system of the

[1] Col. S. G. Burrard and H. H. Hayden, *A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet.* Calcutta 1907–1909.

[2] In the same summer Dr. T. G. Longstaff discovered an imposing peak at the head of the Siachen glacier, then explored for the first time. He reckoned it to be over 27,000 feet high; but later measurements made by the Trigonometrical Survey in 1911 prove it to be only 24,489 feet (± 100 feet).

Himalaya. Thus the three highest mountains on the globe are placed one in the central, one in the western and one in the eastern Himalaya.

A brief survey of the various ranges will give me an opportunity to enumerate the chief mountaineering and exploring expeditions which have been undertaken in the Himalaya, and will make clear the reasons which guided His Royal Highness the Duke of the Abruzzi in his selection of the field for his expedition.[1]

DARJILING AND KINCHINJUNGA.

Kinchinjunga, the third highest peak on the earth (28,150 feet), rises upon the borders between Nepaul and Sikkim, where the central and eastern Himalaya meet. It is fairly easy to reach the glaciers, which are only about 45 miles from Darjiling, the well-known climatic station where numerous English officers and civilians seek health and rest from the burning plains in summer. The valleys which slope up from Darjiling into the mountains are covered with luxuriant forests, whose aspect is tropical even at a great height and where Alpine plants

[1] In the following pages I have not taken note of several ascents to great heights which were made at various points by the topographers of the Trigonometrical Survey of India. I shall have occasion to quote them further on in the course of this work in a critical analysis of the statistics of the ascents to exceptional heights.

reach dimensions undreamed of in Europe—their marvellous beauty has been described by many a traveller. This wonderful vegetation is due to the special climate of the region, where torrents of rain fall throughout the very months of summer which would otherwise be suitable for mountaineering. The fine weather begins only in October, when the intense cold and the shortness of the days present serious obstacles to any attempt at an ascent above 23,000 feet.

THE KABRU, SEEN FROM NEAR JONGRI, SIKKIM (ABOUT 15,000 FEET).

Nevertheless, it was upon a peak of this chain, the Kabru, that the greatest height on record had been reached before the Duke of the Abruzzi's expedition. In October, 1907, two Norwegians, C. W. Rubenson and Monrad Aas, climbed this mountain nearly to the summit, attaining a height of almost 24,000 feet.[1] This exploit put an end to the long controversy among mountaineers as to the credibility of the assertion of W. W. Graham to the effect that he had climbed the Kabru to within a few feet of the summit in 1883.

Kinchinjunga itself was explored on all its slopes in the year 1899 by an expedition led by D. W. Freshfield.[2]

[1] C. W. Rubenson, *An Ascent of Kabru. Alpine Journal* 24, 1908, p. 63.

[2] D. W. Freshfield, *Round Kangchenjunga.* London 1903. Illustrated by Vittorio Sella.

In this expedition Vittorio Sella took part and has given us photographs of the whole of that beautiful group. Although Freshfield abstains from any absolute declaration of the impossibility of ascending Kinchinjunga, and although he even went so far as to plan a route by which an attempt might be made, still he does not hazard any forecast as to the probabilities of success. As seen in Sella's photographs, Kinchinjunga certainly does not appear to offer any very obvious route for an easy ascent—an essential condition to the attainment of the greatest heights.

Thus we see that the Sikkim Himalaya does not hold out good chances for such an ascent. Neither does it offer many opportunities of geographical discovery in the event of unsuccess in mountaineering, should an expedition ever follow on the track of so competent and observant an explorer as Freshfield.

Westward of Sikkim lies the Central Himalaya, between Nepaul to the south and Tibet to the north. These states have long been forbidden country to the European, by the desire of their own rulers as well as by the conventions and mutual undertakings of England and Russia. This portion of the Himalaya comprises Mount Everest, the highest peak in the world, whose altitude (29,002 feet) was calculated by triangulation in 1852. Since that date active exploration on either side of the ranges has revealed no other mountain of equal or greater height, and as time goes on the discovery of such a one becomes less and less probable.

Although no topographer has been able to get within 80 miles of the Nepaul range, nevertheless Burrard's list gives the measurements of twenty-five peaks above 24,000 feet, nineteen of which are above 25,000 feet, eight above 26,000 feet and two above 27,000 feet, beside Mount Everest, which is above 29,000 feet.[1]

This is indubitably the part of the Himalaya where the most important geographical discoveries still remain to be made. So long, however, as the political conditions remain unchanged there is no hope for the explorer in that direction.

[1] Among the panoramas reproduced for the present work there is one (Panorama A) of the Nepaulese Himalaya taken by Sella when he was on the borders of Sikkim and Nepaul with Freshfield's expedition. Beside giving a picture, however dimmed by distance, of the highest mountain range in the world, this panorama permits the mountaineer to compare the general outline and features of the eastern Himalaya with those of the Karakoram.

Further to the west, in the corner between Nepaul, Kashmir and Tibet, lies the Himalaya of Kumaun and Gahrwal. This important group is easy of access from the plain, and not far from good base-stations for supplies. Hence its pleasant and well-wooded valleys are frequently sought out by travellers and mountaineers. It is said that the name Himalaya, or Himaleh, "abode of the snow," or "abode of winter,"

MAKALU. EVEREST.

THE EVEREST GROUP, FROM CHOONJERMA LA, NEPAUL (14,770 FEET). TAKEN BY TELEPHOTOGRAPHY.

had its origin among the snow-capped ranges of Gahrwal. Around the twin peaks of Nanda Devi, which are between 25,000 and 26,000 feet, cluster lower peaks, upon one of which, Mount Kamet, the brothers H. and R. Schlagintweit reached a height of 22,260 feet in the year 1855.[1] In 1883 W. W. Graham made several ascents in this group, reaching 23,185 feet on Dunagiri[2]; and in 1907 Dr. T. G. Longstaff reached the summit of Trisul, 23,406 feet.[3]

[1] Hermann von Schlagintweit-Sakünlünski, *Reisen in Indien und Hochasien.* Jena 1869–1880. 4 vols.

[2] W. W. Graham, *Travel and Ascents in the Himalaya. Proc. Roy. Geog. Soc.* VI, 1884, p. 429.

[3] T. G. Longstaff, *A Mountaineering Expedition to the Himalaya of Gahrwal. Geog. Jour.* 31, 1908, p. 361; and *Mountaineering in Gahrwal. Alp. Jour.* 24, 1908, p. 107.

To the west of Gahrwal the range assumes the name of the Punjab Himalaya, and rises toward the centre to a dominant group of peaks known as the Nun Kun, with twin peaks of about 23,400 feet. In 1906 Dr. Hunter Workman and Mrs. Bullock Workman made an expedition in this range, in the course of which Mrs. Workman reached an altitude of 23,300 feet.[1]

Beyond Nun Kun the Himalaya skirts the north side of the plateau of Kashmir, then seems suddenly to come to an end, as if in one last magnificent effort, in the great peak of Djamirai, better known as Nanga Parbat (26,620 feet). This superb mountain gains in grandeur by its splendid isolation, as there is no rival in the surrounding region. It can be seen from many points in Kashmir and in Afghanistan, and even as far off as near Peshawar; and after Kinchinjunga, at the other extremity of the Himalaya, is probably the most familiar peak in India.

The name of Nanga Parbat will always be associated with that of A. F. Mummery, one of the finest mountaineers of our day, who lost his life on this mountain in 1895. He had reached about 20,000 feet on the north-west slope of the mountain, and had given up all idea of attempting to continue the ascent by that route, which proved too difficult. He was killed by an avalanche while endeavouring to reach the northern slopes of the mountain.

All those who have seen Nanga Parbat from near speak of it as apparently almost inaccessible, owing to the forbidding rock precipices from which hang steep and dangerous glaciers.[2] In the event of a failure upon Nanga Parbat there are no other peaks of great altitude to fall back upon in the neighbourhood, nor would important geographical discoveries reward research in that region.

The Punjab Himalaya, as we have seen, contains few peaks of great height, but to the north of it stretches a huge system of mountains known as the Karakoram. Of all the Himalayan regions not absolutely closed to European enterprise, this is certainly the one that offers the greatest hope of useful work to the geographer, the naturalist and the mountaineer.

 [1] W. Hunter and F. Bullock Workman, *Peaks and Glaciers of the Nun Kun*. London 1909.

[2] See J. Norman Collie, *Climbing on the Himalaya* etc. Edinburgh 1902, where the story of the Mummery catastrophe is told; also C. G. Bruce, *Twenty Years in the Himalaya*. London 1910.

It is separated from the Himalaya proper by the upper course of the Indus, and lies nearly 200 miles from the capital of Kashmir. Thus it is accessible only to expeditions organized for distant exploration, and on this account it has been seldom visited—the greater number of the higher valleys and glaciers are to this day unexplored.

Karakoram in Tibetan means " black gravel." The name was noted and introduced by W. Moorcroft, the first European explorer to cross the chain, about 1820.[1] The word Mustagh, or " ice mountain," was subsequently suggested as more appropriate. The suggestion, however, was not adopted, because in Chinese Turkestan all snow peaks are called Mustagh.

I will barely hint at the discussion as to whether the Karakoram should be included, geographically speaking, in the Himalaya, or whether it should be treated as a separate mountain system. The latter is the opinion of the Schlagintweits, of Cunningham, of the Workmans, etc.[2] Burrard would include in the Karakoram system all the mountains to the north of the Indus. The Karakoram is usually distinguished from the Hindu Kush, which is its prolongation to the westward.[3] In this direction the sources of the Gilgit, an affluent of the Indus, mark the boundary between the two chains. Eastward the Karakoram range is bounded by the sources of the Shyok, an important stream which, after a long and winding course through the greater part of Baltistan, flows like the Gilgit into the Indus. Between these boundaries the Karakoram chain stretches for about 450 miles.

Some of the greatest glaciers of the world are contained in the Karakoram range. In no part of the Himalaya do we find such a number of very high peaks in so limited a space. Burrard counts forty-two peaks of and above 24,000 feet in the whole of the Himalaya proper from Sikkim to Kashmir, and thirty-three in the Karakoram system alone (twenty-nine if we do not include in this system the peaks farther to the north). These mountains are grouped around four great glaciers —the Chogo Lungma, the Hispar, the Biafo and the Baltoro. A fifth and still larger glacier basin, the Siachen, was explored for the first

[1] W. Moorcroft and G. Trebeck, *Travels in the Himalayan Provinces of Hindustan*, etc. Ed. by H. Hayman Wilson. London 1841. 2 vols.

[2] Schlagintweit, op. cit. ; Sir A. Cunningham, *Ladak and Surrounding Countries.* London 1854 ; W. Hunter and F. Bullock Workman, *In the Ice World of Himalaya.* London 1901.

[3] This is the opinion of Col. Godwin Austen (*Proc. Roy. Geog. Soc. N.S.* 5, 1883, p. 610) ; and it is the division adopted by the Trigonometrical Survey of India (Burrard, op. cit.).

time by Dr. Longstaff during the same summer in which the Duke of the Abruzzi went to the Karakoram. The Chogo Lungma and the Hispar form the centre of the mountain groups of Kunjut and Hunza, with seven peaks between 24,000 and 25,500 feet. This is the part of the Karakoram which was first known and has most often been explored since—by G. T. Vigne in 1835, by Dr. Falconer in 1841, by Dr. Thomson in 1847–48 and by A. Schlagintweit in 1856.[1] In 1892 Sir Martin Conway traversed for the first time and surveyed in their entire length the Hispar and Biafo glaciers.[2] The Chogo Lungma basin was the field of several of the expeditions of Dr. and Mrs. Workman, whom I have already mentioned. With remarkable perseverance they returned to the same region in four different summers—in 1899, 1902, 1903 and 1908. In the course of these expeditions Dr. Workman reached a height of about 23,400 feet on the ridge of a peak at the head of the Chogo Lungma glacier.[3]

Eastward of the mountains of Hunza lies the Karakoram proper, which includes the Baltoro glacier, and contains eight peaks between 25,110 and 28,250 feet known before the Duke's expedition. Along the single gigantic valley down which flow the Baltoro and its affluents, tower a series of peaks comprising K^2, the second highest mountain in the world (28,250 feet); the four Gasherbrums, between 26,000 and 26,470 feet; the two Masherbrums, over 26,500 feet; the Bride Peak, 25,110 feet; and the three summits of the Broad Peak, whose altitudes (27,132, 26,188 and 26,022 feet) have been ascertained for the first time by the Duke's expedition. I speak of the higher peaks only.

The Baltoro glacier was first discovered and its lower portion explored by Colonel Godwin Austen in the course of his topographical campaign in the Karakoram (1860–61), which yielded such important geographical results.[4] The glacier was again visited in 1886 by Colonel

[1] G. T. Vigne, *Travels in Kashmir, Ladak, Iskardo*, etc. London 1842. 2 vols.; H. Falconer, cited by I. Murchison, *Jour. Roy. Geog. Soc.* 28, 1858, p. clxxxviii; T. Thomson, *Western Himalaya and Thibet.* London 1852, and various notes in *Jour. Roy. Geog. Soc.* 23, 1853, pp. 232, 318; Schlagintweit, op. cit.

[2] Sir W. M. Conway, *Climbing in the Himalayas.* London 1894. 2 vols.

[3] In addition to their numerous articles in the *Geographical Journal, Alpine Journal* and other periodicals of geography and mountaineering, W. Hunter Workman and F. Bullock Workman have given an account of their expeditions in the following works: *In the Ice-World of Himalaya.* London 1901; *Ice-bound Heights of the Mustagh.* London 1908; *Peaks and Glaciers of the Nun Kun.* London 1909; *The Call of the Snowy Hispar.* London 1910.

[4] Lieut.-Col. Godwin Austen, *The Glaciers of the Mustagh Range. Proc. Roy. Geog. Soc.* 8, 1863, p. 34: and *Jour. Roy. Geog. Soc.* 34, 1864, p. 19.

Sir Francis Younghusband.[1] It was not, however, until the memorable expedition of Sir Martin Conway in 1892 that it was traversed in its whole length and surveyed, as well as its rivals, the Hispar and Biafo glaciers.[2] The Baltoro glacier is divided into two branches in its upper

K² FROM THE SOUTH.

course. The south-eastern branch preserves the name Baltoro, and this part alone had been explored by Sir Martin Conway. The other arm, known as the Godwin Austen glacier, flows round the base of the south face of K², and had been visited in 1902 by an expedition led by the English mountaineer O. Eckenstein, accompanied by two Englishmen, A. E. Crowley and G. Knowles, two Austrians, Drs. H. Pfannl and V. Wessely, and the Swiss doctor, J. J. Guillarmod, who

[1] Sir F. E. Younghusband, *A Journey across Central Asia, from Manchuria and Peking to Kashmir, over the Mustagh Pass. Proc. Roy. Geog. Soc. N.S.* 10, 1888, p. 485.

[2] Sir W. M. Conway, op. cit.

wrote an account of the undertaking.[1] This was the only expedition which had had a near view of K[2] before the Duke of the Abruzzi. Of all the numerous peaks which crowd along the sides of the Baltoro, two alone had been climbed, and both by Sir Martin Conway, in 1892—Crystal Peak, 19,400 feet, on the right-hand side of the glacier, and a minor peak of the Golden Throne group, situated near the upper end of the Baltoro and 26,200 feet high, which Conway named Pioneer Peak.

The basin of the Baltoro glacier appeared by all accounts to be the most suited to a mountaineering and exploring expedition which proposed as its aim the investigation of the problem concerning the possibility of ascending the highest peaks. Here we have K[2], the highest mountain at present open to Europeans to attempt, only 750 feet lower than Mount Everest.[2] The only expedition which had ever had a near view of it was of opinion that there were chances of success, and Guillarmod expressed himself as decidedly inclined to consider the ascent a feasible one. Furthermore, K[2] is surrounded by numerous peaks ranging from 26,000 to 27,000 feet, far above the highest point yet reached upon any mountain; and there seemed a reasonable probability that some one of these might be fairly accessible. Last but not least, the region had been visited by but a single expedition, and that not specially equipped for topographical work. The greater part of the valleys and glaciers were as yet untrodden by man. Whole mountain ranges were still indicated on the map by a few points only, and it was permissible for the geographer to hope to fill up these gaps.

I may add a few words to explain the strange designation of the second highest peak in the world, K[2], for the benefit of those who are not acquainted with the system of nomenclature of the Trigonometrical Survey of India. When the latter began its labours in the Himalaya it was confronted with the problem of how to designate individually

[1] Dr. J. Jacot Guillarmod, *Six mois dans l'Himalaya*. Neuchâtel, no date. Guillarmod puts K[2] and the Baltoro basin in the Hindu Kush, though the chain usually designated by this name is situated, as we have seen, about 250 miles farther to the west. We have also two excellent shorter accounts of the expedition by Pfannl, *Von meiner Reise zum K[2] in den Bergen Baltistans, Mitt. der Geogr. Ges. Wien*, 47, 1904, p. 247, and *Zeit. d. Deut. u. Oest. Alpenvereins*, 35, 1904, p. 88.

[2] The designation of K[2] as the second highest mountain in the world must not be taken too literally. As a matter of fact, it is less than a hundred feet higher than Kinchinjunga, and the calculations cannot yet be made with such exactness as to eliminate all chances of error. There is still the possibility that Kinchinjunga may prove to be the higher of the two.

the thousands of important peaks which had no name. Few and far between are those upon which the natives living at the foot of the ranges have felt the necessity of bestowing a name. Of the seventy-five peaks given in Burrard's list, only nineteen have native names. Furthermore, the tribes on the different sides of the great chains belong to different races and speak different languages, and have little intercourse with one another. Hence the few names which do exist are different on the north and on the south side of the same mountain.

Colonel Montgomerie, under whose direction the work of triangulation of the Himalaya began, invented an ingenious scheme of nomenclature which resembles the ancient system of designating the heavenly bodies, based upon the grouping of them into constellations. He designated the Karakoram region by the letter K, and each peak by the names K^1, K^2, K^3, etc. The advantages of this method as to clearness and simplicity are obvious, had it only been adopted throughout the Himalaya. Unfortunately, other topographers proceeded to give the initial letters of their own names to the peaks which they subsequently measured, and hence arose great confusion owing to different observers having the same initial letter or name.

Burrard's view is that it is better for the present to designate the peaks simply by their altitude; and, as a matter of fact, many of them are indicated in this manner only. This system has been followed by the Duke in his map of the region he explored, with regard to the peaks measured by his expedition.

The only non-indigenous name adopted by the Trigonometrical Bureau of India is that of Everest for the highest peak, which was at first indicated as Peak XV; but in the case of K^2 the name Godwin Austen, proposed in 1888 by General Walker in recognition of the merits of the great Himalayan topographer, has been rejected. Nor is it likely that a better fate awaits any of the numerous names which travellers have collected from among the natives of Baltistan.

CHAPTER II.

FROM MARSEILLES TO SRINAGAR.

Preparations for the Expedition. — Alpine Guides and Porters. — The Most Favourable Season. — Equipment. — From Marseilles to Bombay. — The Railway Journey. — Rawal Pindi. — Ekkas and Tongas. — The Road to Kashmir. — The Jhelum Valley. — The Kashmir Custom House. — Uri. — The Gorge of Basmagul. — Baramula. — Kashmir. — Lacustrian Theories and Legends. — Disagreements among Geologists. — Arrival at Srinagar.

His Royal Highness the Duke of the Abruzzi prepared his expedition between February and March, 1909. He invited to take part in it his aide-de-camp, Marchese Federico Negrotto, Ship's Lieutenant R.I.N., whom he entrusted with the topographical work of the expedition; Vittorio Sella, whose task was to illustrate by photography the scenes through which the expedition should pass; and myself as physician and to collect natural history specimens so far as might be possible on so rapid a march. The number of members of the expedition was limited by the great distance which would have to be traversed beyond the limits of civilized means of communication, the difficulties of transport to be expected in the mountains, and the importance of light marching order to make the most of the brief season during which mountaineering would be possible. On the other hand, it seemed advisable to bring a fair number of European guides and porters, as the Duke's African experience warned him not to count over much upon native portage in the high mountain region—all the more as the distances to be crossed upon the ice were infinitely longer in the Karakoram than in the Ruwenzori range.

For these reasons seven Italian guides and porters were chosen from Courmayeur, in the valley of Aosta. First, Joseph Petigax, the devoted and faithful companion of the Duke of the Abruzzi upon all his expeditions, together with his son, Laurent, who had already been tried with his father in the Ruwenzori expedition. Both father and son had been guides to Dr. and Mrs. Workman in their exploration of the Chogo Lungma glacier of the Karakoram in 1903. The two other guides, the brothers Alexis and Henri Brocherel, were also familiar with Himalayan travel, as they had been on two expeditions in the Kumaun-Gahrwal with Dr. Longstaff, exploring in 1905 the Nanda Devi group and the Gurla Mandhata, and in 1907 acting as guides to Longstaff in his fine ascent of Trisul (23,406 feet). To these we must add three sturdy porters, thoroughly acquainted with the glaciers of Mont Blanc—Emil Brocherel, Albert Savoie and Ernest Bareux. As on former occasions, Sella again brought with him Erminio Botta, at once assistant-photographer, guide and porter, and deeply versed in camp life and in foreign mountaineering.

The most important consideration for any Alpine expedition, especially in remote countries, is the choice of the right season. The Karakoram is so remote from the plains of India and is divided from them by such wide and high mountain ranges, that the climatic seasons of tropical regions, if felt at all, must be felt in greatly modified form. Judging from the experience of the few explorers who had preceded us, it was to be feared that the chief hindrance to mountaineering in the Karakoram would come from the extreme instability of the weather.

In 1892 Sir Martin Conway, exploring the three main glaciers of the Karakoram between May and the beginning of September, experienced hopelessly bad weather, never having more than four consecutive fine days. It was not until September that the weather became fair, and this improvement was attended by intense cold, high wind and short days.

During their repeated expeditions to the western Karakoram and up the Chogo Lungma, Hispar and Biafo glaciers, the Workmans experienced steady bad weather throughout July and August, with the exception of their last journey in 1908, when the weather was exceptionally favourable, fine and warm.

The expedition of Eckenstein, Pfannl and Guillarmod in 1902 found their greatest obstacle in the extremely bad weather from June to August. In June only they had a few short intervals of fair weather.

The conclusion apparently to be drawn from these data was that the best chance would be to get upon the spot very early, quite at the beginning of June. At that season the mountains would not be free from the winter and spring snow, but we could at least hope for longer periods of fine weather, and in any case take advantage of the entire summer season. This was the plan which the Duke adopted.

Time was short to make the necessary preparations for so early a start. However, thanks to the Duke's forethought and order, his great experience gained in former expeditions, his careful study of local conditions and his methodical system of work, everything was actually ready in time. The following narrative will show how perfectly suited his equipment was to the end in view, and how great a part this fact played in assuring our substantial comfort and health in exceptional circumstances of surroundings and climate.

As on his former expeditions, the Duke carried out all his equipment from Europe—camp material, personal effects and supplies for the glacier regions, as well as to supplement the slender resources of the valleys. This system allows of a far more careful selection of each object, greater attention in putting them together and the avoidance of all waste of time in order to procure necessaries along the way.

I need not go into details regarding the careful preparation of the Alpine equipment, including personal outfit, as well as ropes, ice-axes, crampons, nails, cobbler's tools, etc. The expedition was well supplied with meteorological instruments selected and corrected with great care. Among these were the fragile Fortin mercury barometers, a perpetual source of anxiety, causing elaborate precautions at every step. The Duke had decided to adopt Paganini's photogrammetrical system for the topographical work. This method had already been used in important surveys, both in Italy and in other countries.

So a photogrammetric camera with a stock of plates was added to Sella's photographic materials. The expedition was even provided with a cinematograph so as to apply the most modern method of illustration.

Medical supplies had to be brought to minister to the needs of the natives, who seldom see a European doctor and are quite out of reach of civilized means of treatment. On the other hand the expedition possessed only two guns, and these were brought rather on the chance of getting some specimens of zoological interest than with any intention of sport.

It takes at least two months to get from Europe to the Karakoram. Therefore, the whole expedition, including guides and porters, sailed from Marseilles on March 26th by the P. and O. steamer *Oceana*. Such of the supplies as had been purchased in England had already been put on board at Tilbury.

The voyage was a delightful period of rest after the several weeks of hard work at equipment and other preparations. The Mediterranean was kind to us for the four days of our crossing. The steamer followed a course to the west of Sicily in order not to pass the ill-starred Straits of Messina, at that time avoided by traffic as if the cataclysm of December still brooded like a dark menace over the scene of devastation. Then came the lazy voyage down the Suez Canal, where you gaze from the deck over the boundless desert stretching from either bank; and the hot Red Sea, like a sudden summer, languid and enervating; and, last of all, the Indian Ocean, whose blue waters were so dark as to be almost black and perfectly calm—not a ripple to foretell the monsoon which would rage over them a month later.

We entered Bombay Harbour at daybreak on April 9th (Good Friday). The lazy mood of the long voyage gave way suddenly to an impatient desire to get on. A few hours were employed in superintending the unlading of our goods, getting them through the Customs and removing them to the station, and in making arrangements with banks and agents. This done, we set out by railway early in the afternoon.

The journey to Rawal Pindi takes two days, crossing towards the north of the Punjab, with a wide détour so as to leave Rajputana to the east. Notwithstanding special contrivances to protect the carriages from the heat, we felt them to be like furnaces. Fleeting visions were vouchsafed us of dusty districts parched by the first breath of summer; villages of mud and rubble huts, with threshing floors of beaten earth where hump-backed cattle were treading out the ripe harvest, driven round and round by folk clad in white or red cotton, the men wearing the big turban of India, and surrounded by tiny naked children playing in the dust. Beside the great herds and flocks scattered in the wide fields, we would see here and there antelopes fleeing from the train, and jackals; and the whole country is full of birds of all sorts and many colours—splendid peacocks, crows, brilliant jays, doves, pigeons, parrots, vultures, hawks, kingfishers, and many others impossible to distinguish from an express train in motion. The trees give you no suggestion as to a season. One is covered with leaves, another full of blossoms without foliage, another shows bare branches, while others again are bursting into full leaf. Temples and shrines, old forts and ruins, pass rapidly before our eyes, especially near Gualior and Delhi, names which evoke such memories. But of them, alas! we see but the railway stations, crowded with natives of every conceivable tribe, wearing every conceivable sort of dress.

Now we cross the Jhelum, a wide river where many herds come to the watering-place; and the way winds up over a succession of terraces of chalk and clay, and far off against the clear sky to the northward we make out the outline of the snowy mountains which bound the huge plain of India. This is the Pir Panjal range, a branch of the Himalaya, which forms the southern barrier of the table-land of Kashmir. Farther on this range is hidden by nearer and lower hills, which form the Siwalik chain. Not far from this latter our railway journey ends at Rawal Pindi, on the evening of Easter Sunday, April 11th. The train rolls off, carrying with it Major Lockhart, of the Guides, a kind English officer who had interpreted for us in several small difficulties, and our party finds itself stranded on the platform beside a huge pile of cases, crates and bales, which had filled a whole van and which contained our entire equipment. There are 132 pieces, weighing 166 *maunds* of 80 lbs. each, giving a total of about 13,280 lbs.

The whole of this luggage had to be got up to Srinagar by the carriage road, which was finished some twenty years ago. This road is about 200 miles long, and goes from Rawal Pindi (1,700 feet above sea level) along the Jhelum Valley to the high plateau of Kashmir (5,200 feet above sea level), crossing in its course one of the lower spurs at a height of 7,467 feet.[1]

Next morning at 6 o'clock we all met at the station, where the Duke had made an appointment with the agents, porters and transport vehicles. Punctuality, however, is extremely relative in the East.

[1] See map with the itinerary of the expedition.

The agent did not get there until half-past six. About half-an-hour later turned up the representative of Dhanjiboy, a Parsee who has a monopoly of the postal service and of carriages, carts and horses between Pindi and Srinagar. Presently the *ekkas* came slowly dribbling in. Ekkas are strange vehicles. The body is in the shape of an obverse pyramid, which stands upon an axle without any springs, between two high wheels. The shafts diverge so that their farther ends are about two yards apart. All ekkas appear to be centuries old, tumble-down and decayed, patched up here and there and everywhere with bits of rotten string, so that their holding together at all appears a miracle. And yet they usually carry some ten or eleven maunds each (between 800

EKKAS.

and 900 lbs.). Only three or four rather small packages can find room in the actual body of the ekka ; but on top of these are placed two long poles, upon which is piled up a load considerably higher than the top of the wheels, giving to the whole a most extraordinary aspect of instability. The ekka is drawn by a single horse, and does the whole distance in about eight days. Carts of a more familiar shape are also to be had, and are stronger and hold a good deal more. These are drawn by oxen, and it takes them over a fortnight to get to Srinagar.

It took us the whole morning under a broiling sun to count all of the luggage and ascertain that nothing was missing, and then to proceed to its distribution among the ekkas, surrounded the whole time by troops of coolies shouting and arguing and quarrelling without a moment's respite. The division of the luggage into loads is a very long and toilsome job, and is made about four times as long as it need be by endless trying and trying over again. Every time you get up a single piece of luggage on to the ekka you have it pulled down again ; then you try another in the same place, and then a third, and so on. At last, between 1 and 2 o'clock in the afternoon, the whole lot of ekkas, with their shapeless loads tied and roped together, were driven out of the station and assembled in the courtyard of Dhanjiboy, ready to start at night.

We now had a few hours to purchase some articles at Pindi. The town is uninteresting—a typical cantonment with wide roads, well

ON THE OUTSKIRTS OF RAWAL PINDI.

kept and lined with bungalows and gardens. Nearly every afternoon a violent wind blows in hot gusts for a few hours, raising a stifling cloud of dust and sand, which penetrates through every crack of door or window.

By daybreak on the following day we left Pindi in two landaus, which were drawn at a sharp trot by small wiry horses. On the outskirts of the town in front of the verandahs which run along the low native houses the greater part of the population were sound asleep in the street upon their *charpoys*, a sort of bed consisting of a rectangular framework, across which is passed to and fro and interwoven a narrow band of coarsely woven hemp, thus forming a couch which combines the qualities of simplicity, elasticity and strength. The general impression given by the population asleep on these stretchers along the street is that some epidemic is raging or that they have been driven from their homes by an earthquake.

Our personal luggage was sent on ahead upon two-wheeled vehicles of the native variety known as *tongas*. Tongas are two-horse vehicles with a curved, dome-shaped roof, underneath which is one seat parallel to the axle. Upon this four people can find room, two sitting in front facing the horses and two facing backwards. As much baggage as possible is arranged under this seat, on the mudguards and on the sides of the roof, tying it on as best may be.

A TONGA.

Sir Martin Conway observes that the tonga resembles the *carpentum* of the ancient Romans and Gauls, as shown on a bas-relief at Trèves. In spite of their primitive appearance, tongas are in many ways better suited to the mountain roads than the heavy carriages Dhanjiboy provided for us.

The ancient road to Kashmir, which was followed for centuries by the Mogol emperors and their retinues, of whose pomp and splendour such a living picture has been handed down to us by Bernier,[1] the French physician at the Court of Aurengzebe, ran to the east of the modern route, direct to Kashmir from the plain of Jammu, across a pass of the Pir Panjal range. The new road, which was opened in 1890, reaches the Jhelum valley just above the narrow gorge through

[1] François Bernier, *Travels in the Mogul Empire* (A.D. 1656–1668). London. A. Constable, 1891.

which the latter descends from the plain of Kashmir, and crosses the spur of mountains which form the western barrier of this gorge. Near the top of the pass (7,467 feet high) stands Murree, a hill station which is crowded in summer, but was quite peaceful and empty when we passed through. We reached Murree in the pouring rain and shivering with cold, owing to the sudden transition from the hot suffocating air of the plain to the high mountain breezes. The whole of the descent into the Jhelum valley crosses bands of forest, where the pale green of the budding deciduous trees contrasts with the dark conifers and with the lively colouring of the flowering bushes. We proceeded rapidly at a quick trot or gallop even at the steepest points, thanks to the relays of horses which awaited us every four or six miles, according to the steepness of the road. Little time was lost in changing them, because the system of harness is extremely simple. There are no buckles, no straps and no traces. There is only a bar which crosses the pole and fits into two uprights fixed into the saddles of the harness.

THE ROAD TO KASHMIR.

The ragged and dirty postilion sits beside the driver and with the harsh and strident notes of his horn clears the way of the carts, ekkas and tongas which we keep meeting and passing.

The weather had cleared by the time we reached Kohala, our first stage, at the bottom of the valley, at a distance of a little over 64 miles. Kohala stands about 300 feet above Pindi, and is a village of a few houses, which rise on terraces one above another on the steep right bank of the Jhelum at the inlet of the narrow gorge through which the river forces its way out from the mountains. The water rushes fiercely at the bottom of the gorge, whirling on its muddy and foaming waves the numberless tree trunks which are sent down from the mountains to Jhelum, the city of the Punjab plain, which has given its name to the river.

But in the mountains which shelter its hallowed sources and throughout Kashmir the name of the river is Vehut, a corruption of the Sanscrit Vitasta, " one who hastens," from which may also be derived the Hydaspes of the Greek historians. This river formed the eastern limit of the conquests of Alexander, and according to legend the Macedonian navigated its downward course to the Indus.

At Kohala we made our first acquaintance with the *dak* bungalows or guest-houses which are found at every stage on the main roads and on many of the principal bridle paths. They are all built on the same plan, and consist of a ground floor only, with a wide verandah on to which all the bedrooms open. Behind each bedroom there is usually a small bathroom. The furniture is simple but clean. On the high road from Pindi to Kashmir the dak bungalows are real inns, provided with a cook and with supplies and servants, so that travellers need not bring a large amount of luggage. Little equipment is needed beyond the sleeping-bag or the valise which holds a thin mattress, pillow, blanket and sheets, all of which are equally indispensable for railway travelling in India. The bedrooms contain charpoys, upon which you spread your own bedding.

Immediately outside of Kohala the road crosses the Jhelum upon the bridge which marks the boundary between British territory and the Protectorate of Jammu and Kashmir. Here an official dignitary met us to bid the Duke of the Abruzzi welcome in the name of the Maharajah. The road now follows the left slope of the valley at a height of from 600 to 1,000 feet above the river. Upon either side of the valley are traces of alluvial terraces rising one above another to a great height and indicating successive upheavals of the whole mass, while the river kept on its way at its original level by progressive erosion of its bed.[1]

Some 20 miles above Kohala two large tributary valleys, that of Kunhar or Naim Suk and that of Kishen Ganga, open out on the right bank of the Jhelum, divided one from another by a range of hills capped with snow peaks. At this point, before the high road was built, another path came into the Jhelum valley from Abbottabad in the Punjab. At

[1] K. Oestreich, *Die Täler des nordwestlichen Himalaya. Petermann's Mitt., Ergänzungsheft* 155, 1906. An interesting geological monograph, the fruit of observations made by the author while accompanying the Workman expedition of 1902.

its point of confluence with the Kishen Ganga the Jhelum valley suddenly changes its course, doubling back at a sharp angle round the end of the spur of hills on its left side and rising south-eastward with an increasing deflection towards the east. The valley of the Kishen Ganga goes on in the direction in which we had hitherto followed up the Jhelum, towards the north, so that at this junction you feel as if the road had left the main valley to follow up an affluent. As a matter of fact Oestreich questions whether it would not be more correct to regard the Jhelum as a tributary of the Kishen Ganga rather than the latter as a tributary of the former, notwithstanding that the Jhelum has the greater volume of water and a longer course above the point of junction. The Kishen Ganga is also a very considerable river, and in its long course flows round the whole northern boundary of Kashmir. We were to meet this river again in its upper valley on our way back to Srinagar from the Baltoro.

Not far from this remarkable bend of the river stands Domel, the Kashmiri custom-house. It consists of a dirty little bazar which purveys to the needs of a crowd of drivers and carters, who busy themselves with deafening shouts among the oxen and horses which stray loose among the vehicles of every possible type laden with goods liable to custom. Sir Francis Younghusband, the British Resident in Kashmir, had obtained from the Maharajah a free pass for the Duke's equipment, which saved us trouble and delay.

From now on the valley lies between the Kaj Nag to the north and a spur of the Pir Panjal to the south, and the scenery is completely changed. The features due to erosion are less marked, whereas there is a great increase in the alluvial deposits, which often reach a thickness of a few hundred feet and form a series of terraces at the bottom of the valley, which lie with such regularity on either side of the deep channel which the river has cut in the sedimentary mass as to suggest the hypothesis of a lacustrian origin.[1]

The level surfaces of the terraces are carefully irrigated and covered with crops, especially rice plantations, made in narrow terraces rising one above another, each with a raised margin to regulate the flow of water from the top to the bottom.

[1] Lieut.-Col. Godwin Austen, *Geological Notes on Part of the North-Western Himalaya Quart. Jour. Geol. Soc.* xx; and Sir Martin Conway, op. cit.

Where the lie of the land does not lend itself to rice plantations there are fields of corn and orchards in full blossom. The whole countryside is alive with the song of all sorts of birds. The cultivated land reaches up the slopes to the edge of the pine woods and pasture land. Above these, again, are rocks sprinkled with snow and cut by couloirs full of nevés.

As far as possible the road runs over the flat alluvial terraces; but at many points it has been necessary to cut it out along the precipitous cliffs beneath steep slopes of shingle and detritus of all sizes in perpetual course of disaggregation. Every now and then we come upon the débris of former or recent landslides, and meet squads of coolies busily engaged in clearing the road from the fallen earth and stones. During the rainy season it is a hazardous journey, and the road may be cut for days together.

The day's journey was of 69 miles, and we halted for the night at Uri, 4,420 feet above the sea level, where the valley widens out. At this point the scenery is very beautiful. The valley is dotted with ruins of ancient temples, and there are the remains of a fortified city opposite the cliffs of Kaj Nag, which is still crowned with snow. The level is formed by fluvial-glacial deposits, and near at hand are some big granite boulders, whose origin has been a source of much controversy among geologists. The absence of glacier marks in the valley below and above Uri makes it difficult to explain how these boulders came there, and whence the origin of the moraine remnants which are found at this point. Of all the different hypotheses the most probable, perhaps, is that of Godwin Austen, which has been further amplified by Oestreich[1]—namely, that of glaciers from the lateral valleys which may at one time have overflowed into the main valley, leaving the traces in question.

Immediately above the plain of Uri the valley narrows again into the famous gorge of Basmagul, one of the grandest in the world, some 20 miles long and running between walls more than 7,000 feet high. The river rages with fierce anger against the rocky sides of its narrow bed. The slopes above are covered with forests famed from of old for their majestic deodars. Now and again we still found the remains of a spring avalanche of snow along the margin of the road. Next we

[1] Godwin Austen, Oestreich, opp. citt.

pass the hydraulic station of electric power, a characteristic symptom of European invasion. Soon we reach Baramula, the real gate of the high valley plain of Kashmir. The torrent which thundered through the cañon of Basmagul is now transformed into a wide imposing stream, which flows slowly and noiselessly between low and level banks along which are moored endless lines of boats and barges.

Many travellers and the greater part of the freight proceed by water from Baramula to Srinagar, taking two days to navigate up the Jhelum and cross the Wular lake, into which it widens above. This traffic has given rise to the typical little Kashmiri town of Baramula, with houses of sun-baked brick, windows and doors of wood, often well carved,

THE BUNGALOW AT BARAMULA.

and narrow lanes crowded with handsome, dirty people, and with women who are not so quick to cover their faces at the sight of the stranger but that he can get a glimpse of regular features and fine eyes.

The distance by road to Srinagar is about 34 miles, a few hours by carriage. The road which cuts across the plain is quite straight, and runs between two regular lines of tall poplars, set close to one another, as on certain French roads. On either side are little lakes and swamps and rice plantations, where the peasants are busy turning over the mud in the flooded fields with primitive ploughs drawn by oxen. Behind the rows of poplars around the scattered farms are to be seen a great variety of fruit trees in flower and gigantic *chenars* standing alone or in clumps. The chenar, or Oriental plane, which was brought into the country by the Mogol emperors, is a splendid tree which reaches an immense size, with a wonderfully graceful growth of branches and with dense foliage giving a deep, cool shade.

On either side extends the great green plain of Kashmir, circled round on every side and appearing absolutely shut in by a continuous girdle of mountains, at this season all still covered with snow. The

POPLAR AVENUE BETWEEN BARAMULA AND SRINAGAR.

valley stands at a mean height of a little over 5,000 feet, and is oval, with its greatest axis running north-west to south-east, about 90 miles long and from 20 to 25 miles wide, enclosed by the Pir Panjal range to the south, whose peaks rise over 15,500 feet; and by the Himalaya proper to the north, ending in the lofty summit of Nanga Parbat (26,620 feet), whose peaks are visible from many points in Kashmir, although they do not directly command the valley.

The sight of this vast basin enclosed by high mountain walls infallibly suggests the notion that it has been the bed of a lake. No wonder that nearly all those who have travelled there in the past sought for and thought to have found clear tokens of a lake which at some recent geological period presumably filled the valley to a considerable height above the present level of the plain, where all that remains of these supposed mighty waters are the three small lakes Wular, Dal and Manasbal. According to this hypothesis, the great alluvial deposits which form the characteristic terraces called *karewa*, usually situated on the verge of the valley at the foot of the ranges and rising about 200 to 300 feet above the plain, would be mere lacustrian deposits. In the middle of the valley they would have been gradually worn down and swept away by the river current which was formed when the lake broke an outlet through the mountains at Baramula. How this lake came to be and how it came to be emptied has given rise to numerous hypotheses, of which Oestreich has given a clear summary.

There is no doubt that the legends interwoven with mythology which are still current in Kashmir, and which are given in a Sanscrit work by Kalhana, the Kashmiri historian of the twelfth century, translated by Stein, appear to corroborate at every point the geological hypothesis of a former submersion of the valley. From Bernier onwards all those who have written on Kashmir—Thomson, Vigne, the brothers Schlagintweit, Montgomerie, Godwin Austen, Purdon, Lydekker, Knight, etc.[1]—were unhesitatingly of the opinion that this was the true explanation. It is plain, however, that the supposed lake must have had its existence and emptied itself at a geological epoch far earlier than the first appearance of man on the earth. The legend therefore can by no means be connected with direct human observation, and loses all value as a proof. Drew and Stein are thus forced to the conclusion that the earliest inhabitants of Kashmir were competent to read and interpret the geological records of the valley.[2]

Marchese Roero di Cortanze, a Piedmontese who lived in Kashmir from 1853 to 1875, and who travelled in Ladakh and Baltistan, even crossing the Karakoram into Turkestan, has given us in three interesting little volumes his views upon the country. The book is now rare and

[1] W. H. Purdon, *On the Trigonometrical Survey and Physical Configuration of the Valley of Kashmir. Jour. Roy. Geog. Soc.* 31, 1861, p. 14; Lydekker, *The Geology of Kashmir and Chamba Territories. Mem. of the Geol. Surv. of India,* 22, 1883, p. 186; E. F. Knight, *Where Three Empires Meet.* London 1905. The other authors as already cited.

[2] F. Drew, *The Jummoo and Kashmir Territories.* London, ed. 1875 and 1877; M. A. Stein, *Memoir and Maps Illustrating the Ancient Geography of Kashmir.* Calcutta 1899.

difficult to get.[1] He is the only one of the early writers who shows a cautious reserve as to the authority of the legend, suggesting, not unreasonably, that it might owe its origin to some exceptionally heavy spring flood. The latter have frequently proved a fearful disaster to the whole region. Beside the melting of snows, they might have been provoked by some obstacle to the free flow of the river. Kalhana's old history, which we have just quoted, relates that in the second half of the eleventh century an obstruction of the gorge below Baramula caused a partial inundation of the valley. It would seem that this obstacle was removed by contriving to collect the waters of the river behind a temporary dam constructed for the purpose, and then opening it and letting them rush through, a truly colossal work for that period.

Modern geologists are inclined to give up the lake hypothesis altogether. Ellsworth Huntington is of opinion that the sedimentary deposits were the work of rivers and torrents in the basin during its formation, while the Jhelum was gradually eating away the outlet of Baramula, so that there would never have been occasion for a great accumulation of waters.[2] Oestreich has an intermediary hypothesis which does not altogether exclude the possibility of the temporary existence of a lake, but he is of opinion that the present lakes are even now in process of formation, and by no means remnants of a greater ancient lake[3]; while R. D. Oldham, from studies carried out in 1903, came to the conclusion that the deposits are of fluvial and not of lacustrian origin, and that there is no proof that there ever were any lakes larger than those actually existing.[4]

Whatever may have been the geological past of Kashmir, its present state is one of such beauty as to kindle the imagination of all who have attempted to describe it. From the earliest traveller to the latest book of Sir Francis Younghusband[5] there is a unanimous chorus of enthusiasm and admiration. To our party, who had left Italy barely

[1] Oswaldo Roero dei Marchesi di Cortanze, *Cashemir, Piccolo e Medio Thibet e Turkestan.* Turin, 1881. 3 vols.

[2] E. Huntington, *The Vale of Kashmir. Bull. Amer. Geog. Soc.*, 38, 1906, p. 657.

[3] Vigne, Stein and Huntington have, however, found certain indications that the Wular lake was at one time larger than it is now. The village of Bandipur, which formerly stood on the shore of the lake, is now nearly a mile away from it.

[4] R. D. Oldham, *Note on the Glaciation and History of the Sind Valley, Kashmir. Records Geolog. Surv. of India*, 31, 1904, p. 142.

[5] Sir F. E. Younghusband, *Kashmir.* London 1909.

twenty days before, the first impression was one of slight disappointment. The long high road, the lines of poplars across the great uniform plain with the rice plantations, the familiar European trees and the far-off snowy ranges slightly veiled in the soft mist of the atmosphere, combined to produce a scene so like our own Lombard plain in its beauty, that we felt baulked of the East of our dreams which we had come so far to seek. But to travellers who come to Kashmir after months or years spent in the parched and burning plains of India, or after wearying journeys across the barren waste of Central Asia, it must seem a paradise indeed.

About half way between Baramula and Srinagar our carriages began to emit squeaking and groaning sounds to such a degree as to cause grave anxiety, as they appeared to be on the point of going to pieces altogether. The spokes of the wheels looked as if they were coming off, the connection between springs and body went wrong, and to the European mind it really looked as if it would be scarcely possible to proceed. But the drivers, by means of cunning knots, contrived to remedy the more serious disasters, and we were able to pursue our way, though at a diminished pace. The primitive tonga is decidedly preferable to the European carriage for this journey. It is very probable that in a few years both will be superseded by the motor-car, not to speak of the possibility of a railway, which has long been projected and which would at once destroy the pleasant remoteness of this beautiful valley.

Nine miles from Srinagar the Duke was met by a carriage sent from the Residency. Soon we reached the suburbs of Srinagar, surrounded by wide fields which were thronged with people. We crossed the Jhelum on a wide wooden bridge to the right bank, where lies the European quarter. Around the great grassy *maidan*, surrounded by roads shaded with poplars, stand the Residency, the bungalows of the officials and others, the post-office, the agencies and the hotel. The Duke and Negrotto were hospitably entertained by Sir Francis and Lady Younghusband. We have now reached the limits of civilized means of communication.

Botta and one of the guides had travelled with us. The other six, who left Pindi the day after us, were to arrive the next day. The limited number of horses at the stages makes it impossible for a great number of carriages to proceed simultaneously.

CHAPTER III.

KASHMIR.

Antiquity of the History of Kashmir. — The Sanscrit Chronicle of its Kings. — The First Mohammedan Conquest. — The Mogol Emperors. — Afghans and Sikhs. — The Inhabitants — Srinagar. — Life on the Jhelum. — The Hanji Caste. — The City. — The Mogol Gardens. —The European Quarter. — Takt-i-Suliman and Hari Parbat. — The Dal. — Lake Vegetation. — The Kashmiri Spring. — Itinerary of the Expedition. — Departure from Srinagar. — The Marshes of Anchar. — Mount Haramuk. — The First Discovery and Mensuration of K^2. — The River Sind. — The State Camp at Gunderbal.

SRINAGAR is now the summer residence of His Highness the Maharajah of Jammu and Kashmir, one of the great Protectorates of the British Empire. The States of the Maharajah include Buddhist Ladakh, which by race, customs and religion, geographical situation and oro-hydrographic features, is really a portion of Tibet; Baltistan. whose inhabitants are Shiite Mohammedans; and the minor districts of Astor-Gilgit, Hunza-Nagar, etc.—in a word, the whole of the territory lying between Afghanistan, Chinese Turkestan and Tibet proper. The population of Kashmir is Sunnite Mohammedan, whereas Jammu (a vast plain district bordering the Punjab) is entirely Hindu.

The whole kingdom, formed of elements so diverse, was but recently united under the domination of Hindu rulers of the Dogra Rajput race. Kashmir had been for some twenty years subject to the Sikhs of the Punjab when Gulab Singh was sent thither in 1841 to put down a rising.

In the course of the following fifteen years his army, little by little, conquered Ladakh and Baltistan. Meantime the Punjab had been conquered by the British, between 1845 and 1856, and the Imperial Government recognized the sovereignty over Jammu and Kashmir of Gulab Singh, upon whom they conferred the title of Maharajah, and who became the founder of the present dynasty. It would seem as if the peculiar position of Kashmir, surrounded as it is by mountains which are difficult to cross, and passes which before the construction of the carriage road were quite closed by snow for several months every year, ought to have sheltered it from outside influences and put it in a position to follow the lines of its own development undisturbed, favoured by its temperate climate and the marvellous fertility of its soil. This happy isolation, however, only lasted till the twelfth century. Putting aside the many notices of Kashmir which have come down to us from the remotest antiquity, from Herodotus to Marco Polo, we have the story of the country throughout its autonomous Hindu period in an ancient Sanscrit chronicle, the work of several authors, which was put together about the middle of the thirteenth century. This work gives us minute information concerning the great prosperity of the country, the high level of its civilization, the development of its arts and the splendour of its temples.

The first Mohammedan conquest took place in 1341, and thenceforward the country never threw off the yoke of foreign domination. The independent Mohammedan kings were followed by Mogol emperors, under whom it became an integral part of the empire of Delhi, and was adorned with sumptuous palaces and gardens. Next came the Afghan conquest, and not until 1819 was Kashmir once more governed by Hindus—the Sikhs of the Punjab. During the five centuries of Mohammedan domination the old Hindu faith had been almost entirely superseded by Islam.

The Kashmiris of to-day appear to differ little from the Kashmiris of thirteen centuries ago, when the Chinese pilgrim Hwen Tsiang described them as "light and frivolous, and of a weak, pusillanimous disposition, handsome in appearance, given to cunning, fond of learning and well instructed" (Stein).

It is nevertheless indubitable that the long foreign domination has contributed to the formation of their character, which is judged by universal consent to be lacking in manly qualities and inclined to deceit.

They give proof, however, of alert intelligence, of marked artistic talents, and of considerable ingeniousness and dexterity in the various handicrafts for which they are distinguished throughout India.

They are a handsome people and well built, with regular features; and the foreigner would be more inclined to admire them if he were not unremittingly persecuted by the insistent importunity of their offers of service or of wares, which reaches such a point that frequently only the threat of personal chastisement avails to get rid of them.

SRINAGAR FROM THE SLOPE OF HARI PARBAT.

Kashmir seems to be now at last freed from the secular oppression of her invaders, to which was added the calamity of earthquakes, which time after time decimated her population and laid low their habitations, not to speak of the floods, epidemics and famines with which her history abounds in the past as well as in recent times. The general appearance of the population is now fairly prosperous. The people look healthy and well fed, with fine chubby children; nor did we often see persons who were diseased or crippled or rachitic, or any other signs of extreme misery.

During the long period of Mohammedan domination the capital city was known as Kashmir, but when it fell into the power of the Sikhs it resumed its ancient Hindu name of Srinagar.[1] It has a population of about 130,000, and stands almost in the centre of the plain at a height of 5,303 feet, upon the banks of the Jhelum, which flows through it in a sweeping curve. The river is the main thoroughfare of the city, and is always crowded with boats of various sorts. The light, swift *shikara*, the *dunga*, a big flat-bottomed boat with a shelter amidships roofed

SRINAGAR FROM TAKT-I-SULIMAN. THE EUROPEAN QUARTER.

over with matting; the heavy barges loaded with wood, grain, oil or vegetables—all come and go continually up and down the river or lie tied along the banks. The boatmen form a large population, and with their women and children pass their whole life on the water. They belong to a special caste known as Hanji. They are well built and handsome, but are looked down upon, not without good reason, by both Mohammedans and Hindus.

[1] According to Knight and Younghusband (opp. citt.) Srinagar signifies "City of the sun"; according to Ujfalvy, "City of healing," from the Sanscrit çri-nâgara (Ch. de Ujfalvy, *Les Aryens au nord et au sud de l'Hindu Kouch.* Paris 1896).

Srinagar

The principal houses of Srinagar stand along the river. The Maharajah's palace is quite modern. The few old palaces which are still standing are in the hands of wealthy merchants. Over a solid basement wall, built like a bastion to withstand the freshets of the river, rises a façade adorned with several tiers of wooden balconies one above another, elaborately carved with effective and ancient designs. Alongside of these similar great foundations of stone blocks, which must have supported other palaces in the past, now serve to sustain wretched

THE NATIVE CITY, FROM TAKT-I-SULIMAN.

tumble-down hovels. The whole river bank to the water's edge is taken up with houses, except where at intervals long flights of steps give access to the river. Here crowds of men. women and children come and go incessantly, wash their clothes, their persons and their pots and pans, or sit chatting in rows to enjoy the cool of the evening. The two banks are joined by seven bridges resting upon piers solidly built out of the interlocked trunks of trees, with the interstices filled up with stones. Numerous canals branch off from the river, and intersect the city in every direction, giving rise to the title of " Venice of the East," but I must say that the comparison is due rather to a lively imagination than to any actual resemblance between the two cities.

The narrow streets on the land are, as is usual in the East, mainly bazars, and are crowded with natives clothed in the native woollen home-spun, usually brown or dirty white in colour, and known as *puttoo*. You meet few women, and those few evidently belong to the lower castes. The city is full of temples and mosques, but of these only two or three offer any antiquarian or artistic interest. Little trace remains of the ancient civilization described in the old chronicles. This may

STREET IN SRINAGAR.

be due to earthquakes, which have several times laid Srinagar low, to the iconoclastic rage of the Mohammedan conquerors or to Eastern carelessness, made up of fatalism, sloth and indifference to the past. The few monuments of which any trace exists in the neighbourhood of Srinagar are remains of Buddhist temples. Next to these the most interesting buildings are without doubt the sumptuous country houses of the Mogol emperors. Here the splendid old gardens, with their artificial cascades, their great tanks and elaborate fountains, their splendid alleys of huge chenars, the design, still recognizable, of their formal plan, and the architectural detail of their little pleasure-houses, although not to be compared with the marvels of Delhi and Agra, nevertheless bear witness to the luxury, taste and refinement which the world of Islam brought with it to the scene of its conquests, from Spain to India. Defeated and thrust back from the west by the victorious cross, after conquering nearly one-half of the world, it was here that Islam displayed its last splendours.

One of the most characteristic features of Srinagar are the roofs of the houses and even of the temples, which are covered with earth and planted with grass and flowers. In spring they are gay with blue iris and scarlet tulips, around which hover butterflies and birds. The latter

AT SRINAGAR.

pervade and haunt every nook of the city, streets, verandahs, shops in the bazar and temples with their joyous notes, their twittering and their chirping, and seem to live on excellent terms with the whole population.

The European quarter consists of a few dozen bungalows in addition to the Residency. It stands upstream from the native town, and is built chiefly round a great open space like a huge village green. It is enclosed on one side by the river and on the other by the wide canal which comes into the river from the Wular lake; and it is protected from floods by high dykes, along which run roads lined with magnificent ancient chenar trees. On the lower portion of this bank, known as the Bund, next to the native town, stand the rows of European shops kept by Parsees or Eurasians. We must not pass over the mission hospital, which was founded and is kept up by the two Doctors Neve, who have done well-known and excellent exploring and Alpine expeditions in the surrounding ranges during the brief holidays permitted by their arduous missionary labours.

The crowds of European visitors who seek out Kashmir in the spring and summer live mostly in house-boats of from four to six rooms, built

HOUSE AND INDIAN TEMPLE ON THE CANAL.

upon flat-bottomed barges. These are tied up at the pleasantest spots along the banks of the Jhelum or on the canals or lakes. After the middle of June the European colony, both residents and tourists, move up into the hills, either to Gulmarg, where there is a hotel and bungalows, or to the higher valleys, where they camp out under canvas.

Eastward and northward of the town of Srinagar rise two hills, which play a great part in the beauty of the scenery. The one to the east terminates the spur which runs out from the ranges to the north-east into the plain, and rises to a height of about 1,000 feet just above the European quarter. Upon the top of this hill stands an ancient temple known as the Takt-i-Suliman, one of the numerous "thrones of Solomon," a name often given by Mohammedans to any striking isolated peak in the countries subject to their laws and traditions. According to Fergusson, this temple is of relatively recent date, but built upon a much older foundation.[1] The Takt-i-Suliman is a favourite walk or ride of about an hour, and offers a marvellous view of the plain and of the lakes and hills which surround it.

BRIDGE AND HOUSE-BOAT ON THE JHELUM.

The other of the two hills is an isolated and precipitous rock to the north of the city, known as Hari Parbat, on top of which stands an ancient fort now used as a prison.

The expedition remained in Srinagar seven days, from April 16th to April 23rd, partly to wait for the heavy luggage which was slowly toiling up the road we had travelled so quickly, and partly to complete our equipment at all points. The chief job which we had to do in Srinagar was to get a certain number of *kiltas* made. These are strong light panniers made of wickerwork, either rectangular or barrel-shaped.

[1] JAMES FERGUSSON, *History of Indian and Eastern Architecture*. 2nd ed. London 1910 2 vols.

and are covered with rough sheepskin, the lid being fastened with chains and a padlock. The more fragile portions of the equipment, when not otherwise protected, were to be put into these kiltas.

Arrangements for our journey had already been made by the courtesy of the Resident, upon suggestions communicated by the Duke from Europe. Sir Francis Younghusband had entrusted Mr. A. C. Baines with the organization of the caravan, the recruiting of horses and coolies, and the making of deposits of stores at certain points on our march.

UNDER THE CHENAR TREES.

Mr. Baines had left Srinagar a couple of weeks before our arrival, and was waiting for us in the Dras Valley. In this way we had leisure to enjoy the kind hospitality of Sir Francis and Lady Younghusband and the other courteous English officials, and to do a little sight-seeing in the city and neighbourhood. Little by little the strong local colour of the place took possession of our minds, and dispelled the first fleeting impression of vague disappointment. Every stroke of the oar on the river or in the canals revealed fresh details of native life, wonderful groups and charming scenes of Oriental manners and customs.

By far the most fascinating point in the surroundings of Srinagar is the Dal lake, a beautiful sheet of water lying at the feet of the encircling hills which form the spur terminating in Takt-i-Suliman. This lake is joined to the Jhelum by an artificial canal, which is provided with locks ingeniously constructed so as to prevent automatically the river inundations from flowing back into the lake. Upon the shores of the Dal lie the pleasant old Mogol gardens, all blossoming with lilacs and roses, and full of the buds of iris, lilies and narcissus. Under the lofty chenar trees groups of natives stroll in the shade or sit in groups with their children, who seem as serious and solemn as their elders.

CANAL AT SRINAGAR.

An afternoon on the Dal lake leaves the memory of one of the fairest scenes of nature which we have been privileged to behold. The shikara boat flies swiftly before the strokes of a dozen oarsmen, who use short paddles with a wide flat blade shaped like a heart. They chant as they row, following the rhythm with the stroke of their oars; and now and again the head boatman, who gives the time, changes the measure abruptly from quick to slow or from slow to quick, so as to rest the rowers by a change of motion. The strange vegetation of the lake bottom shows like a miniature forest gently swaying in the currents of the limpid, bluish-green water. It seems like navigating in a canal, because, with the exception of the ways channeled out by the current, the whole surface of the lake is clothed with a uniform mantle of vegetation, through which the water is hardly visible. There are wide fields of soft green lotos leaves, above which will rise later on the exquisite milky-white blossoms with their delicately-shaded pink tips. Between the lotos float the huge round flat leaves of the *Annesleya horrida,* whose level surface of velvety green gives no warning of the cruel hooked spines which clothe the under side of the leaf and stem. The long filaments of the Singara, or edible water-chestnut, twist and tangle round innumerable other varieties of aquatic vegetation. Many parts of the lake are dotted with floating gardens, like islands. These have been often described. They consist of tangled masses of water plants, detached from the lake bottom and floating freely. Upon the surface thus obtained mud is spread, upon which grow beans, pumpkins, water-melons, melons, cucumbers, and in fact every species of vegetable, in great abundance.

A LONELY CANAL.

Here you meet great barges full of natives seated in a circle round the narghile, poled slowly along by a bargeman squatting on the stern. Again, towards evening slender barks glide upon the water, where a fisherman standing in the bows gazes intently into the water ahead, armed with a trident which he is ready to hurl down at sight of a trout. The shores are white with blossoming orchards of peach, cherry, apple, pear and plum; and the mulberries, poplars and willows are festooned with luxuriant vines. Here we have every European variety of fruit-tree, with the exception of those which are strictly confined to the Mediterranean region—the orange, lemon, fig and olive. Flocks and herds with their lambs and calves graze in the pleasant shade, and the air is alive with the song of the lively bulbuls, dear to the Persian poets, with the cooing of doves, the strident notes of the *mina* bird and the crow, and the pleasant call of the hoopoe. It was still too early for the migratory birds from the plain, the orioles, the kingfishers and herons, and the great flights of ducks and geese.

Nearly every afternoon the sky clouds over and becomes threatening. Here the winds blowing hot from the Indian plain meet the cold mountain barrier, and hence frequent storms. In the sky, the air and the mountains follow in rapid succession an infinite variety of colours with a wonderful play of light and shade. azure rents opening on every side

THE BANKS OF THE DAL.

in the livid indigo of the storm-cloud. As a rule, the sky clears up after a couple of hours, sometimes with a shower of rain, sometimes without. Then follow marvellous evenings, and the far-off snows are kindled by the flaming sunset.

Lack of space forbids my dwelling longer upon the beauties of the vale of Kashmir. The reader who may wish to know more of this garden of the Himalaya will perhaps find a more spontaneous, lively and picturesque account of the region, as well as greater observation and detail, in the books of the ancient traveller than in those of our own day. Kashmir has not so changed in the last fifty to seventy years as no longer to resemble the descriptions of its earlier visitors.[1]

On the morning of April 22nd the long line of ekkas loaded with luggage entered the garden of the Residency. We worked all day long with the Duke at going over and rearranging the whole equipment. It was loaded on to six dunga boats the same evening, and left Srinagar to cross the plain by river and canal to the foot of the mountains.

ON THE DAL.

The itinerary of the expedition from Srinagar to the Karakoram may be indicated in a few words.[2] As I have already pointed out, the mountains which enclose Kashmir to the north form part of the main range of the Himalaya proper, running from south-east to north-west as far as Astor, where they terminate with Nanga Parbat. This

[1] Among the best are: Baron C. von Hügel, *Kashmir und das Reich der Sick.* Vienna 1840; W. Moorcroft and G. Trebeck, *Travels in the Himalayan Provinces of Hindustan*, etc. (ed. by H. Hayman Wilson). London 1841. 2 vols.; G. T. Vigne, *Travels in Kashmir*, etc. London 1842. 2 vols.; Th. Thomson, *Western Himalaya and Thibet.* London 1852; Sir A. Cunningham, *Ladak and Surrounding Countries.* London 1854; the voluminous works of H. von Schlagintweit and the volume of F. Drew already cited. Among more recent books, *Kashmir* by Sir Francis Younghusband is very valuable, the author being qualified not only by his long career as Resident but also by his travels in the most remote parts of the kingdom.

[2] See the itinerary map, From Rawal Pindi to the Baltoro Glacier.

range divides Kashmir from the Indus valley, beyond which lies the Karakoram range.[1] Therefore, in order to reach the latter from Srinagar the Himalaya must first be crossed. The lowest pass in the whole of this end of the chain is the Zoji La (11.230 feet), at the head of the Sind valley, north-east of Srinagar. Beyond the pass the Dras valley leads down to the Indus. Next the Indus valley is followed northward as far as Skardu, the capital of Baltistan. From Skardu the

SUNSET ON THE DAL.

route crosses the Indus and penetrates directly into the Karakoram. This is the main route, which is open all the year round, with the exception of occasional short interruptions.

Another route, about 50 miles shorter, crosses the Rajdiangan Pass directly north of Srinagar, and by the valley of the Kishen Ganga reaches the vast table-land of the Deosai, which is more than 30 miles wide, with a mean altitude of about 14,000 feet. Hence the route descends directly

[1] GUILLARMOD is mistaken when he says (*Six mois dans l'Himalaya*, etc., p. 47) that the table-land of Kashmir is comprised between the Himalaya to the south and the Karakoram to the north. Nor does the Karakoram separate Kashmir from Tibet, as he seems to think, but in reality lies between Baltistan and Chinese Turkestan.

to Skardu. The Deosai plains, however, are not practicable until after the middle of July. In April we should have found them covered with deep snow and subject to dangerous storms, and with our large caravan and equipment it was an attempt not to be thought of. Even the Zoji La is not quite without danger for a large party encumbered with heavy luggage.[1]

On April 23rd, in the early afternoon, we started from Srinagar with Sir Francis and Lady Younghusband, who accompanied the Duke to the first stage. We took our places in two splendid state shikaras, each with a crew of fifteen rowers dressed in tunics and turbans of flaming red and commanded by the Jemadar Sedik, a dry, little old man, tightly clothed in a gorgeous uniform covered with gold braid, the "admiral" of the Maharajah's fleet.

We went almost directly north, first through a narrow canal, little better than a ditch, between the houses of a series of villages. Out of the muddy water on every side start naked children, dark and chubby, like beautiful little bronzes, and rush to hide behind their elders, while the bigger ones, surprised in their bath, hasten to cover themselves with extremely dirty shirts upon our approach. With some difficulty we pass numerous great grain barges in the narrow canal. Now and again we glide under some arched bridge plainly of ancient date, and we notice here and there foundations and bits of walls which certainly must have supported more worthy buildings than the hovels which crown them at present.

Next we drift between banks green with willows, through a fresh smiling country of rice plantations and fields of cereals of every description, and at last we come out of the narrow canals into a vast sheet of water known as Anchar, a shallow lagoon where the flat bottoms of our boats keep touching and even running aground on the least deviation from the narrow channel, for the passage is not free from sandbanks. On every side the aquatic vegetation is so dense that it would seem like a field were it not for the light skiffs gliding hither and thither over the surface, rowed by women who are busily gathering masses of vegetation to form their floating gardens. Over the whole swamp fly flocks of water birds.

[1] W. Moorcroft was the first European to give us any precise information about the Dras route. Both the Dras and the Deosai routes between Srinagar and Skardu are described in detail by Vigne and Thomson in the books already cited.

The Sind river, the biggest confluent of the Jhelum, flows with its undivided stream into this lagoon. Its lower course is winding and swift, hemmed in between low earth-banks, portions of which are constantly falling into the water, which eats them away. The river, now at low water, was about the size of the Tiber in moderate flood. When we entered the channel our rowers got out on the shore and placed themselves in a file, each putting around him a loop of a long

THE SIND.

rope, by which they towed the boats at a run with the assistance of a crowd of handsome, half-naked lads, who had apparently been on the look-out for our arrival. Our course now turns eastward toward the snowy mountains, and we make straight for the Sind valley, whose gate is guarded by the mighty peak of Haramuk, which rears its crown of glaciers to a height of nearly 12,000 feet above the plain (16,903 feet above sea level). This is the largest of the mountains which encircle the vale of Kashmir. Dr. E. F. Neve, with G. Millais, ascended it for the first time in 1899.[1] It was once more climbed in 1907 by A. L. Mumm and Major Bruce.[2] From one of the western peaks of Haramuk, known as Station Peak, about 16,000 feet high, Colonel Montgomerie

[1] E. F. Neve. *The Ascent of Haramuk.* *Alp. Jour.* 20, 1900, p. 122.

[2] A. L. Mumm, *In and About Kashmir.* *Alp. Jour.* 24, 1898, p. 195.

in 1858 saw K^2 for the first time, at a distance of 137 miles across the Deosai plains, and measured it by triangulation.[1]

We reached Gunderbal, at the mouth of the Sind valley, about 5 o'clock in the afternoon. The Maharajah, Sir Pratab Singh, who was then still in Jammu, had made arrangements to show hospitality to the Duke, notwithstanding his absence. A dozen state tents had been set up on the bank under the shade of the splendid chenar trees, and four state house-boats were tied up on the bank, so that there was room for a far more numerous expedition than ours.

Beyond the river bank the vast rice-fields stretched to the foot of the mountains. Not far from the camp are the ruins of an ancient bridge which once crossed the Sind. Three arches and two or three broken piles are still standing. No road leads to it now. The horses that are to carry our luggage to-morrow, as well as four fine saddle ponies which the Maharajah has placed at our disposal to take us up to the first snows of the Sind valley, are grazing in the surrounding fields.

The dungas with our luggage and guides arrived a few hours after us. The loaded boats drew more water, and had therefore been sent around by the Jhelum and along a canal which connects it with the Sind river, spending a night on the way.

We went to bed early on the charpoys of the house-boats. The murmur of the river, the lapping of water round the sides of the house-boat, the sound of an oar dipping in the stream, called up images remote indeed from the Himalaya. Every now and then a dull thud shakes our floating house—it has been struck by one of the numerous tree trunks which the river carries down.

[1] *Synopsis of Results G. T. S.* VII. Dehra Dun 1879, p. xxx.

CHAPTER IV.

THE SIND VALLEY.

Formation of the Caravan. — Distribution of the Forests. — Glaciers of the Sind Valley, Past and Present. — Gund. — Kashmiri Coolies. — Officials and Functionaries. — Abdullah the Shikari. — The Official Escort. — Coolies' Pay. — The Engagement of New Coolies. — The Gorge of Gagangir. — Sonamarg. — Post, Telegraph and Meteorology. — Post Runners. — Baltal. — The First Baltis. — Avalanches and Landslides.

THE whole of our baggage had been sent off from Europe already divided into packages of the right weight for coolies, and formed altogether 262 loads of about 50 lbs. each. This made it possible to arrange the caravan quite easily and without any waste of time from the very outset, in the early morning of April 24th. Each of our ninety-five ponies carried two or three of these loads, and in a short time all were on the road. We did not follow until 9 o'clock, after taking leave of our courteous hosts, Sir Francis and Lady Younghusband.

Now at last the real journey had begun—the camp life that brings one into the close communion with nature so good for body and mind. Walking is really the only kind of locomotion that puts us on equal terms with the world about us. Our modern mechanical methods of transportation tend to make us lose sight of our relative importance. The first stage of our journey was only 12 miles, and ran along the nearly level bottom of the Sind valley, over a wide path between blossoming trees and cultivated fields. Near the mouth of the valley, on the left side, runs for some distance a high ledge, similar to those we had noticed in the Jhelum valley, but in this case formed by fluvio-glacial deposits. The opposite side of the valley is formed by the southern spurs of Haramuk.

The main trend of the Sind valley is from west to east. The left side, which faces north, is steep and almost entirely clothed with forests. The other side, which the path mainly follows, slopes somewhat more gently, and is treeless, except for the strip of cultivation at the bottom, above which pastures reach up to the foot of the rocks. The limitation of the forests to the slopes which face the north is universal throughout

THE CAMP AT KANGAN.

the region, and has been noticed by many travellers. It is probably due to the fact that the snows lie longer on the northern slopes, and thus give a greater degree of moisture. This holds good even on the sides of the wide plateau of Kashmir, where the slopes of the Pir Panjal range which face northwards are clothed with forests, whereas the slopes of the Himalaya which bound the plain to the north are nearly treeless.

Soon after midday we made our stage at a place called Kangan. Here we found the equipment already deposited in a level field surrounded by large walnut trees, where our tents were not long in setting up. We were still on the Kashmir side of the water-shed, so, as usual in the afternoon, a storm blew up, and it rained until nightfall.

After Kangan the path began to climb more rapidly, and the scenery assumed a more Alpine aspect. The ground on the left side of the valley was covered with snow, which showed between the firs and pines, and, as our way ascended, reached down nearer and nearer to the bottom of the valley. There were no more chenars, but their place was taken by splendid walnut trees, with parasitic orchids growing on the branches. The commonest tree is the willow.

All this part of the valley shows clear traces of glacial action.[1] The whole of the Sind valley was at one time filled by a glacier more than 30 miles long, about the size of the present great glaciers of the Kara-

THE CAMP AT GUND.

koram. To-day there are only a number of small shrunken glaciers in the upper reaches of the tributary valleys. Oestreich has counted thirty-three of them.

Our next stage brought us to Gund, a village standing rather high on the right bank of the Sind river, 13 miles from Kangan. Here we left our ponies behind, as a little farther up the valley was still full of snow, and everything would have to be carried by coolies. These

[1] See R. D. Oldham, *Note on the Glaciation and History of the Sind Valley, Kashmir. Rec. Geol. Surv. of India*, 31, 1904, p. 142.

coolies had gathered at Gund from all the villages in the valley—in fact, during the morning's march we had passed numbers of them on their way up. There were over 250 of them, squatting or lying in groups on the ground or wandering around the camp, which they greatly enlivened by their presence. They were all Kashmiris, with bronzed faces and European features, now and then markedly Semitic in type. They had black hair and flowing beards, and wore garments of puttoo, the coarse country home-spun, with short wide breeches and a sort of coat with ample sleeves that reaches down to a little above the knee. Over the coat they wear a woollen blanket shawl like a shepherd's plaid, wound round the waist or over the back. Their headgear consists of a sort of skull cap, round which is twisted turbanwise a narrow strip of white cotton cloth which has attained an indefinable shade between dirty white and grey. Their feet are clad in sandals of plaited straw, which they make for themselves in spare moments and throw away by the roadside when worn out. Their legs are either bare or covered with puttees.

All the coolies were incessantly interfered with, worried and kept in a state of perpetual excitement by the numerous official escort which was directing the management of the caravan. I will here devote a few words to this official escort, its relative importance and usual relations with the traveller.

All strangers travelling in the domains of the Maharajah, whether for exploration, for sport or for mere pleasure, must be provided with an official permit or *perwanna*, which is supplied by the administrative authorities of each district. This paper authorizes the traveller to demand from the village headmen, with or without the intervention of higher officials, the necessary supplies of coolies, saddles, luggage ponies, provisions, wood, etc., at the legal tariff prices, which are always specified upon a list posted up at the dak-bungalows.

At the top of the official tree stands the Tehsildar, who is a real prefect, with fiscal functions, and who superintends the whole district or *tehsil*. He is usually selected from the official employés who have been trained in the Government schools of India and possess a certain degree of culture and at least a slight acquaintance with the English language. Under him there may be a Naib-Tehsildar, ruling sub-districts. Tehsildars and Naib-Tehsildars, like all the employés of the Central Government of Kashmir, are invariably Hindu. The heads of the villages are the Zaildars or Lambardars. The police service is managed by the Jemadars and their subordinates the Chuprassis, whose duty it is also to enforce the observation of the forest and game laws.

Some districts are still under a Rajah, who is seldom, however, a descendant of the families that ruled the country before the conquest, these having been nearly all deprived of their power. The office is hereditary. They govern through a Wazir or minister, but they are subject to the suzerainty of the Maharajah, and in fiscal matters are answerable to the Tehsildar.

The traveller usually brings with him a Shikari, who treats on his behalf with the Jemadar and with the Zaildar or Lambardar, and notifies these officials of the requirements of the party. The Shikari is likewise responsible for discipline and order among the coolies, pony drivers, etc., and upon him depend mainly the relations between the traveller and the natives. The majority of the Europeans who travel in the dominions of Kashmir come purely for sport, so the Shikari is usually a man familiar with the country from the point of view of game. He knows the best *nullahs* and the habits of the bears, leopards, ibexes, markhor, *ovis poli* and other wild animals which inhabit the western Himalaya. Our Shikari Abdullah had gone on before, and was already at Dras with Mr. Baines, so we did the first part of the journey without him. We did not miss him, as the expedition was accompanied the whole way up the Sind valley by the escort, which comprised all the categories of functionaries I have just mentioned. There was a general superintendent, Baboo Fagir Mohamed, who was intelligent, silent and had very great authority. There was the Naib-Tehsildar Munshi Ghullam Haider Khan, a sort of ferocious-looking Othello in a fanciful jacket of olive-green with cuffs and collar of fur, which made him look rather like a lion tamer at a fair. The interpreter was a fat giant with bloodshot eyes and an apoplectic face with a fringe of beard dyed with henna. There was a Jemadar or police official, and under his orders were five Chuprassis, in addition to the Zaildar of Gunderbal and the Lambardars of the villages from which the coolies came.

The chief officials took their orders from the Duke and transmitted them in regular hierarchical order. In spite of these complicated arrangements the functions of the caravan were carried out with great regularity and precision and perfect discipline.

The day was cloudy and cool, with a few intervals of hot sunshine. The afternoon was laborious. We had to pay and dismiss the pony drivers who had come from Gunderbal—two stages at half a rupee per stage and per horse. The intermediaries are so numerous that the best policy is to pay the coolies direct in person and one by one. This system is being generally adopted by European travellers, who

THE MONEY KILTAS, AND PAYING THE COOLIES.

used to trust to the Tehsildar or Lambardar to divide the sum between the men. The Duke had decided to follow the method adopted by the Eckenstein-Pfannl-Guillarmod expedition, of giving each coolie a numbered metal counter, which he has to hand in against his wages. This enabled the payments to proceed rapidly, and made the supervision simple and easy. The chief drawback was the necessity of carrying an immense weight of money divided into single rupees and fractions of rupees. Our small change occupied nine kiltas and weighed over 450 lbs.

The Duke always superintended the arranging and counting of the luggage: 171 packages were distributed among the same number of coolies, who left at once so as to divide the party and make its movements quicker. As each coolie passes with his load he receives his numbered counter. All round us stands the crowd of those who are waiting for their turn. Some of them seem to be about seventy years old, and some who really look too old for work we are obliged to set aside. And yet these men, in addition to their 50 or 55 lb. load, carry in a skin bag their own food for the whole journey from here to Dras and back—at least another 22 lbs. of rice or flour. This makes a total of 75 or 80 lbs. to be carried through the snow over the Zoji La.

The great number of volunteers who rushed to the spot is to be explained by the extraordinary wages of a whole rupee a day, which the Kashmir Government allows coolies for crossing the Zoji La in the winter or spring, a wage intended as a compensation for the danger of avalanches and the fatigue of walking through the deep snow instead of on an easy path as in summer. The usual tariff is from 4 to 6 annas a day—from 4*d.* to 6*d.*—without food.

The loads, kiltas, boxes of provisions, sleeping-bags, bundles of tents, camp-beds, etc., are placed upon primitive carrying devices. which consist of four upright poles fixed to the corners of a narrow rectangular base. Two ropes serve to fasten it over the shoulders. The coolie's step is elastic and quick, even up-hill. He makes short halts to get his breath, more or less often according to the difficulties of the road. During these brief halts he lifts his load off his back, resting it on a sort of crutch formed by a short pole, furnished at the top with a wide flat support and at the bottom with a broad wooden foot, in order that it may not sink in the soil.

After the daily storm comes the usual clear evening. By half-past eight the whole camp is at rest. Near the kiltas which contain the treasury of small change the chuprassi on guard watches in solitude, squatting on his heels before a few smouldering sticks and well wrapped up in his woollen plaid. The roar of the torrent comes up from far below. Eastward the valley rises steep and straight, then suddenly disappears from sight behind a spur. The slopes above us glitter with snow. We feel that we are at the gates of the mountain.

The following days were an interlude of high mountain life between the green garden of Kashmir and the parched and torrid valleys of the

Indus basin. From Gund onward the caravan consisted of over 270 persons, counting the officials, coolies and servants. 171 coolies had left Gund on the day of our arrival, and 100 remained with us.

For a few hours the path led as before between willows and fruit trees, mingled with fir and pine. But now, little by little, the ascent becomes steeper, and the mountains draw near and become more precipitous. The springlike aspect of the valley disappears to make

THE SIND VALLEY BEYOND GUND.

way for a winter scene. At the foot of each lateral gully or ravine the accumulations of snow become wider and more frequent. Next the valley is cut across by a great step at the gorge of Gagangir, which is piled up with boulders. Here the torrent dashes wildly to the bottom of the gorge, where it is hidden by vast snow avalanches, which bridge it over often 10 or 20 feet deep, and which here and there are covered with fresh avalanches fallen a few days before, and not yet flattened by melting or blackened with dust. The road now passes high up on the right flank of the valley, through a little wood of deciduous trees, whose buds are just beginning to swell, though the path is quite hidden away under snow. On our march we are surprised at passing some of the coolies whom we had thought it our duty to reject on the preceding day because they looked to be about 100 years old. The poor old fellows must have bought back the engagement from the younger men we had selected in their places, and thus thwarted our intentions.

From the gorge of Gagangir we come out upon a small level and cross the Sind valley to the left bank. We then climb over the ridge of a moraine formation clothed with conifers and reach the wide plateau

THE GORGE OF GAGANGIR.

of Sonamarg, which is treeless and covered with a layer of hard snow about three feet deep.[1] The plateau is nearly two miles broad, and at the upper end stands the Sonamarg bungalow, about 14½ miles from Gund. We have now reached a height of 8,763 feet. The sky had been overclouded all day, and it now began to rain. The temperature was only 41° F. Little glaciers were just visible through the mist on the left of the valley, the lower part of which was clothed with pine woods.

[1] There must be great variation from one year to another in the snowfall of this region. When the Eckenstein-Pfannl-Guillarmod expedition travelled by the same road at about the same season in 1902 there was far less snow in the Sind valley, on the Zoji La and in the Gumber valley. See the illustrations of Guillarmod's book as compared with our own.

It was a characteristic Alpine winter scene, sad, monotonous and grey, with a rainy atmosphere melting into the snow of the plain. It seemed incredible that before many weeks passed the place would turn into a great green meadow starred with golden crocus, and with the fringe of the surrounding forest dotted with the camps of English people, whom the heat of the Kashmir summer drives up into the cooler air.

We took refuge in the bungalow, consisting of a square courtyard full of trampled snow and mud, on three sides of which runs a verandah,

THE SIND VALLEY BETWEEN SONAMARG AND BALTAL.

on which open the doors of the sleeping rooms. Two of these are empty and reserved for Europeans, and here we spread our camp-beds. The others are filthy barracks for the use of the coolies.

Shortly after our arrival the 171 coolies who formed the first detachment began to pass through. They had spent the night halfway between Gund and Sonamarg, and were now going on to Baltal. Next came dropping in in small detachments the coolies who marched with us. The courtyard and verandah were soon filled with them. They formed groups around the fires which they lighted here and there in the mud, under kettles where the tea was boiling, in which they soak their small loaves or chupattis. They are wonderfully dirty and very good-natured looking, and they smile at us in a friendly way.

The Sonamarg bungalow lies on the left bank of the Sind River. On the right bank beyond the bridge stands the tiny village, the highest in the whole valley. There is a small house for the post and one for the telegraph. Close by is the meteorological station, which is supplied with a few instruments. There are also three or four huts built of tree trunks, all crooked and apparently on the point of tumbling to pieces. The place seems almost deserted, and it is a surprise to us to find plenty of fresh milk, sheep, fowls, and eggs, which provisions we shall continue to find, with but few exceptions, at each stage of our march through the valleys. This fresh food forms the basis of our diet, which is completed by our provision tins, containing ship's biscuit, butter, soups, vegetables, fruits, coffee, tea, sugar, condiments, etc.

The meteorological office in these remote stations is usually entrusted to the telegraph clerk, who takes the observations twice a day. We were greatly interested in collecting the data of these little Alpine stations, they being necessary to calculate the observations to be taken by the expedition later on, in the high mountains. It was very desirable to have the observations taken three times a day, so as to get a greater probability of their being at the same time as ours. The Duke therefore arranged with the telegraph official to read the meteorological instruments daily at 8 and 10 o'clock in the morning and at 4 o'clock in the afternoon from that day to the end of August. Similar arrangements were made at the meteorological stations of Srinagar, Gilgit, Leh and Skardu.

On the morning of April 27th we accomplished the short stage from Sonamarg to Baltal, which is at the foot of the Zoji La, in a melancholy fine rain with a low mist, which completely shut out the slopes and peaks. This stage is only 9 miles over a good track, well beaten in the snow. The path leads now high on the right side of the Sind valley, where the orange-yellow crocuses (*Colchicum luteum Bak.*) have already come pluckily into blossom wherever a bit of land is bare of snow; and again, along the bottom of the valley through little groves of pine, fir and birch. We keep overtaking and passing groups of coolies who left Sonamarg before us; but we ourselves are caught up with and left behind by the dak-wallah, who runs up-hill over the snow, carrying the postbag and his own blankets and food, with his whole body and mind bent on the exertion, so great a one that it hardly seems possible he can go on for more than a few minutes. He is armed with a spear with a shrill-tongued bell tied to the shaft, to frighten away wild animals. By relays of these dak runners the weekly post goes all the way from Srinagar to Leh and Skardu, covering on an average some 30 miles a day.

NEAR BALTAL.

Except for this lonely wayfarer our expedition was quite alone in the high valley of the Sind. Once the snow is gone, there is a ceaseless coming and going of caravans of Baltis, Ladakhis, Tartars from Chinese Turkestan and Tibetans, often accompanied by their wives, their flocks and their herds, and leading horses or yaks laden with merchandise, crossing and recrossing the Himalaya over this, the only trade route between Tibet and Kashgar on one side and Kashmir, Afghanistan and Persia on the other.

Baltal stands 9,258 feet above the sea level[1] at the foot of a perpendicular spur of the Kanipatri group, which dominates the Zoji La to the south. Here the Sind valley bifurcates. The greater branch, through which the Panjtarni torrent flows, runs south-east; the other is a short, steep gorge, which leads to the pass and carries on the general trend of the Sind valley towards the east. Both are deep gorges with precipitous sides much broken up by landslides. In the angle formed by the meeting-place of the Panjtarni torrent with the stream that comes down from the Zoji La, is a small plateau with a grove of sycamores, birches, poplar and willow trees, mingled with several sorts of conifers.

[1] Hypsometric measurement calculated with four stations of reference. Schlagintweit gives Baltal a height of 9,321 feet; Oestreich 9,350 feet.

Here stands a new, roomy bungalow, where caravans can dwell at ease, to give time to the new-fallen snow either to be hardened by frost or to fall in avalanches, before attempting the dangerous pass.

Mr. Baines had sent thirty Balti coolies from Dras to meet us, under the guidance of the head Shikari Abdullah, so as to beat the path over the snow on the hills and to help our Kashmiris with the loads. Thus there were over 300 coolies gathered at Baltal and lodged partly in

THE BUNGALOW AT BALTAL.

huts around the bungalow and partly in the old bungalow on the other bank of the torrent. They were all very busy plaiting themselves straw shoes. From Sonamarg onward the Duke had smoked spectacles distributed among those of the coolies who appeared to suffer from the reverberation of the snow. We reviewed them again one by one, and about half of them were provided with dark glasses for the journey of the morrow.

All through the afternoon showers of fine snow kept falling like waterfalls off the rocky spur of Kanipatri in the rear of the bungalow. In the clear evening light we could distinguish the deep walls of the valleys furrowed with gullies and chimneys between sharp ridges ending in spires, aiguilles and peaks, covered with virgin snow. From the Panjtarni valley a dizzy ridge leads up to the fine peak of Ambarnath, above 17,000 feet in height. It all seemed quite inaccessible, but it must look very different in the summertime. Later in the evening a great landslide fell from a considerable height from the wall of the Zoji La valley, and hurled itself down with a thundering sound, rolling down earth, stones and snow, which spread out in a gigantic fan, covering the path up to the pass for a long distance. The mountain wall above is left scarred by a wide gash that stands out conspicuous amid the spotless snows surrounding it.

THE MOUTH OF THE ZOJI LA, FROM BALTAL.

We went to bed for a few hours only, for the ascent must be made before the sun rises to melt the bonds of frost which hold the snow fast upon the slopes.

CHAPTER V.

ZOJI LA.

Ethnological and Commercial Importance. — The Gorge of Baltal. — The Pass in Summer. — Geology. — The Gumber Valley. — The Metjuhoy Glacier. — Minimurg. — The Plateau of Mutajun. — Pandras. — The Last Gorges of the Valley. — The Dras Basin. — Fort and Bungalow. — Population. — Farewell to Kashmir.

Zoji La is the Tibetan name of a pass which has the greatest historical and commercial importance. It is 11,230 feet above sea level,[1] and is the lowest point in the Himalayan ridge between the Indus valley and the vale of Kashmir. From time immemorial it has been the great trade route between Chinese Turkestan and Tibet on one hand, and India on the other. It was by this gate that the Sikhs invaded and conquered Ladakh and Baltistan in the first half of the nineteenth century. The telegraph connecting Srinagar with Leh, the capital of Ladakh, and Skardu, the capital of Baltistan, crosses the Zoji La. Once a week all the year round the post runner crosses it with his bag: but for five months at least it is quite blocked to beasts of burden, horses or yaks, and it is often extremely dangerous, even if not absolutely impracticable, for parties of coolies. Many a caravan has perished there of cold and exhaustion, lost in the bewildering tumults of snow

[1] According to Burrard the height is 11,300 feet. Oestreich gives 11,319. Guillarmod, owing evidently to a scribal error, calls it "au dessus des 5000 mètres" (about 17,000 feet) (op. cit. pp. 75-80, and at foot of illustration on p. 79).

which are common in winter and spring. Still more numerous are the victims of the avalanches which pile up vast deposits of snow in the gorge of Baltal. This snow often remains until late in the summer, and occasionally does not entirely melt before the following autumn.

The crossing of the pass in April with a party of over 300 coolies was an undertaking by no means free from anxiety. We left Baltal bungalow on the 28th before dawn. The night was dark, the sky clouded, and a fine rain was falling. The air was heavy and warmish, just the

THE ZOJI LA.

weather for avalanches. We stopped for a few minutes at the old bungalow beyond the torrent to see the last of the coolies off; then we started up the narrow gorge which leads to the pass.

On the short level at the foot of the steep ascent we got ahead of nearly all the coolies, who were toiling through the soft snow, stopping for breath every 200 yards. The sight was an indescribable one, weird and fantastic as a scene in the wildest legend. As we plodded along the track at the even gait of the mountaineer, our lanterns threw an unearthly light on the features of the coolies resting in long files, with the shapeless loads upon the crutch at their backs, transforming them into strange hump-backed dwarfs. An immense length of black shadow stretched behind them on the snow. The ceaseless murmur of voices and confused shouting came to our ears from the farther groups, who moved restlessly and dimly in the feeble light from the lanterns, like men lost and astray in some dreadful gulf shut off on every side by towering cliffs. As for the surroundings, we could hardly distinguish the faint glimmer of the snow on the lower rocks. Higher up it melted altogether into the sombre atmosphere, beneath the unrelieved blackness of the inky sky.

THE TOP OF THE PASS.

The way ascended straight up the gorge over the fallen avalanches, with which it was filled up. The Shikari Abdullah led the way along the steep track, which ran in zig-zags across the snow slope, and kept urging us to quicken our steps, especially at points where big stones and tell-tale lumps of hardened snow marked fresh falls from the overhanging cliffs. We followed in silence, breathing hard from the quick measure of the pace, which was quite out of proportion to the gradient of the climb, and keeping close together to make the most of the scanty light of our two lanterns.

This account must be difficult of belief to those who have crossed the col in the summer months, when it is a pleasant trip to ride over on the easy, clean-cut path which traverses the side of the valley well above the rocks which overhang the right side of the gorge.

In two hours we reached the top. The steep ascent suddenly stopped, and we entered a sort of corridor about 500 yards wide, full of snow and walled in by mountains from 14,000 to 17,000 feet high—so level, that we went on for about half a mile without noticing where the

THE UPPER GUMBER VALLEY.

water-shed came. When the snows are gone there are pleasant meadows here, and in the middle a little lake fed by springs, which swell so high during the melting of the snows as to overflow on both slopes (Roero di Cortanze); but at low water in summer it has only one outlet, which runs northward to form the source of the Gumber torrent.

These curious features have drawn the attention of geologists to the Zoji La. Burrard and Hayden are of opinion that the indentation was cut through the ridge by a prehistoric river. Oestreich finds in it a proof of the progressive erosion of the Baltal gorge, accompanied by the gradual withdrawal of the water-shed line. The Zoji La is, in fact, often quoted as a conspicuous example of the type of erosion known as "back-cutting," a process which may ultimately result in the complete cutting through of a range, and concerning which I shall have a few words to say farther on.

We reached the pass at dawn. Here the rain was replaced by sleet, which during the night had deposited a layer of some four inches of ice crystals on top of the old snow. The misty and hesitating dawn was followed by a glorious day, and the outlines of the mountains grew clear and hard against the perfect limpidity of the sky.

GOING DOWN TO MUTAJUN.

The level passage at the top of the pass runs some mile and a half northward almost without a slope. Then it bends gently eastward and widens out into the real Gumber valley, which is ample and level, a perfect specimen of a round-bottomed valley. Full of snow as it now was and altogether treeless, it had the appearance of a glacial valley. A little lower down the thick floor of snow was broken through here and there, leaving short reaches of the torrent exposed. The descent is broken into low steps dividing level terraces, and the whole drop is very small. Some four miles from the pass we cross under the foot of the Metjuhoy glacier, which falls from the Kanipatri and ends not far from the path at an altitude of about 10,800 feet. A little farther on, on the ridge of the spur, is the bungalow of Minimurg, the highest in the valley. Here we found milk and eggs which Mr. Baines had thoughtfully sent up for us. We rested about an hour, admiring the northern glaciers of the Kanipatri group; then we proceeded leisurely on our way to the Mutajun bungalow, about four miles farther down. which makes a better division of the distance between Baltal and Dras. The Duke prudently lost no time on the way, and kept far ahead of us all. We paid for our lazy and intermittent march by having to go through the soft snow exposed to the intense reverberation of the sun, which gave a sense of unendurable heat, though the actual temperature was about 24° F.

A succession of level bits and short descents brought us to a vast flat reach of valley shrouded in a sheet of snow, and crossed by the telegraph wire stretched on a straight line of posts which the track follows.[1]

The path led past the middle of the plain to a group of hovels, so low that a cow had climbed on to the roof of one of them and stood gazing disconsolately from her vantage point upon the heavy cloak of snow covering the pastures. In the muddy square between the hovels other cows and a pony, all extremely thin, wandered aimlessly. A dozen natives, men and children, wretched, ragged and mud-covered, watched our passage with indifference. Such is the village of Mutajun, over 10.000 feet in altitude. A hundred yards farther on, beyond a small torrent, stands the bungalow, which we reached with joy towards 2 o'clock, and found the Duke had got there two hours before us. Upon a ridge 1,500 feet above us stands a little group of stunted birches. These are the only trees in sight. The sharp eyes of the Shikari discovered on the rocks of the nearer hills several ibexes, the chamois of the Himalaya. We looked at them with interest.

All through the afternoon the coolies kept dropping in, weary with the laborious day's march, and coming in numbers to ask for medicine for headache, slight sun-blindness and other trivial complaints. We all agreed in estimating the march at 18 miles at least, notwithstanding guides and route books, which give it as 15 miles. Owing to the deep snow we left again before dawn on the following day, April 29th, so

[1] In the whole of the Gumber valley the telegraph line has been set up according to the usual rules with telegraph posts, insulators, etc., and must have been entirely rebuilt since 1902, when Guillarmod found the wire "accroché a n'importe quoi, un tronc mort, une branche d'arbre (?)—souvent même . . . posé sur la neige, ou recouvert par elle" (op. cit. p. 78). Only at certain points of the Dras and Indus valleys did we find the wire merely tied to the posts without insulators.

as to make the most of the colder hours. We crossed the rest of the plain of Mutajun and entered a long, winding narrow part of the valley, where at several points at the foot of the rocks which reflect the heat of the sun were bits of path quite free from snow. Again the valley grew wider, and we passed the village of Pandras, which appeared to be uninhabited with the exception of one young yak, wandering in the empty alleys between the houses. A little hay from the preceding year was still piled on the flat roofs of the houses.

MUTAJUN.

Next comes another long defile, a series of narrow gorges which mark the end of the Gumber valley. The snow grew gradually less. As we turned a corner we saw before us a group of saddle-ponies, which had been brought by Mr. Baines to meet the expedition. We mounted, and soon entered the great basin of Dras, a wide plain surrounded by rocky mountains covered with snow to the very foot, which gave it the imposing appearance of a high Alpine valley.

Torrents flow down on every side, cutting deep channels in the alluvial soil of the plain, where they meet to form the river Dras. The plain is dotted with springs and fountains. Along the foot of the mountains stretch great alluvial banks, which rise to a great height over the valley, reminding us of the karewas of the Kashmir plain. In the very midst of the valley, conspicuous from all sides, stands an isolated square fort, with towers at the corners. This is a relic of the Sikh conquest. Only the outer walls still stand, though partly dilapidated, built out of round pebbles embedded in mud. The plain is scattered with groups of houses, and other villages perch like the *rocche* of the Roman campagna upon the margins of the alluvial banks. The houses are all flat-roofed, with thick stone walls the colour of the soil and small windows like loopholes, few and far between. The alluvial terraces with their level tops and their steep regular flanks, like an escarpment, give the impression of huge earthworks and bastions. The whole has the look of a gigantic fortification.

The country is arid and treeless. A few hundred feet from the fort stands a little group of poplar trees with a wall around it. Close by are some half-dozen huts, among them the post and telegraph office and the meteorological station.

The dak bungalow reminds one of a Swiss châlet, with the chimneys in its roof and no verandah, obviously built to protect rather from the cold than from the heat. It stands a little way up on the left side of

THE FORT AT DRAS.

the valley, on a level open space. We reached it at about 10 o'clock with appetites worthy of the excellent breakfast Mr. Baines had had prepared for us.

After breakfast we came out to the open space before the bungalow to wait for our coolies. Our arrival had been the signal for the gathering together of all the natives of the place, and we were immediately struck by the variety of types. The fact is that the population of Dras is a mixture of Kashmiris, Baltis and Brokpas of the Dard stock, with Ladakhis, who are Mongolians. Their chief occupation consists in acting as porters to caravans which cross the Zoji La, as the resources of the country are too scanty to maintain them. The crops are wretched, in spite of the abundant natural irrigation of the valley, because the altitude—10,060 feet above sea level—causes extreme excesses of climate: long, cold winters and summers with burning days and chilly nights. The greatest source of wealth are the cattle, which flourish owing to the abundance of fodder, consisting of a plant called *prangos*, that grows for a great distance up the mountain sides and in sufficient quantity to feed the cattle throughout the winter.

A couple of hours after our arrival the coolies began to come in. The loads were now sorted out and once more counted. Then we proceeded to the payment. Every coolie got four rupees and four annas for

THE BUNGALOW.

his services from Gund, and had to return the metal counter and smoked spectacles. A caravan of ponies was next formed and loaded with 120 of the packages, which were sent straight on. on the Skardu route. A wintry wind blew all day. Only a few crows and magpies hopped around the bungalow.

We were kept busy until late in the evening writing *cits* for the officials. great and small, who had accompanied us hither. They all wanted one, and begged for it with such insistence that we were finally obliged to establish hierarchical limits. beyond which we refused to satisfy their greed. in order not to spend the night writing cits. This was our final farewell to Kashmir.

CHAPTER VI.

THE DRAS VALLEY.

The Contrast between the Kashmir and the Trans-Himalayan Region. — Padre Ippolito Desideri. — Climate. — The Himalaya not a Water-shed. — Geological Theories. — Baltistan. Ladakh. Astor and Gilgit. — Character of the Dras Valley. — Karbu. — The Mongols of the High Valley. — The Poverty of the People. — The Karal Bridge. — The Sand-storm.— Confluence of the River Suru. — Olthingthang. — Dispensary Work. — Anthropology of the Baltis. — Current Theories and the Observations of K. von Ujfalvy. — Religion and Language. — The Brokpas. — The Isolation of the Tribes.

Four days' march through valleys and over mountains still buried in winter snow had brought us to the bare and arid basin of the river Dras. The wintry interlude had almost made us forget the fascinating spectacle of the vale of Kashmir in its spring blossom. and thus the edge was taken off from the surprising contrast between two regions so wholly diverse from each other. They feel this contrast more keenly who cross the Zoji La in summer, gazing to the very top of the pass upon the green forests and rich pastures of the Sind valley, and then looking down on the other side upon the stony desert of Baltistan. There is probably no other range of mountains upon the face of the earth whose two slopes reveal features so absolutely opposed to one another. The traveller has crossed the great northern barrier of India, and has suddenly entered a country which is physically identical with Tibet and Central Asia.

Padre Ippolito Desideri, an Italian missionary who crossed the Zoji La on May 30th. 1715, describes the trans-Himalayan region in the following words: "From the foot of this pass throughout the whole extent of the nine months' march that it takes to get from here to China, there is no fertility, no greenness or pleasantness in the land, nothing but the absolute and horrible desolation of the Caucasian mountains, which stretch all that way and which the geographers call *dorsum orbis*."[1] Padre Desideri went no farther than Leh, which is only fourteen or fifteen marches from Zoji La; but the "horrible desolation" of the mountains stretches over the whole of Baltistan and the neighbouring countries of Gilgit and Astor to the west and Ladakh to the south-east—in other words, the whole of the region lying to the north of the western Himalaya.

It is an enormous strip, over 300 miles broad, all of it above 7,000 feet high, and it seems distorted by a fearful convulsion of the earth's surface. It is covered by a complicated system of mountain ranges, with peaks from 26,000 to 28,000 feet high, and includes immense plateaus from 46 to 60 miles wide and from 15,000 to 17,000 feet above sea level, as well as innumerable valleys and countless glaciers, some of which are over 40 miles long.

The whole of this vast region is quite bare and without vegetation. Few and far between are the groups of trees or bushes, the little grassy hollows hidden away in the high valleys, or the small oases laboriously created by the diligence of the natives. They are all too diminutive to appear as more than dots in the illimitable desert of rock, gravel and sand. No doubt the lack of moisture in the atmosphere is the cause of this extraordinary barrenness. The wall of the Himalayan range stops and condenses on its southern side nearly the whole of the moisture which the monsoon brings from the south-west, thus giving rise to the startling contrast between the atmospheric precipitation of the two slopes. Hence the singular phenomenon of the far lower snow-level and the far lower point reached by the glaciers on the southern slopes of the chain than on the northern slopes, notwithstanding the higher temperature and the greater rapidity of melting brought about by the southern exposure.[2] And not only is there such a contrast

[1] See C. Puini, *Il Tibet, secondo la relazione del viaggio del Padre Ippolito Desideri* (1715–1721). *Mem. of the Ital. Geog. Soc.* 1904.

[2] R. Strachey (*On the Physical Geography of the Provinces of Kumaón and Gahrwal*, etc., *Jour. Roy. Geog. Soc.* 21, 1851, p. 57) has observed a difference of more than 3,000 feet in the lowest level of the snows, and one of more than 4,500 feet in the lowest limit reached by the glaciers, between the southern and northern slopes of the Himalaya of Kumaun and Gahrwal. F. Drew (op. cit.) found corresponding differences in the Western Himalaya; S. J. Burrard (op. cit.) says that the snow line in the Punjab Himalaya is some 2,000 feet lower on the southern than on the northern side.

between the southern and northern exposure on the main ridge, but the further you go behind the Himalaya the higher is the limit of the glaciers.[1] The dryness of the climate is such that in the whole of the trans-Himalayan region there are barely six inches of rainfall in the year. Were it a plain it would be like the Sahara. Fortunately, however, the highest ridges condense into snow whatever moisture escapes being caught upon the Himalaya, so that, whenever the exposure and the slope of the mountains allow it, nevés and glaciers are formed which permit the scanty population to support life in spite of their inhuman surroundings.

The climate is always extreme. The winter is so severe that torrents and rivers are covered with a thick layer of ice and form excellent roads, far better than the primitive paths which wind along the mountain sides. In summer the sun blazes with intolerable violence through the dry atmosphere, though the temperature is by no means excessive. The nights are very cool.

A single valley of vast length winds in deep serpentine curves through the ranges and forms a connecting link among the chaos of valleys—the high valley of the Indus, which runs through the whole region, with a main trend from south-west to north-east, at a height of from 7,000 to 10,000 feet gathering every torrent, every brook, every river that flows down from the springs, the snows and the glaciers throughout the whole vast extent of the region.

Thus we have the singular fact that the chain of the Himalaya is not a water-shed. Kashmir to the south-west, Baltistan and its neighbouring provinces to the north-east, all belong to the same hydrographic basin, that of the Indus. This lack of relation between the orographic and the hydrographic scheme is a feature common to the whole Himalaya. In other words, the Indus, the Bramaputra, and, in fact, most of the great rivers of India, have their sources north of the great chains, through which they cut their way in gorges which are the grandest in the world. Between one range and another they flow through long stretches of the intervening longitudinal valleys, descending gradually from one to the next until they reach the plain of India. The Indus, between its sources in Tibet and its outlet into the Indian plain,

[1] Sir J. D. Hooker, *Himalayan Journals*, etc. London 1905. Drew and Burrard also mention the fact, which is plainly manifested by the total absence of glaciers throughout the vast regions of Tibet, which reach or exceed a height of 17,000 or 18,000 feet above sea level.

flows some 1,100 miles between range and range of the western Himalaya, with a total drop of 16,000 feet and an average drop of less than three per 1,000.

Geologists have laboured to find an explanation of this seemingly paradoxical phenomenon—namely, that the course of the rivers is not determined by the mountain ranges. They usually base their theories upon the geological fact that the chain of the Himalaya is a comparatively recent formation. The whole formidable upheaval which has created the most gigantic bastion on the face of the earth appears to have commenced only in the latter part of the tertiary period, and many are of opinion that it is still going on. This upheaval has been neither so swift nor so violent as to alter the main lines of surface drainage which were already in existence. The Himalayan rivers of our time may therefore represent the ancient hydrographic system, which flowed from north to south, having preserved their course by a process of gradual erosion of their beds progressing contemporaneously with the upheaval of the ranges between their sources and the Indian plain. In this way the valleys would have grown gradually deeper while their side-walls were rearing themselves up to the immense height which they have attained. This is the theory of H. B. Medlicott and of Richthofen.[1] The upheaval would have taken place in a series of long parallel folds, giving rise to the longitudinal valleys.

R. D. Oldham has further suggested another special form of erosion to explain the formation of certain cross valleys. He is of opinion that a torrent by progressive erosion of its bed can eat away the bottom of the gorge in which it runs to such a depth as gradually to cut actually through the chain.[2] This process would go on with greater activity in the gorges of the southern slopes of the mountains than in those on the northern slopes, on account of the greater volume of water, owing to the higher degree of atmospheric precipitation. Once the chain was quite cut through the waters of the valley lying to the north of the chain, at right angles to the newly-formed channel, would flow down

[1] Medlicott and Blanford, *Geology of India*. 2nd ed. Edited by R. D. Oldham. London 1893.

[2] See R. D. Oldham's standard work, *A Manual of the Geology of India*. London 1901; and, upon the specific problem of "back-cutting," *The River Valleys of the Himalayas*. *Jour. Manchester Geog. Soc.* 9, 1893. p. 112; and *The Valleys of the Himalayas*. *Geog. Jour.* 30, 1907, p. 512; also the work of K. Oestreich previously cited, which does not agree with Oldham's theory.

into the southern valley, which is always the lower of the two. In this way the southern water courses would have gradually captured the northern waters.

This brief account will suffice to show that the whole system of Himalayan orohydrography is not a single conception subdivided into two branches depending one upon the other, as is the case in the other mountainous regions known to us. On the contrary, it consists of two absolutely different systems. Hence any description of this region or classification of its features, or even cartography, may, as has been clearly demonstrated by Burrard, be done according to either of two alternative plans, starting either from the hydrographic or the orographic system. This dualism has caused considerable uncertainty and confusion, because most of those who have described this region have based their description indiscriminately now upon the orographic and again upon the hydrographic data, without any definite plan. Burrard, on the contrary, begins with a description of the orographic morphology, giving the scheme of the ranges without taking into account the watercourses; and then he begins over again to describe the same region according to the hydrographic basins and the river courses.

In this state of uncertainty of the whole question it is possible that in the future geology may give the key to a rational classification of the mountains. The observations made by the Italian expedition and by the Longstaff expedition in the same summer certainly showed that the geological structure of the high ranges is far less uniform and simple than has been believed up till now.

The region to the north of the western Himalaya comprises districts which are quite distinct from one another, not merely owing to political frontiers, but because of differences in the anthropological types, religions and customs of their inhabitants. South-westward, wedged between Baltistan, Tibet and Kashmir, lies Ladakh, which is in no wise distinguishable from Tibet, of which it was a province prior to the Sikh conquest. Its inhabitants, like the rest of the Tibetans, are Mongols, professing Llamaism and practising polyandry. Bordering upon Ladakh to the north-east lies Baltistan or Little Tibet, situated, roughly speaking, between 34° to 36° N. Lat. and 75° to 77° E. Long., and inhabited by Mohammedans of the Shiite sect.

Baltistan and Ladakh are both administered by a high functionary of Kashmir, the Wazir-i-Wazarat, who is resident at Leh, and upon whom depend two Tehsildars, one at Kargil and the other at Skardu. The British Government is represented in two districts by an English official, whose headquarters are at Leh, and who is subordinate to the Resident of Kashmir. To the west of Baltistan are the districts of Astor and Gilgit, which march with Afghanistan and are inhabited by Dards.

THE DRAS VALLEY.

Our route now descends the Dras valley to its meeting with the Indus, which latter it follows across Baltistan as far as Skardu. The Dras and the Indus together form a semi-circle giving a diameter of about 30 miles around a gigantic centre of upheaval, the table-land of Deosai, 14,000 feet in altitude. The distance from the village of Dras to the Indus is about 48 miles, with a drop of less than 1,500 feet. For the first 33 miles the route to Skardu is identical with the route to Leh, capital of Ladakh.

We left Dras early in the morning of April 30th. The great basin which feeds the river is closed at the lower end by a sort of natural dam, through which the water has cut an outlet. This obstruction crossed, we enter the Dras valley proper, which is at first wide and open, with a round and level bottom, but lower down becomes narrower and gradually puts on the V-shape. In fact, the valleys of the western Himalaya are characteristically much narrower and more shut in in their lower than their upper course. This feature was very clearly marked in the Gumber valley, which we had just come down. Perhaps the round bottom of the upper part is a sign that the high valley was occupied by glaciers in the past, while the pointed bottom of the lower part suggests the outlet cut by erosion of the river. This hypothesis ought, however, to be supported by geological data, which would require a search for specific glacier marks.

Throughout its whole length the valley is encumbered by huge fan-shaped alluvial deposits or cones of detritus, which mark the mouth of every tributary gorge, and in the intervals between these by immense masses of detritus, which fill the valley bottom and come down in steep falls from a considerable height on the mountain side. There is detritus of every size, from fine sand to blocks of several cubic yards, composed of granite of varying texture and of colour ranging from light grey to nearly black. Although still at low water the stream runs fiercely, and its muddy ashen-grey waters rage in foaming eddies through the generally deep and narrow bed which it has eaten out through a layer of detritus often many yards deep. All these phenomena we shall see repeated on a far greater scale in the Indus valley.

The whole country is barren, without a blade of grass. Only among the stones along the river grow a few very thorny brambles not yet beginning to bud, and a few isolated juniper bushes—*Juniperus excelsa*—the only woody growth of all these desolate shores except where there is artificial cultivation. It assumes such a twisted, stunted and contorted aspect as scarcely to deserve the name of tree, even when it has a thick trunk of many years' standing and numerous branches.

The valley runs eastward at first for 7 or 8 miles, and then turns north-eastward. Some 14 miles from Dras the path leaves the left side of the valley and crosses the river over a bridge built in two sections, resting on a big boulder in the middle of the stream, and not inspiring great confidence by its appearance. We crossed it leading our ponies over the beams, which shook and groaned under the weight.

The long day's march ended at Karbu bungalow, 21 miles from Dras, in a narrow gorge of the valley. Beyond the brawling torrent, on the rocks of the steep left side of the valley, were a troop of ibexes,

The Dras Valley below Karal

which the Shikari Abdullah followed with hungry eyes, pointing them out to us for several hours. All this upper part of the Dras valley, as far as the place where the road to Leh branches off, is inhabited by a mixed population. Among the coolies engaged at Dras and the people we met on the road and in the villages and fields, the marked Mongol types were numerous and perhaps in the majority, with their slanting eyes, projecting cheek bones and hairless faces or thin, bristly beards.

CANTILEVER BRIDGE OVER THE DRAS.

They had not the long pigtails of the Ladakhi, but they had preserved many of his special forms of dress—the long coats open at the sides, the caps with their large brim cut away on the forehead and turned up at the temples; the socks of thick cloth or white felt, into which are gathered the ends of the wide trousers; and even here and there a blue quilted coat. No doubt the cold of the high valley has influenced these descendants of Tibetans to preserve the garments which are suited to their freezing plateaus, whereas the mixture with the Baltis and Kashmiris has made them forego other ethnological traits of purely ornamental value, such as the pigtail.

The haste of our journey, our incomplete preparation and our ignorance of the language prevented us from gathering more detailed particulars. It is certain, as we shall see presently, that the real Baltis show very different anthropological features. I have no doubt that this predominance of Ladakhi traits in the upper Dras valley, forming as it does the first impression of the traveller who comes from Kashmir to Baltistan, has had its weight in the growth of the widely-spread opinion that the Baltis are little, if at all. different from the Ladakhis.

KARBU BUNGALOW.

As for the villages through which we pass after leaving Dras, they are not only not to be compared with the prosperous and solidly-built habitations of the Ladakhis, but not even to the inferior villages of lower Baltistan. These Dras valley dwellings were tumble-down hovels some six feet high, with walls built of stones ill put together, and a flat roof of beaten earth, upon which four flat stones are placed with their edges leaning one upon the next around the hole which serves as a chimney. There are no windows, and only a low hole for a door. Inside there is barely room to stand upright. The wretched appearance of the inhabitants matches the squalor of their dwelling-houses, and is increased by their dirtiness, which is absolutely unimaginable. The domestic animals are small in size like the people, and share in the general misery. The ponies have long shaggy hair, and are as thin as skeletons, with hydropic paunches and knotty legs. The full-grown sheep and goats seem only half developed. The cattle are partly of the humped Indian kind, and partly hybrids between these and the yak, known as *zho*. The cows are small, lean and ill-shaped; the calves are pitiful. The hard Hindu law enforced upon these Mohammedans forbids under severe penalties the slaughter of cattle. Therefore the calves are weaned before their time so as to continue to profit by the milk of the cow, and they may be seen trying to browse upon the lean vegetation, pitifully staggering upon little legs as yet scarcely strong enough to carry them.

In the fields around the villages ragged peasants follow primitive ploughs drawn by oxen. Behind comes the woman, breaking up the clods with a small mattock. She is covered with a pile of unspeakable rags, her face is hidden under a veritable layer of dirt, her head is covered with a cloth, and she wears great earrings in her ears. None of them wears the characteristic headgear set with turquoises and silver ornaments which adorns the head and falls down upon the back of the women of Ladakh. They seem more careless of the presence of the stranger than the women of the Indus.

Not far from Karbu the Dras receives from the left an important confluent, the Shigar, not to be confounded with the other river of the same name which falls into the Indus near Skardu.[1] This tributary of the Dras comes down from the Deosai plain. On the return journey we crossed its sources.

Little by little the last traces of snow, which higher up occasionally lay along the road on the fringe of the avalanches, disappear altogether and the scene becomes even more barren and desolate, for the snow had seemed like a justification of the absence of vegetation. The right bank of the valley, which the path follows, is absolutely bare and parched. On the other side we saw several little cultivated oases. As we descend further the ploughing gives way to the sowing, and the fruit trees are putting forth their first blossom. Here and there shapeless holes hollowed out in the alluvial deposit mark the passage of gold-seekers, whose labours must have been unrewarded, for the works are utterly abandoned. Near the path we observe primitive shelters—

[1] The geographical nomenclature of Baltistan is still somewhat uncertain and irregular. Not only are there many homonyms, as in the case of the Shigar, but in many places the names of rivers change with each important confluent, or even at every bend of the same valley. Furthermore, countries and places change their names without any obvious reason, which has occasionally given rise to unfair charges of inaccuracy against the map of the Trigonometrical Survey of India.

plain rough roofs, covering over some natural hollow of the earth and forming a sort of den, neither high enough to stand nor wide enough to lie in. They suffice. however, for the Baltis, who are in the habit of sleeping in a squatting posture, with the head resting on the knees.

About eight miles from Karbu, at the outlet of a narrow gorge of the valley, we see before us to our great surprise the incredible apparition of a real suspension bridge, built according to rule, with high pillars of masonry supporting the sustaining cables, over 200 feet long and 10 feet wide. This piece of modern engineering stands in singular contrast to the stony desert and the primitive roadway.

PLOUGHING IN BALTISTAN.

The bridge marks an important bifurcation of the road. To go to Skardu you cross the bridge. The other path continues along the right hand of the Dras to its meeting with the Suru not far off, and then proceeds along the latter river to Kargil, whence, after crossing various ridges, it reaches the Indus valley at a higher point, and follows it up to Leh, the capital of Ladakh.

Immediately beyond the bridge, on a sandy alluvial level encircled in a wide bend of the river, stands the bungalow of Karal, very primitive and too small to house the expedition. We therefore set up our tents around it, tying the ropes to big stones, for the pickets would not hold in the deep sand. The great tent of the Tehsildar of Kargil, Pandit Sri, who escorted the Duke from Dras onward, seemed like a palace in comparison with ours. It consisted of a big square central chamber, over which was stretched a fly, a sort of immense second roof, which came down to the ground, forming two other little rooms on each side of the centre one. Inside the ground was covered with rugs, and there

AN OASIS IN THE DRAS VALLEY.

were tables, chairs, etc., a simple but convenient outfit. Hardly had we set up our camp when a violent wind arose, whirling clouds of sand, which filled our noses, mouths and eyes, and lay in a thick layer over everything. The tents flapped furiously in the wind, and offered no protection against the fine dust, which penetrated our clothes, beds and boxes. This was the first of a whole series of dry storms which raged nearly every afternoon. They generally lasted three or four hours and ceased toward evening.

Almost opposite the camp the Dras was joined by the Suru, a large river which flows from the south, bringing the waters produced by the melting of the glaciers of the Nun Kun. Oestreich rightly observes that it would be more correct to regard the Dras as a confluent of the Suru.

A ragged, wretched, sickly-looking crowd was gathered upon the rocks, and gazing at us quite motionless. Perhaps they came from

OUR CAMP UNDER THE APRICOTS AT OLTHINGTHANG.

some village nestled high up among the neighbouring rocks, or possibly from Karkitchu, the big village on the opposite bank of the Dras. We paid and dismissed the ponies which we had brought from Dras; and fifty-eight others, come we knew not whence, were immediately loaded and sent on before.

All through the night we heard our coolies coughing as they squatted round the camp, ill-protected by their wretched woollens from the cold, which went down to 42° F. Next morning we found them still squatting in a circle at a respectful distance from the tents, in the same posture in which we had left them the evening before. Perhaps they had spent the whole night without moving. We had to enlist thirty-eight extra coolies, as only twenty-one ponies were available.

At Olthingthang

The valley, as it approaches its end, grows so narrow that there is no room for the path at the bottom, and it has to wind up and down the steep spurs. The temperature had risen considerably, and the sun was hot even early in the morning, so that our third stage in the Dras valley, though only 14 miles long, was fatiguing enough. The path followed the left and steeper bank of the valley, where there is no level ground suitable for cultivation. The opposite bank was dotted with villages and gardens.

GROUP OF BOYS AT OLTHINGTHANG.

A short distance from the outlet of the valley, sloping down the sides of a spur 800 to 1,000 feet above the river, lies the big village of Olthingthang. We passed through it up the steep stony path which winds through the oasis. The houses have no upper story, and are built in the usual way with stones and mud. They stand in groups among trees and fields, and distributed one behind another up the slope, in such a way that the flat roof of the house below forms the terrace on the ground level of the one above. These roof terraces were crowded with swarms of children and their elders, who watched the passing of the expedition with lively comments.

The dak bungalow stood at the top of the village—dirty and primitive, and only fit for coolies. But immediately above it was a semi-circular terrace, shaded by the branches of two huge apricot trees in full bloom, beneath which ran a cool brook. We set up our tents in the midst of this scene of blossoming spring.

In the course of the afternoon we proceeded to hold a dispensary and distribute medical advice. The whole population of Olthingthang crowded thither, more to enjoy the sight than to be healed. The crowd gathered in a sort of courtyard, perhaps a house that had lost its roof, below the camp; and we had the sick brought up one by one to the open space before the tents after a first summary inquiry into their complaints. Mr. Baines translated my questions into Urdu for the Shikari, and he repeated them in the Balti dialect to the patient. The answers came back by the same devious course, so that I was obliged to put more trust in the objective than the subjective symptoms of disease. I was finally consulted by the Rajah of Karmang—Aman Ali Shah—who was afflicted by a chronic dermatitis of the hands, and who had come hither to pay his respects to the Duke.

NATIVES OF OLTHINGTHANG.

This medical review gave us our first opportunity of studying at close quarters a great number of natives. The population was entirely Balti, and appeared to us all to be indubitably and markedly Aryan in type. The Mongol types were the exception, and could be distinguished at once by the marked contrast of their features with those of the majority. This first impression was confirmed throughout the journey, in the course of which we came into close contact with thousands of Baltis in the process of engaging and paying off the coolies, in the medical consultations, or among the crowds at the polo games and the receptions given us by the Rajahs. I am unable to agree with the unanimous opinion to the opposite effect on the part of all the English travellers who have written about Baltistan.

Roero di Cortanze is the only one among the older writers who describes the Baltis as " of the Caucasian or white race, in contradistinction to the Ladakhis, who are Mongols and copper-coloured." Vigne, one of the earliest visitors to the region, puts them down as a mixed race, combining Mongol characteristics with the nobler features of the Indian or Persian. Cunningham states explicitly that they are a branch of the Mongol race, possessing its characteristics to a marked

GROUP OF NATIVES FROM SHIGAR.

degree, although slightly modified by climatic conditions and by mixture with the Indo-Caucasians of India. Drew likewise assimilates them with the Ladakhis, slightly modified by climatic influences; while Biddulph modifies the assertion of their Tartar type by admitting a strong element of Aryan blood, owing to mixture with the Dards. In the last edition of the *Gazetteer of India* the Baltis are described as of common stock with the Ladakhis, and as Mongol in feature. Even Dr. A. Neve, who lives in Kashmir and has been many times in Baltistan, confirms the Tibetan origin of the inhabitants.[1]

[1] O. Roero di Cortanze, G. T. Vigne, Sir A. Cunningham, F. Drew, opp. citt.; Major J. Biddulph, *Tribes of the Hindoo Koosh.* Calcutta 1880; *Imperial Gazetteer of India.* Vol. VI. *Kashmir.* Calcutta 1908; A. Neve, *Picturesque Kashmir.* London 1900.

All these opinions are based solely upon ocular impression. Not one of these authors has collected anthropological data to prove the asserted kinship of the Baltis with the Ladakhis. If the reader will compare Cunningham's description with the comparative study of the Dards, Baltis and Ladakhis made by Ujfalvy, the Hungarian anthropologist, at a more recent date and based upon scientific methods of anthropomorphic investigation, he will be able to draw his own conclusions as to the uncertainty of a mere description of the features as a basis for racial classification. Cunningham asserts that, except for a few individual cases in the upper classes, the Balti type is characteristically Tartaro-Mongol, low in stature, face wide, flat and square, with projecting cheekbones, narrow forehead, small, oblique, slit-like eyes, broad flat nose with wide nostrils, large, thick, projecting ears with long lobes, large mouth, and black, thick, usually curly hair. Ujfalvy, on the other hand, describes them as clearly Aryan in type, of medium stature, low forehead, thick and only slightly curved eyebrows, eyes set straight and close together, cheekbones not projecting, nose long and straight, ears small and flat, mouth of middle size with thick lips, chin oval, hair black, curly and abundant, beard full, etc.[1]

A CHUPRASSI FROM ASKOLEY IN THE BRALDOH VALLEY.

The important point, however, is that Ujfalvy corroborates his statements with anthropometric measurements. He collected his observations in Skardu, Shigar, Parkutta, Kharmang, Olthingthang, Karkitchu and Dras, measuring also Baltis from other places. He found that the Baltis had an average cephalic index of 72·35, which is much nearer that of the Dards (73·62) than that of the Ladakhis (77). I will not enter into any long repetition of figures, as I think the photo-

[1] K. E. von Ujfalvy. *Aus dem westlichen Himalaya.* Leipsic 1884; and *Les Aryens au nord et au sud de l'Hindou-Kouch.* Paris 1896.

graphs of natives reproduced in this volume and taken by Sella from the purely artistic point of view, without any specific selection of types, are sufficient to prove that the great majority of the Baltis correspond more to Ujfalvy's description than to Cunningham's.[1]

As to their origin, Ujfalvy considers them to be descendants of the ancient Saci, who came from the north of the Tien Shan and mingled later with the aborigines of Northern India, the Dards and the Tibetans. Biddulph quotes a tradition which is still current in Skardu and Rondu,

GROUP FROM PARKUTTA IN THE INDUS VALLEY.

to the effect that Baltistan was first inhabited by Dards of Aryan race, and later invaded by Mongols, who became fused with the original population.

The Balti dialect is Tibetan, and this is their only common ground with the Ladakhis. The difference in customs is fundamental. I have already mentioned that the Ladakhis, like all Tibetans, are Llamaists and practice polyandry, while the Baltis are Mohammedans and polygamous. There can be no doubt as to the radical difference in racial customs, ethics, family life and political institutions springing from points of departure so diametrically opposed.

[1] See also the groups of Baltis shown on pp. 106, 107 118, 164, 192, etc.

A very interesting point is the circumstance that the Baltis belong to the sect of Shiite Mohammedans, whereas all the neighbouring peoples of Chinese Turkestan, Kashmir and Dardistan belong to the Sunnite sect, like the rest of Islam in India. The Baltis thus form a little island of Shiites surrounded on every side by Sunnites, Hindus and Buddhists. Little is known as to the origin of their religious traditions. Cunningham supposes that Islamism was introduced among them in the first half

BALTI FAMILY FROM SHIGAR.

of the thirteenth century. Drew is of opinion that the four missionary brothers of Kurasan, to whom legend attributes the conversion of Baltistan, must have been Shiites. The Brahminic bas-reliefs carved upon great slabs of stone near Dras, as well as the religious inscriptions and Buddhist symbols inscribed here and there upon the rocks along the path, certainly prove that the Baltis have passed through the same religious phases as the rest of northern India.

In addition to the Baltis proper, who form the bulk of the population, there are in Baltistan small settlements of a people known as Brokpas, of Dard descent and Buddhist religion, whose idiom, customs and caste are peculiar to themselves. They are less civilized than the Baltis, who hold them in slight regard ; and they lead a primitive life, mainly as shepherds of the high valleys, where the greater degree of moisture allows of a small extent of pasture. We did not come into contact with any of them.

The indulgence of the reader will forgive this long digression, whose object has been to make clear how little we know, and how uncertain is even that little, as to the origin, history, tradition, legend and even ethnographical classification of a population so interesting, and showing

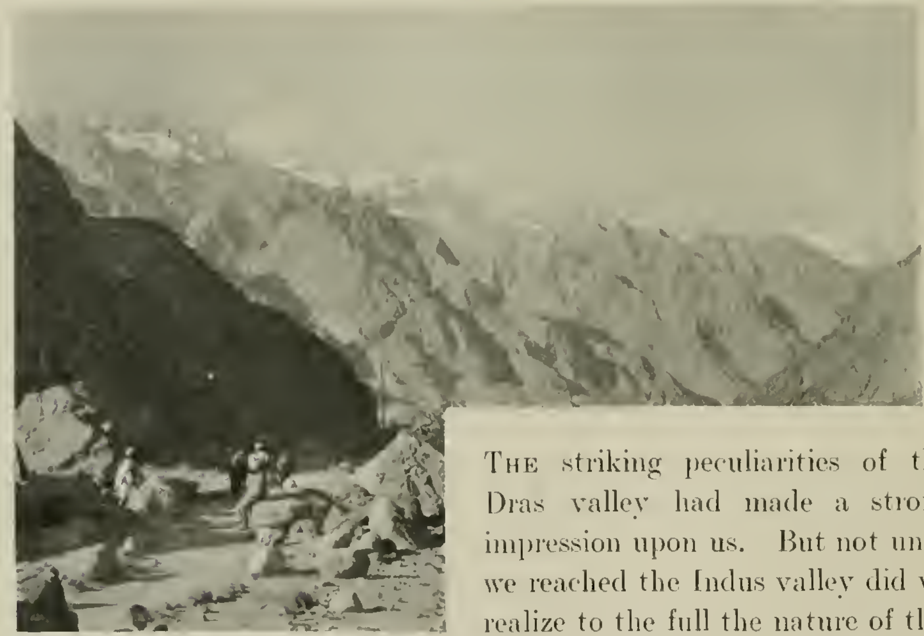
NATIVES OF ASKOLEY IN THE BRALDOH VALLEY.

such clear signs of strong external influence in the past, despite a geographical position so secluded, in a country so wild and inhospitable that whole groups of villages are cut off from all communion with the rest of the world during ten months of the year. The Balti race deserve a high degree of esteem and goodwill. They are scrupulously honest, mild of manners, gentle and good-tempered, naturally amenable to discipline, capable of the hardest labour, incredibly temperate, happy with very little and invariably good-humoured.

CHAPTER VII.

THE INDUS VALLEY.

Character. — Geological Chaos. — Stone-falls, Landslips, Deposits and Erosions. — Alluvial Cones. — Signs of Climatic Change. — The Temporary Damming of the Valleys. — Great Historical Floods. — Oases. — Irrigation Canals. — The Skardu Route. — The Formation of the Caravan.—The Order of the Marches. — Saddle-ponies. — Coolies. — The Escort. — Climate. — The Camp. — Kashmiri Servants. — Camp Work. — Cook and Kansamah.



The striking peculiarities of the Dras valley had made a strong impression upon us. But not until we reached the Indus valley did we realize to the full the nature of this land of desolation and sterility. The gigantic scale of all the features does not grow upon one until after days and days of sojourn in this strange scenery, because the perfect proportions of the valleys and their enclosing hills keep the traveller under an illusion as to their actual dimensions.

In the Alps one has the impression that everything has been moulded in a remote past, and reached once and for all a settled state. The ancient gashes and scars are cloaked with a mantle of verdure which hides the great wounds and mutilations left by prehistoric landslides. The rocks have been polished by the hand of time; they are overgrown with moss and lichens; no ledge, no crevice, is without its plant life. A rock-fall here, a landslip there, seems to matter as little as grains of sand that slide down the dunes.

But in Baltistan the colossal forces of nature may be seen in active operation. Geological evolution is proceeding with such obvious plainness that the traveller feels as though he were beholding a country in a state of formation and witnessing the modelling of the earth's crust. Cliffs fall and mountains are disintegrated. The slow work of the waters hollows out gorges and hews their walls into new shapes, almost under one's eyes, with such activity and on such a scale that nothing elsewhere can be compared with it.

The impressiveness of these geological forces is so great that the barrenness of the earth seems on the whole quite justified, as if the vegetation were only waiting for the earth to acquire a settled shape before clothing it. Animal life appears to be limited to a few insects and lizards, which are still in their winter sleep. The few species of timid mammals remain in the high nullahs or valleys. Now and then a brilliant jay or a few crows fly about the oases, and sometimes we see a great vulture or hawk soaring high above the valley.

The whole land is one vast labyrinth of high, barren. desolate mountain chains, of cliffs split and shattered in every direction, usually precipitous; overhanging valleys full of rocks and stones, pebbles and sand; detritus of all shapes and sizes hurled down in avalanches and mingled with vast accumulations of alluvial deposit. The disintegration is so continual and on so vast a scale that the general aspect of the valleys must perforce change at many points every few years. Traces of avalanches are everywhere visible, signs of ancient or recent cataclysms, boulders polished to a shining red-brown surface by time and the action of water, lying alongside of huge blocks, whose clear-cut fractures seem of yesterday, at the feet of rock walls torn with fresh gashes.

Sir Martin Conway attributes this remarkable decay of the rocks solely to climatic causes—drought and swift and extreme changes of temperature. But surely a great part must be played by the absolute lack of any layer of vegetation which would protect the live rock from the direct action of excessive heat or frost, and by absorbing the waters to hinder them from bursting in sudden torrents down into the valleys.

The bed of the valleys alters its shape incessantly. Unremittingly the river gnaws, wears down and digs out its bed, and shifts, rolls and

THE INDUS JUST BELOW THE MOUTH OF THE DRAS.

drags down millions of tons of matter, which it deposits wherever the current slackens above a narrow gorge or pile of boulders, only to move them again once the obstacle is removed or cut through.

The layers of detritus and sediment sometimes attain a thickness of 1,000 feet or more. The sedimentary deposits are of every species and variety: banks of the finest and purest clay, pebbles, agglomerates of every variety and period. They usually take the form of terraces cut steep down to the river. They are not, however, invariably at the bottom of the valley, the remains of ancient sedimentary deposits sometimes clinging to the walls up to a great height. Thomson found clay deposits between 1,000 and 2,000 feet above the stream, as high up as the brow of the cliffs along the valley; and Schlagintweit found deposits of pebbles and sand from 3,000 to 4,000 feet above the actual level of the water.[1] Such deposits, as well as the places where the rock walls have been gnawed away, hollowed out and cut by the water into spherical cavities, afford clear proof that at one time the Indus

ALLUVIAL TERRACE AND STRETCH OF PATH BETWEEN KARMANG AND TOLTI.

ran at a far higher level than at present; or rather, they point to an uplifting of the whole region, while the river went on cutting its valley by erosion and maintaining more or less the same level throughout.

The various levels of the alluvial deposits along the cliffs show that the upheaval was not continuous, uninterrupted and regular. Oestreich

[1] Th. Thomson, *Journey to the Karakoram Pass. Jour. Roy. Geog. Soc.* 19, 1849, p. 25; Schlagintweit *Jour. Asiat. Soc. of Bengal* 26, 1857 (cited by Burrard).

holds that the whole valley between Dras and Skardu was first cut through, then filled up with detritus to about 600 feet above the present level, and then once more dug out.[1] According to him the present valley would be a recent formation, and the river would be still actively cutting its way. However this may be, the immense geological forces have made of the upper Indus one of the longest and wildest valleys on the face of the earth.

THE INDUS VALLEY ABOVE KARMANG.

At first sight the huge sedimentary deposits, often divided into strata, seem to indicate that the valley was once filled with a series of lake basins. Sir A. Cunningham and Sir Martin Conway are of opinion that such gigantic sedimentary formations can be explained in no other way. Thomson had, however, already noted that this simple theory would explain neither the extraordinary extension of the sediments—which are to be found with unvarying characteristics throughout the whole of the Indus valley—nor their immense thickness at various points,

[1] Godwin Austen also mentions this succession of phenomena. See *Geog. Jour.* 25, 1905, p. 245.

nor their frequent appearance at the mouth of tributary valleys, where they often take the form of deltas. Drew believes the origin of the deposits to be fluvial, and very ingeniously explains the stratification of the clay as caused by the periodic muddiness of the waters and the increase in their volume during the melting of the snows, which together give rise to deposits of fresh sand and mud upon the banks.

VIEW IN THE INDUS VALLEY—A SMALL OASIS.

Another objection to the lake hypothesis in the Indus valley lies in the fact that lakes are extremely rare throughout the Himalayan system. Not only is there a complete absence of those lakes at the foot of the mountains which are so typical a feature of our own Alps, but even in the high valleys no considerable lakes are to be found. The frequent stoppage of the river waters through temporary damming up of their course has always been, in historic times, of short duration, a few months at most, and could not have brought about any permanent modification of the aspect of the valley.

The largest and thickest sedimentary terraces usually lie at the mouth of tributary valleys and lateral gorges, and spread out in the shape of alluvial fans. They range between a few hundred yards and a few miles across, and form symmetrical cones, whose apex is frequently a great height above the valley bottom, while the base towards the river is cut vertically. They are usually bisected by the tributary water-course.[1]

The formation of these huge deltas is certainly hard to explain by the present climatic conditions of the region. The torrents which flow down the valleys and lateral gorges are usually little more than rivulets, and in many cases no longer flow across the delta, but between the latter and the valley wall, on their way to the main stream. Furthermore, the surface of the cones is usually sprinkled with numerous blocks and rocks which have fallen from the mountain sides, often at a remote period, since when it is evident that no new material has been deposited so as even partially to cover up their bases. Lastly, nearly all the deltas of any size are covered with cultivation, being, in fact, the only inhabited parts of the valley, and the aspect of the villages and the dimensions of the trees prove that from time immemorial there have been no floods.

These facts seem to me to justify the hypothesis that the present extreme lack of moisture was preceded by a period during which the streams which flow through the tributary valleys were, at least during a portion of the year, powerful torrents capable of carrying down great masses of rock, earth, etc., in amount sufficient to form these great alluvial cones. After all, it is not improbable that this belt between the Himalaya and Central Asia may at one time have enjoyed a moister climate than it does now, considering that a similar state of things obtained in Central Asia itself, as the evidence gathered by all explorers there goes to show.

I have already alluded to the temporary damming up of the valleys. Their depth and their trough-shaped bottom between the steep cliffs, from which landslides and stone avalanches fall continually, make them especially liable to this accident. But the strangest form of dam is, without doubt, that produced by a glacier coming down out of a tributary valley and projecting until it forms a dyke straight across the main valley. The river, hemmed in by any one of these causes,

[1] Sir M. Conway thinks that the angle of the slope of these fans proves that they are formed by landslides and not by matter brought down by the streams. His observations were made in a portion of the Bunji valley between Astor and Gilgit, but I do not think the theory would apply to the Indus valley, where the deltas show the typical characteristics of alluvial cones.

naturally forms a temporary reservoir or lake. Sooner or later the pressure of the water succeeds in undoing the dam and a devastating flood bursts down into the valley, sweeping before it every trace of villages or cultivated oases, and bringing ruin down to the far-off plains of India.

In 1841 a landslide in the deep gorge of the Indus to the west of Nanga Parbat almost entirely dammed up the course of the river, forming a lake about 40 miles long. Six months later the dam gave way, and the huge reservoir was emptied in a single day, obliterating every trace of life for 800 miles of valley. At Attock, where the valley opens into the Punjab plain, Gulab Singh's Sikh army was encamped. The fearful flood swept it away, destroying 500 men.[1] These catastrophes are not confined to the Indus. History records several similar disasters proceeding from the same causes in the other valleys of the western Himalaya.[2]

THE INDUS BELOW TARKUTTA.

In the midst of this geological chaos, lost in the vast stony desert, are humble human dwellings hidden away in the recesses between the ridges, sometimes so deeply secluded among the tremendous precipices of the gorge that the sun reaches them for one hour only in the twenty-four. With ant-like industry the inhabitants have succeeded in wresting their

[1] This disaster was for a long time attributed to the damming up of the Shyok valley, a tributary of the Indus above Skardu (Sir A. Cunningham, op. cit.). Years subsequently Drew discovered the real cause. Beside Drew, D. Fraser has described this fearful inundation (see *The Marches of Hundustan*. London 1907); also Burrard, op. cit.

[2] One of the greatest was the destruction of the city of Bilaspur in 1762, through the sudden giving way of a dam which had been formed in the river Sutlej by a landslide and had held up against the water for forty days.

nurture from the terrific nature round them. They have caught every trickle of water, every rivulet fed by high nevé or glacier, and have led it for miles through carefully constructed conduits to a point where a little sloping ledge, or more often the surface of an alluvial delta, permitted of irrigation and culture. All along the march down the valley you can follow with your eye the tiny far-off water-course,

THE INDUS VALLEY BELOW TOLTI.

gradually and evenly descending along the rocky cliffs, always clearly outlined by the thin green line of shrubs and herbs which follows its precious course, and sometimes as it descends by veritable avenues of willows or poplars which line its margins until it ends at the oasis. The line of the little conduit never deviates as it crosses the steep side of old landslides, precipitous cliffs or transverse gorges. However small the scale it is a true aqueduct, constructed with consummate skill and needing ceaseless labour for its upkeep, frail and undefended as it is among the mighty powers of ruin and destruction.

The oases are always cultivated in terraces, each of which contains its little field surrounded with groups and rows of trees, among which nestle the little reddish-brown cottages. In the midst of the appalling desert, under the scorching rays of the sun, the blossoming oasis with its green shade seems like a miracle, a delight to the eyes of which it is impossible to render the faintest idea in words. The pink and white

A CULTIVATED ALLUVIAL DELTA BELOW TARKUTTA.

blossoms of the apricots gleam in the faint light of dawn as if they were covered with hoar-frost. Over them rise tender green willows and slender poplars, just in their first bud and showing all the delicate design of their branches. Between the trees are set like emeralds small fields where the green corn is now a few inches high. The soil is too valuable to use for anything except corn. Only at the edge of the meadows and on the brinks of the irrigation canals grows a little grass mingled with tufts of pale iris leaves, whose buds do not yet show. The skirts of the oasis end in a perfectly clean line, beyond which lies the illimitable waste of stone.

A poverty-stricken people live upon the verge of starvation in these gardens. Their neighbours in Ladakh have received from their religion customs and social laws which prevent the increase of the population, hence their agricultural resources suffice to give them relative plenty. The Baltis, on the other hand, have increased through polygamy and concubinage in number beyond all proportion to the resources of the

BETWEEN KARMANG AND TOLTI.

country, for cultivation is strictly limited to the land which can be brought under irrigation, and this area is not capable of extension. Thus they are obliged to emigrate in large numbers to Kashmir, Simla and the Punjab in search of work and the means of subsistence.

From the meeting of the Dras and the Indus to Skardu is about 86 miles down the left bank of the river Indus, with a drop of about 1,500 feet. We covered the distance in six stages. The path was everywhere in good condition, evidently lately repaired, so that it was possible to ride the whole way. The Baltis are the best road-builders in the western Himalaya, and have done a good share of the important military roads which lead from Kashmir to the frontier posts of Chitral and Afghanistan.

The path follows the winding course of the valley, now crossing stretches of alluvial deposit or flats of fine sand in a wide part of the valley bed, again creeping across the steep inclines formed by the fall of detritus from the cliffs. At points where the valley narrows to a

THE PATH ACROSS THE CLIFFS, BELOW GOL.

gorge between granite precipices it climbs to a great height to cross the ridges or *parri*, as they call them here. At other times, to save the wearying ups and downs, a path is made straight across the face of the precipice. Beams are fixed in the ledges of the rocks and cross-beams laid over and covered with stones and beaten earth. The bridge thus formed is supported from beneath by slanting props between the rock and the edge of the path. The whole forms a sort of ledge hung across the precipitous rock wall above the swift waves of the Indus, which hurries far below through its narrow bed.

In some places the sides of the valley are so steep that their crests are not visible from our path in the bottom of the gorge. Huge precipitous ridges run down on each side and overlap each other, apparently blocking the way before us. We have but rare and fleeting glimpses of the higher chains whose rocky spurs enclose us on every side. Only as we toil across occasional openings of the valley, sinking at each step into the fine sand, do we get a sight of the far-off snow-peaks.

In all this distance we do not find a single large confluent on the left side of the valley. We miss the fresh springs, the little waterfalls and torrents of our Alps. The torpid stream of the Indus, laden with sand and mud, rolls its grey waters lazily through open spaces and around curves, where it spreads into a wide bed with beaches of snow-white sand. Only in the narrow gorges does it flow rapidly with foaming waves; and it never forms real waterfalls except at one point a little below Karmang, where it leaps down a step some 15 or 20 feet high. This waterfall, which was discovered by Conway, is worthy of remark, because it is such a rare phenomenon in either the small or the great rivers of the Himalaya. The Indus is a great river, even now when the melting of the snows has scarcely begun ; but it seems small in proportion to the vast size of the basin from which it is fed—103,823 square miles, about the size of the whole of Italy, including her islands. The fact helps us to realize the extreme dryness of the climate.

Our life in the Indus valley was systematically arranged. We were called between five and half-past in the morning, and immediately began our struggle with the coolies to prevent their snatching our beds and baggage before they had been rolled up, closed and got ready. In the great variety of packages formed by our complicated luggage there were some which the coolies preferred to others, for though the weight of all was approximately the same, the shape and dimensions of some pieces made them handier for the back of the coolie or the pony. The men would very nearly snatch the equipment from our hands, so great was their impatience, and we had to defend our possessions energetically. Next, while the guides with the help of our Kashmiri bearers struck and rolled up the tents, we would get a good English breakfast, prepared by Mr. Baines' *kansamah*.

Soon after six everything was ready for the start. Negrotto was paymaster of the caravan, and he would stand on the road with Mr. Baines and Alexis Brocherel and deal out numbered counters to the coolies and ponymen as they passed before him. It was necessary to engage fresh coolies and ponies at nearly every stage, as they could not leave the field labour of their villages for more than two or three days. As soon as the last porter was off we would set out ourselves. Sella usually left the camp before breakfast with his assistant Botta and the coolies to carry the photographic and cinematographic apparatus. In this way he got more time to photograph the scenery, and was able to stop on the way with the cinematograph and catch the expedition on the march at picturesque points of the road.

Part of the way we walked and part of the way we rode the forlorn-looking ponies of the district, all dirty and covered with long shaggy hair, but plucky and willing like their masters. The primitive saddles were so uncomfortable that we usually preferred to walk, riding only across long reaches of sand, or here and there for a rest on the march. Between these impossible saddles and the pony's back goes the thick folded *namdah* (a species of soft felt manufactured in Kashgar and used throughout both sides of the Karakoram region), which had a tendency to slip out and drag saddle and rider with it. Anyone intending to take a long journey through Baltistan should provide himself with a good leather saddle in Srinagar.

The first half-hour of our march was always tiresome, until we had passed and left behind the whole lot of coolies. The smell of these natives is unbearable, even in the open air, and if you get to leeward of them will simply take your breath away, even at a distance of a dozen or so yards. They do not, however, look sickly like the people of the upper Dras valley, but seem robust, healthy and well fed. They are born porters. Their step is nimble and short, even at the worst parts of the path, and their halts are frequent and brief. They shave a large strip in the middle of the head, from the forehead to beyond the crown. The rest of the hair is allowed to grow long, and falls in curls around the circular Balti cap. Those of a Semitic type remind one of Polish rabbis; those whose features are pure Aryan look like Florentine pages of the Renaissance. Their clothes are of puttoo, originally white, with wide trousers cut short above the knee, and a coat of the same length, and each is provided with a blanket shawl of the same wool, which he carries twisted round his waist or spread on his back to relieve the pressure of the load. The latter is fixed to the shoulders by strong twisted cords of black and white goat's hair. All our parcels were so arranged that they could be tied on to the shoulders direct, but when they carry their own goods the Baltis use conical baskets of woven withes, very like those in use among our peasants of the province of Biella. As on his other expeditions, the Duke had brought from Italy a number of the load-carriers designed by the Sellas for mountain portage, to carry the more fragile part of the baggage, such as the meteorological instruments, photographic materials, etc. The Baltis, however, were quite as firmly set against innovations as our own peasants, and insisted on tying both load and load-carrier on to their backs with cord in the usual manner, instead of passing their arms through the wide straps which are so much easier for the shoulders and collar-bones of the porter. Before the end of the campaign, however, Sella did manage to persuade a number of the coolies who remained longer in our service of the advantage of the load-carriers, and quite converted them to the system.


GROUP OF BALTIS.

One by one we would pass ahead of the coolies on the narrow path, where they stood on one side to let us go by. At the least encouragement gathered from our looks their faces would expand in a broad and jovial grin. Bowed down with their heavy loads, streaming with sweat under the burning sun, they are always ready for a laugh, and never look hostile or ill-tempered. They were always scattered in little groups over very long stretches of the road, but the coolies who carried the treasure kept together under the escort of a chuprassi.

They are a mild and timid people, quite incapable of any sort of violence, noisy and talkative but not at all quarrelsome, even when they are squabbling over the coveted pieces of luggage. You never see them maltreat or beat their ponies. They encourage them with the voice, they shove them or haul them in the worst bits of the road, but they never beat them, even lightly. When they have any request to make they join their hands in a suppliant attitude or even kneel, yet they have none of the crawling servility of the Kashmiri, and their timidity does not seem like cowardice.

Our guides marched in a group, sometimes at the head of the caravan, sometimes behind. To their care were entrusted the precious mercury barometers, which were too fragile to be put into the hands of such primitive people as the coolies.

COOLIES AT KARMANG.

In less than an hour we would leave all the porters behind us and find ourselves alone in the desolate valley. The foreguard of the expedition was rather numerous. The Duke was invariably escorted by the Shikari Abdullah, the Tehsildar of the district, and usually by the local Rajah, who would bring with him one or two Jemadars and Lambardars, a few chuprassis, and usually his minister or Wazir. The high officials wear turbans of white muslin, the Lambardars turbans of *pashmina*, a goat's hair tissue which varies in quality and is sometimes marvellously soft. We were also accompanied by the tiffin-coolie, who carried the luncheon basket and who was selected for his running qualities, so that he could follow our ponies even when they trotted.

The sun was very hot and the radiation so intense that we were forced to wear our pith helmets, although the temperature was not above 60° to 68° F. The air was very dry, nearly always breezy, and with a slight haze rather of dust than of moisture.[1] Nearly every afternoon towards three o'clock a strong wind arose, blowing usually from the west or south-west, and raising such clouds of fine sand that the atmosphere would grow dark like fog up to a very considerable height.

About ten o'clock we would stop for luncheon in some garden under the shade of blossoming apricots, or else in one of the tiny groves of poplar and willow enclosed in a square of wall, which you see now and then on the way, and which are probably resting-places for the caravans or to shelter the flocks and herds during the hot hours. I must here mention the existence of a few great solitary trees which you meet in the very midst of the desert and which appear to be centuries old, usually dead except for a branch or two, with the trunk half buried in the sand, but far bigger than any of the trees to be seen in the cultivated oases. Are they, perhaps, a solitary relic of some ancient settlement, driven hence by the drying up of the water supply or buried by a flood or crushed by a landslide ?

We usually came to the end of a stage before two o'clock, and set up our camp. We had six tents in all, of the usual light tropical type, made of Willesden green canvas. These were for the four of us and for our eight European guides and porters. Mr. Baines had another tent. The Tehsildar used to make his own arrangements apart. Another group was formed by the kitchen and the little cotton tents of the bearers.

Throughout India domestic service is divided among a large number of servants whose functions are strictly specified and limited by caste exigencies. We had four bearers—two for our tents, one for our guides and one for the kitchen. They helped the coolies to set up and strike

[1] See in the scientific appendix the tables of meteorological observations put together by Professor Omodei from the data collected by the Duke. The relative humidity of the air, which in the Sind valley had been ·44, ·88 and ·89, came down to ·70, ·71, ·63 and ·64 in the Dras valley, and ·07, ·05, ·0, ·04, ·22 and ·16 in the Indus valley, with a tension of aqueous vapour almost invariably below the unit.

camp; they waited on us at meals and brought us water to wash. During the march they were seldom in sight or calling distance, though they carried the water flasks. But the moment we reached the stage and sat down they would rush to our feet and proceed to massage our legs energetically, a most excellent practice, which any coolie can apply if there is no bearer at hand. It is wise to prevent your private servants

PAYING THE COOLIES.

from interfering with your relations with the natives, for whenever the Kashmiri can he takes advantage of the ignorance and timidity of the Balti.

As soon as camp was set up every one would go about his own work. The Duke would take the daily meteorological data and make comparative readings of the instruments, which were to be used later to prove that the latter had not shown variations in the course of the journey. He also gave daily attention to the general ordering of the expedition, checking the baggage, organizing the parties to be sent on ahead, and supervising the hundred odd businesses of a caravan on the march. Vittorio Sella, when he had not stopped behind attracted by some special beauty of landscape, would wander round the outskirts of the camp seeking subjects for photography. Negrotto presided over the payment of the coolies if it was one of the days when the old ones had to be paid off and new engaged.

Shortly after our arrival sick people would begin to troop in from the villages. The most common diseases were forms of chronic dermatitis, mange and tinea. It is possibly from the prevalence of this last that the custom has grown up of cauterizing babies' heads on the top and above the ears, which Ujfalvy observed and attributed to a belief in the healing action of fire. Conjunctivitis is very common, as well as chronic bronchial affections, all forms of disease due to dirt and pauperism.[1] The sick people were frequently brought to me by the Rajah himself or his Wazir, with a certain degree of affectionate concern. They ask for medical relief with anxious hope, and take the little tabloids given them with superstitious reverence and the ingenuous trust of a primitive people in the wisdom and power of the European. It is, however, almost impossible to be of much assistance to them in so short a sojourn.

Tea would gather us together again, and we would discuss with the Duke the future organization of the expedition when we should have left the last village, and would depend on ourselves, our coolies and our equipment for our only resources.

Meantime fowls, eggs, sheep and milk have been brought from the village. The cook of the party is Ernesto Bareux, who is full of goodwill, attentive and painstaking. But no European can compete with the Indian or Kashmiri cooks for camp cooking. They know how to use their primitive utensils and to make the most of the monotonous provisions to be found in the villages, cooking them in an attractive and varied way.

Mr. Baines' Kashmiri kansamah used to get luncheon for us all and Bareux the dinner, so that our supplies and those of Mr. Baines were more or less in common. This gave rise to an acute rivalry between his native servants and ours. Not a pinch of salt lent by one culinary

[1] In Tarkutta alone I have noted down one case of old dislocation of the thigh, one of double cataract, pterigion, gastro-intestinal helmenthiasis with uncontrollable vomiting, Bright's disease, two cases of heart disease, one of infantile paralysis—of which last disease I observed victims in several villages.

establishment to the other but became a source of internal bickering, and heaven knows what complications might have arisen between the two camps had not our guides kept order through their prestige as Europeans.

By nine o'clock we were all in bed. The temperature used to go down to 41°–45° F. The Baltis squatted around fires on the outskirts of the camp, and apparently remained awake the whole night. They certainly chatted up to a very late hour, and many coughed without interruption. We were roused of a morning by hearing the ponies being got ready for a start, and greeting each addition to their own company by noisy, gay and shrill neighing.

CHAPTER VIII.

FROM OLTHINGTHANG TO SKARDU.

The Meeting of the Dras and the Indus. — Tarkutta. — The Castle of Karmang. — The First Jhula Bridge. — Tolti. — Exchange of Tehsildars. — Parkutta. — Polo. — The Shyok River. — Glacier Marks in the Indus Valley. — Gol. — The Skardu Basin. — Lacustrian and Glacial Theories. — We enter the Balti Capital. — Official Visits. — The Forts of Skardu. — The Polo Ground. — Arrangements and Contracts for the Expedition.

In the foregoing chapter I have given a general account of the Indus valley, which I will now supplement with a few notes of the journey, so as to call attention to the more interesting details of each place and give a clearer idea of the part of the valley through which the expedition marched.

We entered the Indus valley on the morning of May 3rd, after an hour's march from Olthingthang. The meeting of the rivers takes place at the bottom of a precipitous gorge, where the path has to cross a spur of granite 1,000 feet above the level of the rivers. Beyond this spur it descends to the bank of the Indus, which it follows for a short distance. Then it is again forced to climb a high ridge of sedimentary deposit, from the top of which a precipitous way leads to Tarkutta, a village built on an alluvial terrace some 300 feet above the stream. We passed through the whole village, which is shaded with walnut and apricot trees, and set up our camp at the foot of the oasis, near a wide beach of very fine dove-coloured sand on the bank of the Indus. It was so hot that we were tempted to bathe, and to our great surprise found the water icy cold.

Confluence of the Dras with the Indus

On the following day we proceeded down the valley northward, following the path up and down over ridges or across the face of precipices or over reaches of sand scattered with granite boulders. At one point there is a veritable torrent of huge snow-white blocks, whose origin is seen on glancing at the great white scar newly left exposed at the top of the overhanging precipice.

KARMANG: THE CASTLE AND THE RAJAH'S HOUSE.

Around a bend of the river we catch sight of a picturesque castle standing high up on the opposite bank. The architecture is complex, and although a part of the roof is gone, the building is not in ruins. This is the old fort of Karmang, now no longer inhabited by the Rajah, who lives in a little house at the foot of the same rock, near the river. Around his house is a garden containing other huts inhabited by his family and dependents, while a little farther on is the village of Karmang, or Kartash, with about 500 inhabitants.

On our side of the river, nearly opposite the village, stands on a sandy level the little dak bungalow, exactly like that of Karal in the Dras valley. Upon the table in its single room were arranged plates containing lilac blossoms and chupattis, the small round cakes which are the bread of the region. This was an attention of the Rajah, who had come as far as Olthingthang to meet us. Later he came over to pay his official visit, accompanied by a ragged Wazir and bringing his two little boys, whose features were so fine as to be almost effeminate.

THE BUNGALOW AT KARMANG.

The village of Karmang communicates with the left bank of the Indus and thence with the Skardu and Kashmir road by means of a long rope bridge across the Indus. This was our first experience of these strange bridges known as *jhula*. They are to be found in every part of the Himalaya, and are made either of canes fastened together in bundles, or of cords, or of plaited grasses as in Sikkim, or of withes of willow or birch twisted into ropes, as in Baltistan and Tibet. While the camp was being set up near the bungalow two of our party, impatient to experience the sensations we had so often read of in books of Himalayan travel, climbed up on the big pile of heavy stones which holds the ends of the cables forming the treadway and balustrades of the bridge. These three cables stretch across the river in parallel curves. One, which is thicker than the others, hangs somewhat lower, and upon this you walk, while the smaller cables are higher up and are arranged one on each side to hold by with your hands. At intervals of about two yards thin bands join the footway cable to the side-ropes, so that the whole thing takes the shape of a sort of skeleton trough with a pointed bottom. The two ropes which form the handrails are kept a certain distance

JHULA BRIDGE AT KARMANG.

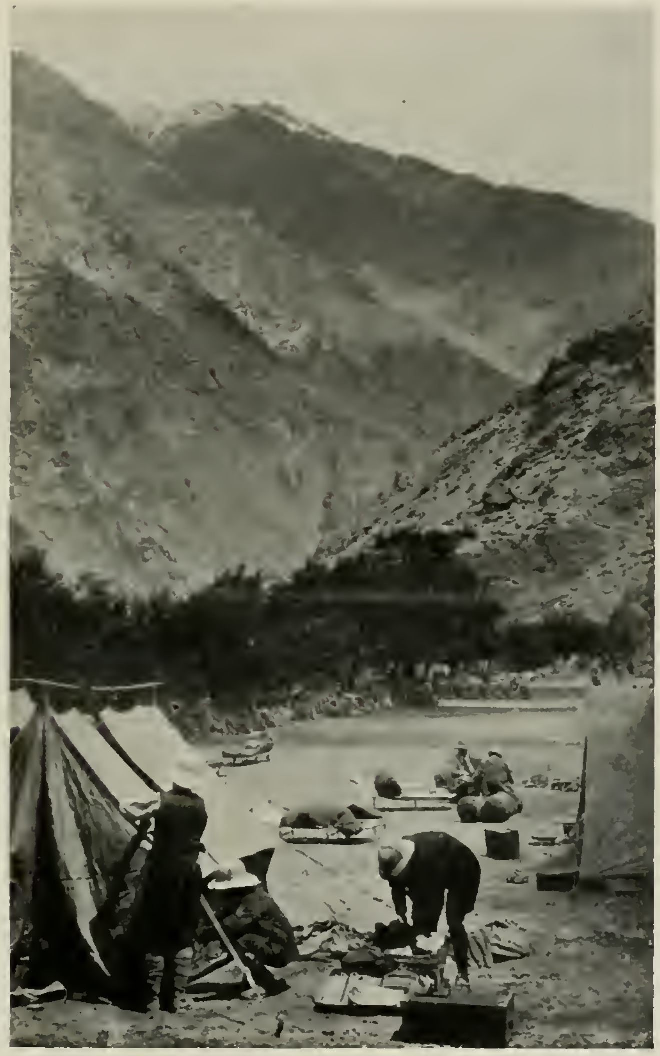
apart by cross-bars fitted into them at intervals of 10 or 12 yards. The only difficulty of crossing consists in climbing over these cross-bars, and the greatest danger is of scratching your hands on the sharp points of the birch twigs which project everywhere from the rough cables.

On the whole jhula bridges are simple, strong and cheap, and the system might do good service in some of our own mountain valleys. The crossing is really perfectly simple, and offers no difficulty as long as the bridge is properly kept up and the cables taut. But when half of the cross-bars are broken and the bridge sags in the middle owing to the relaxing of the cables, the crossing may become most disagreeable, especially when the wind blows the whole thing about like a swing. None of us ever suffered from giddiness even when the bridges were hung very high over swift torrents. But you have a feeling as though the bridge were being carried upstream and you with it. As a rule from four to six people are able to cross at a time, but if the condition of the cables is doubtful only two should try it at once. It is related of the Greek hermitages among the high cliffs of Thessaly that the rope which is used to pull people up to the threshold in a basket is never

BALTI BRIDGE MADE OF TWISTED BRANCHES.

changed until it breaks, and every one takes his chance. The same tale is, of course, told of the jhula bridges, and Oriental inertia and fatalism may give it a semblance of truth. It is, however, somewhat difficult to prove.

Near Karmang the valley narrows into a gorge, which Thomson gives as the end of the basin of a great lake which, in his opinion, used to reach from here as far as Rondu, a little below Skardu. From here the valley slopes north-eastward in a wide curve round the foot of the Deosai table-land, and now grows a little wider, notwithstanding a number of narrow twists and bends into which it is forced by a series of very steep rocky spurs. Just beyond one of these, which forms a precipice overhanging the river, lies the great oasis of Tolti, which fills the whole width of the tributary valley of Kusuro Cho. The green glade thus shut in by steep mountain walls is covered with luxuriant



THE CAMP AT TOLTI.

vegetation, among which, in addition to the usual apricots, poplars and willows, we noted walnut, pear, plane and mulberry trees, the last festooned with fronds of grape-vine.

Our way led uphill through the large and prosperous village, and we passed beyond the dak bungalow to the polo ground, which is about

300 feet long and 100 feet wide, running across the little valley and surrounded by shady trees, quite at the top of the oasis. Here the Duke was welcomed by the Rajah of the district, who resides at Parkutta, our stage for the next day. He was a man in the prime of life, wearing a round beard dyed with henna, and swathed in white muslin with a big

THE CROWD ON THE POLO GROUND AT TOLTI.

white turban on his head, like a Mullah. The Tehsildar of Skardu also came to Tolti to meet the Duke, and the Kargil Tehsildar took his leave, as we had reached the confines of his jurisdiction.

At the polo ground was gathered a crowd of several hundred people, kept in bounds with unwonted severity by chuprassis. Throughout the last two stages the whole of the luggage had been carried on the backs of coolies, but at Tolti we were again able to hire ponies. It was the first place where the coolies seemed unwilling to enter into an engagement. The Rajah and his high officials marched about in the crowd, seized hold of the more refractory subjects and practically dragged them into our presence. Perhaps on some former occasion they had been defrauded of their pay, because throughout our journey we always found the natives rather anxious to be engaged. Some of the horses, too, were recalcitrant, refused to be loaded, kicked and rolled. These were, no doubt, polo ponies, who objected to the degradation of carrying loads.

The afternoon was windy as usual, but the little valley was sheltered by the hills and so green that we had neither sand nor dust, and enjoyed

A MOSQUE OF THE HIGH INDUS VALLEY.

to the utmost the cool shade of the trees. Little rivulets ran all round our camp, and their murmur mingled with the rustling of the leaves in the breeze.

The next stage was of about five and a half hours, and was more diverse and entertaining than the preceding ones. During the second half the way runs through several villages whose gardens join, forming wide belts of vegetation, where the path is all in the shade. The houses are better built, some of sun-baked bricks, and the occupants even indulge in the luxury of a verandah. Now and again the windows have carved wooden frames. There were a few mosques with flat roofs, formed by long transverse beams resting upon uprights and outer walls of masonry, now and then strengthened by incorporating the trunks of trees, as in the houses of Srinagar. The eastern façade was adorned with a portico.

Parkutta is a big village standing over 300 feet above the river, built upon both sides of a deep ravine cut through the thick alluvial deposit by a torrent. As in Karmang the old palace of the Rajah stands upon a high rock dominating the town. At the entrance of the village the Duke was greeted by a musical band that marched before the caravan as far as the polo ground, which is much larger than the one at Tolti. The players squatted on their heels in the middle of the polo ground.

CEMETERY AT PARKUTTA.

Their instruments were drums, tambourines, horns and a gigantic straight trumpet. A big crowd had gathered round, presenting a lively spectacle. The front rows squatted upon their heels, those behind them stood up, and behind these others perched upon the wall enclosing the ground. Some of the young children and boys wore crowns of leaves. Later on they adorn themselves with flowers. We saw some Baltis with black or dark hair and a fair beard or moustache. The whole population spent a great part of the afternoon on the polo ground, grouped around three sides of the square at a distance of some 50 yards from us. They seemed to be naturally polite, respectful and orderly.

Hardly had our tents been set up when the Duke received the official visit of the Rajah, who was followed by a servant carrying his son and heir, a child of four or five years old, dressed in bright colours and with a turban quite out of proportion to his slender little neck. He was very serious, and saluted us with amusing gravity, lifting his little hand to his forehead. Servants brought dishes of cakes and two huge copper teapots full of Balti tea, a sweetish greasy beverage, pale pink in

A DANCER AT PARKUTTA.

colour. The orchestra then began to play again, and four dancers whirled slowly round and round on their own axis, following the cadence with the rhythmic motions of the arms and head common to all Oriental dancing.

At four o'clock in the afternoon a game of polo was organized in honour of the Duke. Twelve players took part. In the excitement of the game horses and men totally changed their aspect. It seems strange that a game which requires so much pluck, strength and dexterity should have been evolved among a people of timid disposition, and in so many ways rough and primitive. It is, however, improbable that polo was, as Ujfalvy would have us believe, invented in Baltistan, a country so rough that, with few exceptions, there is no place for galloping outside the polo grounds themselves, which are levelled and beaten on purpose. The origin of the game is certainly remote. It seems to have been common at the court of the Mogols. Then the tradition was lost in India, and only kept up at Manipur (on the confines of Burma), in Baltistan, Ladakh and Gilgit.[1] The English of

A BALTI POLO GAME.

Calcutta learned the game in Manipur, and were so attracted by its fine and manly qualities that they made it their own and have diffused it throughout the world.

About eight miles below Parkutta the Indus meets one of its greatest confluents, the river Shyok, which comes down from the Dapsang table-land, gathering in its course of nearly 400 miles the waters of the numberless glaciers which flow down the southern slopes of half the Karakoram. As at Dras, the meeting of the waters takes place at the

[1] Drew quotes an extract from the history of the Emperor Manuel Comnenus, by Johannes Cinnamus, which was communicated to *The Times* of June 12th, 1874, by an anonymous correspondent, showing that polo was played at Constantinople in the middle of the thirteenth century and that the emperors themselves took part in it. TH. THOMSON (*Jour. Roy. Geog. Soc.* 19, 1849, p. 25) says that the native name of the game is *changan*. ROERO DI CORTANZE (op. cit.) calls it *atka*; while according to Ujfalvy *polo* means ball. Vigne has given us one of the best descriptions of the game, while Drew goes minutely into the rules, the dimensions of the ground, the arrangement of the teams, etc.

bottom of a narrow gorge. Oestreich has identified at a height of from 700 to 1,000 feet above the present level, on the walls of both valleys, what he considers the remains of level terraces which marked the confluence of these two rivers at an earlier period.

There are signs which indicate that the Shyok was at one time filled up by a glacier which projected into the Indus valley, where it formed a barrier some 1,000 feet in height, but did not, however, dam the course of the river. This phenomenon can be seen to-day in the upper Nubra valley, and we shall find a most clearly marked example in the case of the Biafo glacier.

The whole of this region is still very little known, and the data we possess regarding its glacial history, as well as all other questions concerning the Indus basin, are so incomplete as to be hopelessly insufficient to support any general theory. As early as 1847 Thomson observed that the lie of the loose rocks and detritus at the mouth of the gorges and lateral valleys suggested a glacial origin. Conway identified them more explicitly as loose boulders and moraine residuum. Oestreich believes that the Indus valley itself was never occupied by a glacier, but only the tributary valleys.[1]

In fact, geologists in general seem to hold that the Himalayan region has never been the scene of periods of "Inlandeis" (like Greenland, Europe and North America), nor of large "pedemontane" glaciers (such as the Malaspina glacier in Alaska, and the former glaciers on the northern slopes of the Alps); but has merely witnessed periods of very considerable expansion of the glaciers in the mountains themselves, such as took place in the valley of the Po, where only the largest glaciers succeeded in emerging from the valleys as far as the edge of the plain. Godwin Austen is of this opinion, and cites indications of two distinct glacial periods, separated by an interval of milder climate. Strachey and Medlicott hold similar views.[2] Ellsworth Huntingdon counts five periods of moist and cold climate, separated by interglacial epochs of dry and warm climate, succeeding each other up to a recent period; but he calls the former periods *fluvial* instead of *glacial*, because they are distinguished by increase in the rivers rather than by any extensive

[1] T. Thomson, *Western Himalaya and Tibet*. London 1852; Sir W. M. Conway, op. cit.; Oestreich, op. cit.

[2] Lieut.-Col. Godwin Austen, *Proc. of the Geog. Section of the British Assoc.* (in *Proc. Roy. Geog. Soc. N.S.* 5, 1883, p. 610); Sir John Strachey, *India*. London 1888; Medlicott and Blanford, op. cit.

filling up of the valleys by glaciers.[1] R. D. Oldham mentions only three periods of "glacial extension."[2] I might mention here that Schlagintweit attributes the diminution of the glaciers to the deep cutting of the valleys and the consequent formation of wide surfaces, which, when heated by the sun, would give rise to ascending currents of hot air.[3]

The volume of the river Indus is nearly doubled by its meeting with the Shyok, yet owing to the narrowing of the main valley below the meeting-point it seems hardly increased, as it cannot expand in the narrow gorge, but only runs deeper. Colonel Montgomerie observed the same lack of apparent increase in the Indus at its juncture both with the Dras and with the Zaskar near Leh. It was in this portion of the valley that we found the largest deposits of clay, quite pure or mingled with a few stones.[4] No fossils were found by which it would be possible to date the deposits.

In the wide bit of valley which follows after the gorges of Shyok lies the oasis of Gol. We reached it by a long avenue of big willow trees buried half-way up their trunks in sand. Immediately behind the lines of trees crops had been sown in the midst of the sand. It seems as though the sprouting wheat must be buried at the first gust of wind, and one wonders how it can ever reach maturity. This is possibly a means of winning new soil for cultivation, but it gives the impression rather of gradual encroachment of the desert on the oasis, such as occurs in many places in central India.

On May 8th a stage of 21 miles brought us to Skardu. We struck camp at Gol at half-past three in the morning by moonlight, and were soon on the road. Little by little the valley grew wider and more open. The path ran along the bottom in deep sand, where the ponies were a great resource.

[1] Ellsworth Huntingdon, *The Vale of Kashmir. Bull. Amer. Geog. Soc.* 38, 1896, p. 657; and *The Pulse of Asia.* London 1897.

[2] R. D. Oldham, *Note on the Glaciation and History of the Sind Valley, Kashmir. Rec. Geol Surv. of India,* 31, 1904, p. 142.

[3] Schlagintweit, *Jour. Asiat. Soc. of Bengal,* 26, 1857.

[4] At many points, especially near the river and on expanses of clay recently abandoned by the water, I have noticed that the sand was quite covered with a white efflorescence like hoar-frost. This phenomenon seems widely diffused throughout the region. I met with it in the Shigar and Braldoh valleys. Chemical analysis proves it to be merely carbonate of lime (calcite). Thomson (op. cit.) collected apparently similar efflorescences in Tibet, on the margins of springs, but there the substance was sesqui-carbonate of soda.

Polo at Parkutta

About half-way, some 10 miles below Gol, the valley takes a sharp turn to the south and then bears to the west, becoming wider and wider until it forms a great plain. This is the table-land of Skardu, about 20 miles long by 5 miles wide, and covered with sand, which lies in long parallel waves or low dunes as in great deserts. The Indus winds its tortuous course through the plain between high banks of sand and deposit.

MOSQUE IN THE INDUS VALLEY.

The view over the plain to the far-off chains of mountains on the horizon appears vast indeed after the long journey between narrow valley walls. Northward above the spur which divides us from the Shigar valley we catch a glimpse of the snowy peaks of the Mango Gusor range, 20,633 feet high. Westward and southward the level sand seems to run to the feet of a great chain of snow peaks which rise 10,000 feet above the plain.

It is in this plain that the Shigar river, fed by some of the greatest glaciers in the world, beside numberless smaller ones, meets the Indus. There is much to interest both geographer and geologist. Oestreich claims that the origin of the plain is techtonic, and not to be attributed to erosion. On this hypothesis the basin would be primitive, and by its formation would have determined the course and the meeting of the Indus and the Shigar.

In the middle of the plain rises a huge round-backed rock, over 1,000 feet high, which looks like some strange monster crouching upon the sand. On top of it Colonel Godwin Austen thought that he could detect stratified lake deposits, which, together with other indications, would go to prove that before the glacial period the basin was occupied

THE INDUS ABOVE SKARDU, WITH MANGO GUSOR IN THE BACKGROUND.

by a lake up to a great height. Schlagintweit was also of opinion that the sedimentary deposits which are found at a great height throughout the valley had been formed by an ancient lake.[1] As in the case of the Kashmir basin and other parts of the Indus valley, so also in the case of the Skardu plain the lacustrian theory has gradually lost ground. On the other hand, Godwin Austen's observations as to the undoubted traces of glacier action over this plain in the remote past have been strengthened and amplified by all subsequent geologists.

The displacements and steep angles noticed in the sedimentary strata (Drew), as well as the rounded surfaces of the rocks protruding

[1] Lieut.-Col. Godwin Austen, *The Glaciers of the Mustagh Range. Jour. of the Roy. Geog. Soc.* 34, 1864, p. 19; H. von Schlagintweit, op. cit.

above their level, are attributed to the pressure and friction of glaciers, while the deposits on the rock of Skardu have been recognized as morenic in character. The early hypothesis which placed the sources of these glaciers in the mountains to the south of the plain has been replaced by Lydekker's theory, derived from the glacier traces in the Shigar valley and accepted by Conway and Oestreich, to the effect that a gigantic glacier projected from the mouth of the Shigar valley so as to cover the whole plain.

THE BASIN AND ROCK OF SKARDU.

Five miles above Skardu, at a point where a projecting spur runs down to the river, a little fort stands across the path, and we pass through a vaulted corridor of it, so low as to oblige us to dismount. A little farther on a bend of the river Indus quite cuts off the way. We have to go down the steep alluvial bank to the level of the stream, and follow its curve along an avenue of gnarled and twisted old willows, whence we ascend again to the plain. Here at the top of the ascent the Duke was received by the Rajah of Skardu and his brothers, accompanied by a suite of dignitaries, a numerous orchestra and a great crowd. Salaams were exchanged, and we formed into a long procession, preceded by the band. With all this pomp we walked for over a mile, flanked by the crowd on either hand, and at about half-past eleven we reached the bungalow of the civil engineer, who had put it at the disposal of the Duke in his absence. The guides were lodged in one of the numerous buildings of the dak bungalow, a huge place with separate buildings for servants, kitchens, etc.

THE OLD AND THE NEW FORT AT SKARDU.

The wide verandah of the bungalow was quickly turned into a reception room. The Rajah, the Tehsildar and the chief merchants of Skardu paid ceremonious visits to the Duke, followed by servants bringing all sorts of delicacies, such as sweet almonds, dried apricots, raisins, cakes and, above all, a wealth of fresh vegetables such as we had not seen since we left Srinagar.

Our own quarters and the neighbouring group of dak bungalows stand to the east of the town, which stretches between the rock of Skardu and the base of the mountains, with straggling suburbs scattered through the plain as far as the villages which lie at the very foot of the mountains.

To the south of Skardu we observed a curious wall stretching across the mouth of a tributary valley, so perfectly regular as to give the impression of an artificial dam. It is really a moraine, which closes the entrance into the Sutpa valley, thus forming a lake three-quarters of a mile long, which Oestreich notes as the only example in the whole region of a lake of glacial formation.

Upon the detached rock between Skardu and the Indus stands an ancient fort built about 1610 by Ali Sher, the first of the dynasty of independent Mohammedan chiefs which came to an end when Ahmed Shah was conquered and dethroned by the Sikhs in 1840. The fort is now abandoned, and another was built by the Sikhs at the foot of the rock, on the verge of the plain.

The legend of Alexander the Great, which is so living throughout central Asia, has penetrated even to this remote spot, and tells us that Skardu is a mere corruption of Iskandaria, or city of Alexander. The tradition is, however, quite baseless. It is true that early travellers called the town Iskardo, but according to Thomson the real Tibetan name is Skardo or Kardo. The Baltis are unable to pronounce the hard *s* followed by a consonant at the beginning of a word, and always prefix an *i* in the case of English words beginning in this manner.

The place seems to have been far more prosperous and civilized in the past than at the present day. Thomson, who made a long stay there, spending the whole winter in 1874, found ruins of buildings constructed of quarried stone, marble fountains, hanging gardens, aqueducts, etc. Ujfalvy collected ancient household utensils worked with the finest art. To-day the whole town, with the exception of a small nucleus, which includes the wretched bazar, lies straggling over the plain in small groups of huts, forming little islands of cultivation dotted at random over the desert. There is a great variety of fruit trees, now already past blossom and covered with leaves, and all sorts of cereals and vegetables.

The houses are, for the most part, two stories high. The lower story is built of rough stones and mud, about nine feet high, and is used for stabling and to live in during the long severe winter. The upper floor is of rough basket-work plastered over with mud, or even of wood, and is usually smaller than the ground floor, so as to leave part of the roof of the latter for a terrace, which is used as a threshing-floor and granary. Skardu has also a small number of houses inhabited by the upper class, constructed as in other Oriental cities with walls plastered with lime. They have no windows, and but one door, which leads into the inner court, upon which the rooms and verandahs open.

The half-day we spent at Skardu passed very quickly, for we had hard work to do. First, there was the usual inspection and sorting of baggage, coolies to pay off and new ones to engage. Next the Duke sent ahead 147 loads to Shigar. Then we laid in supplies in the bazar —tea and sugar, salt and tobacco, needles and thread and coloured cotton handkerchiefs, all to be kept for the coolies who were to be with us in the high region. In the bazar we saw a few stray dogs. In the other towns of Baltistan we had found none at all, whether from the

TYPICAL BALTI HOUSE.

Mohammedan dislike of dogs or because the earth supplies food in so niggardly a measure to man we were unable to make out.

The Duke made the necessary arrangements to have the meteorological observations taken in Skardu three times a day through the period of the expedition, and also organized our postal service. The Government telegraph and post runners do not go beyond Skardu, but we were to remain in communication with our homes through special runners engaged by the Duke; they performed their service with marvellous exactitude up to our very farthest post on the Karakoram glaciers.

At five o'clock we went to see the polo match got up in honour of the Duke. The polo ground is very large, and lies on a flat natural terrace to the west of the city, overlooking the great sandy plain and the splendid amphitheatre of snowy ranges, between which the great Shigar valley cuts a wide trench northward. On one side is a high covered stand, at the foot of which the orchestra played incessantly. All round was the festive crowd, diversified by the khaki uniforms of the soldiers and the white, pink or blue turbans of the important personages of the place. The polo players were sixteen in number, all dressed in white. The Rajah was a first-rate horseman, following and hitting the ball very cleverly with his polo mallet, supported by his own side, with

THE RAJAH'S POLO TEAM AT SKARDU.

their great white cloaks fluttering in the sunshine. It was really a fine sight. After the match we went back to our work, and the polo ground was invaded by boys, who continued the game on foot, practising hand and eye for the difficult art.

The Duke deposited with a Skardu merchant the portion of our provisions which would be needed for the return journey, also a considerable bulk of money. It is a long, tiresome business to count all this small change. In our few free minutes we wrote letters and telegrams. At about eleven o'clock, after a long heavy day of more than eighteen hours, we went to bed tired out, but glad to have got through the first big stage of our journey. We had covered about 225 miles in eleven days among the chains of the western Himalaya.

CHAPTER IX.

FROM SKARDU TO ASKOLEY.

THE SHIGAR AND BRALDOH VALLEYS.

Crossing the Indus. — The Oasis of Shigar. — The Mosque and the Village. — Presents, Polo, Concerts and Dancing. — The Shigar Valley. — The Meeting of the Basha and the Braldoh. — Glacial History. — The Chain of Mango Gusor and Koser Gunge. — The B^{21} Chain. — The Skoro Lumba Pass. — Crossing the Braldoh on *Zhaks*. — Dusso. — The Braldoh Valley. — Gomboro. — Mud Streams. — Rope Bridges. — Chongo. — Balti Graveyards. — The Hot Springs of Chongo. — Askoley. — Rearrangement of Baggage. — Provisions for the Coolies. — Isolation of Askoley. — Raids from Hunza and Nagar. — The Ram Chikor. — The Lambardar of Askoley.

On Sunday, May 9th, at half-past six in the morning, we left Skardu with 111 coolies and eight saddle-ponies to cross the Indus and penetrate into the Karakoram ranges. Fifteen coolies and forty-eight horses had been sent ahead the day before.

There is a way to get from the Indus into the Shigar valley without going through Skardu, by crossing the Indus at Gol and following its right bank up to the spur between the two valleys, then crossing this over a pass that leads directly to Shigar. A glance at the map will show that this route is by far the shorter. The difficulty is that at Gol there is no means of crossing the Indus except on small native rafts, and it would have taken the whole day to get a party like ours across. Besides, we had too many important things to do at Skardu to think of leaving it out.

We retraced our route of the day before to a point where the path comes down from the alluvial terrace into the river bed. Some way up the bank above the meeting of the Indus and the Shigar a couple of great barges were awaiting us, upon which we embarked with baggage, coolies and ponies. Each boat was handled by a dozen powerful oarsmen. who put the whole expedition across in half an hour,

CROSSING THE INDUS.

landing on the right bank nearly opposite the starting-point, in spite of the strong current and the breadth of the stream, which here is about 300 yards.

We mounted our ponies, and rode a couple of hours up the right bank parallel to our course of the day before on the left, and along the foot of the spur which separates the Indus from the Shigar valley. This spur was once the bottom of the basin, and its upheaval at a recent period between the two valleys has forced both rivers to bend westward before meeting. The spur slopes down into the vast sandy delta formed by the meeting of the rivers, and ends in a descending series of huge blocks, rising singly out of the plain, separated from each other by stretches of the delta sand. I fancy that in times of exceptional flood the Shigar may overflow into the Indus valley through these gaps. There are six of these great rocks quite distinct from one another, and the last but one is 1,300 feet high. Between it and the last, which is none other than the citadel rock of Skardu, flows the river Indus. On either side of the spur lies a vast extent of sand drifted into clearly marked dunes, with a general trend from north to south and the steepest slope turned to the east. They make marching heavy for ponies and coolies. There is no trace of vegetation.

THE PATH ON THE RIGHT BANK OF THE INDUS.

In this way we covered some three miles along the bank of the Indus, and then made for the ridge, following up a very narrow and tortuous rocky ravine, where a few euphorbia were growing, and which, after a short ascent, led us to a wide rounded saddle known as Strongdokmo. Here the vast Shigar valley opened before us, stretching north-east as far as the eye could see. On both sides of the saddle boulders have been observed which, if taken together with the polished round-backed rocks (*roches moutonnées*), prove that the great Shigar glacier must have flowed over this spur. We now cut diagonally down the north slope of the ridge, and soon reach the bottom and green cultivated land.

The map of this district shows all along the left bank of the river a series of villages below and above Shigar. In reality there is one single belt of cultivation several miles long, dotted with houses which are here and there grouped around a mosque. The only group of any size is the village of Shigar. The path is all shaded with trees, and runs between rice plantations and fields of various crops. Between these and along the way run ditches and irrigation canals full of yellow water, so loaded with deposit that, in order to make it drinkable, it must first

SAND-DUNES OF THE SHIGAR-INDUS DELTA.

be gathered into cisterns to deposit its sediment. The Workmans attributed to this wealth of sediment the extreme fertility of the soil, which permits the Baltis to gather abundant harvests on the same land year in and year out without rotation of crops. As a matter of fact, however, they manure their fields abundantly (Moorcroft, Godwin Austen).

About two miles below Shigar the Duke was met by the Rajah with the usual cortège and an orchestra, neither less important nor less noisy than that of Skardu. They all escorted us to the polo ground, said to be the largest in Baltistan, around which grow trees of exceptional size. A walnut, a poplar (whose ancient trunk is hollowed into a huge cavity) and an immense plane remind us of the giants we had admired in Kashmir, having, like them, all the grace of trees which have been left to grow naturally and never mutilated by pruning. Near the polo ground, in the shade of the chenars, stands a large mosque with richly carved windows and doors. Inside, the columns which support the roof are arranged round a central square, from the ceiling of which depends a hanging lamp. The arrangement is similar to that in the Srinagar mosques, and according to Conway is characteristic of the Shigar valley, whereas in the Indus the centre of the mosque is usually occupied by an ornamental column.

THE POLO GROUND AT SHIGAR. KOSER GUNGE IN THE DISTANCE.

Of all the villages through which we had passed, Shigar gave us the impression of the greatest prosperity. The increase in well-being derived from the wide extent of the irrigated fields showed itself in the cleaner clothing of the people and in the houses. Some of these were built of sun-baked bricks, with verandah and roof terraces protected by a light awning of wood. Here and there in little open places between the houses great slabs of stone are set up against the wall and carved in rough bas-relief into concentric circles, which seem to be targets for archery.

The people look happy, and when the grain is sown they seem to have nothing to do but lie in the pleasant shade and wait for the crops. Nevertheless, they must have hard and continuous work regulating the irrigation water, building and keeping up the canals, preparing the terraced fields (which often need strong retaining walls), removing stones and bringing large quantities of earth. At all events, they celebrated our arrival by a cessation of all work, and the whole population had a holiday to observe with intense interest every visible detail of our life. They kept, however, at a respectful distance, not so much out of fear of the slender rods of the chuprassis, which could hardly inflict much pain through heavy woollen clothing, as owing to a natural sense of modesty and respect.

In addition to the usual gifts of flowers, fruit and bread, they offered numerous elaborate cakes, so adorned with white sugar that they would have done honour to any confectioner. We were now beginning to get accustomed to the native tea, which was frequently flavoured with rosewater, and always cleared with a salt which precipitates the tannin and colouring substances. Among other things they brought us cups, tumblers and pipes carved in soft green soapstone, which is taken from a quarry in the valley behind Shigar.

Among those who came to pay their respects to the Duke we recognized a man who had joined our escort at Tolti, whom we had confounded with the Lambardars and chuprassis, but who now turned out to be the Wazir of Shigar. He had accompanied the Eckenstein-Pfannl-Guillarmod expedition on the Baltoro glacier, and when he heard of our coming he met us, wishing to join the Duke's caravan. He accompanied the expedition throughout the campaign, and was always quiet, silent and discreet, and of great use owing to his power over the coolies.

A young English officer back from shooting ibex and markhor encamped near us and showed us his trophies. The afternoon was spent pleasantly in watching a lively match of polo and in listening to the orchestra, which played for dancing. The crowd stood, as usual, in a semi-circle behind the musicians, and here and there from the rows of spectators peered the little heads of ponies, who seemed to enjoy the game as much as any one. We agreed with Ujfalvy and Biddulph in finding the Aryan type purer and more universal here than in the Indus valley.[1] Cunningham, however, considered Mongol characteristics especially prominent among the Baltis of Shigar. The women seemed to be kept less carefully secluded here than in the Indus valley. One

[1] See the illustrations on pp. 87, 90, etc.

met them frequently about the villages, and when they are alone they expose their faces with no great amount of backwardness. They often wore violet-coloured clothing, and the faces of the younger ones were regular and pleasing, and surmounted by luxuriant black hair.

Throughout the Shigar valley, and farther up in the Braldoh, I observed a number of goitres, frequently accompanied by characteristic signs of cretinism, both among the people and our own coolies.

POLO AT SHIGAR.

The wide Shigar valley, with its level bed open on every side, makes a marked contrast to the gloomy valley of the Indus, so deeply imprisoned between its high and precipitous walls. It begins at the meeting of the Basha and Braldoh valleys, whose rivers flow together and form the Shigar. Both valleys are narrow and trough-shaped, with features common to the other valleys of the region. The Basha valley continues in the same direction as the Shigar toward the north-west, and gathers the waters of the numerous glaciers of the southern slopes of the western Karakoram, which has been the scene of the frequent expeditions of the Workmans. The Braldoh valley turns eastward and rises to the Biafo and Baltoro glaciers.

Between its source and the point where it alters its course to wind round the spur which divides it at the lower end from the Indus, the

Range to the left of the Shigar Valley (from near Sildi)

Shigar valley runs from north-west to south-east for about 25 miles, maintaining a width of about three miles and with a drop of some 350 feet.[1] The sand has obliterated nearly every trace of glacial action. Only in sheltered corners and on the lee side of lateral spurs are to be found moraine remnants,[2] which bear witness to the past occupation of the valley up to a great height by a gigantic glacier, which included the

CHAIN ON THE RIGHT OF THE SHIGAR VALLEY, WITH B^{21}.

volumes of the Chogo Lungma, the Biafo, the Punmah and the Baltoro, all of which glaciers even now, confined as they are to their own valleys, inspire amazement by their vast dimensions.

Of the two mountain ranges which stand right and left of the Shigar valley, the greater and more important is beyond doubt that to the

[1] The official altitude of Skardu is 7,503 feet. The height of the village of Shigar, calculated on the basis of the Duke's observations, is 7,517 feet, and that of Dusso, at the entrance of the Braldoh valley, 7,874 feet.

[2] According to GODWIN AUSTEN (*Jour. Roy. Geog. Soc.* 34. 1864, p. 19) the village of Shigar is itself built upon a thick deposit of earth and angular, not stratified, detritus of morenic origin.

east, which separates it from the Braldoh valley and contains Mango Gusor (20,633 feet) and Koser Gunge (21,000 feet)[1]. The valleys of this range are, however, so deep and so long that only the peak of Koser Gunge is visible from Shigar, standing at the north end of the chain and covered with great glaciers. Farther north the Shigar valley appears to be closed by a group of snowy mountains, the Ganchen, 21,204 feet

THE SKORO LUMBA, ON THE LEFT OF THE SHIGAR VALLEY.

high, which it seems the Shigar people call Simbilla. The western side of the valley is formed by a steep range, which is all in sight from top to bottom. It is furrowed by ravines and precipitous gorges, full of small hanging glaciers, and dominated by a fine snow peak in the centre, the B^{21} of our maps.

The path ascends the Shigar valley on the left or western side. From Mango Gusor runs down into the Shigar valley the first side valley, the Baumaharel, which comes out just behind Shigar, with a

[1] According to the Workmans, who ascended it in 1899.

mouth like a gate, only a few yards wide, between cliffs of gneiss. Immediately beyond this opening the valley grows wider, and is cut across by an ancient moraine. Five miles above Shigar the second great tributary valley, the Skoro Lumba, opens out.[1] This valley leads up to a pass of the chain, the Skoro La, 16,716 feet high, which is the direct route to Askoley. The journey from Shigar to Askoley is done in three stages, but at this season the pass was still blocked with

MEETING OF THE BASHA AND THE BRALDOH, AND HEAD OF THE SHIGAR VALLEY.

snow, and we had to go all the way around the chain and ascend first the Shigar valley up to its bifurcation, and then the Braldoh valley from its mouth to Askoley, more than twice the distance but all along the valley beds.

The Shigar valley is usually taken in three stages, stopping at the villages of Alchori and Yuno; but we did the 29 or 30 miles in two days. After Shigar, for about six miles, we went along a shady road, unbroken even by the wide stony beds of the torrents which flow down from the mountains on our right. Little by little, however, increasing reaches of desert intervene between the villages, and the cultivated land again takes the form of oases.

[1] *Lumba*, or *loomba*, means valley.

The Shigar river, divided into a network of rivulets, fills the whole of the flat valley bottom, so that the path is forced to skirt the foot of the range, whose high peaks are hidden by projecting spurs. As we approach the peak of Koser Gunge it too disappears with its glaciers, and is no longer visible except now and again through some valley opening. Torrents flow down from these openings, fortunately subdivided into small streams quite easy to cross by jumping or to ford on the ponies. We stopped for the night at Kushimul, in a field

THE SHIKARI ABDULLAH, AND THE GIANT VINE OF KUSHIMUL.

enclosed with a little hedge, under a cherry, a pear and an apricot tree and an old mulberry, the last festooned with a gigantic vine whose trunk had grown almost as great as its support.

The second half of our route took us round by the projecting spur of Busper, which runs northward from Koser Gunge, and whose ridge, running down in the opposite direction to the Ganchen, bounds the opening of the Braldoh valley. The mountain spurs have shoved back the path to the sand and pebbles of the valley bottom, save for an occasional brief space where the river flows to their very bases. Between the ends of these spurs we crossed considerable reaches of sand, which appear to be a few hundred yards wide, and are sometimes as much as a mile. Several tributary streams obliged us to mount our ponies so as to ford them. The water grew thicker and muddier, as if to prepare us for the mud streams of the Braldoh valley. It must certainly ferry down immense quantities of clay yearly.

We now began to turn eastward little by little round Koser Gunge, and hardly noticed that the mouth of the Braldoh valley had been entered until we found ourselves opposite Dusso, its first village, standing on the other bank. Two primitive native rafts, known as *zhaks*, composed of interwoven branches tied by cords to inflated skins, were

THE GANCHEN GROUP FROM THE MOUTH OF THE BRALDOH VALLEY.

waiting for us on the bank. Each raft was piloted by two men, and driven out into the stream with long poles as soon as we had taken our places on the boughs, whose interstices were so large that we felt as if we were sitting in the water. The Braldoh is at this point about 100 feet wide and very swift. As the current caught us we began to whirl round and round, seeing the whole of the panorama about us five or six times in the space of a minute. A little farther downstream, at a narrow point of the river, a light bridge had been thrown across the stream, made of two tree trunks with cross-bars and branches laid over them; and by this route our guides and coolies reached the opposite bank. Once on the other side, we went up as far as the trees of Dusso and set up our camp.

We were now again shut in between steep mountain walls, and could see none of the high peaks around us. Only westward, through the narrow mouth of the valley, could we catch sight of a bit of the chain to the right of the Shigar valley. A little farther upstream two long spurs of the Koser Gunge and Ganchen run down opposite one another, and seem quite to cut off the valley. On the ridge of the second, just over the camp, rises the strange monolith indicated on the map by the name of Shamasir Pir Gombar. According to the local legend, as given

CROSSING THE BRALDOH ON A ZHAK.

by Godwin Austen, it is inhabited by a snow-white bird which guards a lump of pure gold placed on a cushion of embroidered velvet. Any object which cannot be found in the morning is supposed to have been stolen by the Pir. Luckily this thievish fowl paid no attention to us.

The Tehsildar of Skardu took leave of the Duke, and retired to his home, carrying our mails with him. The ponies had been left on the other side of the river, and henceforward our journey was all on foot.

The Braldoh valley is of the same type as the Indus, only its smaller dimensions make it seem even more narrow, and its walls more precipitous. It makes sharper turns, too, round the foot of the spurs which run down on either side and cross each other. The masses of detritus and sedimentary deposit which cling to the precipices up to a considerable height are extremely insecure, and the path must, without doubt, be frequently destroyed or cut off by landslides.

THE LOWER BRALDOH, WITH THE GANCHEN IN THE BACKGROUND.

The distance up the valley from Dusso to Askoley, the highest village, is about 22 miles, with a rise of 2,140 feet—from 7,874 to 10,013 feet. But the path is several miles longer than the distance as the crow flies, and there must be several thousand feet of up and down involved in crossing the numerous ridges which lie in its way. The first and one of the very steepest is the long spur which runs down just above Dusso, and which the path crosses about 1,000 feet above the river. At the top of the laborious climb we halted a little to take breath, and to gaze upon the great glaciers of Ganchen. The coolies made a little fire in the shelter of a big projecting rock, and prepared their usual early breakfast by crumbling their chupattis into hot water with a little salt. Others were inhaling, turn and turn about, a few mouthfuls of smoke from the pipes which they construct in the clay soil. A thin stick is buried in the earth with the two bent ends projecting. Around one end they mould the earth into a funnel-shaped pipe bowl, and then pull out the stick, leaving a little tunnel under the earth through which they inhale through their hands. The tobacco, which is extremely evil-smelling, will only burn when kept in contact with a live coal. There is generally some coolie in the caravan who has brought his primitive narghile, made out of a little gourd or hollow bit of wood, into which are stuck the clay pipe bowl and stem, through which they smoke in turn, grasping the end of the stem with their fist and inhaling through it. This is also their ingenious method of smoking cigarettes. Notwithstanding their heavy loads, they reached the top of the ridge without panting or signs of fatigue. Those among them to whose lot the easier loads had fallen carried the flour and provisions of their more heavily burdened companions.

Once over the top of the ridge, the path skirts down along the barren slopes till it reaches a narrow ravine cut by the water through a terrace of detritus. Down this we descended to the river, whose bank we then followed around the base of high perpendicular cliffs of friable conglomerates, with notched upper edges which represented the section of the terraces they support. Southward we could see the whole of the Koser Gunge, with the great radiating buttresses which run down from it; while northward, between the Ganchen and the Mushun, opens the tributary valley of Hoh Lumba, which, with the glaciers at its head, was explored by the Workmans in 1903. A little beyond the mouth of this valley we set up our camp, near the village of Gomboro. Here the apricots were still in blossom, and germination barely beginning. The sown fields were still quite bare.

On the morning of May 13th we pursued our march up the valley, everywhere hemmed in between steep mountain spurs coming nearer and nearer to one another and forcing the river into a winding course. The whole valley must at one time have been filled with immense masses of detritus mingled with clay to a height of 700 or 1,000 feet, which were then cut through by the torrent, forming extremely steep if not absolutely vertical sections. Above the level of detritus the rock walls are in even more active process of disintegration than in the Indus valley. Lydekker has observed traces of glacial action as high as nearly 2,000 feet above the bed of the valley—vestiges of the glacier which was once formed by the conjunction of the Baltoro, the Punmah and the Biafo.[1] The path, which often becomes a mere track, runs nearly the whole way along the bottom of the valley, and is exposed to landslides, which must be common even when the weather is dry,

KOSER GUNGE, AND THE ALLUVIAL TERRACES OF THE BRALDOH.

so frequent are the projections of the detritus wall and so ill held in place by the loose clay. Wherever the walls looked unusually threatening we would find ourselves unconsciously quickening our steps.

We frequently came across places where the path had disappeared under streams of mud, which had formed into fan-shape and then dried and hardened, leaving deep indentations on the brow of the overhanging cliff. At other points, where side ravines joined the main valley, we would go down to the bottom of deep torrential beds covered with a

[1] LYDEKKER, *The Geology of Kashmir and Chamba Territories. Mem. of the Geol. Surv. of India*, 22, 1883, p. 186.

thick layer of hardened mud, through the middle of which oozed a thin trickle of muddy water. These were plainly the beds of mudstreams. We found none in active progress, but these traces sufficed to show the great difficulty they must present when they flow across the road many yards wide and deep, carrying down with them heavy masses of rock. They are a characteristic feature of all upper Baltistan, where they are known as *shwa*. Many a traveller has been surprised by one of these

THE HOH LUMBA AND THE MUSHUN GROUP.

moving masses—half avalanche, half flood—and has run grave danger of seeing some of his caravan carried off by them. All our predecessors, Godwin Austen, Conway, the Workmans and the Eckenstein-Pfannl-Guillarmod expedition, witnessed the strange phenomenon on a smaller or greater scale.[1]

The origin of the streams has never been fully explained. Very different forms of alluvial action have, in fact, been included under the

[1] In addition to the works of the above-named authors, already quoted, see Col. H. C. B. Tanner, *Our Present Knowledge of the Himalayas. Proc. Roy. Geog. Soc. N.S.* 13, 1891, p. 403; and the article of Ch. Rabot, *Glacial Reservoirs and their Outbursts. Geog. Jour.* 25, 1905, p. 545.

name shwa—as, for instance, great floods caused by the breaking of a temporary dam formed by a landslide or by the protrusion of a lateral glacier, to which I have alluded in my description of the Indus valley, or the sudden inundations produced by the breaking of a glacier reservoir. These are unusual disasters, and purely casual, as are the causes which bring them about, and they happen with the violence of the true cataclysm. They have certainly nothing in common with the mudstreams which may be seen every year towards the end of April[1] oozing down the tributary ravines of the high valleys. One strange characteristic which has been several times observed in them is their intermittent nature. A volume of half-liquid mud rolls down like a wave, mingled with big stones and pieces of rock of all sizes. Then there will be an interval, long or short, of which the traveller takes advantage to cross the bed with all speed. Then comes another great gush and another interval, and so on. The mud gradually grows less thick, and ends by being simply muddy water.

The volume of matter thus brought to the bottom of the valleys must be enormous, a fact which suggested to Conway the somewhat hazardous hypothesis that to these mud avalanches may be due the filling up of the valleys with detritus to the depth of hundreds of yards, or even in some places absolutely up to the crests, so as to form great table-lands such as those of Tibet and Pamir.[2] There is no doubt that the mud streams come from the huge banks of clay which hang upon the walls of the valleys. These are little by little saturated with water from the spring melting of the snows, until they reach such a point of semi-fluidity as to slide upon the steep slopes and finally descend by their natural paths, the gullies and ravines. Temporary obstructions caused by some great boulder and by the viscosity of the mass itself explain the intermittency and oscillation of the flow, which is similar to that of the lava streams on the slope of a volcano during eruption. As I have said, we did not come across any active mud streams. The mud in the beds was dry and hard, and looked as though it had been long solidified, whether through an unusual delay in the melting of the snows in this particular year or for some other reason.

[1] According to Conway the shwa are active in the hot days of June and the early part of July.

[2] The hypothesis of Conway among other things fails to explain the origin of the gigantic clay deposits necessary to feed such torrents of mud.

We observed at frequent intervals, especially along the banks of streams, reaches of sand covered with a white efflorescence similar to that I have described in the Indus and Shigar valleys. The oases were few and lean. The region is poor, like the upper Dras valley. Outside of the oases the sole vegetation consists of a few thorny thickets of roses and barberries, clumps of wormwood with a scent between thyme and camphor, wild currant bushes and a few gnarled junipers. Insects and lizards were still in their winter sleep. We were nearly 10,000 feet up, and spring had hardly begun.

TEMPORARY BRIDGE OVER THE BRALDOH BELOW CHONGO.

Presently our path was cut by a spur which ran down into the river, and we were forced to cross to the left bank. A temporary bridge of beams supported on big rocks projecting out of the torrent saved us from crossing on the rope bridge, which was hanging loose and in a very dilapidated condition. A little over half a mile farther on we returned to the right bank of the Braldoh over a solid rope bridge, well kept up. But here, too, the coolies hastily set up a little bridge in sections across the river, greatly facilitating the crossing of our large party. We went up the bank as far as a wide terrace upon which stands the little village of Chongo, where we encamped.[1]

[1] Caravans usually make their stage on the left bank of the Braldoh, between the two bridges, in the oasis of Pakora. There is a mistake in the itinerary map which puts Chongo in the place of Pakora. Chongo is on the right bank of the Braldoh and a little farther upstream.

The valley now seemed to open out, but heavy mists rested upon the mountains, and we scarcely caught brief glimpses of Mango Gusor, an extraordinary rocky tooth which falls sheer to the valley, forming a huge smooth black wall cut across by a few long straight white lines marking crevices and chimneys filled with snow. The day was windy and cold.

ROPE BRIDGE BETWEEN PAKORA AND CHONGO.

A little below the village are three cemeteries, standing one above another along the slope, so large as to seem quite out of proportion to the number of the living, as if they had served for a much larger village than the Chongo of to-day. Children's graves are in the great majority in all three. In fact, the lowest of them, through which runs the valley path, is entirely made up of the tombs of infants. We had already noticed burying places in the Shigar valley, entirely filled with these tiny graves, which speak volumes of the cruel process of selection inflicted upon this people by the hard climate, their poverty and the unhygienic conditions of their life from infancy upwards.

In the Indus and Shigar valleys the tombs, large and small, consisted of slabs of stone planted in the ground or of a low wall enclosing a rectangular plot.[1] They showed no sign of being regarded with any special reverence[2]—indeed, so little is this the case that we would find here and there one of the older and larger graves turned into a diminutive kitchen garden. These tombs were scattered haphazard over any open space, mostly under the trees, and not within any enclosure. The tombs at Chongo are quite different. The low wall is replaced

CHILDREN'S GRAVES AT CHONGO.

by a rectangular fence of little wooden beams fitted into four square corner posts, whose tops are cut in the shape of a die or a diamond. The most interesting of the three cemeteries is the highest. It is now plainly abandoned, the wall which once enclosed it partly in ruins, and of the door only the wooden frame is left. Within this enclosure are a dozen tombs surrounded by the small wooden railing just described and a few others, so much larger as to seem monumental by comparison, these latter consisting of clay brick walls strengthened at the corners

[1] See illustration of the Parkutta cemetery, p. 120.

[2] We occasionally met with an isolated tomb adorned with one or two upright poles hung about with rags; the grave of some saint, but held in far less veneration than similar burying places in Central Asia.

Chongo

by beams incorporated in the masonry. The strange thing is that constructions so elaborate are to be found in the Indus valley only in the most prosperous villages, whereas the habitations of Chongo are rudely built of rough stones and mud. Upon the corners of these walled enclosures are placed four or more big round stones. The ground within had in several cases broken through, showing that under the enclosure the earth was hollowed out into a chamber with a roof made of beams and beaten earth. There was no trace of funeral objects or any fragments of skeletons.

A CEMETERY AT CHONGO.

The stage from Chongo to Askoley is only about six miles, and we had time to stop and enjoy a warm bath in a hot spring by the way. We came across it a little above the small torrent which supplies the Chongo oasis, on the west side and nearly at the top of a conical hillock some 150 or 200 feet high, with a base perhaps some 650 feet in diameter. The ground sounded hollow to the tread or the blow of a stick, and was quite covered—possibly entirely composed—of saline encrustations, white where new, yellowish where old. The conical formation is incomplete, because it is cut off on one side by the slope of the mountain. At the top it is split by a long, deep fissure, about 18 inches wide, through which apparently no gas issues.

The basin is perfectly round, from 50 to 60 feet in diameter and about three feet deep in the middle—a veritable little pond, full of the most limpid water having a slight odour of sulphurous anhydride, and an exquisite emerald hue due to the algæ which cover the bottom. The water bubbles up through five or six openings in two groups, one near the edge of the fountain, the other in the centre. It overflows the furrowed lip of the basin, which is formed by yellowish-white saline

THE HOT SPRING.

conglomerates. This formation likewise covers the whole of one side of the cone with regular layers. The temperature of the water, taken at the biggest opening near the edge, was 120° F. (thermometer Hicks, N. 449,310).[1] All round this opening was a flourishing growth of long weeds. Among them or scattered over the bottom of the basin were bundles of filaments encrusted with calcite. Guillarmod made the interesting discovery that these bundles are composed of hairs, but it seems improbable that they could accumulate in such large quantities

[1] In 1902, according to Guillarmod, the temperature was 100·7° F. Godwin Austen found in the various hot springs of this region temperatures of 104·5°, 137°, 122°, 117° and 110° F.

merely from the occasional falling of hair of the natives when bathing there.[1]

From the opposite or east side of the fountain the cone slopes down in a series of small terraces, where a stratification is occasionally visible. Many of these terraces are fringed with a close series of small stalactites, which makes them look like petrified cascades.[2]

THE STALACTITES OF THE HOT SPRING.

After a good half-hour's bath we started on with a lighter step, and after crossing two more torrents reached Askoley before nine o'clock. Near the village is an open space divided into little fields and shaded by willows and poplars. The Duke had the camp set up in one of these fields, and the guides' tents and kitchen in another.

[1] Professor R. Pirotta kindly examined for me the specimens collected at this fountain. He found them to be composed of a thick tangle of colonies of schizophytes and green filamentous weeds, encrusted with calcareous deposit and mixed with crystals of calcite and higher vegetable forms which must have come into the fountain from outside. Other specimens proved actually to consist of bundles of human hair, so thickly encrusted with calcareous salts as to resemble vegetable tangles not unlike the bundles of *caraceæ* found in thermal springs. All the samples of encrustations collected from around the fountain were proved by analysis to be simple specimens of carbonate of lime, or calcite (Novarese).

[2] Beside this spring Godwin Austen mentions three others lower down near the bank of the Braldoh. These were still there in 1902, when the Eckenstein-Pfannl-Guillarmod expedition saw them; but we found no trace of them, and the natives told us that the bank out of which they sprang had been carried away by the river.

We had now reached the last inhabited spot on this side of the Karakoram. Twenty-two days' march had brought us 295 miles with all our luggage, without any interruption and without a single mishap. Notwithstanding the extremely complicated nature of the equipment and the thousands of hands it had passed through, we had not only not lost a single piece out of over 200 packages, but we had not even lost a single small article. What better proof could there be of the

THE CARAVAN AT ASKOLEY.

honesty of the Baltis? We were all in splendid condition, and our well-divided stages had brought us almost imperceptibly up to a pitch of training for the far greater demands which were now to be made upon our strength.

Askoley stands 10,013 feet above the sea level, at the very gate of the high mountains.[1] We had now come up out of the stuffy heat of the valleys. A little farther on all trace of path ceases and the great frozen basins of the Karakoram begin. We had now to change our

[1] Sir Martin Conway gives Askoley a height of 10.360 feet, but this must be a misprint, for he gives the same height to Korophon, farther up, beyond the Biafo glacier (op. cit. pp. 412 and 419). According to the Workmans the fort of Askoley (half a mile to the east of the village) is 10,300 feet.

personal equipment, put aside whatever we no longer needed and make a thorough and careful selection of what it would pay to take with us. Furthermore, from this point on we should have to provide for our coolies. The grasping Kashmiri and Sikh merchants of Skardu had made us believe that Askoley would be unable to furnish us sufficient flour, so we had bought it all at Skardu and sent it on to Askoley before us.

The Duke organized an advance caravan that afternoon. Ninety-three coolies carried as many maunds (80 lbs.) of flour sewn in skins. Thirty-five more were loaded with cases of provisions for the high regions, and ten carried the flour which this advance party would need on the way. A huge crowd of natives from Askoley and the lower villages assembled, hoping to be enlisted. They were of all ages and appearances, from mere boys to feeble old men, and even some who were crippled. For the present we engaged them as they came. Later on we would make a careful choice of the strongest and fittest to take with us to the high camps.

Askoley is a poor village indeed, and certainly one of the dirtiest in all Baltistan. Numbers of the houses are empty and in ruins, as if some of the population had abandoned the country. We were surprised to find stray dogs about, a rare sight in a Balti village. They were as large as wolves and looked like them, yellow and grey in colour. They wandered hungrily around the camp, only kept off by the missiles and threats of the angry servants. Possibly they are descendants of the dogs which Godwin Austen mentions as having been kept by the people of Askoley for hunting and trained to drive the ibex toward the huntsman. That was in 1861. Nowadays the natives are no longer permitted to have firearms.

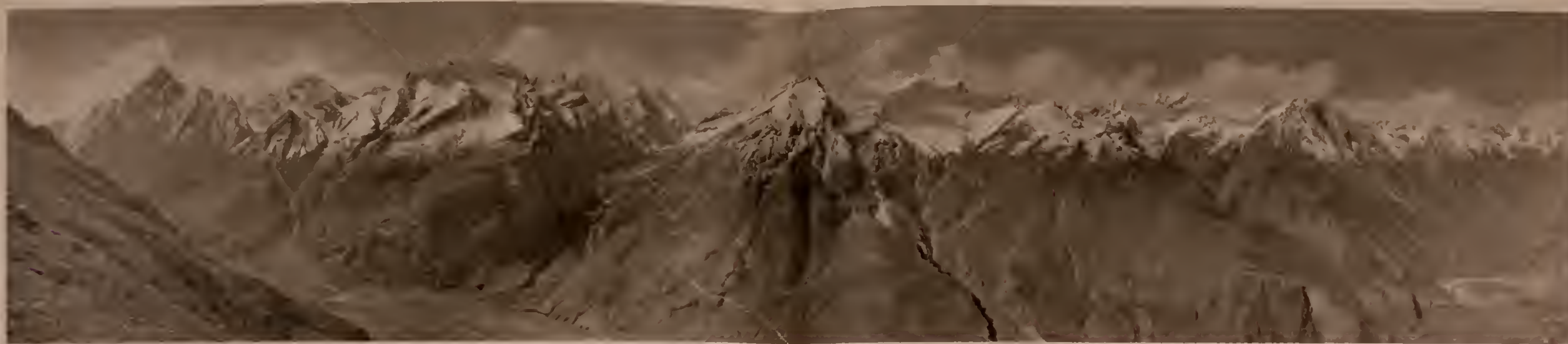
There are only a few fruit trees, but plenty of willows and poplars. The cultivated fields are very extensive, sloping down from the village to the river, while at a little distance above the river the mountain side is covered with very fair pasture. The place is liable to earthquake. In 1902 the Eckenstein-Pfannl-Guillarmod expedition felt two perceptible shocks on May 30th and 31st.

Few communities are so cut off from the world as this little population of Askoley. Before them lies an infinite extent of glaciers, shut in by the most gigantic mountain ramparts in the whole world: behind them a desert valley, which for eight months in the year is absolutely blocked by the snows, the avalanches and the Arctic temperature. The two small panoramas here reproduced show far better than words the appearance of the country round Askoley. They display the utter barrenness of the slopes, the cliffs of detritus reaching half way up the mountain walls, the cones formed by the falls of disintegrating rock, the deep gorges hollowed out by the rivers and torrents in the thick alluvial deposits, and the little oases of cultivation around the last three villages at the mouth of the tributary ravines of the valley. They include, too, the fine chain of Mango Gusor, opposite Askoley, with the valley of the Skoro La, opening on the very face of the mountain wall at least 1,000 feet above the Braldoh; and to the west of it a great snowy peak, whose glaciers come to a sudden end at the top of steep couloirs, and every now and then fill the valley with the roar of their avalanches.

MANGO GUSOR FROM ASKOLEY.

In spite of these formidable natural protections, Askoley was for a long time wasted by raids of robbers from Hunza and Nagar. These were only brought to an end with the conquest of the latter territories by an English military expedition and their annexation to the kingdom of Kashmir. Incredible as it may seem, these marauding bands used to traverse the whole length of the Hispar glacier, cross the col and descend the Biafo, more than 65 miles of ice, for the purpose of raiding Askoley. The last raid was in 1840. A band of 700 or 800 men, led by the Wazir Hollo, reached Askoley in the autumn, and seems to have departed with rich booty, obtained either by violence—as Godwin Austen was told in 1861—or according to Conway in the form of a ransom paid by the village. But the season was too far advanced, and the whole band is supposed to have been lost among the glaciers and snowstorms on the way back, only the leader escaping with his life.[1] I will

[1] Guillarmod (op. cit. p. 146) gives a wholly different version of this raid, confusing the Nagar tribes with the Tibetans, the Hispar with the Mustagh pass, etc.



Range ou the left hand side of the Braldoh Valley (from a height to the North of Askoley, about 13.000 ft.)

The Braldoh valley above Askoley

speak later on of two other routes—across the Punmah glacier and across the Baltoro—which at one time connected Askoley with the country north of the Karakoram, Chinese Turkestan.

We had a great deal of work to get through, which kept us at Askoley for the whole of the day following our arrival. Sella, who had worked late into the previous night to set the photographic equipment in order, took advantage of the halt to climb with his gun and camera on to the rock wall which overhangs Askoley. He was

GETTING SUPPLIES AT ASKOLEY.

rewarded by a panorama of the Mango Gusor range, a collection of specimens of garnets and a fine *ram chikor* (*tetraogallus Tibetanus*), the giant partridge of the Himalaya. According to Thomson the people of Askoley hunt these partridges by forming a ring around them in great numbers, and beating them from side to side with shouts and sticks until they are so exhausted that they can be caught with the hand. In spite of the remarkable barrenness of the slopes, big herds of ibex and markhor, and innumerable marmots, partridges and other wild creatures, manage to live on the scanty grass growing on the high slopes in corners and crevices known to them only.

We had a little flock of sheep and goats put together to keep us supplied with milk and meat. They were to be kept on one of the southern spurs of the Baltoro glacier, where there would be pasturage throughout the summer months. They were at once sent ahead with their shepherds. We carried with us also a fair number of fowls and several dozen eggs. In this way we managed to keep supplied with fresh provisions even on the high glaciers, and these, taken alternately with tinned food, rendered our nourishment more palatable and less monotonous. Our Kashmiri servants were not to accompany us any farther, but to await our return at Askoley.

During the two days we spent at Askoley the weather was changeable, sometimes cloudy with heavy and stagnant atmosphere, sometimes gusty with a little sleet. The evenings were calm and clear. The temperature went down to 28° F. in the night.

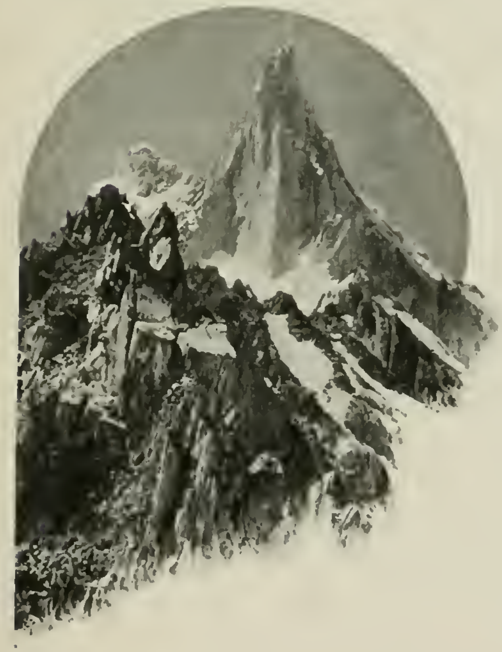
The Lambardar of Askoley, who, like his people, looked extremely wretched, took charge of and placed in a tolerably dry and sheltered room the part of the equipment which we had decided to leave here and the cases of provision for the return journey to Skardu. We hoped we should not meet with the ill-luck of the Guillarmod expedition, which was prevented from returning to Askoley by an outbreak of cholera.

CHAPTER X.

FROM ASKOLEY TO RDOKASS.

THE BIAFO AND BALTORO GLACIERS.

The Valley Walled across by the Biafo. — Crossing the Glacier. — The Boulder of Korophon. — Oscillations in the Volume of the Biafo Glacier from 1861 onwards. — Inundation of the Braldoh Valley. — Present Condition of the Glaciers in the Western Himalaya. — The Biaho Valley. — Mango Gusor. — The Ford of the Punmah. — The New Mustagh. — Deserted Passes. — Bardumal. — First Sight of the Baltoro. — The Trout of the Biaho. — Paiju. — The Snout of the Baltoro. — Striking Absence of Frontal Moraine. — Glaciological Notes. — Getting on the Glacier. — The Layer of Moraine. — Appearance of the Baltoro. — Glacier Lakes and Torrents. — Walls of the Lower Baltoro. — Paiju Peak. — Machichand Camp. — Marginal Lakes. — Liligo Glacier. — The Mustagh Tower. — Second and Third Southern Confluents of the Baltoro. — The Gasherbrum Range. — The Buttress of Rdokass.



We set out from Askoley a little before six o'clock on the morning of May 16th, very impatient to get at last within sight of the goal we had come so far to seek. At Srinagar we had taken leave of civilization, and at Skardu of its slender and far-reaching tentacle, the telegraph wire; but at Askoley we were cutting ourselves off from human society altogether, at the entrance of the ice deserts of the Karakoram.

A little above Askoley, where a broad squat tower bears witness to the ancient strife against the Hunza raiders, we came down into the alluvial bed left dry by the stream now at low water. Farther on, however, the river flows close round the foot of a rocky spur, which we were thus forced to cross by a short climb. The Biafo glacier, lying in its deep valley, was not yet visible, but beyond it stretched the range of icy peaks which form the eastern wall of the Punmah valley, dominated by a magnificent mountain known to the natives as Paiju, because its other slope overlooks a camping ground of this name at the foot of the Baltoro glacier.

We now once more made our way across the shingle and pebbles of the valley bottom, no longer the narrow gorge it was below Askoley, but over a mile wide and quite level. In less than an hour we stood

THE FORT AT ASKOLEY.

before the marvellous spectacle of the Biafo ice stream, over 300 feet high, which, coming down out of a tributary valley on the right, breaks into the Braldoh valley and appears to cut it off for its whole width as far as the rocks at the foot of Mango Gusor. The glacier is covered with a black layer of shingle, showing the clear ice only in vertical breaks and cracks. In its invasion of the Braldoh valley it has pushed the river up against the left wall of the valley, while its own emissary, the Biafo torrent, escapes from its side near the right bank of the valley and meets the Braldoh farther down. The two rivers and the side of the glacier thus enclose an irregular sandy delta on the level valley bed, which is dotted with brushwood, dwarf junipers and willows.[1]

[1] The terminal snout of the Biafo and the delta between the two rivers are clearly visible in the panorama reproduced opposite p. 158.

We had no difficulty in fording the various branches by which the Biafo torrent leaves the glacier, to whose immense proportions the

VIEW OF THE BALTORO GLACIER AND PAIJU.

volume of water so little corresponds as to lead us to suspect that its main output must still be through its snout, where the waters mingle with those of the Braldoh. The side of the Biafo, which is fringed at intervals of a few yards with small and low moraine deposits, is completely covered with stones, in spite of its steepness. From the top of this lateral wall the surface still rises gradually until about the middle of the glacier, where it must be some 400 or 500 feet thick. No longer compressed within the narrow walls of its native valley, the glacier spreads out in the shape of a fan, some two miles in width. Our way across, however, was about twice as long, because the surface was extremely irregular, covered with fragments of all sorts of rock—granite, quartz,

COOLIES RESTING.

schist, and occasionally limestone—and we had to take a very winding route. There were few great boulders and few open crevasses, but there were frequent splits, where one of the margins has sunk below the other, forming perpendicular steps from a few inches to several yards in height. The surface melting had not as yet gone very far. There were only a few pools on the right side of the glacier, a few rivulets and occasional glacial tables which had not reached any great height. As you look across the valley from the centre you get the impression that the glacier actually reaches the rocks of the left valley wall. This was, however, a mile off, and we could not be certain. A couple of hours brought us to the left side of the glacier, which is higher and steeper than the right, and descending which we reached the bottom of the valley. From this point onwards it is known as the Biaho.

A few hundred yards above the glacier lies a gigantic boulder called Korophon, at whose foot shepherds are accustomed to shelter at night. Here we halted to examine the snout of the Biafo. From this point it still seems to close the valley completely, and its thickness appeared to be uniform as far as the eye could reach. A projection of the glacier, however, prevented our seeing whether any space is left for the Biaho between the end of the snout and the side of the valley, or whether the water passes through a tunnel under the glacier. On our return journey Sella tried to reach the snout of the glacier to make sure whether the valley is completely cut off or no, but he was prevented by the lateral torrents, swollen from the summer melting. It was only when, on our return journey, we ascended the left side of the Braldoh valley on the Skoro La road that we clearly saw the river flowing under the open sky through a narrow gap between the valley wall and the steep front of the glacier. The latter showed no trace of frontal moraine. It is, however, possible that at some point of the left half of the glacier the ice may bridge over the river and actually reach the rock.

I have described in detail the position of the Biafo in the summer of 1909, because it has passed through considerable changes during the last fifty years. Godwin Austen found it in 1861 filling the valley from one side to the other, resting its snout on the rocks of Mango Gusor and entirely covering the river. In 1892 Sir Martin Conway found the snout a quarter of a mile away from the wall of the valley, and noted that during August it lost another quarter of a mile. As it withdrew, it left before it a wide moraine covered with earth and vegetation. This diminution in volume lasted and its rate increased during the following years, for in 1899 the Workmans found the Biafo so shrunk as barely to reach the outlet into the Braldoh valley at all. Then a period of increase must have followed. In 1902, according to Guillarmod, the glacier had again advanced as far as the right bank of the Braldoh river, driving before it a low frontal moraine.[1] The Workmans, however, on their

[1] Dr. Pfannl does not mention this frontal moraine, and describes the Biafo as a mass of ice 600 or 700 feet thick, protruding across the valley, squeezing the Braldoh into a narrow bed and ending with a steep snout 400 feet above the river. This description agrees with our observations made in 1909 (see *Mitt. d. Geog. Ges. Wien*, 47, 1904, p. 255).

return to the region in 1908, noted the Biafo as practically in the same position in which they had found it in 1899. Therefore, between their two expeditions it must have grown and shrunk again. Finally, in the year between the last visit of the Workmans and the Duke's expedition it must evidently have increased again considerably.

It would be strange if during such constant oscillations the Biafo had not at some time quite dammed up the Biaho river so as to form a lake. As a matter of fact Godwin Austen found current among the natives of Askoley the legend of such an accident, occurring perhaps some two centuries earlier. When the pent-up waters forced their way the devouring flood swept off a village of the Braldoh valley and carried its mosque entire down to the Shigar river. The sacred edifice which had performed so miraculous a voyage was rebuilt, piece by piece, in another village of the Braldoh valley, where it was still to be seen in 1861.

The alternate growth and shrinkage of glaciers at short intervals has been observed at many other points in this region. For instance, the caravan route from Leh to Kashgar over the Karakoram pass was obliged to abandon the upper Shyok valley, which was too often blocked by the glaciers flowing down the confluent gorges, and to follow a much longer and less direct route. Dr. Longstaff has collected and compared the existing data and local traditions on the oscillations of these glaciers, which have more than once dammed the stream of the Shyok and caused vast disasters.

Observations made on glacial changes are of real practical importance, because they afford the only possible way of determining changes of climate too slow and gradual to be studied directly. To establish, however, the behaviour of the glaciers of any region it is necessary to keep a good number under observation throughout a period of years, so as to get general results rather than isolated cases. If we consider the single observations made by travellers, we can only conclude that in the Himalaya in general and the Karakoram in particular every glacier appears to obey laws of its own, as we read of some which show all the signs of rapid shrinkage, others undoubtedly stationary for long periods, and others which, on equally unexceptionable testimony, are in a period of actual increase, occasionally so rapid as to sweep away and bury in their irresistible progress whole fields and cultivated tracts, and to threaten neighbouring villages with ruin. Behaviour so capricious on the part of phenomena which must presumably depend upon local conditions common to all, might possibly be explained by periodic changes of climate following each other at short intervals, as the time required for masses of snow precipitated in the upper basins to produce changes in the position of the glacier snouts may vary very considerably, according to the shape of the basins and the length and slope of the valleys.

The Geological Office of India undertook in 1905 a series of observations on the conditions of the glaciers of the western Himalaya, to be repeated at regular intervals. There is hope that in a few years the work thus done may lead to some exact conclusions.[1] Meantime we may refer to the opinion of Dr. Arthur Neve, who, after observing a great number of glaciers in the regions round Kashmir at varying intervals of time, is of opinion that they are, on the whole, in a period of growth.[2] Longstaff also found many glaciers in process of increase in the valleys of the eastern Karakoram, while the writings of Godwin Austen, Conway and the Workmans abound in confirmatory examples. It is, nevertheless, wise to take into account the cases which go to show the contrary—they are not few in number, and have been observed by the same travellers in the same regions—and to reserve judgment, contenting ourselves with careful observations of the appearance and position of the glaciers when occasion offers.

The Biaho valley, wide and with a level bottom, rises gradually and without sudden breaks eastward to the foot of the Baltoro, about 820 feet higher up. On leaving Korophon we marched along the bottom of the valley on the right bank of the stream, admiring as we went the tremendous rock wall of Mango Gusor, formed of great slabs of absolutely smooth stone which seemed from in front to be nearly vertical.[3] An hour's march brought us to the opening of the tributary valley of Punmah, and we crossed the sandy delta to the river, some 200 feet wide and two feet deep, flowing swiftly over a pebbly bed. Our Shikari Abdullah and two strong coolies saved us from a wetting by carrying us across on their shoulders. Later in the season the river becomes so much

[1] See H. H. Hayden, *Notes on Certain Glaciers in N.W. Kashmir*; and *Survey of Glaciers in N.W. Himalaya. Rec. Geol. Surv. of India*, 35, 1907, p. 123; T. H. Holland, *Glacier Movements in the Himalayas. Geog. Jour.* 31, 1908, p. 315.

[2] A. Neve, *Rapid Glacial Advance in the Hindu Kush. Alp. Jour.* 23, 1907, p. 400.

[3] On the northern slope of Mango Gusor, more than 3,000 feet above the bottom of the valley, Sir W. M. Conway found the imprint of a colossal glacier which must at one time have filled it.

higher as to be no longer fordable, and the traveller is obliged to ascend the valley to the jhula bridge suspended across a narrow gorge three miles higher up. We set up our camp on the alluvial deposit dotted with big stones which fills the angle between the Punmah and Biaho valleys. Here grows a poor and sparse vegetation of dwarf juniper, wormwood and astragalus. Mango Gusor from this point looks like a horn strangely twisted and bossed, covered with snow and ice, rising from

MANGO GUSOR, TAKEN FROM THE CONFLUENCE OF THE PUNMAH WITH THE BIAHO.

a wide base of black rock. The sky was clouded over and the dark atmosphere hid the upper valley from our view. Luckily the air was calm; wind would have been extremely obnoxious in this crotch of the valleys where we had raised our tents.

The Punmah valley, which ran up northward in our rear, leads to a vast and complicated glacier system, across which the peoples on either side of the Karakoram contrived to find a route by a pass of some 19,000 feet, known as the New Mustagh, because it was intended to take the place of the old pass of the same name situated in the northern range of the Baltoro when that became impassable owing to changes in the glaciers. Now, however, the New Mustagh has also been given up, either because the raids of the Hunza robbers have given it ill fame, or else because its glaciers too have become harder to cross.

No European has ever crossed the New Mustagh. In 1856 Rudolf Schlagintweit tried the ascent from Askoley, but was driven back by a snowstorm. Godwin Austen had the same experience in 1861. He

AN ALLUVIAL DELTA OF THE BIAHO.

met on the glacier four Baltis, who came from Yarkand, and he says that it would be quite easy to trace a convenient and safe route across the pass, which is approached on both sides by so easy a slope that it was formerly used for horses and yaks. Drew gives quite a different account, stating that the horses had to be hauled up by ropes, and that it took several men to hoist and support them, so that the pass fell into disuse, and between 1863 and 1870 all communication ceased between Baltistan and Turkestan. The last to try to reach the New Mustagh was Sir Francis Younghusband, who had reached Askoley by the older pass of the same name in 1887. His ascent was stopped by falls of séracs, which seems to prove the truth of the story that the glaciers had changed. In fact, twenty years previously Godwin Austen had noted that the Punmah glacier had so far progressed as to cover the path for some distance, and even the site which had been used for a camping-ground. He also mentions another important symptom of change in the climate of the region—namely, that at Shigar from 1849 onward it became impossible to ripen two crops in a season, as had always been done in the past.

In addition to the two Mustaghs, a number of other passes which used to join Baltistan with the Hunza-Nagar district, Yarkand, etc., have been so utterly abandoned that in some cases it is no longer known where they were. The only pass which still remains open is the Karakoram, much further eastward and coming under the influence of the arid climate of Tibet, thanks to which it is free from ice and snow, though nearly 19,000 feet in altitude.

The next day, May 17th, we started off early, because the Duke wanted to camp that very evening at the foot of the Baltoro. We still had the advantage of the season of low water, and could march in a straight line over the sand and pebbles of the river bed, thus saving the long ups and downs of the path which skirts the flank.[1]

From Bardumal, a halting-place marked by a boulder considerably smaller than that of Korophon, we enjoyed a fine view up the Shingkan valley, a tributary on the left crowned by a group of high snow peaks. Here the Biaho valley, still running eastward, takes a slight trend to the north, and the river flows around the foot of the northern wall, so that we had to climb up on the alluvial terraces. Once we had rounded this barrier, we returned to the bottom of the valley.

A little farther on our way was cut across by a wide terrace which has driven the river to the left. This terrace forms a sort of table-land with a rolling surface, whose transversal ridges are very slightly marked and dotted with medium-sized boulders mainly composed of granite

[1] Guillarmod relates that he and the rest of the expedition of which he was a member began between Korophon and Bardumal to note the first symptoms of fatigue due to altitude, although they had stopped at Askoley for eight days in order to rest and accustom themselves to the thin air of 10,000 feet. Our own experience was quite different. Not one of us thirteen Europeans was conscious of the least indisposition, and we reached the Baltoro glacier with a sense of absolute well-being and in full enjoyment of our strength, which had been developed by gradual and continuous training. We had not the slightest need or wish to interrupt our march.

in various stages of disintegration and rounded at the corners, mingled with blocks and pebbles of limestone. The material appears, indeed, to be alluvial deposit; but the aspect and shape of the whole formation, running so characteristically across the valley, is such as to suggest an ancient frontal moraine of the Baltoro, which now ends five or six miles farther up the valley. Between this terrace, however, and the glacier lies a long stretch of valley without the smallest trace of moraine

THE BIAHO JUST BELOW THE BALTORO.

detritus; and so sudden and complete an interruption of the deposits would be hard to explain. From a little lateral valley, the upper part of which is filled with a glacier, there runs down to the centre of the terrace a delta of white stones, probably limestone, standing out clearly against the grey of the granites. The entire formation might be just the ancient alluvial delta of this tributary.

Half way across this terrace we suddenly saw before us the snout of the great Baltoro glacier, like a huge black monster crouching with flattened back in the bottom of the valley. Here and there we could discern the gleam of bare ice showing through some rift in the dark layer of detritus that covers it. There is no accumulation of moraine before it, only a little moraine ridge clings to the valley wall, cutting off our view of the right side of the glacier. From this point Godwin Austen beheld the peak of K[2] and Guillarmod the Mustagh Tower. But thick mists filled the high valleys, and we saw no peaks.

Keeping our way along the steep right wall. we now traversed the last stretch of valley, which here grew wider still, level. sandy and sprinkled with pebbles. The sand is intersected by a network of rivulets, which bubble up everywhere in the plain from absolutely pure and limpid springs, delightful to see and delightful to drink after weeks of filtered or boiled water or tea. In the cold crystal-clear water swim little mountain trout seven or eight inches long.[1] Sella, who was some distance behind, managed to catch a good many of them without net or hook by striking heavy blows with stones on the rocks under which they lurk and thus stunning them.

Sheltered at the foot of the last spur which divides it from the Baltoro and protects it from the icy winds, nestling against the steep right wall of the valley, lies a little islet of vegetation, a strip of earth covered with long grass, thick bushes and little willow and rose trees. This is the stage known as Paiju. There was a time when the Baltis used to come here for a few weeks in summer to dredge the valley sands for gold which comes, according to Godwin Austen, from the granites of the Masherbrum. The place was abandoned because the river changed its course and came to flow along this side of the valley. Ferber found that the sand does contain gold, but not in sufficient quantity to make the process remunerative.[2]

For the last time we set up our camp under the trees, not far from a rough construction of stones which the Eckenstein-Pfannl-Guillarmod expedition had used as a deposit for provisions. The Baltoro valley opened wide before us. Against a purple-grey background of relentless mists which concealed the upper part of the valley stood out upon its right side three groups of rocky peaks, ending in a host of turrets, pinnacles and needles, strangely wild and menacing to behold. On the other side is a short chain simpler in form, which just above

[1] This species of trout (*T. Himalayana*) appears to be the sole inhabitant of the streams of the upper Himalaya. Cunningham caught some that were over 15 inches long in the torrents of Ladakh, about 15,000 feet high. Vigne, too, says it is the only fish inhabiting the Indus at Skardu.

[2] A. C. Ferber, *An Exploration of the Mustagh Pass in the Karakoram Himalayas. Geog. Jour.* 30, 1907, p. 630.

the termination of the Baltoro glacier rises into a peak bristling with sharp teeth, out of a base covered with snow. This and Paiju Peak—far more important but invisible from our camp, over which it towers—are the two gate-posts at the entrance of the fantastic world into which we were about to penetrate. From the tributary valleys round about us on both sides of the Biaho run down glaciers broken into icefalls, and black with moraine throughout the lower portion, all of them terminating at about the same height as the Baltoro.

On the rocks above our camp, which are covered with clay, worn out and furrowed by water-courses, we counted thirty ibexes. Partridges nest in the bushes just above the camp. The whole caravan was now united, as the coolies sent ahead from Askoley had taken three days to do the journey. We formed a community of nearly 400 persons. As night fell the air grew suddenly cold, and soon the whole place sparkled with little fires, about which moved the dim shadows of the coolies.

May 18th dawned with the usual doubtful and cloudy weather, which seemed to mock our impatience for a glimpse of the new world before us. The sun rose wearily through the thick veils of cloud and dense vapour which hung heavily upon the upper Baltoro. We marched hastily round the foot of the last spur, which was clothed with moraine up to some 300 feet high. The ice wall of the Baltoro glacier lies some 300 yards farther on, and in the corner between it and the spur is a little remnant of moraine about 50 yards away from the glacier.

The river issues from the glacier not in the middle of the front but nearer the right margin, and out of a tunnel so low that the stream seems to spring between the glacier and the stony bed of the valley. At the point of issue the front of the glacier has a deep indentation which divides it into two unequal parts, that to the right forming a steep wall 300 or 400 feet high, at whose foot we have just arrived; and a greater lobe to the left, comprising at least three-quarters of the whole frontage. This main part runs about half a mile farther down the valley than the right portion, and terminates in a tongue of ice less steep and less thick, which is divided only by a little moraine from the snout of another glacier running out towards it from a small tributary valley on the left.

Godwin Austen and Conway found the snout of the Baltoro in much the same condition. Both, however, describe the river as issuing from a veritable tunnel with a high roof, from the edge of which ice blocks were constantly falling. In Conway's time the front was divided into three lobes instead of two. Godwin Austen furthermore mentions a large boulder lying in the middle of the river at a certain distance from the glacier. This boulder is recognizable in the illustration in Conway's book as well as in one of the photographs taken by Sella, which would

THE SNOUT OF THE BALTORO.

lead us to suppose that from 1861 to the present day the snout of the Baltoro has remained stationary or undergone changes of small import. I must, however, note that Godwin Austen had the impression from Conway's photographs that the glacier came down farther in 1892 than in 1861[1]; while H. F. Montagnier in June, 1903, found the Baltoro pressing with its right edge against the moraine ridge which I have described, on the wall of the valley. The latter was rapidly disintegrating and rolling its pebbles down upon the glacier.[2] If so the snout must

[1] See report of discussion after the lecture of Sir W. M. Conway at the Roy. Geog. Soc., in *Geog. Jour.* 2, 1893, p. 301.

[2] Verbal communication made to me by M. Montagnier in London, Dec. 1910.

have retreated about 300 yards between 1903 and 1909. an insignificant shrinkage in an ice-stream about 36 miles long.[1]

The front throughout its whole extent is formed of live ice down to the bottom, without any fringe of moraine. At the foot of the wall there are merely a few scattered blocks of medium size. and a little farther down no trace of moraine detritus is to be found on the level alluvial valley bottom. This entire absence of frontal moraine in a

THE END OF THE GLACIER AND THE SOURCE OF THE BIAHO TORRENT.

glacier so vast and so entirely covered by a thick layer of moraine material, whose snout seems to have remained about in the same place for the last fifty years, is certainly amazing. The Workmans have observed the same absence of frontal moraine in several of the great glaciers explored by them, while sometimes others quite close to them would have their whole frontage covered with high and thick moraines.

[1] Guillarmod's book does not give any exact data as to the look of the front of the Baltoro in 1902. The article of Dr. Pfannl in *Zeit. d. deut. u. oest. Alpenver.* 35. 1904. p. 96. contains an illustration showing the mouth of the Biafo river and the snout of the glacier. where they seem to have the same appearance and character as that noted by us in 1909.

Our theories as to the formation of frontal moraines afford no convincing explanation of this strange phenomenon.[1] We are thus obliged to fall back upon other considerations suggested by the condition of the particular glacier basins where the phenomenon in question is displayed.

The characteristic absence of frontal moraine has been most especially observed in the largest glaciers, such as the Siachen, Biafo, Hispar, Baltoro and Chogo Lungma, which, with the exception of the last, are all over 30 miles long and occupy wide valleys with very slight inclination, so that their progress must be determined rather by pressure of the ice masses coming down from the upper basins than by their own plasticity and weight. The absence of frontal moraine can be explained only by the immobility of the terminal portion of these glaciers, which has turned into dead or stagnant ice, and may be considered, geologically speaking, in every respect as rock. The snouts of these huge ice rivers would thus stand for an ancient phase of development. They are, as it were, the fossils of a previous glacial period. To this a period of suspended advance must have succeeded, or even a shrinkage of the upper portion of the glacier, leaving this extreme end where it stood. This presumable immobility of the snout by no means excludes the possibility of a fresh period of activity following after, such as may possibly to-day be found going on in the upper part of the Baltoro. The glacier in its new activity might flow for a longer or shorter distance over the dead ice, which forms its bed just as the bottom of the valley would. If the pressure became sufficient it might even revive the whole mass and drive it farther down the valley. Such would seem to have been the case in the recent oscillations of the snout of the Biafo which I have mentioned above.

The recent slight displacements in the snout of the Baltoro, which seem quite established when we compare our own observations with the descriptions of our predecessors, do not actually contradict this theory. It is quite conceivable that the bulk of dead ice may have been pushed forward by pressure from the rear without changing its condition of intrinsic immobility—that is to say, without any flow of ice caused by its own plasticity, the only form of motion which could

[1] See on this point the discussion which took place at the English Royal Geog. Soc. after the lecture of Dr. Workman: *From Srinagar to the Sources of the Chogo Lungma. Geog. Jour.* 25, 1905, p. 245; and the comments of the same author in *Exploration of the Nun Kun Mountain Group*, etc. *Geog. Jour.* 31, 1908, pp. 34–35.

cause an active and continuous carriage of material from the high valley to the front of the glacier. It may be that the Baltoro is again preparing for a period of activity in the more or less remote future. As a matter of fact, especially on our return journey in the beginning of August, we noted for some miles through the lower portion of the glacier great waves rather deeply marked, whose direction was mainly transversal, whereas higher up the ridges and hollows ran lengthwise. This transversal undulation of the glacier might be the result of immense pressure exercised by the volume of confluent glaciers in a state of active increase.

The formation of dead ice either separate from or else more or less closely related to the original glacier is a phenomenon long familiar to students of glaciology. Examples of it on a much smaller scale may be found in our own Alps. The above considerations, which have been suggested to me by Ingegnere Vittorio Novarese, of the Regio Ufficio Geologico, I have dwelt upon at some length in the hope of drawing the attention of travellers to a state of things which, if confirmed by further observations, would bring about results of real importance to the study of glaciology.[1]

The end of the Baltoro is about 11,000 feet above sea level, some 820 feet above the end of the Biafo. Of the other great glaciers of the Karakoram, the Siachen ends at an altitude of 11,600 feet (Longstaff, 1909), the Hispar at 10,803 feet (Workman, 1908), and the Chogo Lungma, the lowest of all, at 9,519 feet (Workman, 1902).

The wall of the glacier facing us was cut obliquely by a sort of narrow ledge, overhung by big blocks of rock poised—it would be hard to say how—upon the declivity. This ledge forms the way of access to the top of the glacier. On the previous evening at Paiju it had seemed settled, after endless discussion, that the coolies would cover in two days instead of three the whole of the distance to Rdokass, the southern spur of the Baltoro, which, judging from Guillarmod's account, seemed to be the most suitable position for our base camp. This morning, however, the rumour was afloat that the coolies were making pretexts for delay in order to force us to set up camp at Liligo, a third of the whole distance. The Duke met this by waiting at the foot of the glacier

[1] These considerations, based upon the glaciological observations of the expedition, were the subject of a communication by Ing. Novarese to the Ital. Geolog. Soc. (summer meeting, Sept. 1911).

until nearly all of the 260 coolies had started off; it took about an hour. Twenty minutes after we were on the Baltoro.

The top of the slope was covered by big blocks of granite, so light in colour as hardly to be distinguishable from the pieces of marble mingled with them. We turned toward the left or southern side of the valley, cutting across the glacier in an oblique line just above the outlet of the stream. Here the layer of moraine was without any trace of arrangement into stripes, and composed of widely-contrasted materials —granites of every conceivable quality, quartzites, schists, slates. marbles, many-coloured conglomerates and silicacious rocks of dark red and purple shades. Nearer the left bank the moraine was almost entirely composed of dark grey granite, broken up into irregular fragments. The biggest blocks measured some 15 or 20 feet in their largest measurement, grading down from these to the smallest gravel. Real sand was rare. The surface is irregular; we could make out no ridges or troughs arranged according to any general orientation. Yet this lower portion of the glacier is less unequal and broken than the Biafo. We found it much harder to traverse on our return journey two months later. There were occasional little plants here and there among the stones, and even a few small shrubs; but the vegetation was so rare and isolated that it seemed impossible it could give rise to real thickets on the moraine later in the season. As we went higher, close to the left bank of the glacier. the inequalities of the surface became more pronounced. until the whole looked as though it had suffered some huge convulsion. It was distorted into deep valleys and irregular holes among hills and ridges and steep slopes running in every direction. Wherever the surface was not absolutely vertical these were covered with sharp and insecure detritus stones that threatened sprains and bruises at every step. The Duke walked ahead with our two guides who determined our route through the labyrinth. They set up cairns on the larger rocks to indicate the tortuous path to us coming after.

Before we had gone far on our way up and down across the ridges, skirting the big hummocks and deep hollows, we began to feel the weariness well-known to all those who have marched on moraines. And this was the very outset of a long journey. On every side our view was cut off by steeps of ice and stony slopes, the guides naturally preferring to follow the valleys and skirt the base of the ridges. Whenever the caprice of our obstacles obliged us to climb over some higher ridge the gigantic bulk of the Baltoro offered us the same uniform view, of an unbounded desert covered with masses of detritus, with here and there a gleam of black or bluish ice laid bare by a fissure.

The air was heavy and close, though here, as on the Biafo, the melting had scarcely begun. Only here and there did we encounter a small rivulet or glacial pool; yet the water has no channel through the

SURFACE LAKE ON THE LOWER BALTORO.

depth of the glacier, there are no open crevasses and none of the glacier moulins, those characteristic wells so common in our own glaciers below the snow line, by which the water produced by surface melting disappears into the depths. We found signs of running waters, however, in the shape of round worn pebbles of typical alluvial appearance, mingled in small numbers with the sharp-cornered moraine fragments. The glacier fills the valley from side to side, forming a V-shaped trough between its steep side and the rocks of the valley wall. On the maps of Conway and Guillarmod a torrent runs through this deep trough, but it did not appear to be flowing as yet. No tributary glacier flows into the Baltoro from the south side, by which we were ascending it, for the first four miles of the lower course.[1] But on the other side of the valley there flows into the Baltoro a few hundred yards above its end a large confluent bare of moraine, which, like a stream in flood over-

THE ULI BIAHO GLACIER JOINING THE BALTORO.

flowing the surface of the river it enters, overrides the Baltoro for a long distance with its dazzling white torrent of séracs. Between two and three miles farther up a second tributary valley opens on the same side, as deep and level as the first in its lower course, but much wider. Out of this, too, flows a glacier with a wide medial moraine, and overtops the margin of the Baltoro with a high front of séracs. These valleys

[1] The map of the Baltoro contained in this volume shows only the upper two-thirds of the glacier, which the reader must imagine to be prolonged for 10 miles more toward the west. The little panorama which is here reproduced, together with the left half of panorama B, must make up for the lack of the map.

are separated from each other by the rocky spurs which we had already admired from Paiju, and which from near at hand appear even more inaccessible. They form a wild architecture of their own, a maze of turrets, pinnacles, needles, reaching up to a height of some 1,000 feet and so precipitous that they scarcely leave the perpendicular from top to bottom. They remind one of the dolomite towers, but it was difficult

THE STONY WASTE OF THE LOWER BALTORO, SHOWING THE NORTHERN WALL.

from this distance to recognize the true nature of the formation. To the west of these we saw Paiju Peak, a pile of triangular rock pyramids rising one above another, clearly outlined by their ice ridges and lifting up a symmetrical pointed summit completely covered with snow.

About half-past nine we reached a point opposite a little gorge opening out in the left wall of the valley, in such a way as to leave free a small space at the bottom of the gully between the glacier and the rock. This was the stage known as Liligo. Here the coolies crowded round us, trying to induce us to stop, though it was still quite early. We had no great difficulty in persuading them to go on for another hour, when we reached another couloir in the wall almost exactly similar to the first. Here the guides quickly cut steps in the steep side of the glacier, which was some 200 feet high, and we descended to a sort of oval well, quite level, some 60 yards wide by 150 or 200 yards long, and strewn with stones.

This place is known to the Baltis as Machichand. There was nothing to show that the little hollow had ever been occupied by a lake. Numerous smooth pebbles pointed rather to its being occasionally the

PAIJU PEAK. TAKEN BY TELEPHOTOGRAPHY FROM THE LOWER BALTORO.

bed of a torrent. On one side it is bounded by the flank of the Baltoro, an ice wall black with detritus, down which ran a thousand small streams, ceaselessly whirling along stones to the gully below, where the ice met the bottom of the valley and a little brook flowed. On the other side the valley wall rises steeply, cut in the centre by a ravine. It is a great wall of loose conglomerate, from 400 to 500 feet high, with a clayey top eaten out and carved by the waters into deep vertical furrows and fringes, forming a long row of tall pillars, each of which is crowned by a rock or boulder resting on it like a mushroom on its stalk.

Paiju and the Towers on the north of the Baltoro

(Telephotography)

They looked extremely unstable, and if it had come on to rain our camping ground would have proved very undesirable. At either end this oval space was blocked by the meeting of the glacier with the wall. At the upper end a narrow corridor remains free at the bottom of the gorge; at the lower the glacier abuts on the rock. The section of the glacier seen thus from the side shows plainly in its whole length the

THE CAMP AT MACHICHAND, LOOKING UP THE VALLEY.

arrangement of the ice in two horizontal strata of nearly equal thickness, coming together along a regular line, separated only by a thin layer of detritus which makes the formation quite evident.[1] If we admit the hypothesis of the immobility of the snout of the Baltoro, the upper layer may be supposed to represent the active glacier and the lower the motionless mass.

We cleared away the detritus a little in the centre of the oval space and set up our tents. The coolies arrived in camp not by twos and threes as usual, but in numerous bands, after a very cautious descent down the steps in the ice. The fact is they are afraid of the glacier, especially of being alone upon it, to avoid which they had finished their

[1] This arrangement is plainly visible in the illustrations here given.

short but hard stage at unaccustomed speed. They laid down their loads and scattered up the valley slope to hunt for firewood. They found a few gnarled trunks of dead juniper, and these they rolled down to the camping place.[1] A great rock rolled down into the bargain, and it was a real miracle that it did not crush any of the coolies below. They lighted their fires along the wall, where they made their bivouac at the greatest possible distance from the glacier. Down the latter at very brief intervals stones and boulders came crashing with loud reports,

THE CAMP, LOOKING DOWN THE VALLEY.

followed by a trail of small detritus that slid down the ice with a prolonged crackling sound. All this fell at the foot of the slope without danger to us, but the coolies were uneasy and kept looking at the glacier as though they had an obscure consciousness of the life animating the huge mass. It is so seemingly inert, yet within so full of motion and ceaseless transformation, that one gets an impression as of something furtive and insidious, like a monster crouching. One single raven kept watch over our camp the whole day, perched on a near-by projection and following all our movements with the closest attention.

[1] Guillarmod noticed similar trunks of old juniper upon the slopes above Liligo, and the Workmans saw along the sides of the Chogo Lungma valley dead tree trunks considerably larger than any of the living trees. These too are symptomatic of a change of climate.

With the cool of the evening the atmosphere gradually cleared, but from the bottom of the hole where we were we could only get glimpses through the openings between ice and mountain side. Night came swiftly, almost without twilight. The stones fell at longer intervals from the glacier ; the rivulets froze over and stopped flowing. Soon the silence was unbroken, except by the coolies, who squatted and murmured as usual round the fires that lighted with strange gleams the walls of our prison.

A GLACIAL LAKE OF THE LOWER BALTORO.

On the following morning Abdullah, instead of bringing us up to the glacier again, took us along the narrow ravine between it and the valley wall, which is exposed in many places to danger from falling stones. Wherever the glacier abutted against the rock we climbed over it, always redescending as soon as possible into the ditch. In this way we had but brief glimpses of the valley or of its clear little lakes, whose limpid emerald-green waters are never clouded by the continually dropping stones. They are surrounded by high ice-banks hanging down in dazzling white stalactites and undermined by melting. The turrets of the northern valley wall made a wonderful background for the scene.

After over an hour's march we reached a marginal lake some 200 yards long and from 5 to 10 yards wide, which fills up the gap between the glacier and the rock. It appeared to be confined by an ice-dam of no great thickness or strength. If this slight barrier had given way before the pressure of the waters or the motion of the glacier

THE LILIGO GLACIER

our camping ground of the night before would have proved a dangerous one indeed. It is certainly far more prudent to encamp upon the glacier rather than in these lateral ravines. The Workmans upon the Hispar witnessed more than one vast and violent flood caused by the breaking of glacial reservoirs; and Longstaff came near losing his camp by the same cause on the margin of the Rgyong glacier.

First Camp on the Baltoro, between Liligo and Rhobuts

Another half-hour's march brought us to the mouth of the first tributary valley on the southern side, smaller than those which open on the northern side and filled up by the Liligo glacier. The latter is very broken, without surface moraine, and barely occupies the centre of its valley. It stops about a third of a mile from the edge of the Baltoro, with a steep front about 300 feet high, without any detritus at its foot. Without counting the little hanging glaciers of the smaller gullies, the Liligo and one other glacier near the junction of the Baltoro with the Godwin Austen are the only tributaries which do not actually flow into the mass of the Baltoro. The Liligo valley slopes up gently from the Baltoro to the foot of a rocky height, whose structure in tiers of pyramids reminds us of Paiju Peak, though it is far less imposing. The valley then bends eastward and is lost to view. The space between the snout of the Liligo and the side wall of the Baltoro is partly taken up by a little lake, above which is a second and smaller one. Later in the season the two lakes flow into one and fill up the whole mouth of the tributary valley. Near them a small level was pointed out to us beside the Baltoro as the camping ground called Rhobutse.

We were now marching upon the glacier again, but so near to the left margin that we were able to see nothing of the high valley, partly because it changes its north-easterly direction a little farther up and takes a turn due east. At this point our attention was chiefly concentrated upon a group of rocky peaks of the northern chain. Among them, as we knew, is the Mustagh Tower, but it was as yet still hidden among the minor peaks, and only much later were its noble outlines revealed to us.

The distance between the Liligo glacier and the second confluent on the left is certainly greater than appears on the maps of Conway and Guillarmod (just over one mile). At least we took more than an hour and a half to cover it. This second tributary is nameless, although its dimensions are by no means insignificant. It flows down from a peak of dazzling whiteness, loaded with snow despite the steepness of the slope, and it flows for a long way on top of the Baltoro, so that our route cut straight across it. It is almost level, without crevasses, and dotted with single blocks and a little small detritus. Here and there were groups of ice-tables and numerous ice-cones, the pedestals of old fallen tables. There were none of these upon the lower Baltoro, where the uninterrupted layer of detritus causes uniform fusion of the whole surface.

We now crossed the next spur, skirting its slope along a stretch of track, which was a real rest after the long march across the moraine. Thence we reached the third tributary on this side of the valley, which, like the last, has no name, and flows over the surface of the Baltoro for a considerable distance. We had nearly reached the centre of this glacier when the upper part of the Baltoro valley finally unfolded itself to our view, as far as the distant chain containing the marvellous and symmetrical peak of Gasherbrum^{IV}, 26,000 feet high. To its right a slender and more distant peak is just visible, quite covered with snow. This must be Gasherbrum^{III}, just a little higher than Gasherbrum^{IV} (26,090 feet).

This third southern confluent opens into the valley opposite the spur which separates the third from the fourth northern confluent, or the Dunge glacier from the Biale glacier, to use Guillarmod's nomenclature. But on Guillarmod's as well as on Conway's map the valley mouth is placed a little below that of the Dunge glacier, in such a position that it would be impossible to see from this point the chain of the Gasherbrums. In reality the mouth of the valley lies much nearer the point where the Baltoro valley turns eastward, and to the promontory of Rdokass, which one reaches from it in only three-quarters of an hour, with a short crossing under the mountain side and skirting a recess filled with a large nevé, from which one passes directly on to the spur of Rdokass.[1] Our feet were bruised and sore from the long march over hard moraine, and it was a great relief to walk on the soft earth covered with elastic grass. The coolies were not far behind, and were nearly all in camp an hour after our arrival. They did not appear to be tired, and were quite in their usual good humour, which turned to noisy joy when the Duke added to the usual daily ration of meal a present of tobacco, tea and sugar.

[1] In Conway's and Guillarmod's maps the distance between Rdokass and the third left-hand tributary is over three miles, which on such a surface as that of the Baltoro would certainly take at least two hours' march. Ferber had already (op. cit.) noted this discrepancy between the southern and northern sides of the Baltoro in Conway's map. For the rest it is a fairly accurate map, and a truly remarkable piece of work to have been produced by a short month's work on the Baltoro, and considering that it represents only a part of the vast glacial system explored by Conway in a single campaign.

The Baltoro

CHAPTER XI.

RDOKASS.

Rdokass as a Base Camp. — The Timber Limit. — The Permanent Coolies. — How Chupattis are made. — Equipment of the Expedition. — The Meteorological Station at Rdokass. — Panorama of the Baltoro from above Rdokass. — Size and Appearance of the Glacier. — Its Tributaries. — Various Systems of Nomenclature. — Mustagh Glacier and Pass. — The Younghusband and Ferber Expeditions. — Two Days of Bad Weather. — Goats, Sheep and Coolies. — The Fauna of Rdokass. — Measurements of the Rate of Flow of the Baltoro. — Preparations for the Start.

THE Duke's plan, which he had worked out to the smallest detail, was to leave a base camp at Rdokass, with supplies of food and other stores, and to form an advanced base camp on the Godwin Austen glacier at the foot of K². Mr. Baines was left in charge of the Rdokass station, with the important duties of provisioning the high camp and communicating with Askoley when needful. It was, therefore, necessary for him to have at his disposal enough coolies to keep him constantly in touch with the expedition. The task involved both responsibility and sacrifice, and Mr. Baines showed great ability and punctuality in the performance of it.

Rdokass lies on the western slope of a great spur belonging to the southern chain of the Baltoro, about 300 feet above the glacier and some 10 miles from its end. It is a place which lends itself wonderfully to a long stay with a sufficient number of coolies. The camping ground was covered with dry grass from the previous year, through which new blades were pushing their way, as well as here and there the first tiny blue stars of the early primula. A heavy landslide had at some past time covered the slope with gigantic blocks of granite, some of them as big as houses, which were piled up in confusion, leaning at all possible angles, and forming in their interstices nooks and caverns large enough to afford shelter to hundreds of coolies.

THE CAMP AT RDOKASS.

Our tents were set up on a narrow level space, while a similar ledge farther down held those of the guides and the kitchen. A stream ran close by through a little vale covered with thick underbrush which yielded us abundant fuel. It consisted of a species of *lonicera*, which only grows six or eight feet high and is apparently the shrub found at the greatest height in the Baltoro basin. The grass runs up about 1,000 feet higher, and later on we found saxifrage and potentilla in blossom at about 18,000 feet. But the woody growth apparently stops at about 13,200 feet, though Conway and the Workmans found specimens at from 14,500 to 15,000 feet on the slopes of the Hispar in the shape of dwarf willows, not much more than a foot high.

The Duke had planned to stop only one day at Rdokass to make the arrangements for supplies, etc., and then to start ahead with a small party to select the best place for the high camp, the rest of the expedition following the next day with the heavy baggage and supplies. About half of the coolies who came with us to Askoley were to help carry the luggage to the upper camp; they were then to be sent back with the exception of thirty-five—ten for the use of the expedition on the high glaciers and twenty-five to remain under Mr. Baines' orders at the Rdokass base camp.

Our first task, therefore, was to select thirty-five volunteers among the younger and stronger coolies, who should remain with us until our return to Askoley. We had no difficulty in finding them, for they were all equally anxious to stay. We next proceeded to equip the ten who were to be with us in the high mountains. First, we made sure that each of them was provided with the usual native garments in good condition—tunic, trousers, blanket and puttees. To these we added heavy woollen socks, nailed boots, snow spectacles and sheepskin sleeping-bags, and three tents were allotted to the party of ten. Later on we distributed puttoo mittens, roughly made but very serviceable. The mere sight of all this wealth filled the coolies with joy, particularly the European boots, which were looked upon enviously by those not among the fortunate ten. The coolies who formed the Rdokass contingent were furnished with the native sheepskin boots known as *pabboos*, which are excellent for walking over rocks and moraine. The Duke had had several hundred pairs of these made, for they do not last long in the wear and tear of moraine work. We carried also a supply of skins, awls and cobbler's thread to mend them with.

Meantime the coolies had built little fires along the stream, and were busily preparing and baking a supply of chupattis large enough to last for the next few days. The meal is coarse and grey. It is simply kneaded with water without leaven, and shaped into flat cakes. Some of these, intended for immediate consumption, were baked by wrapping them around a red-hot pebble and then rolling the pebble over a slab of hot stone. The rest, which were to be carried as supplies, were baked on big iron plates. The daily ration of a Balti is one *seer* (about two lbs.) of coarse meal, counting a good deal of bran, and a little salt, nothing more. Now and again as a special reward a little tea, sugar or tobacco was served out to them. I know of no other human race capable of an equal amount of work in such a severe climate, upon nourishment so poor in quality and meagre in quantity.

We next paid off and sent back the 200 coolies who were no longer needed. Each of them was entitled to 2½ rupees, beside two seers of meal for the return journey; and they were told that the meal would

COOKING CHUPATTIS.

be served out to them as soon as they had been paid. But finding themselves in possession of so vast a sum they were so eager to get home that they all rushed off joyously without stopping for the meal before we were aware of their going, busy as we were in paying out the wages. The result was that the 800 lbs. of meal went to swell our stock.

We still had more than 150 coolies to carry our equipment and supplies to the foot of K^2. The baggage was first gathered together: the Alpine equipment, consisting of extra ice-axes, a large supply of mountaineering rope, crampons, snow-shoes and iron spikes for the rocks; the topographical instruments—photogrammetric camera and plates, and compasses; the meteorological instruments—mercury barometers, aneroids, hypsometers and thermometers; lastly, Sella's photographic equipment, except the cinematograph, which was left behind at Rdokass. We also left our camp-beds, and from now on spread our sleeping-bags on the floor of the tent. Few people know that it is warmer to lie directly on the waterproof bottom of the tent, even when it is set up on snow or ice, than on a camp bedstead which leaves a perpetually chilly void between you and the ground. Our sleeping-bags, which had been specially planned by the Duke, were admirably fitted for a journey on which every variety of climate was to be encountered. They consisted of four bags, which could be used separately or one inside the other. One was of light soft camel's hair, one of eiderdown, one of thick goatskin with a woollen covering, and one of waterproof canvas, to be put outside the other three.

Our cooking apparatus was aluminium, and we used Primus paraffin stoves.[1] The food and stores were soldered up in tins, each one weighing about 46 lbs. and containing all the necessaries of life for a single day.[2] A light wooden case protected these tins from blows, and the coolies carried them with such care that they all reached Rdokass intact.

We carried to the high camp the same tropical tents we had used up till now, of green Edgington canvas, small size. The Duke had also provided two Whymper tents and two extra light Mummery tents for the camps in the high glacial basins and on the slopes of the mountains. Our stores were completed by a box of medical and surgical necessaries and two big tarpaulins to protect our supplies from the weather.

We levelled the ground under a projecting rock and arranged in systematic order all the supplies that were to be left at Rdokass. Around the whole the coolies built a wall. They worked quickly and ingeniously, forming a chain between the rock and the nearest point where suitable stones were to be had, and passing material from hand to hand, so that there was no pause in the building operations, and the wall was soon finished.

Lastly, the Duke set up a meteorological station in the shelter of a rock flanked by a wall on either side, and supplied it with a mercury barometer, thermometer and psichrometer. Readings were taken by

[1] At altitudes of 17,000 feet and over the low temperature and the rarefaction of the air prevents the easy combustion of ordinary spirits of wine. It is necessary to have absolute alcohol, or at least 96 per cent., to start the Primus lamps and the little lamp of the hypsometer.

[2] In Chapter XIX I give a detailed account of the composition of the daily ration.

Mr. Baines three times a day from May 29th to July 15th, and at the same hours observations were made at Leh, Skardu, Gilgit and Srinagar. The calculations based on these data give Rdokass an altitude of 13,205 feet.[1] It thus became a station of reference for the calculation of the Duke's observations in the high mountains during this period.

We had now reached more than 13,000 feet above sea level, without experiencing any symptom of suffering from altitude. We all slept

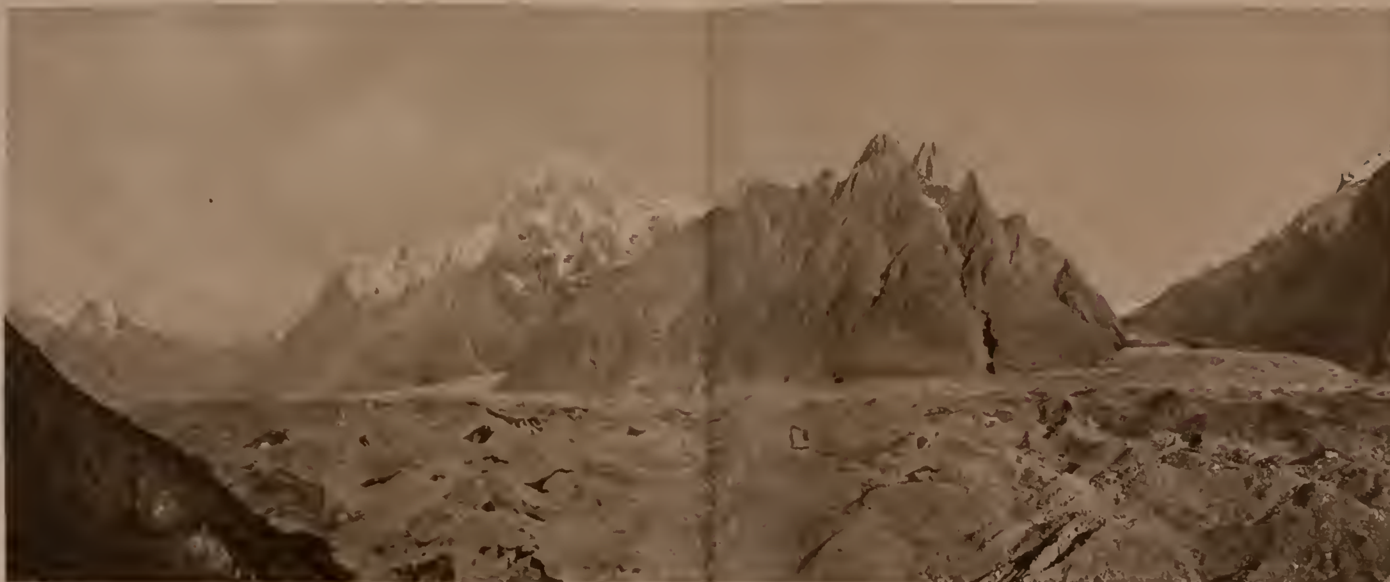
PAIJU PEAK AND THE LOWER BALTORO FROM RDOKASS.

soundly, and our appetites were excellent. Some of us, however, noted even at this early period that when we stooped down to tie our shoes or wind our puttees, for instance, we would be caught by a slight sense of oppression on standing up again, and obliged to take four or five deep breaths. It is, of course, impossible to walk uphill as fast as in the lower regions without some shortness of breath, but I can hardly count this as a symptom of mountain sickness.

The grassy slope of Rdokass ends some 300 feet above the camping place with a little level terrace, from which springs the real wall of the

[1] The meteorological appendix by Professor D. Omodei gives the results of these observations and the data for the altimetric calculations. This makes it superfluous for me to discuss the altitude of 13,904 feet attributed by Guillarmod to Rdokass.

Paiju Pk.
Uli Biaho Gl.*)
Tramgo Gl.*)



Lower end of the Baltoro Glacier

* After Guillarmod

valley, all of rock still covered with ice and snow. This terrace gives a fine outlook over the whole lower course of the Baltoro which we have just traversed. But, like the camp, it lies on the western side of the spur behind a big ridge, which cuts off the view of the upper Baltoro. To obtain a sight of the whole marvellous valley in its incomparable grandeur you must climb much higher behind Rdokass, to the corniced ridge of snow which terminates the wall about 3,000 feet above the glacier. It was from this point, on our return, that Sella made panorama B, which shows 25 miles of the Baltoro glacier, from the foot of the Gasherbrum down to a point quite close to the snout.

The Baltoro is the fifth of the great glaciers of the world outside the Arctic regions. The distance from its snout to the foot of Hidden Peak is 36 miles. The Siachen (or Saichar) glacier is 45 miles long (Longstaff), the Inylchek (of the Tian Shan range, north of the Karakoram) is 44 miles (Merzbacher), and the Biafo is nearly 37 miles (Workman). The Hispar is about the same length as the Baltoro—just above 36 miles (Workman). No other known glacier reaches 30 miles. In fact, the largest glacier of the Himalaya proper—the Zemu, of the Kinchinjunga group—is only 16 miles long (Freshfield); but the Nepaul Himalaya and the Everest group may have surprises in store.

The Baltoro ascends as far as the foot of the Gasherbrum in an almost straight line, with an even regular slope from 11,000 to 15,700 feet, giving a grade of barely 3½ per cent., and a uniform width of about two miles, which makes it look from a distance like an immense highroad. Godwin Austen wrote that it is as if a great glacier filled up the Val d'Aosta from Mont Blanc to Chatillon, or flowed down from the Simplon to Lago Maggiore through the Valle del Toce. But even if we could imagine such a sight, it would not much resemble the Baltoro. No Alpine valley has the elements of anything even remotely similar to this vast roadway of ice between its precipitous walls. It is beyond all comparison; it differs from all Alpine scenery not merely in the scale, but in the actual form and features.

Our attention was drawn from the Baltoro to fix itself upon the wild rampart to the north, dominated by a forest of unnumbered peaks that are between 20,000 and 23.000 feet high and show a fantastic variety of form and structure. Not until the clouds descended and lay motionless over the high peaks did we return to the observation of the valley and its tributaries.

The Baltoro seen from above is chiefly of a uniform grey colour, due to the detritus which covers it. Only higher up do the moraines become separated and distinct. The centre is marked, however, by a tall moraine ridge running lengthwise and slightly sinuous, which lends the semblance of organic structure to the glacier, making it look like some monstrous vertebrate crouching at the bottom of the valley, whose outline it follows with its full and rounded flanks. Here and there pale streaks of limestone in the moraine, or a gleam of ice like the glint upon shining scales, completes the imaginary likeness to a dragon of fable. Unlike the Hispar and the Biafo, which are shrunk within the walls of their valleys, not even extending to their own ancient marginal moraines, the Baltoro fills its bed completely, as may be seen from panorama B. But what gives it its most characteristic feature and makes it absolutely unlike our own valleys is the appearance of the side spurs, which do not slope down to the valley with ridges and diminishing buttresses, but come to an end suddenly, as if they had been cut off, with wide and high perpendicular walls. Between these spurs open at regular intervals tributary valleys five or six miles long, also deeply set between vertical walls and forming almost a right angle with the main valley, like streets opening between blocks of buildings on either side of the main thoroughfare of a city. The glaciers of all these tributary valleys flow out on top of the Baltoro with a high front and without any trace of terminal moraine. They certainly give the impression of being in a state of active growth.

Conway gathered names from the natives for most of these tributary glaciers. Guillarmod made further inquiry, and changed the names about from one glacier to another, adding new ones. Ferber kept these names for the glaciers, but added others for the valleys down which they run. The Workmans, too, rearranged or changed the names given by Conway to the confluents of the Hispar glacier. Probably every voyager to these regions at intervals of a few years could collect data for further changes. It is evidently not alone in the inhabited portions of Baltistan that the names of valleys and rivers change. It is to the interest of the geographer to establish a fixed nomenclature—he cannot be expected to conform with capricious changes. The Duke has adopted in his map the nomenclature of Guillarmod, as being simpler than that of Ferber. The following comparative table shows the names given by different travellers to the same places, and at the same time gives a list of the confluents of the Baltoro in their order from the snout to the Concordia basin. The northern tributaries are all shown in panorama B except the lowest, the Uli Biaho of Guillarmod.

Tributary Glaciers of the Baltoro from its Lower End to the Concordia Amphitheatre.

List of glaciers going up the valley.	Conway 1892.	Guillarmod 1902.	Ferber 1903.	
		Right or Northern Side.		
1	—	Uli Biaho	—	Valley Uli Biaho
2	Uli Biaho	Tramgo	Gl. Uli Biaho.	,, Tranhongè
3	Dunge	Dunge	,, Dunge ...	,, Talve
4	Durni..................	Biale	,, Durni ...	,, Piale
5	Piale	Mustagh	,, Piale	,, Mustagh
Next follow three small secondary valleys between the southern spurs of the Mustagh Tower. Only the middle one has a glacier that runs down as far as the Baltoro.				
6	Younghusband ...	Younghusband ...		—
Five more small secondary affluents.				
		Left or Southern Side.		
1	Liligua	Liligo..................	Gl. Liligua.	Valley Chober Zechen
2	—	—		,, Chober Zechen Germi
3	—	—		,, Choblak
4	Mundu	Mundu		—
5	Stachikyungme ...	Yermanendu.........		—
Group of secondary affluents.				
6 & 7	Two very large unnamed affluents.			

Rdokass stands opposite the Biale, the fourth confluent on the right bank, a secondary glacier filling a steep gorge carved out on the face of a spur (see panorama B). A little beyond is the mouth of an important valley filled by the Mustagh glacier, which runs deep up into the chain to the ancient pass of the same name, 19,000 feet high, over which Askoley used to communicate with Yarkand. The pass seems to have been in use in early times—Ujfalvy states that the Portuguese Jesuit, D'Espinaha, crossed it in 1760. According to Vigne, it was still open under Ahmed Shah, the last independent Rajah of Skardu in the first half of the last century. But when Godwin Austen went to Askoley and the Baltoro in 1861 it was said to have become impracticable, owing to great accumulations of snow and ice.

We owe our first detailed account of the route across the pass to Colonel Sir Francis Younghusband, who traversed it at the end of 1887.[1] He was on his way from Kashgar, which he had reached after crossing the whole of China; and he started over the Karakoram with a few coolies, no tent, a single sleeping-bag, a fur coat apiece, and a scanty supply of dried provisions. He ascended to the top of the pass by the

MUSTAGH PASS. MUSTAGH TOWER.

MUSTAGH TOWER AND PASS FROM THE ROCKS ABOVE RDOKASS.

gentle slope of the Sarpo Laggo glacier, which was deep in soft snow, and descended on the Baltoro side by a steep and broken ice wall, a proceeding both difficult and dangerous for a party lacking the simplest mountaineering equipment. The condition of the glaciers more than justified the abandonment of this pass. A. C. F. Ferber climbed up to the Mustagh col with E. Honigmann in September, 1903, and collected some interesting indications of active coming and going across

[1] Col. Sir F. Younghusband, *A Journey across Central Asia*, etc. *Proc. Roy. Geog. Soc. N.S.* 10, 1888, p. 485; and *The Heart of a Continent*, etc. London 1904. 4th ed.

it in the past.[1] Upon a grassy slope near the Mustagh glacier he found a village of twenty-two huts, abandoned and in ruins, one of which contained a tomb. There were clear traces of camping grounds, and even an artificially levelled spot called Sharagan, 800 feet long by 160 feet wide, which had once been used for polo matches, presumably on foot, between the Baltis and Yarkandis.[2] Ferber also brought back from his expedition a topographical sketch of the Mustagh glacier and pass, whose position had heretofore been only vaguely noted on the map.

On the day following our arrival at Rdokass, after a brilliant morning, the sky clouded over little by little—at first with only a thin veil; then sleet began to fall, growing thicker and thicker, until it settled down into a heavy snowfall. The aspect of the glacier changed utterly. The tall central moraine ridge, with its notched crest, remained quite black, owing to radiation from the thick strata of detritus; but on both sides the glacier grew white as far as the marginal moraines, where again the snow melted as it fell. A clear distinction was thus drawn between principal and secondary moraines.

It was useless to think of starting on May 21st, with fresh snow lying a hand's-breadth deep on the Baltoro. Even had it been possible to induce the coolies to move, we could not have gone far over ground so treacherous, even when uncovered, that you risk a fall with every step. The snow continued to fall, but no longer so heavily; and later on the sun showed for a few hours, feeble and veiled but sufficiently powerful to melt most of the fresh snow.

During the day Botta was taken with chills and fever. It was a passing illness, and gave way to salicylic treatment within twenty-four hours. The sheep and goats were now straggling into camp, worn out with being driven for three days without food. They greedily began

[1] A. C. F. Ferber (beside the article cited from the *Geog. Jour.*), see *Die Erkundung des Mustaghpasses*, etc., in *Zeit. d. deut. u. oest. Alpenver.* vol. 36, 1905, and *Boll. del Club Alp. Ital.* vol. 38, 1906, p. 319.

[2] These discoveries of Ferber are interesting because they seem to prove that the Mustagh was once a familiar and regularly used route, despite the fear of the glaciers displayed by the natives who live at their foot. Stein thinks that only troublous times of war and danger from enemies could have induced them to risk their lives on the glaciers (see the discussion after Longstaff's lecture, *The Baltoro Pass*, printed in *Alp. Jour.* 25, 1911, p. 670). Longstaff agrees with Stein that the glacier routes were more probably used by war refugees and messengers, in times of hostile invasion, instead of for trade purposes, and were abandoned with the return of peace.

to nibble the dry grass that stuck out here and there through the snow. During the day we finished all our arrangements for the base camp.

The coolies enjoyed the unexpected rest, huddled in their dens as thick as rabbits in a warren. They swarmed in every chink and hollow among the rocks. We discovered that they made as many separate little camps as there were villages from which they came, but evidently

THE SHIKARI ABDULLAH (ON THE LEFT), THE WAZIR OF SHIGAR (CENTRE) AND THREE CHUPRASSIS.

not owing to any hostility between these communities, for their relations were unbroken and seemed very cordial. The variety of anthropological types is striking. By far the greater number are dark, but a few are blond, occasionally even red-haired. Some are absolutely smooth-faced, others have thick beards. One would say that the Italic types prevailed—characteristic Lombard heads, the full and somewhat heavy features of certain portrait busts of Roman antiquity, and most marked of all, the type, by no means uncommon, of the Florentine page of the trecento, with a face that agrees very well with the fringe of long hair hanging all round the head. One sees sometimes a group positively

Sunset. Taken from the rocks above Rdokass

Biblical in appearance—figures draped in white blankets, with the head swathed in a narrow piece of the same stuff, the ends hanging down the back, and faces of a Semitic cast. Again, one notices a plainly Mongol type, with the characteristic oblique eyes and prominent cheekbones. Many of them while busy baking the chupattis took off nearly all their clothes, with complete indifference to the snow which fell on their backs. They almost always go about barefoot.

Rdokass has abundant animal life, notwithstanding its altitude of over 13,000 feet and its situation among the glaciers. Small rodents about the size of guinea-pigs, with long light grey hair and round erect ears, start up in every direction and hide away under the stones.[1] Small birds hop about the tents, and flights of ash-grey pigeons with black heads pass above us. Not far from the camp flocks of some bird of the genus *passer* chirp about on the turf. They are the size of blackbirds, grey and dark green in colour with a black throat. From the near-by bushes we hear the call of the giant partridge or ram chikor, and every level spot on the mountain side is full of the prints of ibexes. The arrival of so large a party and the smell of smoke had frightened them all off to a distance. Along the margins of the glacier nearly up to the Concordia we found remains of ibexes which had fallen victim to avalanches or to the snow leopard.[2]

The brief interval of sunshine proved a deceiving prophecy. The snow came on again in the night, so heavily that by the morning of May 22nd the whole scene had become absolutely wintry, and the Duke was obliged to give up another day. It did not turn out to be altogether lost time, for Sella, with the guides and a few coolies, went down to the Baltoro and crossed it to the central moraine ridge, where they set up a large stone pyramid. Meantime Negrotto with his graduated staff and tacheometer had measured out along the slope an accurate base line of about 300 feet, from either end of which he took the angles to the apex of the pyramid. When we got back to Rdokass on July 23rd he repeated these observations. The pyramid had somewhat gone to pieces, but was still easily recognizable, and from his data Negrotto ascertained that it had moved 361 feet down the glacier during

[1] They are probably little animals of the genus *ochotona*, and have been observed in other places. Longstaff says the natives call them *shippi*, or whisperers.

[2] Prof. Camerano has published a monograph on the ibex horns brought back by the expedition (*Osservazioni sullo stambecco del Baltoro*, etc. *Atti R. Acc. delle Scienze di Torino*, vol. 46, Feb. 1911).

the interval of sixty-two days. This gives a notable average daily speed of nearly 5 feet 10 inches for the central stream of the Baltoro 10 miles from its snout. If this rate were kept up, it would result in a progress of 2,124 feet a year; but in reality it must be less, for we know that the current is slower in winter than in summer. Observations on the speed of the current in Himalayan glaciers have been very scanty up to the present. R. Strachey gives some measurements taken in the Kumaun-Gahrwal group, where the glaciers are nearer those of our own Alps in size. They move much more slowly than the Baltoro. At the centre of the glacier which forms the source of the Pindi—a confluent of the Ganges—an average advance of 9½ inches in twenty-four hours was observed in May, and from May 21st to October 15th the same glacier moved 98·57 feet, giving an average of 8 inches a day. It flows down to 11,900 feet. Another glacier, the Gori, which flows down to 11,500 feet, covered 37·92 feet between August 2nd and September 30th, an average of 14¼ inches a day.[1] Mr. Hewett, an English topographer who was with the Workmans on the Chogo Lungma, took various measurements of the rate of the latter at two points 15 and 18 miles from the snout, by observing various points of the surface at different distances from the two stations. His results varied considerably for the different points. However, the highest speeds which he observed—namely, 3·08, 3·16 and 3·29 feet in twenty-four hours—may be compared with Negrotto's results on the Baltoro, taking into account the difference in volume between the two glaciers. On the other hand, on the Hoh Lumba, a much smaller glacier, which runs down to the north of the Braldoh valley, the Workmans found a mean velocity of about ·26 feet in twenty-four hours, at a point where the inclination is barely 2° 32′. It looks as though the giant glaciers of the Karakoram flowed at a much higher speed than the ordinary Alpine glacier, and, of course, it would be reasonable to expect that, other conditions being equal, a certain relation should exist between mass and velocity.[2] Let us hope that these observations may soon be taken on the other great glaciers of the region.

[1] R. Strachey, *On the Physical Geography of the Provinces of Kumaun and Gahrwal*, etc. *Jour. Roy. Geog. Soc.* 21, 1851, p. 57.

[2] In the *Grundzüge der Physischen Erdkunde* (A. Supan, Leipsic 1911, 5th ed., p. 197) the author says "The giant glaciers of the Himalaya move much more rapidly (than the Alpine ones), with a speed which in the summer reaches 2–3 up to 7 metres," etc.

Toward evening the weather showed symptoms of clearing, and the Duke had everything prepared for a start on the following morning —not in two parties, according to the original plan, but all together. Mr. Baines, who was anxious to get a glimpse of K² before shutting himself up in his Rdokass hermitage, accompanied us as far as the meeting of the Baltoro with the Godwin Austen, whence he returned to the base camp with the coolies.

CHAPTER XII.

FROM RDOKASS TO THE CONCORDIA AMPHITHEATRE.

Map and Panoramas of the Expedition. — We leave Rdokass. — Glacier Tables. — The Median Moraine of the Baltoro. — The Workman Theory of Glacial Ridges. — Changes of Nomenclature. — Ice-cones and Pyramids. — Their Origin. — Glacier Lakes and Reservoirs. — Camping on the Glacier. — Conway's Crystal Peak. — The Doksam Glacier. — The Marble Peak. — Godwin Austen Glacier. — In Sight of K^2.

FROM this point forward the narrative may be supplemented by the map of the expedition comprising the two upper thirds of the Baltoro and its formation basin, drawn to the scale of 1 : 100,000. But no description, even with the assistance of photography, can succeed, I fear, in giving a just conception, even if a faint one, of this extraordinary region. To compose the picture as far as may be, the reader must tax his patience to make a careful study of Sella's panoramas, which were taken from many points, and compare them with one another and with the map. It is in order to make this possible that not only the topographical stations, but also the points from which the photographs were taken, are marked upon the triangulation map, and the panoramas provided with the nomenclature and altitudes of the different peaks. In addition, the points from which other panoramas were taken are marked with a small cross so as to make comparison easy. The illustrations in the text and the plates are intended to give special details from the panoramas. I hope that the frequently recurring references to the latter may be justified by this explanation.

On the morning of May 23rd at about eight o'clock, after a little hesitation owing to the uncertain look of the weather, we placed our trust in the stability of the barometer and in the wind, which seemed to be veering from south-west to north-east, and we all set out from Rdokass, leaving only the shepherds, a couple of chuprassis and a few coolies in Mr. Baines' service. The Duke's plan was to follow the return route of the Eckenstein-Pfannl-Guillarmod expedition—that is, to cut across the Baltoro toward a camping ground at the foot of the northern slope, a little above Younghusband glacier, where Conway had made his Storage Camp. We skirted the Rdokass ridge downward, and crossed the left hand moraine, which consists of good-sized granite blocks, and comes from the united marginal moraines of the Yermanendu and Mundu glaciers, two affluents much larger than any on the northern side, which flow down from the Masherbrum group, separated by a long and low spur. We then went a long way up the Baltoro between the central and the left-hand lateral moraine. Here the surface was comparatively smooth and the detritus of granite and schist rather fine, so that the marching was not very fatiguing. This part of the glacier is dotted with ice-tables, none of them very large or high, and mingled, as usual, with cones and broken columns of former tables. The tops of these latter had fallen off, and were lying on the surface of the glacier, where, by sheltering another small extent of ice from the rays of the sun while the surrounding level sunk by melting, they would in time form new tables, the process repeating itself indefinitely. After an hour's march we stopped to distribute smoked spectacles to the coolies, for there was a great deal of fresh snow among the stones, and the reverberation was trying, in spite of the cloudy sky.

We were now drawing nearer the median moraine, which rises abruptly to a height of 100 to 200 feet, or even more, above the level of the glacier. We finally climbed on top of it, and found ourselves amid rugged and broken ice covered with all sorts of minerals, mainly limestones and polychrome conglomerates. The extraordinary irregularity of the surface contrasts curiously with the gentle slopes and the structural lines of the valley. We were, above all, struck by the absence of crevasses, a state of things to be explained only by a level valley bottom, unbroken by abrupt falls or projections. But what can then be the origin of this labyrinth of heights and hollows? What are the forces which have heaved up the glacier into high cones, into curving waves or vertical steps, with every appearance of a surface shaped by fracture? Freshfield attributes the irregularity of surface in the Zemu glacier of the Kinchinjunga group to the action of the surface streams, which have furrowed and carved out the glacier in every direction. At first sight, it does not seem possible that confusion and irregularity on such a vast scale as here could be produced by the action of such simple forces, even taken together with unevenness of surface melting, which would be brought about more actively where the layer of detritus was thin, and more slowly where it lay thick enough to protect the ice from the sun. The Workmans noticed that the ridges and valleys on the Hispar were most pronounced where some big confluent joined the glacier and pressed upon it from above with the enormous weight of its own moving mass, in some cases even driving the main stream toward the other side of the valley. They advanced the hypothesis that the surface upheavals are caused by this pressure, which thus forms veritable folds in the plastic mass of the glacier. The theory is ingenious, and appears the more probable in that many indications in the Baltoro glacier seem at first sight to confirm it. Upon this hypothesis the long high spinal vertebræ of the Baltoro would be formed by the pressure in opposite directions exerted by the Godwin Austen and the upper Baltoro, where they meet in the Concordia amphitheatre, a pressure increased by the confinement of their united mass within the limits of the Baltoro valley, and still further by the force of confluent glaciers running into it perpendicular to its axis from the high mountains on either side.

Panorama Q gives a long stretch of this central upheaval of the Baltoro, showing how it starts abruptly from the surface of the glacier and how its walls are cut into vertical sections, apparently due to fracture produced by pressure too great for the elasticity of the glacier. The look of the ice recalls, though on a smaller scale, the great dykes caused by pressure in the polar ice-pack, where an analogous process goes on. Conway, too, attributes the long undulations of the Baltoro to pressure brought about by its confinement in the narrow parts of the valley.

Notwithstanding all this, when two months later we again traversed the glacier on our return and saw the extraordinary changes a few weeks had been able to effect in digging out fresh valleys and vastly increasing the differences of level, we were forced to own that uneven surface melting, due to the varying thickness of the moraine layer, is without doubt the main factor in the irregularity of the glacier surface. It is also possible that the pressure of the glaciers against each other does bring about some upheavals and projections of the mass, and that these, in their turn, by determining certain falls and displacements of detritus, add to the irregularity of the melting process and so contribute to the general result.

We had now nearly reached the mouth of the Younghusband glacier, at about the point attained by Godwin Austen in 1861.[1] Although we had passed the spot where we had intended to camp, Abdullah and the native guides kept on up the glacier instead of crossing it direct to the northern side. After long explanations we succeeded in making out that the coolies put the stage of Gorè above the confluence of the Younghusband glacier, where Guillarmod's map has Biange, a mere inversion of names. It was obviously wise to profit by the goodwill of the porters and make the camp as far up as possible. We therefore allowed ourselves to be led without further discussion. The coolies were being paid per stage (*parao*) at the exceptional tariff of seven annas, and not by the day, so it was to their interest to march quickly and cover two or more stages in a day.

Inconsistencies in nomenclature are, to my mind, far less surprising in this region than the fact that there are any names at all, implying a certain familiarity with places which the natives must never have visited voluntarily, if one judged by their violent aversion to the glacier, which is certainly strong enough to counterbalance any natural curiosity. Yet there are other indications which seem to show that they have some degree of acquaintance with these ice-bound solitudes. As early as 1892, at the time of Conway's visit, a Balti of Askoley made on the sand a rough sketch of the district in order to show Eckenstein the position of the Mustagh passes, the Baltoro, the Mustagh Tower, Masherbrum, Gasherbrum and K².[2]

[1] From here Godwin Austen climbed part way up one of the spurs of the southern chain of the Baltoro in order to get a view of K².

[2] See the letter of Sir W. M. Conway, in *Proc. Roy. Geog. Soc.* 14. 1892, p. 857.

From Rdokass on we observed, as did our predecessors, some higher hummocks or pointed cones far too large and broad-based to be identified with the pedestals of fallen glacier tables. Little by little as we went up these strange formations became more numerous, and increased in height up to from 30 to 70 feet or more. They are in shape either cones with an oval base or flattened pyramids, whose greatest

ICE PYRAMID ON THE BALTORO.

diameter runs parallel to the direction of the valley. They usually terminate in a sharp point. On the right side of the glacier, to which we had now crossed, we found them large and imposing and arranged in rows running in the direction of the moraine. As you go farther down they get farther apart, but remain between the same moraine lines. The glacier marked with these snow-white pinnacles over a dark background of moraine presents an odd appearance—like a grave-yard with rows of tombstones, or a river dotted with fleets of white lateen sails.

The first observer to call attention to these ice pyramids was Godwin Austen, whom nothing noteworthy escaped. Guillarmod supposes them to be séracs fallen from overhanging side glaciers, and reduced to this shape by melting. Ferber notes the phenomenon without attempting an explanation. They seem to be peculiar to the Baltoro—at least, the ice cones and pyramids seen by the Workmans on the Hispar and by Longstaff on the Siachen, and the glaciers which cut into the upper

ICE PYRAMIDS.

Shyok valley, appear to be merely supports of fallen tables. In any case, we have no detailed descriptions which would suffice to identify them with the pyramids of the Baltoro.

These formations we observed only as far as the entrance to the Concordia basin. We saw none of them on the higher portion of the glacier, where the action of melting is equally intense. But in the Concordia amphitheatre and on the upper Baltoro we saw formations which might account for the origin of the pyramids. I mean the long high dykes of ice which rise between the dark moraine ridges hollowed by melting. They are generally bare of detritus, possibly owing to the steepness of their sides, and stand out sharply from the moraine-covered surface as if the live ice had violently thrust itself up through the shroud of detritus. Panoramas K and N show some of these icy crests. Here and there they appear already divided into segments and separated blocks, in consequence of the melting of the intermediate parts due to

EMPTY BASIN OF GLACIAL LAKE.

patches of detritus. Godwin Austen observed on the Baltoro itself, in addition to the pyramids, certain oblong blocks with a sharp ridge on top, which must have been larger sections of one of these ice dykes.

In this part of the Baltoro, between the ranks of pyramids, are numerous exquisite little lakes, mere collections of water in hollows, not fed by streams or provided with outlets. Some of them are covered with ice vaults, recalling similar formations on the Agassiz glacier in

Masherbrum, from the Baltoro

Alaska. The ice pyramids poised on the margin of these little lakes are dazzlingly reflected in the translucent water; or where the basin has been emptied the adjacent ice pyramid appears to have added the whole depth to its own height. In other places we look through fissures into large caverns filled with water up to various levels. Godwin Austen made a special study of these spherical reservoirs, noticing outlets upon their walls, some of which reached the proportions of real tunnels

OPENING OF A RESERVOIR.

traversed by endo-glacial torrents. I must mention also the symmetrical conical hillocks on wide bases, entirely covered with detritus, which reach sometimes a height of 300 feet. The Workmans, who observed similar hillocks on the Hispar, attribute them to thrusts acting concentrically from different directions. But Dr. Cesare Calciati and Dr. Mathias Koncza, who accompanied the Workmans upon their last expedition, think they are due to irregular surface melting. We did not get sufficient data to conclude in favour of either hypothesis. On our way down from the median moraine to the right half of the glacier we crossed a moraine streak of white marbles coming from the last glacier on this side of the valley near the Concordia basin. Beyond this point the granite begins again. Here we also found scattered pebbles worn to varying degrees of roundness.

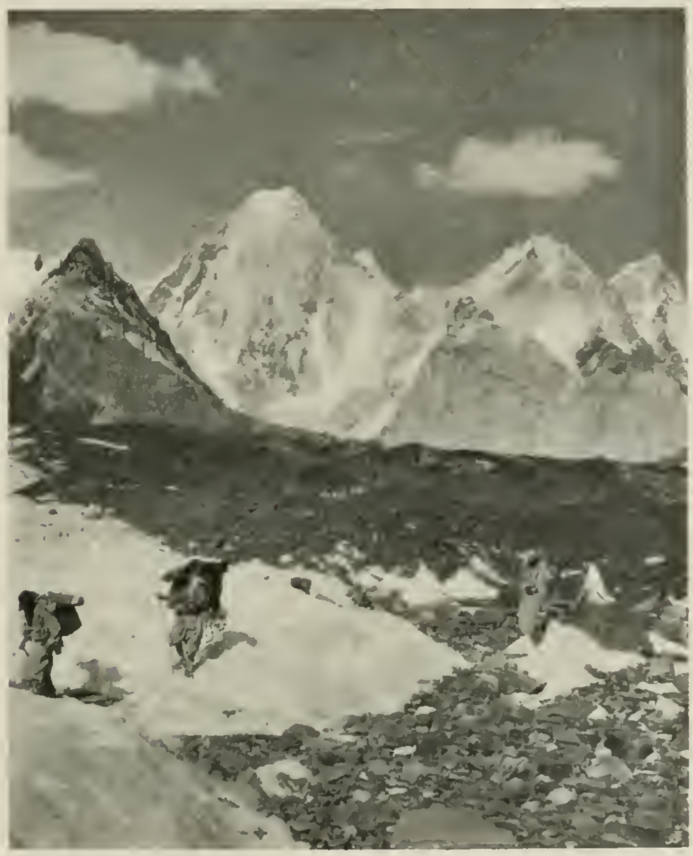
Little by little the weather improved. Though the sky did not quite clear and light mists were still lingering on some of the peaks, we now began to get sight of surrounding summits which told us we were nearing the high peaks. It seemed as if the whole southern chain of the Baltoro had no other office than to form a base for the marvellous Masherbrum, which towered up in its midst, showing a little dimly

MITRE PEAK WITH ADJACENT SOUTH WALL OF THE BALTORO.

through the mist. Its gigantic northern wall is deeply furrowed and loaded with glaciers breaking into icefalls down the sides of a tremendous central rib of rock. This latter is also covered in great part with ice, and leads up to the small horn which forms the topmost peak, 25,660 feet. The second peak, 25,610 feet high, is hidden behind the first one. The foot of the mountain is at least four miles from the Baltoro, and the space between is traversed by two large glaciers, the Mundu and Yermanendu, which flow on either side of a long, low and deeply indented spur, like a miniature chain of peaks running at right angles to the main one. To the east of Masherbrum and beyond a series of minor spurs which divide a few secondary valleys, the Baltoro receives two more confluents as large as the glaciers of the Masherbrum, flowing

Gasherbrum

down in great icefalls from precipices loaded with snow. Then comes Mitre Peak, a colossal, strangely-shaped crag, which terminates the left wall of the valley. In front of us, apparently quite close at hand, the transversal chain of the Gasherbrum seems to shut in the valley. It is a file of peaks and snow crests, stretching on both sides of the precipitous rock wall of the Gasherbrum itself, all ridges and ice gullies,



GASHERBRUM.

and nearly 10,500 feet. It is bounded by two ridges which would meet at a sharp angle were they prolonged beyond the truncated peak. To the north of the Gasherbrum, on the continuation of the same range, the great rounded domes of Broad Peak rise above the last spurs of the right wall of the Baltoro, which still project in front of us. Lastly, to our rear the Mustagh Tower has detached itself from the lesser peaks and stands up alone and menacing. It has not even yet revealed the full splendour of its outlines.

About 4 p.m., after a little over seven hours' marching, when we had long passed all the coolies, we found a spot on the moraine which was relatively level and free from boulders, at a point half-way between Younghusband glacier and the stage of Gorè, or Biange, as Guillarmod has it. Here the Duke decided to place the camp. The coolies did not arrive until after sunset. They had but ten loads of firewood, all small and wet, and they experienced great difficulty in kindling their tiny

MITRE PEAK FROM THE CAMP BETWEEN RDOKASS AND THE CONCORDIA.

fires. The sky had clouded over, and it began to snow again. We could not leave the poor wretches without shelter for the night with the snow falling, so we lent them the two large tarpaulins. Quickly and thoroughly the ingenious Baltis cleared two big squares from superfluous stones, built a low wall around them, stretched the tarpaulins across, and were soon all sheltered, packed as close as herrings, but quite happy and satisfied. In order not to encroach upon their slender stock of firewood we inaugurated our Primus stoves, which, as usual, required our personal supervision for the first few days, until Bareux had time to learn how to use them.

During the night the thermometer fell to several degrees under freezing point, and the next morning was very chilly. The air was still but slightly veiled, reminding us of the dusty horizons of the Indus valley. Our native guides made us descend nearly at once into the deep trough between the valley wall and the glacier, full of very unstable blocks, where the whole march is up and down hill, because one has constantly to cross portions of the glacier which jut out on to the rock. These stretches were covered with very coarse detritus, upon which you must step very lightly, because if you move one block the whole of the stony slope above and below you begins to slide down, and the least that could happen would be an unexpected plunge in some marginal lake. It would doubtless be easier and less dangerous to walk along the surface of the glacier, as we should have done but for the violent objection of the coolies to marching on it, not so much on account of the cold as from superstitious terrors.

In less than an hour we reached a little lake at the foot of a secondary valley (the next but one after the Younghusband glacier), which our coolies called the stage of Gorè. Here Conway camped (Pool Camp), also the Eckenstein-Pfannl-Guillarmod expedition (Biange); and one of the two parties set up a cairn, which is still standing. From this point Conway ascended a peak of the ridge above, 19,400 feet high, which he named Crystal Peak. Thence he discovered the Concordia basin and the three mighty glaciers which flow down to it—the Godwin Austen, the upper Baltoro and the Vigne. This peak which Conway climbed has nothing to do with the one 20,587 feet high which bears the same name on our map and lies farther east, almost directly above Doksam. The latter, which is very well suited to be a topographical station of reference, owing to its striking pointed shape, was provisionally called Crystal Peak by Negrotto in his surveying work, and the name was preserved inadvertently. In the course of a topographical campaign it is unavoidable to give some temporary conventional name or sign to peaks which have to be identified from different stations. Beyond this casual naming the Duke, as I have explained, named none of the many peaks measured by us, agreeing with Burrard that, until a rational system shall be found, it is better to designate peaks simply by their altitudes.

We now crossed the mouth of another small valley, and at the next opening in the wall we left the ice and skirted a gentle grassy slope where Conway had camped (Fan Camp), and whence he climbed to a saddle on the ridge, from which he had his first sight of K[2] and was able to realize the vast dimensions of Broad Peak.

We finally came back to the glacier proper, where we were able to proceed more rapidly and with less fatigue, in a space between two bands of moraine, where there were numerous little lakes. In a few

THE MARBLE PEAK AT THE CORNER BETWEEN THE GODWIN AUSTEN AND THE BALTORO.

minutes we reached the last confluent glacier on this side of the valley, which is not very large, and flows down from a strange-looking peak, a pinnacle of pure white marble rising from a wide base of black slaty schists. This glacier, like the Liligo, does not reach the Baltoro, but ends not far from it, between two moraines of dazzling white marble, in a great frontal wall of broken ice like a line of surf. The Shikari Abdullah told us that this glacier had totally changed its appearance since 1902, when the Eckenstein-Pfannl-Guillarmod expedition camped in the space between it and the Baltoro (Doksam Camp). Certainly it would not now be possible to set up the tents on the small level that remains, which is under continual fire from the séracs of the advancing glacier.

We had now nearly reached the end of the Baltoro valley proper. At a short distance from us a promontory from the base of the marble peak ran down to the glacier. We knew that this was the last obstacle

FIRST SIGHT OF K^2.

between us and the sight of the Godwin Austen valley and K^2, which lay behind it, and we were seized with unspeakable restlessness and fear lest the mist should cut us off from the long-looked-for reward, which had been in the background of our consciousness through every step of the long way.

We rounded the spur following the wide sweep of moraine, now grown level and even, almost without noticing the vast space of the Concordia amphitheatre spread out before us. Suddenly, and without warning, as if a veil had been lifted from our eyes, the wide Godwin

Austen valley lay before us in its whole length. Down at the end, alone, detached from all the other mountains, soared up K^2, the indisputable sovereign of the region, gigantic and solitary, hidden from human sight by innumerable ranges, jealously defended by a vast throng of vassal peaks, protected from invasion by miles and miles of glaciers. Even to get within sight of it demands so much contrivance, so much marching, such a sum of labours.

It fills the whole end of the valley, with nothing to draw the attention from it. All the lines of the landscape seem to meet and converge in it. The mountains group themselves about it, yet without any intrusion upon it or interference with its extraordinary upward effort. Its lines are ideally proportioned and perfectly balanced, its architectural design is powerful, adequate to the majesty of the peak without being heavy; the steepness of its sides, its ridges and its glaciers is appalling; its rocky wall is 12.000 feet high.

For a whole hour we stood absorbed. We gazed, we minutely inspected, we examined with our glasses the incredible rock wall. All the time our minds were assailed with increasing doubt, culminating almost in certainty, that this side of the mountain was not accessible, and did not offer even a reasonable point of attack. Meantime the atmosphere grew gradually thicker, the veil of whitish vapour heavier, stretching and expanding and melting together, until even the last spectral image disappeared and a uniform grey curtain of mist filled the end of the valley. The vision was gone. Beneath a lowering sky the Concordia ice-plain lost itself to the south in the dim vastness of the upper Baltoro.

CHAPTER XIII.

FROM CONCORDIA TO THE FOOT OF K².

PRELIMINARY INVESTIGATIONS AND FIRST ATTEMPT.

The Concordia Amphitheatre. — Confluent Glaciers. — The Southern Wall of K². — Broad Peak. — Gasherbrum, Golden Throne and Bride Peak. — The Arrangement of the Moraines. — Photogrammetric Work begun. — The Lower Part of the Godwin Austen. — Structure of the Broad-Gasherbrum Range. — Height of Broad Peak determined. — The "Nieves Penitentes" of Dr. Workman. — The Camp at the Base of K². — Exploration of the Eastern and Western Slopes. — The Plan of Attack. — The Camp moved to the Southern Ridge of K². — The Duke leaves the Base Camp. — Three Days on the Slopes of K². — Defeat. — Return to Camp. — Coolies and Crows. — Snowfalls and Avalanches.

THE dawn of May 25th found us up and abroad. The thermometer stood at 15° F. On the evening before veils of mist and cloud-curtains had so shrouded the landscape that we had not in the least realized the incredible spectacle of glaciers and mountains which now stood revealed in the pale light of morning. The air was perfectly still and just lightly dimmed, like a crystal breathed upon, yet clear enough to show every detail of the marvellous scene.[1]

We had camped on one side of the huge glacial cross roads, named by Conway the Concordia, after the glacial basin of the Oberland, in which the Aletsch, the largest glacier in Europe, has its source.

[1] See the map of the Baltoro and panoramas C and D.

The basin is formed by the bifurcation of the Baltoro valley, at the foot of the bastion made by the Broad Peak (Gasherbrum range). One of the two branches of the valley is the Godwin Austen, which goes up northward to K². The other is the Upper Baltoro, which runs south-east to Golden Throne and Bride Peak. Both valleys then curve eastward, and combined they form a letter C made up of nearly 31 miles

MITRE PEAK FROM THE CORNER BETWEEN THE BALTORO AND THE GODWIN AUSTEN.

of glaciers. In addition to these, two other good-sized glaciers come into the Concordia from the western walls of the Broad-Gasherbrum chain. They meet directly outside their own valleys, and wedge themselves between the Baltoro and the Godwin Austen, crossing the basin in a white stripe of bare ice between the moraines of the two main glaciers. These four main affluents alone are at least five miles broad, without counting the numberless smaller tributaries coming in from the valleys, gorges and couloirs of the mountain chains; while the basin which receives them all is only two and a half miles in diameter, and the Baltoro valley itself, into which the whole mass is compressed, less than two miles broad. The entrance to the latter is guarded by two characteristic heights—to the north Conway's Angle Peak, a marble summit 20,088 feet high: and to the south the bizarre tooth-shaped Mitre Peak, 20,462 feet high, entirely composed of black schist.

SOUTHERN VIEW OF K².

On every side the eye meets a spreading vista of wide valleys filled with almost level glaciers, which go up at a gentle slope among the lofty chains. The Godwin Austen is composed of parallel stripes of black and white, formed by the alternation of bare ice and moraine detritus. It runs northward for six miles to the base of K², which rises, a pyramid of rock, 12,000 feet high from base to summit, between two ridges that outline themselves to west and east against the sky. The first of these is all rock, running straight down to the valley. The second forms a broad ice-covered shoulder nearly 3,000 feet below the terminal peak, from the edge of which it drops in a very steep descent divided into two minor crests. In the centre of the pyramid another great rocky ridge comes down directly south-west to a narrow icy saddle (Negrotto Pass, 21,322 feet), beyond which it shoots up in a graceful snowy peak (22,490 feet high) of a slender pointed shape, recalling our own Grivola. The neighbourhood of the colossus robs it of all significance.

The southern face of the mountain is cut obliquely by a glacier coming down from the eastern shoulder in four great leaps or cascades

LOWER PEAKS OF THE GASHERBRUM RANGE. BY TELEPHOTOGRAPHY.

of séracs, separated by slanting terraces. All the ridges and gullies of the wall are exposed to its avalanches. The terminal cone, from the saddle up, shows plainly the stratification of the rocks. Every mountaineer will recognize, at first sight of the illustrations, the resemblance of K², as seen from the south, to the Matterhorn.

The valley appears to end at the foot of the mountain; instead of which it bends abruptly north-east, and runs in between K² and the northern slopes of Broad Peak. The heavy and massive outline of the latter, surmounted by its three huge rounded peaks, comprises in itself almost the whole left side of the Godwin Austen valley. A short broken ridge joins it to Gasherbrum IV, whose summit rises above the spur dividing its two western glaciers. From the Gasherbrums the chain extends toward the south in a ragged edge of rocks and snowy peaks to form the western side of the Concordia amphitheatre and the upper Baltoro.

The upper Baltoro rises gently toward the south-east, and has an aspect similar to that of the Godwin Austen. It is covered with stripes

BRIDE PEAK FROM THE GODWIN AUSTEN, NEAR THE CONCORDIA.

of moraine, which grow narrower and farther apart as they go up the valley, and are divided by wider and wider spaces of bare ice: it runs to the foot of a mountain whose broad, rounded top is covered with glaciers. This is Conway's Golden Throne, some 15 or 16 miles distant from the Concordia. Here the Baltoro turns eastward and disappears from view. A wide glacier-covered depression separates Golden Throne from Bride Peak on the west. The latter, too, is white with snow. It turns toward us its characteristic northern wall, shaped like a trapezium, topped by a long ridge, the ends of which form the two peaks of the mountain. The one to the east, 325 feet higher than the other, is a station of the Indian Survey (Karakoram No. 8, 25,110 feet). From Bride Peak a long spur runs northward toward us, ending in a sharp angle. Between it and Mitre Peak opens the Vigne valley, which contains the third largest glacier of the Concordia basin.

The picture presented by the mountain groups just described, which close our horizon to the south with their glacier-covered flanks, is entirely different from that formed by the precipitous rocks of K^2 and the crags of the western ranges extending to the Gasherbrum and beyond. The eye and mind of the mountaineer turn for relief to the broad curving lines of Golden Throne and the snowy sides and ice-covered wall of Bride Peak, since everywhere else he looks he sees nothing but perpendicular rocks, sheer precipices thousands of feet high, turreted battlements of rock, needles, pinnacles, sheets of ice bordered with great cornices, walls and gorges running at extravagant angles up to extravagant heights, crowned by séracs, and showing everywhere the gleam of living ice. Yet, despite it all, one felt the compelling and irresistible ambition toward a closer acquaintance and more intimate knowledge of the lonely giant which so few men before us had ever even beheld.

It was only on the return journey, after the end of the campaign upon K^2, that the rare occurrence of two days of unbroken fine weather enabled Sella to take panoramas C and D—the first from the outer base angle of the marble peak which stands on the corner between the Baltoro and Godwin Austen glaciers (17,329 feet); the second from a point opposite the first, 17,917 feet high, on the western ridge of the Gasherbrum. Taken together these two panoramas show the whole region of which the Concordia basin is the centre, and the great glacial streams that converge in it. They also bring out clearly the arrangement of the moraines, which is almost geometrical in its regularity. It seems unbelievable that a haphazard combination of rocks, ice and snow on so vast a scale could result in such a harmony of line and form. The long, sinuous bands of moraine, converging and blending into one, or remaining separate and running down in pairs of rigidly parallel lines as far as the eye can follow them into the lower Baltoro, seem like a graphic representation of the movement of the glacial masses, and give one a very definite idea of the ice-flow. The panoramas show likewise the series of ranges running up and up, one behind the other, to the last point of vision and beyond, as well as the innumerable host of peaks that tower above them. The work of triangulation carried out on the photogrammetric survey of the expedition has designated a considerable

From a western spur of Gasherbrum, 17.917 ft.

number of these peaks, ascertaining their height and position; but there remain countless others, by no means small or unimportant, not indicated by any sign upon the map.

On our first view of it, in the morning of May 25th, the landscape was still shrouded in the spring snows. It looked quite different at the end of June, when Sella took his photographs. The impression made upon us was so strong, so moving, that no words can convey it to the reader. It was like no other experience, it provoked no recollections or comparisons. So inconceivably vast are the structural lines of the landscape, that the idea comes into one's mind of being in the workshop of nature, and of standing before the primeval chaos and cosmos of a world as yet unvisited by the phenomenon of life.

In all Alpine ascents one knows one has left the green fields, the trees and the villages only a day behind; and from all the heights one looks down on the green mantle of verdure covering the earth. The bare rocks and ice are but limited areas, not huge unconfined wastes. Here one is conscious of not a single manifestation of life. It is comparable to the polar regions in this respect, but in no other, for instead of the monotonous horizons of the far north, all the landscape around K² has the richest variety of design, the greatest majesty of form, and an infinite diversity of plane and perspective.

The scale is far too vast for one to receive an impression of the whole at once. The eye can only take in single portions. For a long time we did not become fully conscious of the dimensions of the landscape. We had no standards of comparison, and the glaciers and valleys are so well adjusted in their proportions to the surrounding mountains that it was hard to realize the absolute size of any object. All this was revealed to us gradually, by dint of daily contemplation and detailed observation, most of all by repeated failures in estimating heights and distances. Thus it happened that our amazement, instead of diminishing with familiarity, grew greater every day, and this extraordinary region never made a more profound impression upon us than on the day when we bade it farewell.

The Concordia basin, lying in the heart of the ranges, at the junction of their greatest glaciers, is the place above all others adapted for the base or point of departure for topographical work. Four of the most important trigonometrical stations of the region are visible from it—K², Gasherbrum IV, Bride Peak (Karakoram No. 8) and Masherbrum I.

For this reason the Duke had arranged the evening before that we three should remain at the Concordia for a whole day, while he, with the guides and the bulk of the luggage, went up the Godwin Austen glacier to the foot of K^2 to look for a suitable spot for a base camp, whence he could conduct operations upon all the slopes of the mountain. This plan was carried out. Unfortunately the misty atmosphere, which later became actual fog, prevented Sella from doing any photographic work. Negrotto, however, succeeded in getting out two panoramas available for topographical purposes.

The next morning we said good-bye to Mr. Baines, who went back to Rdokass with all the coolies except the ten chosen to remain with us. We then set out to join our leader at the foot of K^2. The weather was perfect, for the first time since we had set foot on the glacier. The clear sky, the pure transparent air and the splendour of the sunlit snows, seemed to us like a welcome to the region, and filled our minds with the boldest hopes.

For some distance we proceeded along a tongue of ice between two stripes of the left-hand moraine. On this side, between the Concordia amphitheatre and K^2, the Godwin Austen receives two affluents. The lower comes in between the Crystal Peak chain and a short ridge that runs up to the water shed; the second is a more considerable glacier, coming from the western slopes of K^2. Between the two, at the foot of the intervening spur, the Eckenstein-Pfannl-Guillarmod expedition placed their Camp VIII. We were gradually getting nearer the centre of the glacier, which is occupied by wide median moraines still largely snow-covered. The snow lay very unevenly: in some places a couple of feet deep; in others, even outside the moraine, it had quite disappeared. All the longitudinal furrows of the glacier had water running in them from the surface melting, covered by a more or less thick sheet of ice. Some of us, walking rather incautiously, went in over our knees in the icy water.

We walked at an easy pace up the hardly perceptible slope, glad to have left behind the rough moraines of the Baltoro. The sun was mild and the reverberation not severe. Little wisps of tourmente raised by the wind floated here and there over the high ridges, moving across the pale blue sky. Immense chains rose all about us as far as the eye could see. In spite of their size, the mountains have all the bold design to be seen anywhere in the Alps—the barren precipices, the snowy slopes and the upward thrust of slender peaks, the ample curving cornices, the multiform broken architecture of séracs, and the overweighted glaciers hanging on vertical rocks. But all this exists with such luxuriance and upon such a gigantic scale, that one stands bewildered in the midst of a scene that seems to beggar the human imagination.

THE WESTERN FACE OF BROAD PEAK.

The left wall of this part of the Godwin Austen is largely formed by a low screen of black rock, which detaches itself from the western crest of Broad Peak and runs southward. Behind it the glaciers of the whole enormous wall of Broad Peak fall down and run together. Wherever this wall is not covered with ice one can see distinctly the light grey rock arranged in broad strata. We had already noted the similar appearance of the rock in the spurs of the Gasherbrums. From an examination of the moraines that have their origin in the various mountains, we were able to ascertain that the whole chain of Broad Peak and the Gasherbrums, including Hidden Peak and Golden Throne as well, is a sedimentary formation ; while the outer curve of the letter C formed by the two great valleys, covering all the distance from

Staircase to Bride Peak, taking in the pyramid of K^2, is composed of crystalline rocks, granites, gneiss and quartzes, with the single exception of the marble peak which forms the corner between the lower Baltoro and the Godwin Austen. This last appears to be a splinter broken off from the calcareous mass of the other side of the valley. Ing. Novarese has confirmed our conclusions by an analysis of the mineral specimens brought back by the expedition. With the aid of our descriptions and Sella's photographs he has been able to reconstruct on its general lines the geological scheme of the high glacier basin. Most interesting to observe is the close analogy between its structure and that of the great glacial valley of the Siachen, which lies south-east of the upper Baltoro. Dr. Longstaff, who explored the latter in this same summer of 1909, and demonstrated for the first time its vast extent, mentions the fact that it is contained within a compound formation, one wall being a granite chain to the south-west, and the other, on the north-east, a range of limestone sedimentary rock. The latter contains Mount Teram Kangri, 24,500 feet high.

The presence of calcareous rock in the Gasherbrums is sufficiently evident, and did not entirely escape the observation of Conway. He says that the Concordia basin is surrounded by mountains in which one can distinguish alternate black and pale grey streaks of gneiss, granite and limestone. T. G. Bonney and Miss C. A. Raisin, who made the mineralogical report of Conway's expedition, concluded from their examination of the specimens brought back that "a considerable mass of sedimentary rock must be infolded from Gasherbrum to Golden Throne." Guillarmod only mentions the white marbles of the Doksam glacier, near the angle between the Baltoro and the Godwin Austen.[1] But up to now the vast extension of sedimentary rock had not been suspected by any one, nor the fact that it forms the chief constituent of the whole mighty barrier which interrupts the course of the Baltoro on the west. Even in the recent monograph of Burrard and Hayden, the axis of the great Himalayan peaks and of the mountain systems belonging to them is described as a granite formation.

It is probable that the thick-set form and huge mass of Broad Peak rather blinded Godwin Austen and Conway to its remarkable height.

[1] He says also that marble has been found "sur les flancs mêmes du Chogori" (K^2), without more precise indication; but we are unable to confirm the existence of limestone in the rocks of K^2.

The result obtained by triangulation from Negrotto's data shows it to possess a peak 27,132 feet high, flanked by two others of 26,024 and 26,000 feet. No other mountain over 27,000 feet has been found since 1858, and Burrard considered it improbable that there would be further discoveries of peaks 27,000 or even 26,000 feet high. In a list of our highest known mountains Broad Peak would occupy the sixth place, those ranking above it being Mount Everest, K^2, the two peaks of Kinchinjunga, and Malaku in the Everest group. All these peaks have been measured from several stations, with all the exactitude at present obtainable, considering that there exist some elements not precisely calculable, such as that of refraction, which thus remain sources of possible error. The peaks recently discovered are still awaiting the confirmation of further observations carried out from different stations and with more precise methods.

In our first stage on the Godwin Austen we did not, as this long digression would seem to indicate, concentrate our attention on Broad Peak. K^2 had too great a fascination for us, now that we could observe it from base to summit. As we approached it the wall appeared to grow less steep, but, on the other hand, the obstacles became more evident—the live ice of the gullies, dominated by overhanging séracs; the gleam of *verglas* on the rocks; the sheer precipices showing everywhere on the face of the wall. We left the central moraine where it began to curve toward the base of the south-western spur, and walked across on the glacier to the left-hand marginal one. Where it rounds the western angle of Broad Peak the glacier is heaved up in folds cut and broken in every direction, forming a perfect cataract of séracs. These waves, gradually diminishing in height, reach to the centre of the glacier, and there form in regular rows of small séracs along the sides of long flat corridors, which afford an easy and rapid progress. Dr. Workman would call these formations "nieves penitentes, sérac variety." The term *nieves penitentes* is generally used to designate specific surface formations of the snow in the Andes mountains and other places, caused either by melting or by the wind. Dr. Workman has, in repeated publications,[1] urged its extension to all the manifold projections and

[1] W. Hunter Workman, *Geog. Jour.* 31, 1908, pp. 34 and 394; 32, 1908, p. 139; 34, 1909, p. 570; *Zeit. für Gletscherk.* 2, 1907, p. 22; 3, 1909, part 4; also the volumes written by him and Mrs. Workman, *Peaks and Glaciers of the Nun Kun.* London 1909; *The Call of the Snowy Hispar.* London 1910, etc.

protuberances which render uneven the surface of mountain ice or snow, and has created at will a complicated classification, distinguishing eight varieties and three sub-varieties. It is not easy to understand the advantage gained from confounding the most diverse glacial formations, which have neither origin, production nor composition in common.

SOUTHERN WALL OF K ^{2}.

We directed our steps straight toward the angle at the right side of the glacier which cuts the southern wall of K ^{2} and flows out on the Godwin Austen with a high front of séracs, like the tributaries of the Baltoro. At the foot of this glacier is a small stretch of marginal moraine, shut in between the valley wall and the side of the Godwin Austen, below a depression in the south-western spur of K ^{2} (Negrotto Pass). Here there was a refuge from falling stones and ice, protected on three sides from the wind, and getting the sun from early morning till four in the afternoon. Upon this spot the Duke had fixed his camp. K² towered up immediately above us, but so foreshortened as to lose much of its height—it does not seem possible that it rises to nearly 12,000 feet above us. Broad Peak is opposite, across the valley; while to westward rises a beautiful snowy range with inaccessible cliffs. It forms the right side of the glacier that curves about the western side of K², and empties itself upon the Godwin Austen in a great wave of séracs. To the south there is a spreading view that ends in the gentle and reposeful outlines of Bride Peak and the snowy saddle on its left.

The camp was deserted when we reached it. The Duke, according to his habit, had not lost an hour, but set to work at once. Accompanied by Giuseppe Petigax and Enrico Brocherel, he had reached the mouth of the glacier which comes into the Godwin Austen below the camp, and climbing its terminal cascade, not without considerable difficulty, gradually rounded the end of the south-western spur of K². Beyond the séracs the glacier expands into a wide valley running northward below an impregnable wall of rock, the western flank of K². The valley ends in a broad rounded col, upon which descends the north-western ridge of the mountain, which is less steep than the southern ridge. If one could, with the help of the coolies, once set up a camp on this saddle, there would remain only about 6,500 feet to conquer between it and the peak. The Duke climbed the glacier up past its centre, searching on his return for some way of access to the valley that would be easier for the coolies than the route over broken ice, full of treacherous cracks, by which he had entered it. The furrow between the glacier and the rock on the left side of the valley gave him what he sought, and at three in the afternoon he returned to the camp.

In the meantime a second party, composed of Alexis and Emilio Brocherel, Bareux and Savoie, had gone up the Godwin Austen above the camp to examine the eastern slopes of K². Their report was not very encouraging. The long north-eastern ridge was out of the question, as well as the whole eastern side of the mountain, which was extremely steep, covered with ice and exposed to avalanches of séracs. They then turned their attention to a ridge of rock visible from the camp, running directly up from the glacier to the edge of the great snowy shoulder of the mountain. This was the only route that looked at all possible to them.

Thus on the first day after reaching the foot of K² the Duke had already made a cursory examination of two-thirds of the circumference of the mountain. Nowhere had he discovered an easy, obvious and safe route to the peak, and the undertaking assumed a doubtful hue. Nor did there appear to be in the neighbourhood any low saddle, any easy pass, by which to get over and examine the northern side. Moreover, Colonel Sir Francis Younghusband, who had seen the northern

THE BASE CAMP AND RIGHT WALL OF THE SAVOIA GLACIER.

side of K² from no great distance, described its precipitous and forbidding aspect in terms that left very little to hope for a route on that side. The Duke decided to act at once upon the knowledge already gained, but before choosing any one slope in preference to others, he waited in order to examine for himself on the morrow the rocky ridge which Alexis Brocherel had proposed for a trial.

Meanwhile we had sent the coolies back to bring up the few remaining loads left behind at the Concordia. By May 27th we had

established our camp and were provisioned for a month, sufficient for a long siege. The tents were set up in two rows on the levelled stony surface of the moraine, with the little settlement of coolies a hundred feet away and a little below us. Our stores were sheltered within stone walls with the tarpaulins stretched over them. Thus the place (Camp III on the map) was, in all its arrangements, a permanent encampment and point of departure for the explorations to take place on K². A series of meteorological observations was kept up there, synchronous with those carried on at Rdokass and the four Kashmir stations. The result gave for the camp a height of 16,493 feet,[1] and it became a second station of reference next to Rdokass, for the calculations of pressure readings taken by the expedition on the glaciers that girdle the base of K².

The Duke decided to make the attempt on the southern ridge of the mountain. It is certainly steeper and longer than the north-western crest, which runs down to the col at the head of the glacier he had already explored. But, on the other hand, it had certain advantages. In the first place, there was not the unknown quantity of the climb up the ice-wall to arrive at the col. And more important still, the slope faced full south and got the sun from early in the morning. This is a consideration of the greatest importance in ascents above 24,000 feet, as the intense cold can prove not only a difficulty, but a grave danger to the explorer.

The route being chosen, it remained to settle upon a plan of campaign. Almost everywhere on the ridge we could see with our binoculars the gleam of *verglas*, bare ice, hard and polished like crystal, which gives the last touch of difficulty and danger to a climb. However, we hoped that a few days' sun and wind might lay bare the rugged rock, where one would be able to get a grip with hands and nailed boots. About 3,500 feet above the valley there stood out from the ridge a prominent rock of a reddish-yellow colour. The plan was to make a high camp there with the Whymper tents, so as to be able to wait a few days if necessary. The small light Mummery tents are no protection against the weather, being good only for temporary night shelters. From this spot the Duke hoped to gain the shoulder of the mountain, making an intermediate light camp with the Mummery tents. The

[1] 16,512 feet on the map. For the discrepancy in the figures see the discussion of the altimetric data in Chapter XIX.

peak itself, from the shoulder up, looked inaccessible from where we were; but even if it proved quite impossible on nearer view, the conquest of the shoulder (25,354 feet) was in itself an undertaking amply worth while.

Despite the most painstaking and rigid selection of equipment, our luggage, consisting of tents, sleeping-bags, food for a week, cooking apparatus and paraffin, and the Alpine outfit, made a considerable weight and bulk which we knew not how to reduce further. It was useless to embark on such a project without being armed at all points. But a calculation of ways and means brought us to the irresistible conclusion that it would not be possible for any of us to accompany the Duke. He therefore made up his mind to go alone, with all the resources of the expedition, intent on reaching the highest possible point at a dash. Then, if his powers did not hold out to the last proof, he would come back, leaving the tents on the ridge, and handing on the undertaking to one of us, who would have the advantage of fresh strength and the fact that the equipment was already on the spot.

We discussed all these details, and made ready the loads with the greatest care. The mountains about us were constantly flinging down long white avalanches of snow, enveloped in flying dustlike clouds, and filling the valleys with rumbling echoes. During these two days of good weather we had had a prevailing east and north-east wind, but now towards evening it was veering to the south-east and the air became somewhat less pure.

Guides, porters and coolies worked for two days, carrying the necessary equipment up to the ridge. We meanwhile occupied ourselves with the never-finished task of adjusting the camp, arranging the tents more suitably, filling up with stones the holes in the ice to prevent the formation of puddles, and levelling off surfaces with pick-axes. The weather became bad again. The wind whistled on the high ridges as violently as on the Alps in winter. Storms raged about the summits and snowy peaks, and long streamers of fog, tattered and tenuous, were brought up by the south-west wind. The veils of mist gradually thickened and settled down layer after layer around K^2 and Broad Peak. Above the Concordia basin the sky was all streaked with clouds, which hung dark and lowering over the entrance to the Baltoro. The temperature remained steadily below freezing point. There were no more avalanches, and when the wind was down the silence was so unbroken as to become oppressive.

On the morning of May 30th all was ready. The weather had not changed and the mountains looked sinister. We bade adieu to our leader with good wishes, which did not succeed in disguising from ourselves the insecurity we felt as to the outcome of his bold undertaking. The simple fact is that these are not mountains like other mountains, and one cannot look at them without disquiet and foreboding.

THE DUKE LEAVING THE BASE CAMP.

The Duke was accompanied by the three guides, the four porters and the coolies, carrying their own tents and supply of chupattis. He crossed the front of the glacier that comes down from the southern wall of K², and went up the Godwin Austen to the foot of the southern ridge, some 500 feet higher than the base camp, traversing the broken margin of the glacier and the shallow depression between it and the wall, and climbing up over broken detritus loosely scattered over the solid rock. The incline was moderate. He kept close to the right side of the ridge, and reached a sheltered sunny nook (18,245 feet high) at the base of a rocky tooth, where the guides deposited the equipment. Little levels were soon made by means of retaining walls, for the two Whymper tents. The coolies camped close by. After a few hours of rest and some food, the guides, porters and coolies, with their loads, started on again. But only a short distance from the tents the coolies flung down their burdens and turned back, despite the commands and entreaties of the guides. The latter kept on climbing between the principal ridge and a secondary one to the east of it, and then by small

SOUTHERN RIDGE OF K².

ravines and divisional crests, till they reached a narrow saddle less than 1,000 feet above the camp. The rock was broken and mingled with snow and ice, but thus far the way had not been difficult, though here and there exposed to falling stones. They put down their loads on this saddle, and went back to the tents.

May 31st turned out unexpectedly fine and still. The loads now weighed only 25 lbs., and the coolies consented to take them and follow the guides up to the saddle. A steep icy couloir runs down to it, divides and continues lower down in two branches. It was impossible to climb up along the rocks on the sides of the couloirs, so the guides went up the gully itself, leaving the coolies at the bottom with Bareux. They climbed for a short distance on hard snow, then on bare ice, sticking to the left side in order to utilize the rocky projections, on which they fixed more than 100 yards of rope for a help to those coming after with the loads. In this way they gained 600 feet, and then succeeded in clambering up the rock some 300 feet more. They turned back at about three in the afternoon, after having reached a height of certainly 20,000 feet. In two hours they were again at the tents.

In the meantime the Duke had remained alone at the camp, and had taken this opportunity to examine minutely the central portion of the Godwin Austen. From where he was he had a view of the whole formidable northern wall of Broad Peak and of the semi-circular basin which connects it with the left-hand ridge of the upper glacier. He noted in the edge of this basin a depression easily reached by a wide couloir full of snow, and he made up his mind to climb this later on in order to examine the region east of the Gasherbrums. Avalanches of ice were hurling themselves down from Broad Peak at frequent intervals, and even at this distance he could hear their roar.

From all that they had been able to ascertain from the ridge above the couloir, the guides thought there would be no very grave obstacles to encounter; but it was plain that the ascent would take much longer than they had thought. For this reason the Duke sent six coolies back to the base camp next morning to bring up provisions for a longer stay. They came down roped together, bringing us a letter from the Duke, which we naturally received with great eagerness. The sun and wind had bronzed even the tough skins of these Baltis; but they were in their usual good temper, and started back directly the things were ready—food for themselves and for the Europeans, extra rope and pickaxes.

In the meanwhile those on the ridge had lost no time, even though the weather had again turned adverse. The guides and porters, free from the encumbrance of luggage, left the tents in the morning bent on exploring a good stretch of the ridge to find out if it offered a chance of ascent before fetching up more impedimenta, perhaps uselessly. They climbed rapidly to the saddle, then on up the couloir by the rope left there the day before. This height gained, they found themselves on a slender crest of rocks quite broken and crumbling, so as to give no security to the foot nor safe hold for the hands. On one side went down steeply into the valley the couloir by which they had come up; on the other a dizzy steep of ice descended to the Godwin Austen, 3.000 feet and more below. The guides were unanimous in telling the story of the incredible optical illusions they suffered, all due to the deceptiveness of these mountains. Slabs of rock which at a few yards distant looked like gentle and easy inclines, turned out to be little less than perpendicular. It was impossible to estimate the grade of the slopes or the distances between salient points of the ascent. These conditions had misled them when, on the day before, they had measured with their eyes the route above the couloir.

The cold wind had raised up a little tourmente, fortunately not enough to interfere with their progress. They went on for three hours, with all the slowness and precautions rendered necessary by the difficulties of the route, climbing always toward the reddish rock where the Duke had hoped to set up camp, and never reaching it, though it seemed constantly within a few steps of them. It would be necessary to fix ropes all the way, for the porters to use in fetching up the loads. As for the coolies, taking them over such rough ground was not to be thought of.

The guides finally came to the reluctant conclusion that it was useless to proceed further, not because they had encountered insurmountable obstacles, but because it was hopeless to think of bringing so long and formidable an ascent to a successful issue, when from the very first steps they had met with such difficulties as made the climb barely possible to guides not hampered by loads, and put out of the question the conveying of luggage necessary to keep one from perishing of cold and exhaustion. They came slowly back, gathering up the rope they had put along the way. The Duke heard their report, and wisely decided to relinquish the attack in that direction.

The next day, June 2nd, before 12 o'clock we were again united, and we ceased our anxious scrutiny of the ridge through our telescope. The weather grew steadily worse, and before evening it began to snow heavily. It was fortunate that the Duke had at least been able to satisfy himself of the actual conditions to be faced on the ridge of K^2. Among other things the experience had proved that the coolies, when properly equipped and protected, can hold out in the high camps, and can even do without fire, at least for some days. At the base camp they seemed very much at home. They spent their time squatting about their little fires, which they tended with the utmost care and economy, and boiling tea in our empty provision tins. They do not carry fire, like the Bakonjo in Africa, always coming to beg matches of us directly we reached a stage. We noticed on our arrival at the base camp their number had increased to eleven, by the addition of a chief or Jemadar. He went up with the others to the upper ridge, but came back with an attack of acute enteritis, and we were obliged to send him down to Rdokass with the first provision caravan. In the absence of a head, personal relations were established between ourselves and the coolies. Though we could only communicate by means of a few words of Urdu our guides had picked up in former Himalayan expeditions, there were no difficulties or misunderstandings, and we led a life of the utmost harmony up to the end.

Mr. Baines sent us regular caravans, bringing fowls, eggs and roast mutton, as well as wood and chupattis for the coolies. But our rations were always sufficient and well-balanced, and we preferred our tinned foods to the Rdokass meat. The eggs, however, were always a great addition. Every seven or eight days we received post, with wonderful and gratifying regularity.

Our constant companions in camp were a dozen great crows, who hopped about among the tents, picking up remnants of food and displaying rather curiosity than fear of us. Every time an exploring party set out and made a camp elsewhere, a pair or so of these crows attended them. They actually followed the Duke to the ridge of K^2. Sometimes we saw a stray falcon sweeping the sky 3,000 or 4,000 feet above the valley. Later in the season the small rodents we had seen at Rdokass made their appearance and maintained existence, one knew not how, amid surroundings that seemed incompatible with any sort of animal life. Sella even saw some of them at nearly 18,000 feet of altitude on the rocky ridges around the Concordia basin.

Negrotto had profited by a few hours of clear weather to continue the survey of the Godwin Austen with the tacheometer and photogrammetric camera. The surrounding mountains rise so high and so abruptly above the valley that it was necessary to go for some distance away from them on the glacier in order to get their summits into the picture although the camera was fitted with a wide angle lens; while with the tacheometer one is never certain of sighting exactly the mountain summits with the telescope.

It snowed uninterruptedly for twenty-four hours. Then on June 3rd the great curtain of fog was rent in every direction, and peaks and mountain walls emerged in fresh splendour. Some light wreaths of mist still hanging about the slopes looked grey against the dazzling whiteness of the snow. The mountains were not slow to shake off its weight, and on every side the snow barely deposited on the steep inclines began to fall off and slide down into the reservoirs which feed the sources of the great ice rivers. The valleys resounded with the noise. We had a perfectly clear and calm sunset. The lofty snows of K^2 were tinged with yellow. The most delicate wisp of rose-coloured cloud barely hid the topmost peak, and a triple shadow flung itself all across the mighty wall, growing more and more distinct. The moon, not yet in sight, was projecting upon K^2 the giant profile of Broad Peak, while the northern face of the latter still diffused a tranquil white light from its snowy surface. Far to the south Bride Peak stood out white and clear against the steel-blue sky. Now the valley shook to the roar of an avalanche of ice—prolonged, cyclopean. The temperature had gone down to several degrees below freezing, and we reluctantly turned from the splendour of the moonlit night to take refuge in our warm sleeping-bags.

On the morrow would begin the execution of a new plan of campaign.

Broad Peak, at sunset

CHAPTER XIV.

THE SAVOIA GLACIER AND PASS.

The Duke's new Plan. — The Camp moved to the West of K². — Going up the Savoia Glacier. — Preliminary Excursions. — Cold and Bad Weather. — Mountain Climbing, Photography and Topography. — The Western Wall of K². — Ascent of Savoia Col. — Disappointment. — Sir Francis Younghusband's Description of the Northern Wall of K². — Return to the Base Camp. — A Shortage of Chupattis. — Change in the Appearance of the Godwin Austen. — Variable Weather. — Sunsets.

HAVING concluded the exploration of the southern slope of K², the expedition turned its attention to the glacier already visited by the Duke which girdles the base of the mountain to the west. No one else had ever trodden its snows, and upon the map even the lower part of the valley was scarcely indicated. The Duke's design was to climb up to the watershed col at the top, with the hope of examining from that point the northern slopes and the north-western ridge of K². There was the possibility that alongside and behind this ridge might be a snowy slope which would offer an easy climb to the peak. The preliminary expedition would give the opportunity of deciding whether it was possible to carry a camp up to the saddle. Moreover, if an attempt on this side did not display any greater chance of success than that on the southern wall, at least it would enable the Duke to ascertain whether he could cross over the watershed and reach the northern slopes and the unknown valleys below them. In the meantime Sella and Negrotto would complete the illustration and survey of the valley to the west of K².

The guides and coolies began to move camp on June 4th, only the latter coming back to the base camp. The next day they left again with the porters, and Sella, Negrotto and I accompanied them. Our route shows plainly on the map, going around the foot of the south-western spur of K², above which rises the fine snowy peak 22,490 feet

THE MOUTH OF THE SAVOIA GLACIER.

high. We descended the right-hand margin of the Godwin Austen, full of holes and ridges and covered with stones and moraine detritus, as far as the end of the spur, skirting the latter across masses of ice heaped up at its base by avalanches from glaciers hanging 1,000 feet above. Next we entered the ditch between the glacier and the great wall of metamorphic rock arranged in almost vertical strata. Our route was that followed by the Duke on his way back from his first investigation of the western side of K². It is the only one that could be taken by the coolies, who would be badly off among the dangerous séracs of the centre part of the glacier, by which the Duke had made his ascent. We went up rather fast, now in the bottom of the trough between glacier and rock, now on the side of one or the other, often exposed to falling stones or ice from either side. The brow of the glacier was all ragged with séracs of the strangest shapes, with stalactites hanging down like long beards—hollowed out, pierced through and eaten away by melting, and often poised over our heads at very uncomfortable angles. In the lower part of the ascent were some small marginal lakes, covered with thick ice. Higher up our way became a regular climb up a sort of couloir, half rock and half ice. At the top

TERMINAL CASCADE OF THE SAVOIA.

of it we stopped to let the coolies rest. They had gone well over the difficult ground, despite their burdens. The whole climb was a little over 600 feet.

We had not yet gone all the way around the spur, from which descend great radiating ridges. The terminal fall of the glacier faces directly eastward, and we had now before us the second part, rising at an easier pitch toward the north-west. Looking back we had a magnificent view of Broad Peak, picturesquely swathed in mist, and of the dizzy heights between it and the Gasherbrum range, dominating cliffs of rock and snow cut into innumerable furrows by avalanches. On the right of the valley extends a row of jutting peaks, six of which are 20,000 feet high or over. In front of us the glacier rises at a moderate slope, with numerous crevices, which, however, were narrow and easily crossed. Nearly all their fragile snow bridges had been broken through by yesterday's party.

Before long we reached the upper basin of the valley, a wide plateau facing the north, of a pure whiteness never seen in the Alps except in

A SÉRAC AT THE EDGE OF THE SAVOIA GLACIER.

the first hours after a snowfall. The glacier was covered with thick snow, but the track beaten by the coolies the day before was perfectly good and saved us much trouble. Botta, however, though he was carrying a light load, did not hold out through the march. He seemed exhausted, and we were obliged to leave him behind on a mass of fallen rock to wait for the coolies who were to go back on the same day to the base camp. He had not entirely recovered his strength since the attack of fever at Rdokass, though he had been relieved of heavy work and his appetite and sleep were normal. A longer experience convinced me that at these heights the system readjusts itself only very slowly after any disturbance, however slight.

We had now gone all the way around the spur. Alongside us a glacier comes down from a narrow snowy col (Negrotto Pass), the same which on its other side overlooks the base camp. Just below this was

WESTERN WALL OF BROAD PEAK FROM THE TOP OF THE TERMINAL CASCADE OF THE SAVOIA.

erected the Whymper tent brought up the day before. Not far from us a rocky crest stands out above the glacier, dividing the western wall of K^2. It rises to its very summit in a series of great steps, defined by large towers. It is this crest which is outlined against the sky and forms the western side of the pyramid as seen from the south. The encampment is thus separated from the base camp only by the south-western ridge of K^2, a horizontal distance of less than two and a half miles. It is, however, 1,664 feet higher up. We had hardly covered half of the glacier basin, and were still a considerable distance from the end of the valley; for the coolies, having reached this spot at about two o'clock on the previous day, tired out with marching on the soft snow and having still to get back that day to the base camp, had refused to go any farther.

We found the tent deserted, the guides having spent the day exploring a route to the col. It looked very close to us, but we were misled, as usual, by the deceptive appearance of the glaciers in this region. Presently we descried far off on the level the tiny moving figures of the returning party. It had taken them more than five hours to reach the foot of the col, and they had found the wall very steep and covered with live ice, making the undertaking look very different indeed from its aspect as considered from below. We sent the coolies back to the base camp.

At this height—18,176 feet—we not only found ourselves in perfect condition, but could actually breathe more easily here than at the base camp. The latter, situated as it was in a sort of hollow between the glacier and the rock, had perhaps a little less active circulation of air. We had had a west wind all day, and towards evening it became a hurricane. The weather was very severe, the thermometer falling in the night to 5° F. The storm was not over by morning, but the guides went off notwithstanding, hoping to make their way farther up the slope of the col than they had succeeded in doing the day before. On coming out of our tents we found a pair of crows from the colony at the base camp, walking about over the snow, their feathers all ruffled by the wind. We took shelter again almost at once, for it was too intensely cold to stand about outside, and nearly all the mountains were covered with mist, preventing any topographical work. The guides returned at 10 o'clock, driven back by the blinding tourmente. Little by little, however, it subsided, and the solar radiation became so intense that we almost regretted the cold of a few hours previous. The actual temperature was only 28° F., but the solar thermometer registered 142° F., the highest record we noted on the glaciers with one exception throughout the campaign, though considerably lower than some observed by other explorers in the Karakoram, of which I will speak farther on.[1]

At 11 o'clock the Duke joined us, and an hour afterwards the coolies arrived with the remaining loads, going back immediately. Three of

[1] See Chapter XIX.

them stopped half-way, among the rocks above the cascade of séracs, where they had placed a tent, a few provisions and a little wood. They were to facilitate our communications with the base camp below, where Botta had remained on guard.

The wind came up again towards evening from the north-west. The air was wonderfully clear. One after another the peaks were lighted up by the last rays of the sun. The monster beside us, in full sunlight, was surmounted by a great tuft of rosy storm-cloud. On the ridges the wind lifted the snow in columns of tourmente, or stirred up squalls that filled the air of the valley with crystalline dust. Again the thermometer went swiftly downward, and the cold, sharpened by the wind, soon became so unbearable that we took refuge in the tents. Their walls shook all night in the gale, but towards morning its fury slackened, and when we rose at five o'clock on June 7th we found a perfectly still air and a temperature of 5° F.

At half-past five the Duke set out with three guides, having decided to try to reach the ridge of the col the same day. The four porters remained with us, and we soon got under way with the tacheometer, photogrammetric and photographic apparatus, to take advantage of every minute of the propitious day. We climbed obliquely up the valley towards its right wall, which is overhung by precipitous heights of 23,000 feet, from which large glaciers come down into the basin. Sella betook himself to a prominent icy hummock above us; but we could not get very near the base of the wall, covered as it was with broken ice clinging insecurely to the steep incline. In fact, we had just set up the photogrammetric camera, when a huge mass of séracs detached itself and came down with tremendous force. We were saved by a depression in the surface of the glacier, which deflected the course of the moving mass.

What we now had before us was the scene pictured in panorama E. Here, too, the whole landscape was nothing but a mere setting for K[2], which dominates every near-by object. We could see its entire west wall, splotched with snow, but so steep that no glacier could cling to it. Between the base and the peak there is little more than a mile of horizontal distance, and nearly 10,000 feet of perpendicular. The arrangement of the rock in slightly oblique strata is still more evident here than when seen from the southern side. The north-western ridge, which bounds the pyramid on the left, ends with a low group of towers and pinnacles, from which a secondary ridge runs down to the glacier, bisecting the top of it. West of this group of rocky crags is the broad, curving, ice-covered saddle which was the goal of the Duke's present ascent. On the other side, south-west of the pyramid, stretches the long ridge which ends in that satellite to the great peak, 22.490 feet high, which I have already described. Lastly, behind the mountains which close the basin to the south, a sharp peak of rock just shows its head, the Crystal Peak of our map.

The small exploring party with the Duke at its head had quickly crossed the plateau. At the foot of the col, in the rounded bottom of the valley, is a large hump of the glacier, which they skirted on the left, going along the trough between it and the valley wall, where they went in above their knees in the heaped-up snow. In less than four hours they reached the foot of the slope, which was cut by a large *bergschrund*. The latter was easy to cross, as it was half full of snow fallen from the height above.

Now began the attack on the wall. For a little distance at the bottom it was covered with snow, which made a solid footing. But this grew thinner and thinner, until there was nothing over the bare ice but a dry powdery layer, without any compactness. From the camp, to which we had returned after our work, we watched with the telescope the slow ascent of the climbing party. The diminutive figures, separated by long lengths of rope, one almost vertically above another on the wall of ice, betrayed the steepness of the pitch. They went straight up, very slowly, climbing the long ascent which the head guide was cutting as he went in the hard ice. About half-way up was a projection of rock, to the right of which the climbing party passed without deviating from their course. The clear, calm day was greatly in their favour. At a quarter past five in the afternoon, after almost twelve hours of effort, the ridge was conquered, at a point to the right of the col and somewhat higher. The Fortin barometer registered 13·740 ins. with a temperature of 16° F. The altitude calculated from the photogrammetric survey was 21,870 feet.

The watershed proved to have on its northern side a broad cornice prolonged to the right in such a way as to cut off completely the view of the northern slope of K^2. Below the col to westward they could just make out the wall descending toward the north and disappearing vertically from view. And that was all. As a reward of his labours

the Duke thus s w utterly annihilated the hopes with which he had begun the ascent.

It is possible that Sir Francis Younghusband saw this saddle, as well as the northern wall of K², when he came over the Mustagh pass from the north in September, 1887. According to his map the col would belong to a little valley running into the Sarpo Laggo, a tributary of the Oprang, one of the main affluents of the Yarkand river. Sir Francis Younghusband described K² as he saw it from the Sarpo Laggo valley, somewhat more than 12 miles away. On the northern side, "where it is literally clothed in glacier, there must have been from 14,000 to 16,000 feet of solid ice."[1] He made his description somewhat more exact in his recent book—"Kashmir"—where he says that he saw K² towering almost immediately above him, "very abrupt and upstanding. and with immense masses of ice accumulated at its base." It is possibly these masses that feed the glacier which the Duke saw flowing westward at the base of the col. He could, moreover, ascertain that no large spur detached itself from the northern slopes of K² and Staircase Peak. Beyond a great valley to the north, presumably the Oprang, there extend chains of lower mountains without any glacier of great size.

It was too late for the party to linger upon the col. After about a quarter of an hour they descended, the ropes making the return so quick that by eight o'clock they had reached the *bergschrund*, where they found the porters we had sent to meet them with hot drinks and the Alpine lanterns. At half-past nine they were at the camp. The rapid march testified to their good condition. They were not exhausted, despite the sixteen hours of exertion at heights between 18,000 and nearly 22,000 feet. The excursion to the western side of K² had not revealed any feasible way of ascent to the peak, but it had enabled the Duke to locate upon the map a great tributary valley to the Godwin Austen. He gave the name Savoia to the new glacier and the pass.

Next morning, June 8th, Sella, Negrotto and I began the return march of the expedition, with five coolies who had come up from the base camp. When we reached the bend of the glacier just above its last cascade, we left the path to make a photogrammetric station in the centre of the valley. We had to go backwards and forwards a great

[1] Sir F. E. Younghusband. *Proc. Roy. Geog. Soc. N.S.* X. 1888. p. 785.

deal to escape the numerous broad crevasses, and, as usual, we lost considerable time in experimenting upon methods for preventing the ice from melting under the points of the tripod supporting the camera and thus destroying the level laboriously attained. The slow and ceaseless progress of the melting was revealed by the level in the apparatus, even when we set up the latter on the stones of the moraine. The only surface stable enough for our purpose was that of the large boulders, and these were unfortunately of rare occurrence. Since our return a simple device has been suggested to me, which I set down here for the benefit of any one in a similar difficulty. Put the points of the tripod into milk-tins filled with a mixture of ice and salt, which will keep congealed the ice or snow directly beneath it, and ensure a stable equilibrium for the apparatus long enough to execute the panorama.

Our work done, we went down the ravine and reached the base camp toward sunset. The Duke joined us the following day, June 9th. It was the warmest day we had had, and without a breath of wind. The gentle, even murmur of the rivulets running down the moraine slopes near by suited well with the summer calm. Even the cawing of the crows sounded subdued.

For the first time the provisions for the coolies were late in arriving, and there was a scarcity of chupattis. The coolies ended by submissively accepting some of our biscuits to fill out their ration, and even some roast mutton, when we had convinced them that it had been prepared at Rdokass by people of their own religion and caste. They also found a little sack of flour, which they ate raw with great gusto. Fresh provisions reached us on the 11th, and with them five extra coolies sent for by the Duke to help shift the camp from one place to another.

Everything was brought down from the Savoia glacier, and we made ready for the next move. We stayed at the base camp four days. I noted at this time, and on similar occasions, that during such days of idleness one feels often a little heavy-headed, and experiences some loss of sleep and appetite. I imagine that moderate exercise, by enabling the processes of nutrition and metabolism to go on with more rapidity, facilitates the elimination of noxious products, which are either not so easily converted or remain in the system in larger quantities at these heights than in the conditions of atmospheric pressure under which we normally live.

In the sixteen days since our arrival at the base camp the appearance of the lower Godwin Austen had changed considerably, notwithstanding the continual alternation of good and bad weather. From the foot of K^2 down to the Concordia its surface was now quite free of snow, rough and full of sharp points, and traversed by long ridges of ice between the wide streaks of moraine, which had become low and flattened. The rocky walls were baring themselves—the snow was

MITRE PEAK FROM THE LOWER GODWIN AUSTEN.

confined to scattered patches and the glaciers were thus more clearly defined. The lower spurs of Broad Peak displayed surfaces of inaccessible rock. Mitre Peak turned toward us a ridge that ran almost vertically from base to summit, ice-covered on its right side, entirely black on its left.

We had not yet had three consecutive days of fine weather. The wind blew almost uninterruptedly about the high peaks and ridges, and light falls of snow and sleet were not infrequent. There was no sign of a change for the better in the sky or in the barometer, which remained fairly steadily at the same point, with but slight variations. When the wind turned easterly or northerly it generally became clear and somewhat calmer, but unfortunately that state of things never lasted long. We gradually resigned ourselves to taking the weather as it came, without attempting prophecies always set at naught by the capricious meteorological conditions.

Twilight was always followed by severe and increasing cold, which arrested alike the falling stones, snow and ice and the currents of water. Profound silence would brood over the valley, even weighing down our spirits with indefinable heaviness. There can be no other place in the world where man feels himself so alone, so isolated, so completely ignored by Nature, so incapable of entering into communion with her. Every clear evening we enjoyed the triumphant spectacle of Bride Peak, displaying herself in immaculate purity among a cortège of bridesmaids all arrayed in virgin white. Her northern wall seemed to gather and reflect all the last brilliance of the dying day, and gleamed resplendently white against a cold blue sky, which toward the zenith became itself pale almost to whiteness.

CHAPTER XV.

THE UPPER GODWIN AUSTEN GLACIER

AND THE EASTERN SLOPES OF K^2.

Length and Situation of the Godwin Austen Glacier. — The Gorge between K^2 and Broad Peak. — The First Step of the Glacier. — Survey and Map of the Eckenstein-Pfannl-Guillarmod Expedition. — The Glacier Basin of Broad Peak. — The Speed of the Godwin Austen. — Avalanches from Broad Peak. — The Eastern Wall and North-Eastern Spur of K^2. — Staircase Peak. — Two Ascents to Sella Pass. — The Region East of the Broad-Gasherbrum Range. — Teram Kangri. — The Ascent to Windy Gap. — The Attempt of Guillarmod and Wessely on K^2. — The Basin of Staircase Peak. — "Border Saddle." — K^2 from Windy Gap. — The Region East of the Col. — The Duke at Windy Gap. — First Attempt on Staircase Peak. — Snowfalls and Avalanches. — Second Attempt. — K^2 from the Ridge of Staircase Peak. — Observations on the Region east of the Baltoro.

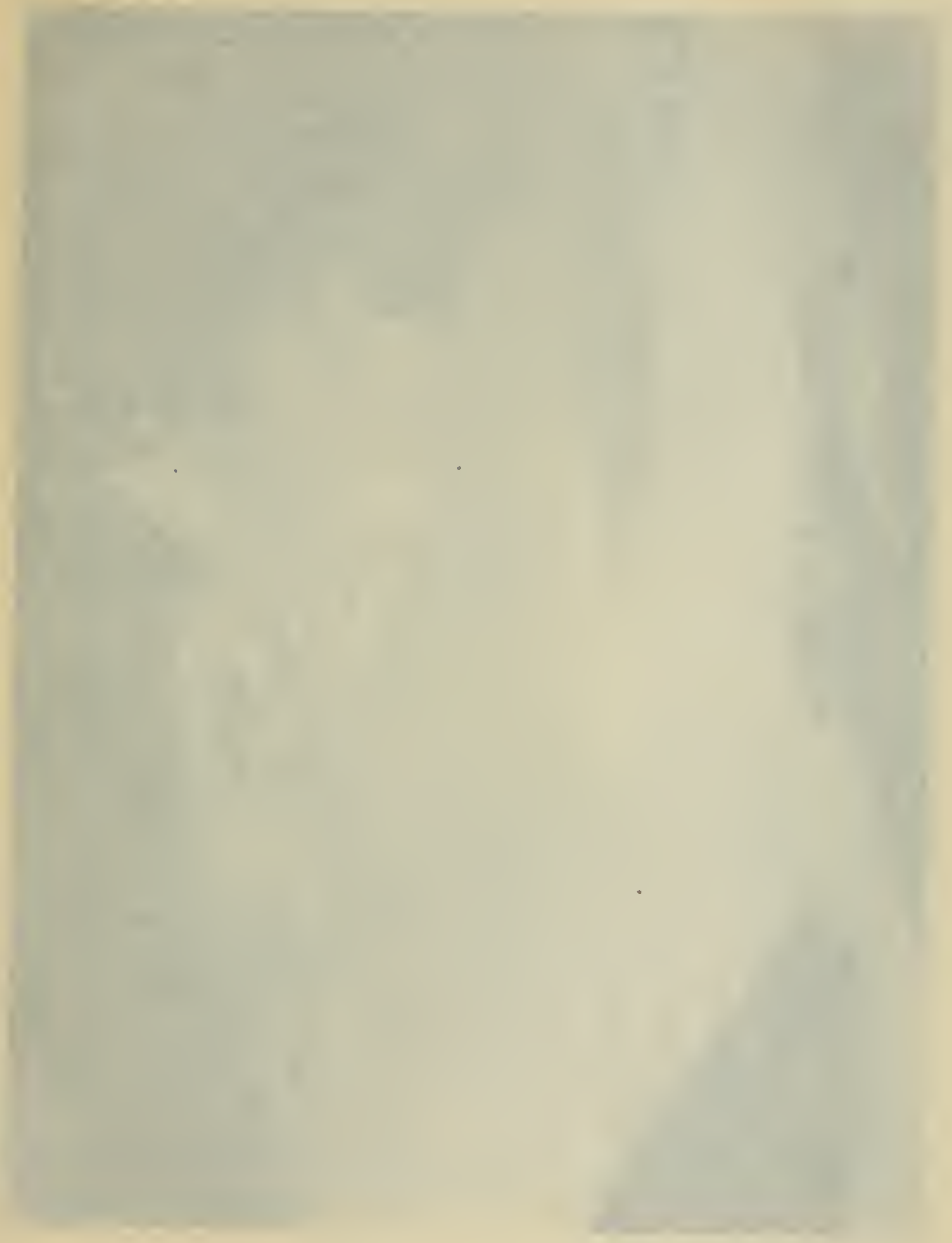
We had still to explore the upper basin of the Godwin Austen and the eastern slopes of K^2—a work which occupied the next fifteen days of the campaign.

According to the survey made by the expedition, the Godwin Austen from the Concordia to Windy Gap is twelve and a half miles long, and divided into two nearly equal parts, the lower of which I have already described. It runs north, loaded with moraine, and rises about 820 feet in the six miles between the Concordia and the foot of K². From this point on the glacier runs north-east, in a deep gorge between K² and Broad Peak. It has no longer any surface moraine, and it gains some 3,950 feet of altitude in six and a half miles, chiefly by means of two great rises or steps, between which is a relatively level space.

The Duke foresaw that the new enterprise would be of some duration, and arranged to set up a camp suitable for several days' sojourn between the base camp and the upper glacier. It took only three days for our augmented force of coolies to carry to the chosen spot three of the large tents, the Whymper and Mummery tents, a good part of the coolies' encampment and all the necessary supplies. The first party of guides, porters and coolies started on June 12th, all of them except the guides returning the same day. Sella, Negrotto and I joined the party on the second day; and on the third—June 14th—the Duke arrived with the coolies who carried the last part of the luggage.

We came out of our base camp and upon the moraine at the end of the southern glacier of K², beyond which the Eckenstein-Pfannl-Guillarmod expedition had set up its Camp IX. We could still see some remains of shelter walls built by them. The glacier was nearly level, with few cracks and almost free of snow. It runs at the bottom of a gorge perhaps three-quarters of a mile wide, between the tremendous walls of K² and Broad Peak, over 8,000 feet above it. Threatening ice clings high aloft along these walls, and the Godwin Austen is scattered with masses of rock and large fragments of ice from avalanches that have fallen from both sides and come out across the valley almost as far as the opposite wall. There would be no escape for a party surprised by one of these avalanches, and it would be foolhardy indeed to attempt the passage directly after a heavy snowfall.

The first steep of the glacier begins at the base of the southern ridge of K², by which the Duke had already attempted to reach the summit. The grade is moderately steep, broken in every direction by crevasses, most of them covered with treacherous snow. We found it necessary to put on the ropes. At the top of the short ascent the glacier again becomes almost level for a little stretch, forming a terrace 18,370 feet in altitude, covered with a thick layer of snow and full of crevasses. We had been approaching the left side of the valley, and we reached this level not far from a rocky spur that comes down toward us from the



Broad Peak, from Camp VI

northern summit of Broad Peak. This was the site of the Eckenstein-Pfannl-Guillarmod expedition's Camp X.

At this point Conway's map leaves off. In surveying the valley, from Fan Pass in the Crystal Peak chain, about seven and a half miles distant, it looked to him as though the brow of this little plateau might be the top of a col (Possible Saddle). The Eckenstein-Pfannl-Guillarmod expedition discovered and explored the upper basin of the Godwin Austen, and put the site of the watershed much farther toward the north-east, at Windy Gap.

Guillarmod's narrative is accompanied by a map of the Baltoro, on a scale of 1 : 200,000, which reproduces that of Conway in its general lines, with the addition of the upper Godwin Austen.[1] He does not describe the methods employed in the survey, but the map of the new part, despite its appearance of exactness and its being furnished with contours, is only an approximate sketch, in which the outlines of the mountains, the lateral valleys and the confluent glaciers are so altered that it is difficult to identify them when one is on the spot. Without going into detail, it is sufficient to instance that the upper basin of the Godwin Austen is represented as over nine miles long (from Conway's Possible Saddle to Windy Gap), whereas it actually measures less than four miles; that the horizontal distance between Windy Gap and K^2 is given as nearly $10\frac{1}{2}$ miles instead of $4\frac{1}{2}$ miles; and that the bearing of the valley is incorrect. The altimetric figures of Guillarmod are generally considerably in excess of the ones measured by us.[2]

Dr. Pfannl, whose name is not mentioned in the title of the Eckenstein-Knowles-Guillarmod map, published with his account of the expedition[3] a sketch of the upper part of the Godwin Austen, mentioning that it is only approximate, and probably bears too much to the north—

[1] The map is constructed "d'aprés les données existantes et les documents de l'expédition rapportés par O. Eckenstein, G. Knowles and Dr. J. Jacot Guillarmod."

[2] The following instances will suffice :—

Place.	Heights determined by the expedition of the Duke.	Heights given in Guillarmod's map, tables and text.
Mitre Peak	20,462	24,600
Broad Peak	27,132	28,000
Staircase	24,078	26,250
Mustagh Tower	23,950–24,950	26,250
Rdokass	13,205	13,904
Camp X	18,350	18,733
Windy Gap	20,449	21,500

[3] *Zeit. des deutsch. u. oest. Alpenver.* 35, 1904, p. 88.

as is, in fact, the case. Except for the exaggeration in the width of the glacier, this drawing is nearer the actual dimensions of the valley than the map published by Guillarmod. The outline of the chains and ridges is also more nearly correct.

Our predecessors stayed in the upper Godwin Austen for a month, from June 20th to July 21st, 1902. They suffered much from bad weather. However, the two Austrian doctors, Pfannl and Wessely, were able to make numerous exploring expeditions, which I mention in the course of my narrative. Dr. Pfannl was seized on July 15th by a somewhat serious lung trouble, and the expedition was obliged to put an end to its campaign and return home.

From the northern summit of Broad Peak (26,017 feet) the left side of the valley makes a wide circuit to the south-east, circumscribing a circular basin over a mile in diameter, filled with a level glacier which flows into the intermediate plateau of the Godwin Austen. We crossed the mouth of this tributary, and at the base of the spur which bounds it on the right we found the camp set up on a level strip of moraine with a little frozen marginal lake near by. This was the Camp VI of our map, 18,602 feet above sea level. The Duke kept twelve of the coolies with us at this camp, the others returning with Bareux to the base, to keep up our communications with Rdokass.

In the ascent to the camp the Duke had made an interesting discovery. Below the plateau, at the base of the rise in the glacier, he found half buried in the ice two mallets used for driving in tent pickets, some kiltas with the bottoms knocked out, some single snow-shoes and several empty provision boxes. These were all articles left behind at Camp X by our predecessors (Guillarmod mentions the incident in his book) when, after weeks of struggle against bad weather and under serious anxiety over their sick comrade, they took the return route, carrying him on a sledge improvised out of skis. In the interval of seven years the cast-off objects had been carried down the glacier to nearly a mile below the spot marked Camp X on Guillarmod's map. One may accordingly argue an average yearly speed of 702 feet for the glacier, much less than that calculated by our expedition on the Baltoro at the level of Rdokass.

The camp faced the wall which terminates Broad Peak to the north, the wildest and most impressive bastion one could possibly imagine, a series of vertical cliffs of rock dominated by blue walls of ice 1,000 feet high, which represent sections of the northern glaciers of Broad Peak. They slide along unceasingly on those tremendous steps, shoving their edges farther and farther over the abyss until finally the weight conquers the cohesiveness of the mass, and enormous pieces break off and hurl themselves down to the bottom of the amphitheatre with a deafening

EASTERN SIDE OF K 2 AS SEEN FROM CAMP VI.

crash and a roar that makes the valley tremble. Long echoes of the tumult come back from the mountain walls, and from where we are we can feel the cold breath of the avalanche like a great gust of wind. Day and night every few hours this thunder reverberates, and in the intervals the mind unconsciously remains in suspense, waiting for another downfall. The wall is dominated by the northern summit of Broad Peak, which looks pointed from this side. To its left, just behind the ridge, rises the rounded centre peak, the highest of the three. Five other peaks rise along the circular wall of the basin, between 23,222 and 20,981 feet high. Our camp is at the base of the fifth and lowest.

The appearance of K² is quite changed; it has become a mountain of ice. Its shape is that of a regular cone comprised between the southern ridge already attempted by the Duke, and a secondary one, ice-covered, which descends to the bottom of the valley in front of the great north-east spur. The apex of this cone is really formed by the edge of the eastern shoulder of the mountain, which obscures the outline

CAMP VI AND STAIRCASE PEAK.

of the main peak. The whole cone is covered with ice, above which just show the low, little accentuated rocky ridges converging to the top. The wall, at a very steep angle of inclination, is live ice for 7,000 feet up, and crowned by séracs. It is absolutely inaccessible. The north-east buttress detaches itself from the broad curving shoulder, also entirely ice-covered, and takes up a good share of the right side of the valley, which is rugged with teeth and *gendarmes* and surmounted by some goodly peaks, and ends more than two and a half miles from K², in the snowy dome which Guillarmod and Wessely attempted to climb from the Godwin Austen. At no point of the entire distance is there a place where one could gain the ridge directly from the glacier.

The farthest height, at the head of the valley, is Staircase Peak (24,078 feet), of which we see the south-western face, a rocky vertical

K², as seen from the east, from the rocks above Camp VI

triangle nearly 4,000 feet high. Between it and the ridge that runs toward it from K² is another glacial basin, which empties by a narrow mouth into the Godwin Austen; it is like the basin below Broad Peak, but much smaller. From Staircase Peak to Windy Gap a rib of ice descends by a series of steps or leaps, its side traversed by glaciers and furrowed by deep channels; and this rib, together with Windy Gap itself, terminates the valley of the Godwin Austen. From our camp we can see neither the saddle nor the left wall of the valley.

20,981. 22,306.

FIRST STEP OF THE GODWIN AUSTEN GLACIER, AND SELLA PASS.

During several days we only saw this or that portion of the panorama I have described, according to the caprice of the wind, which would tear away the cloud masses here and there, letting in a rift of sunlight speedily obscured again by the marshalling of the cold mists or a fresh onset of snow or sleet. I have already mentioned that the Duke had noted from the southern ridge of K² a depression in the circle of mountains around the amphitheatre of Broad Peak, and had formed a project of climbing up to it for a glimpse of the region east of the Gasherbrums. This was undertaken on June 15th. The depression is in the northern wall of the amphitheatre, between peaks 22,306 and 20,981 feet, beneath the second of which our camp was stationed. It was necessary to round the base of this peak and enter the glacier basin in order to reach the bottom of the couloir, by which one could ascend to the col. Three guides accompanied the Duke. They found the level surface of glacier filling the basin to be cut in every direction by cracks which were covered over with treacherous powdery snow, not firm enough to walk on. They had hardly got past the entrance when Alessio Brocherel broke through one of these snow bridges and fell heavily into a fissure. The rope went taut, giving him a violent wrench in the chest. It did not seem at the time to be more than an ordinary incident of mountain climbing, not serious enough to interrupt the march, but it was the probable cause of much later suffering for him. The wall itself proved to have a good layer of firm snow, upon which the party could ascend with the crampons without needing to cut steps. In three hours they reached the saddle, about 2,000 feet above camp. By good fortune the air was clear, as well as the sky beyond the col, whereas the ranges of the Godwin Austen were largely in fog. It was impossible to stay long on the top, because of the intense cold and violent wind, but before returning the Duke was able to make observations of many details of the region east of the saddle.

In order to avoid repetition later on I will interrupt the chronological narrative here, and mention a second visit to the col, made by Sella, with one of the porters and a coolie, seven days later, on June 22nd. He went beyond the ridge, crossing obliquely the eastern slope of the mountain, which was strewn with small rocky detritus covered by a crust of thin transparent ice. He stopped at a point where the Gasherbrum range came into view on the south, about half a mile from the saddle and somewhat lower down ; and here he took panorama F, from a ledge on the ridge that runs down south-east from peak 22,339. It was a labour of two hours, rendered doubly arduous by the strong wind. He regained the col with some difficulty, having to contend with squalls of fearful severity. Wonderful to say, the coolie endured all this without a single complaint. With the help of panorama F it is possible to get an idea, if not of the topography, at least of the general aspect of the region east of the Baltoro basin, a region into which but one single explorer, Sir Francis Younghusband, has ever penetrated, and he only for a short distance, in 1889.

As far as the eye can see, there is a succession of glacier-filled valleys and rocky and snowy chains. One can neither see nor guess at the situation of the lower valleys, where there must be torrents and rivers running. From the pass, which the Duke named after Vittorio Sella, a glacier flows southward in a wide valley, bounded on its right by an ice-covered spur radiating from one of the peaks of the amphitheatre, and on its left by a short ridge surmounted by a fine rocky pyramid, which detaches itself at right angles from peak 22,995 of the eastern side of the Godwin Austen. As far as could be judged from above, the

TERAM KANGRI FROM THE EASTERN SIDE OF SELLA PASS.

descent on the farther side of Sella Pass did not look difficult, provided the glacier did not terminate in a cascade of séracs. This pass seemed, in fact, to be the only way of exit from the Godwin Austen basin that did not present serious obstacles.

To the south the scene is dominated by a group of splendid mountains, among which are the eastern peaks of the Gasherbrums I (Hidden Peak), II and III. From this last a great steep spur runs out northward, just indicated upon our map. This spur, taken together with the eastern walls of Broad Peak, encloses a wide valley filled with a broad glacier bare of moraine. At the foot of the col this glacier bends to the north-east to mingle with another and even larger one, covered with moraine, which comes down east of the great ridge of Gasherbrum III just mentioned, and seems to flow north-east, gathering up several affluents from among the spurs of the Gasherbrums, on its course toward a distant chain of lofty mountains laden with ice and snow. Three peaks of this chain, marked X, Y and Z on the panorama,

STAIRCASE PEAK AND THE END OF THE NORTH-EASTERN SPUR OF K 2.

were distinguished by the Duke from Staircase Peak, as I shall describe shortly. Almost in the centre of the picture, behind all the succession of ranges, rises a peak of evidently exceptional height. Sella took the horizontal angle of it with the surveying compass. From the situation, shape and appearance of this peak, there can be no reasonable doubt that it is Teram Kangri, the mountain discovered and measured by Dr. Longstaff from the upper Siachen glacier on June 17th, only five days before Sella photographed it.[1]

I will now resume the narrative from June 14th, on which day the Duke had sent ahead Sella, Negrotto and myself to set up a light camp at Windy Gap. Lorenzo Petigax, Emilio Brocherel and twelve coolies

[1] T. G. Longstaff, *Glacier Exploration in the Eastern Karakoram. Geog. Jour.* 35, 1910, p. 631. See also a note by Dr. Longstaff in *Alp. Jour.* May, 1911 (vol. 29), p. 488, where he gives reasons for identifying Teram Kangri with the peak photographed by Sella.

formed our escort, and we were roped together in two long files. The morning was cold and windy, with a thick atmosphere. We climbed up the left side of the glacier, in the furrow next the wall, reaching in a few minutes the top of the second level. The drop of the glacier beside us was cut by broad crevasses, typically V-shaped, with the apex pointing downwards. We went gradually toward the centre of the valley to get out of range of possible avalanches from the glaciers

STAIRCASE PEAK, THE END OF THE NORTH-EASTERN RIDGE OF K², AND THE OPENING OF STAIRCASE BASIN.

hanging on the steep walls of the left side. This wall runs fairly straight, without marked side valleys, and has only two peaks—22.339 and 22,995 feet in height—from the latter of which a rounded rocky rib, loaded with ice and snow, descends to Windy Gap. The other side of the valley is formed by the long north-east buttress of K², a sheer precipice, all ice and perpendicular cliffs. It ends in a round snow-covered shoulder, above which towers a sharp pinnacle of rock (peak 22,378 on the map). At the foot of this peak our predecessors had set up their Camp XI; and thence, on July 10th, 1902, Wessely and Guillarmod had tried to gain the snowy shoulder, in the hope of finding a route to K² along the broken and slender north-eastern ridge.

Guillarmod relates that they were greatly embarrassed by the deep snow, and obliged to turn back after getting within 150 feet of the top of the shoulder, the aneroid barometer showing a height of 22,000 feet.[1]

Beyond the north-east ridge of K^2 the valley is broken into by the glacial basin of Staircase Peak. This basin is so shut in by high and steep walls as to form a sort of pit or rather an enormous trench. Pfannl and Wessely camped inside of it, and climbed up a gully in its western wall in an attempt to reach a depression in the ridge, whence they might be able to examine the northern side of the north-eastern buttress of K^2. They were driven back by falling stones and the steepness of the ice.[2] The precipitous walls of Staircase Peak close in the top of the Godwin Austen, about whose summit the wind was furling and unfurling veils of mist.

The glacier was of a dense whiteness, without brilliance. Not even on the broken ice of its walls was to be seen any of the blue-green hue of our Alpine glaciers. The weather was very severe, and the coolies suffered bitterly. Whenever we paused they shook with the cold and the cruel wind that penetrated the loose folds of their garments. We were nearly at the level of the Staircase basin, and there remained only a last short climb between us and the little flat space below Windy Gap. Here the coolies stopped and piteously implored us not to go any farther. One of them flung himself weeping on the snow, pointing to his aching head and numbed feet. We had his shoes and stockings taken off to make sure his feet were not frozen. We gave him some caffeine tablets and coaxed him and the others to go on, less in words than by sympathetic looks and tones, and by pointing out the near-by goal. We got them on again in a little. As a matter of fact we were never, throughout the expedition, prevented from going reasonable distances by any illwill or rebellion on the part of the coolies, and we learned from experience that the Baltis are much more susceptible to kindness and persuasion than to threats or violence.

After about another hour of walking, at an easy gait, we reached the foot of the last slope, above 100 feet high, and in ten minutes more we were on the rocks of the saddle, which is divided into two unequal

[1] Comm. Paganini has calculated the altitude of this shoulder from four photogrammetric stations (X, XIII, XV and XVI on the triangulation sketch), and obtained an average of 21,588 feet. According to this the height reached by Wessely and Guillarmod would be about 21,400 feet.

[2] See the article by Pfannl, already cited, in *Zeit. des deut. u. oest. Alpenver.*

parts by a small rocky tooth. It is prolonged on one side by the southern ridge of Staircase Peak, and on the other by the rounded flanks of peak 22,995. A villainous wind was blowing. We scarcely gave a glance down the narrow steep valley beyond the col, through which a glacier flows to enter a larger valley. Beyond the second one rises a snow-covered range. There was no place on the col to set up a camp, so we went down the last short ascent and placed the tents near the little bergschrund at its foot.

WINDY GAP.

The coolies went back at once, accompanied by Savoie. who for the safety of the party entrusted to his care must, of course, put himself last in the file. The question was, which of the twelve coolies would be brave enough to march at the head. After some little excitement one of them volunteered, and they started off in their usual good humour.

All day long the storm wind blew furiously, driving fine grains of ice through every cranny in the tents. The heights were all covered. Later on the wind lessened somewhat and snow began to fall. Most of the next day, June 15th, we spent at the top of the ridge, Negrotto and I with the photogrammetric apparatus on a little rocky ledge south of the col; and Sella on the other side at the foot of Staircase Peak, with his photographic equipment—all three of us waiting in a cutting wind, our teeth chattering, stamping our feet and slapping our hands together, indulging the vain hope that the sky might clear. The temperature was not lower than 21° F. or thereabouts; but inactive as we were in the face of that piercing wind, our suffering was acute. The weather played with us for hours, partially uncovering now one peak, now another. But toward four o'clock it grew definitely worse, and drove us back to the tent, where we prepared our simple meal. A party of coolies, under the escort of Savoie, had come and gone during the day leaving provisions and supplies.

The pass well deserves the name of Windy Gap given it by Guillarmod. However, I should mention that Pfannl called it Grenz Sattel (Border Saddle), because it is the limit of the hydrographic system not only of the Baltoro basin, but of the Indus as well. Pfannl gives it a height of 20,550 feet, much nearer our figure of 20,449 feet than the 21,500 feet given on Guillarmod's map. Dr. Wessely made a short expedition to the col, being the only one of the party to do so. In Pfannl's sketch a precipitous ice wall is marked to the north of it, and at its base a large glacier running westward, beyond which is indicated another mountain chain, the same as that shown on our map. From the route traced in the sketch it appears that Dr. Wessely went on beyond the col, continuing somewhat toward the right up to a point marked 21,150 feet.

As if maliciously, the weather turned fine after sunset. The summit of K² was already in shadow, but from the lofty cone stood up an immense volume of vapour, more than 3,000 feet high, with wonderful whorls outlined against the sky, gilded by the sinking sun, whose last rays just reached its topmost part, perhaps 32,000 or 33,000 feet high.

By way of exception the fine evening did not prove this time to have been a false prophecy, and on rising next morning we were delighted to behold a brilliantly clear sky. We lost not a minute in returning to the ridge of the col, where for the first time we saw the entire eastern face of K² revealed without a trace of mist.[1] It looked like another mountain entirely; and of all the manifold aspects of the colossus this is certainly the most imposing, the richest and boldest in design. Alas, it is also such as to annihilate the last remnant of hope that might

[1] See panorama G.

linger in the mind of the mountaineer. The cone itself rises from a great sloping shoulder entirely covered by a glacier that comes down to its very verge and breaks abruptly off, forming a perpetual menace to all the ravines. furrows and ridges of the steep wall beneath. The peak, which from this side looks very sharp, has a huge icy dome or cap coming down to the edge of a formidable vertical descent of rock;

K² FROM WINDY GAP.

and to this the chance disposition of the ice and the hollows and protuberances of the rock have given the semblance of a grotesque face, a sort of demon of the mountains. Below the shoulder to the south is visible in profile the crest of rock first tried by the Duke; it is much steeper than it looked from below and very long. The north-western buttress projects toward us, very sharp, broken and rugged. full of needles and icy pinnacles, between which run northward the curves of long and ample cornices. If he had seen it from this point, Guillarmod would never have thought of choosing it as a route. The end of it joins like the shaft of a T to a transversal ridge which encircles one of the sides of Staircase basin.

To the south-west we could look down through the Godwin Austen valley as far as the point where it bends toward the Concordia. From our point of view the background is formed by the right-hand ridge

MASHERBRUM, FROM THE HEAD OF THE GODWIN AUSTEN. TELEPHOTOGRAPHY.

of the Savoia glacier, behind which, 24 miles away, rises Masherbrum Peak, a great rocky mountain, extraordinarily imposing, terminating in a sharp point. On the left all the summits along the Godwin Austen look diminished and robbed of significance by the ponderous bulk of Broad Peak ; but the latter is balanced on the north by the magnificent icy cliffs, like gigantic steps, running from the saddle to the dome of Staircase Peak. This impressive formation is joined by an almost horizontal ridge to the top of the triangular wall of rock that faces down the valley.

We are now in a position to satisfy our curiosity more completely with regard to the country beyond the col to the north-east.[1] A glacier descends precipitously at our feet, falling with almost vertical leaps for about 2,000 feet, then flowing somewhat less steeply to empty

PEAK 22,113, EAST OF WINDY GAP. TELEPHOTOGRAPHY.

upon another glacier, which is nearly as large as the Godwin Austen, covered with snow, and soon disappears from view in a south-easterly direction. On the north this glacier reaches a low snowy col at the base of the eastern wall of Staircase Peak.[2] Its left wall is formed

[1] See panorama H.

[2] The Duke thinks it possible that by this pass one might attain directly to the glacier which was to be seen flowing at the base of Sella Pass, coming from the northern side of K².

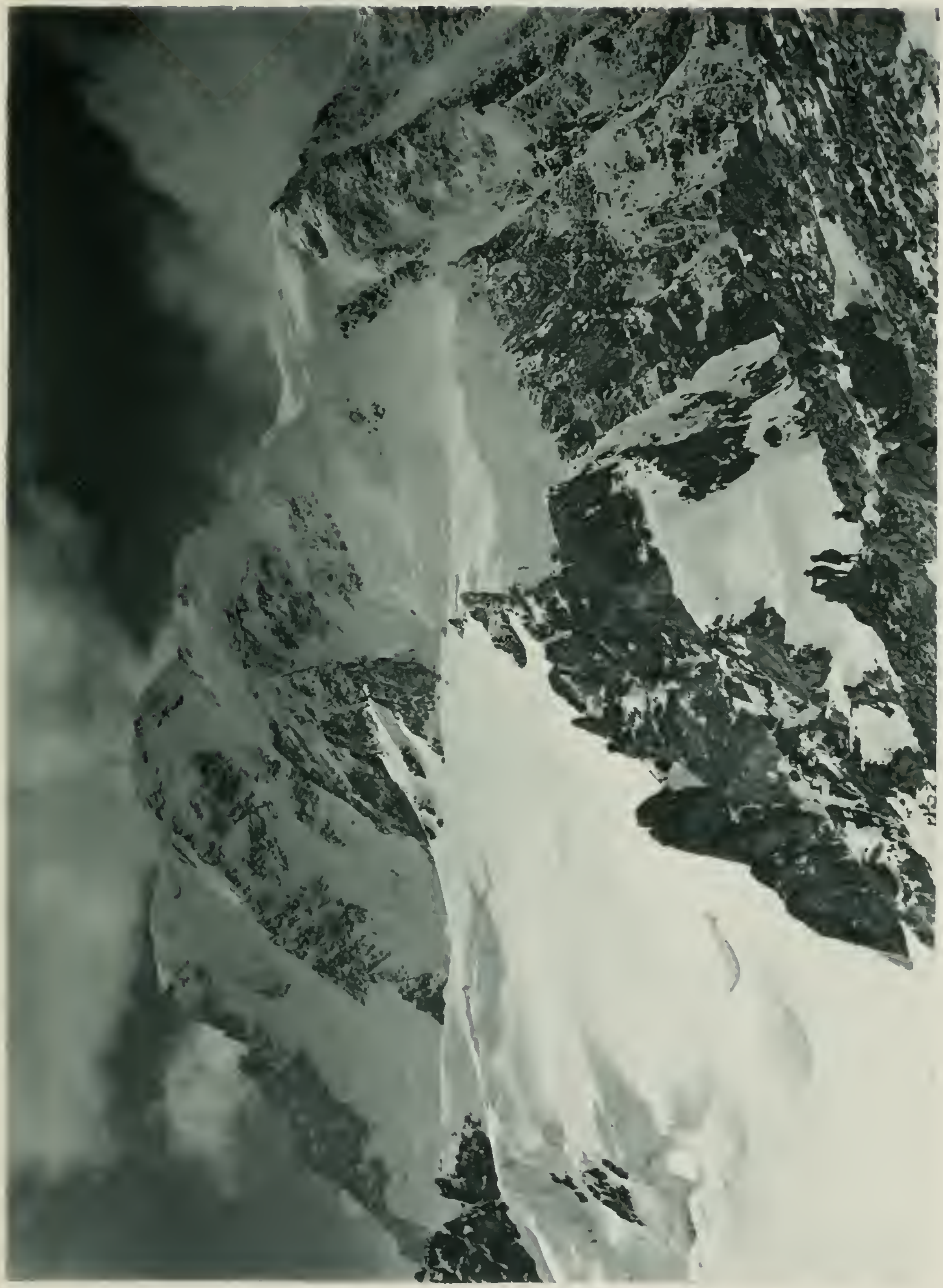
by a chain of mountains of varied design, the highest of them being twin peaks, a snowy and a rocky one (22,113 feet). The chain runs from north-west to south-east, and at half its distance there detaches itself at right angles a branch which runs to join the eastern ridge of Staircase Peak, by means of the low col I have mentioned. Finally, above and behind this screen rise here and there the peaks of still another chain, evidently larger and more important.

By half-past seven Negrotto had completed a photogrammetric panorama from the southern extremity of the col. We dismounted the apparatus, traversed the whole length of the ridge of the col and climbed, partly on ice, partly on rock, to the foot of the ridge of Staircase Peak. At the base of a sort of turret we made another station on a little level cut with our pickaxes in the ice near the cornice. It was from these two panoramas that the short chain north-east of Windy Gap was placed upon the map. We got down directly to the tents without going back to the col through a gully full of ice with a light covering of snow. Sella in the meantime had taken panoramas G and H, and photographs of several single mountains. The three guides and seven coolies came up presently from the camp below.

Our work at Windy Gap was finished, and we prepared to return to Camp VI, leaving the tents behind for the use of the Duke. He wished to make the ascent of Staircase Peak, not so much as a mountaineering feat as because it was evident that there must be from the top an excellent view of its own north-western slopes and those of K², as well as of all the unknown territory lying east of Windy Gap, Broad Peak and the Gasherbrums. If too serious obstacles offered themselves to an ascent, it might still be possible to descend to the other side of the col and make an expedition on the glaciers eastward and southward, or to round Staircase Peak to a point where the northern wall of K² might become visible.

We had been wise to profit by the early morning hours, for it now began to cloud over again. We returned roped together in three caravans, one formed entirely of coolies. They had been quick to learn the use of the rope, and also how to avoid the insidious crevices. Whenever we had once persuaded them to cover new ground, they returned to it with a good will, never making objections even when the route was difficult. The reluctance which they sometimes showed was never laziness or obstinacy, but only fear of the unknown. We

Staircase Peak, from Windy Gap



conquered it by persuasion and example. Severity would only have made the case worse.

On the morning of June 17th the Duke ascended to Windy Gap in his turn. The guides had reached it the day before, and on that day they went to cut a long stairway in the ice of the ridge up to the first terrace. Unfortunately it began to snow in the night and kept on till the day following, making all their work in vain. On the 19th the weather was exceedingly uncertain, but the Duke went up the first section of the slope, accompanied by the guides. At the edge of the plateau rise two well-defined towers, which show plainly in panorama G. It had begun to snow again, and for five hours the party waited, sheltering themselves as best they could in the lee of the towers. They saw a little bird hopping about on the rocks—it seemed lost in this desert of ice. Finally, they had to give up and go back to the tents. Alessio Brocherel, who had been ailing ever since his fall two days before, was seized with exhaustion, coughing and acute pain on the right side of the chest, and the Duke thought it best for him to return at once to Camp VI, with Emilio Brocherel and Savoie as escort.

In the meantime at Camp V we had spent the three days to no great advantage. On the 18th Negrotto and I pushed our way through a labyrinth of crevasses, which obliged us to retrace our footsteps continually, as far as the centre of the middle level of the Godwin Austen, where we made a photogrammetric station. Sella was spending whole days of patient waiting, renewing the experience of the Ruwenzori expedition, on the ledge of a crest some 2,000 feet above camp, where, crouched beside his machine, he watched for a break in the clouds. The wind kept up, cold and penetrating, piercing the thickest woollens one could put on ; and whenever it did slacken the air grew sultry, and we experienced such reverberation from the snow and fog as to suffer more from it than from the unclouded sun.

The coolies, huddled about their tiny fires, chanted plaintive monotonous little ditties half under their breaths, sometimes accompanying them by beating time on the empty provision tins. They had made themselves a whole cooking outfit with the tins in which the food came. The three coolies who had remained with Bareux at the base camp came up periodically with our post and with chupattis and bundles of wood. We were often wakened suddenly at night with palpitating hearts by the terrible noise of an avalanche from Broad

Peak. The echoes would reverberate for several minutes in the silence of the night with a sound like cars going at full speed over uneven pavement or the long roar of a passing train.

At evening on the 19th the sky was more obscured and shut in than ever, and heavy snow began to fall quietly through a windless atmosphere. The thermometer registered 19° F. Alessio Brocherel suffered all night long from a dry racking cough, which aggravated the strain in his side. He had scarcely any fever, but he looked weak and worn out. In the absence of any other morbid symptoms, I believe the case to have been one of a slight and limited traumatic pleurisy, caused by the wrench from the rope which he had sustained in his fall.

At midday on the 20th the Duke returned to camp. He had not given up his attempt, but it seemed wisest to wait until the spell of bad weather had broken and the guides had been able to prepare a route on the ridge of Staircase Peak, or else downward through the glacier east of Windy Gap.

Although the heavy snowfall had not sufficed to clear the sky of clouds, Negrotto and I made a topographical excursion on the glacier as far as the basin of Staircase Peak. We had hardly set up the instrument when the whole formidable east wall of K^2 seemed to disembarrass itself at one stroke of all the snow that had fallen in the last days, and an immense avalanche, heralded by a vast white cloud, flung itself down for nearly 10,000 feet right in our direction. For an instant we were bewildered, not knowing if the distance would be sufficient to break the force of this tremendous downfall. But its course became slower directly it reached the level of the glacier, where it opened out in a great fan. The cloud of powdery snow filled the entire valley, enveloping us even where we stood in its dense folds, accompanied by an actual heavy snowfall which lasted several minutes. It was almost half an hour before the air cleared sufficiently for us to go on with our work.

We found the sun's rays very intense on our way back to camp, and there was a powerful reverberation from the new snow. All the surrounding mountains, as though they had been awaiting the signal from the monarch, shook off their burdens, which came down in streams, torrents, rivers of the purest white, and heaped themselves up at the foot of the walls. After a brief interlude of only a few hours the weather grew bad again. Broad Peak, always the first to condense its vapours, speedily covered itself with an enormous cap; thick stormclouds appeared settling down over all the hills and weighing down the north-eastern buttress of K^2; and to the west was displayed the "mackerel sky" that always portends bad weather.

On June 23rd the Duke again rejoined the guides at Windy Gap. He had to go through a furious storm resembling in character the polar drift. There were in all five guides and porters with him at Windy Gap—all the forces except Bareux, Botta and Brocherel. The last, though somewhat better, continued very weak. The guides had not been able to do much work in the interval. They were driven back by the wind on two successive days from the ridge of Staircase Peak, not getting farther than the first terrace. They were of opinion, however, that it would be easy to find a route up to the second stage of the ascent, though there was no possibility of attaining the peak in less than three days, which meant three days of fine weather, a condition up to now without a precedent. They had also examined the steep glacier east of the saddle and had planned a descent on its right margin. The loads would have to be let down through a steep icy well at the left of the col, a very dubious undertaking and one that would require some days of work. What the return route would be was an unsolved problem.

On the morning of June 24th, on account of the doubtful look of the weather, the Duke had decided to give up the ascent and try the way down the eastern glacier of Windy Gap. But a change for the better induced him to return, take the two Mummery tents, four sleeping-bags, some provisions and cooking utensils, and set off with all speed for the ridge of Staircase Peak. He went up the sloping ice wall toward the two rocky towers that guard the edge of the first level, crossing over on the snow just below these to reach the brow of the terrace or little rolling snowy plateau, upon which he set up the small camp in a sheltered hollow.

The two Petigax and Enrico Brocherel stayed with him, Emilio Brocherel and Savoie returning to Windy Camp. During the night Enrico Brocherel, an uncommonly robust man, with the physique of an athlete, was taken with coughing, from no apparent cause, had pains in the breast, and spit blood. In the morning he wished to go on with the others, but his cough grew worse, and alarmed by the unusual symptoms he was obliged to give it up. The illness was unexplainable, for no further evil results followed, and later on, in the much higher camps of Chogolisa Saddle, he always felt perfectly well. The appearance of clear and serene weather made the mishap all the more vexing. Despite it, the Duke did not hesitate to set off with the two Petigax, with the intention of getting as far as possible up the ridge. They wore two sets of woollens for protection against the stinging cold, and their feet and legs were wound with heavy cloth kept in place by the straps from the crampons. It took about an hour to cross the plateau, full of large furrows and snowy ridges. Thence they climbed the gentle slope to the foot of the second step and began the attack upon it. It was covered with dry snow with the bare ice shining through here and there. After some three hours of work with the pickaxes they reached a point very near the top, where the wall began curving on to the edge of the second terrace. Here they were confronted by a wide crevasse, the edges of which were particularly unsafe from melting. It cut the steep slope at right angles in such a way that its upper edge was several yards higher and receded by about the same amount more than the lower. The guides followed along the edge going toward the left, and Lorenzo, standing on his father's shoulders, tried in vain to gain the upper edge. Then they went to the right, and finally found a spot where the edges were close enough together to permit them to cross. But once beyond it they found themselves on a strip of ice only a few yards across, separating them from another huge crevasse, 20 or 30 feet broad, which went all the way across the slope to where the side walls went down right and left into the valley. There was no getting around this obstacle; it formed an absolute barrier to further progress. To go all the way around it on the right one would have to climb an almost vertical wall of live ice exposed to falls of threatening séracs. It might be possible to pass it on the left by climbing on the rocks some 700 feet below the ridge. Midday was already at hand, and it would be necessary to make a camp and begin again the next day. Added to all this the Duke, for the first and only time in the campaign, felt very weary, and the endurance of young Lorenzo was sorely taxed. As for his father, Giuseppe, this indomitable man appeared insensible to altitude, to cold or to fatigue. He was never found wanting or known to feel a moment of weakness throughout all the campaigns upon which he accompanied the Duke, and probably found a source of strength in the silent devotion which he manifested toward our leader.

Rather than waste the time in doubtful trials, to gain, perhaps, another hundred yards, the Duke determined to derive the utmost profit from the work already accomplished, by making a thorough observation of the wide horizon which his present station (21,650 feet high) enabled him to embrace. He had a splendid view of K², which always showed itself more lofty, more threatening and more inaccessible the higher one's point of view, as if to mock at any competition with itself. The photograph which the Duke took of it that morning from the shelter camp, reproduced in the frontispiece of this book, is undoubtedly the best picture of K² boasted by the expedition.

From his station on the ridge the Duke took panorama I, which is important from the illustrative as well as from the geographical point of view. As usual K² dominates the scene, showing its terminal cone in its true proportions, covered with a heavy coat of ice on the east and south, and having a steep smooth angle of rock on the north, which ends more than 3,000 feet below the summit by merging into the northern wall. The latter falls precipitously behind the north-east ridge, certainly the nearest to the perpendicular of all the faces of the mountain. Farther off and lower down another rocky ridge shows itself against the sky, in all probability part of the smaller north-western ridge that runs down to Savoia Pass. If so, the Duke had now completed the circuit of exploration of K². He might now abandon the struggle in the consciousness that he had left undone nothing within human power to convince himself of the impossiblity of the undertaking.

The Godwin Austen valley, which looked so broad when we were going through it, shows in the panorama a mere cut or gorge between the walls of K² and Broad Peak. Masherbrum in the distance has lost much of its imposing appearance. Gasherbrum I and II are just visible behind the left wall of the Godwin Austen valley.

Toward the east comes the most interesting part of the panorama, geographically speaking. The short chain of which Negrotto made a survey, and which appears on our map, has sunk down quite low, the southern summits just showing. On the other hand the lofty chain, some peaks of which were to be seen from Windy Gap showing behind the nearer range, now reveals itself in its entirety. It was possible, thanks to the three characteristic peaks marked X, Y and Z on the panorama, to identify this chain with the one which extends on the left in Sella's panorama F, taken on June 22nd from behind the eastern ridge of the Godwin Austen. The glacier which flows eastward at the base of Windy Gap empties after a short course into another larger one, almost free of moraine; and of this glacier one sees a tiny triangular portion in panorama I, apparently flowing south-east. By comparing the two panoramas F and I one can see that this glacier must join the large one, entirely covered with loose moraine, of which one sees a stretch in panorama F, and to which contribute a large number of affluents from the eastern wall of Broad Peak and the Gasherbrums.[1]

Having finished their observations the little party quickly returned to the shelter tents. Shortly afterwards they were joined from below by the two porters, and with their help descended to Windy Gap, taking the small quantity of luggage. They all rested next day—Lorenzo Petigax still feeling some fatigue, and also Enrico Brocherel. The former had a slightly frost-bitten foot. On the 27th the Duke sent these two to the base camp with Emilio Brocherel, and on the 28th he himself left Windy Gap and rejoined the rest of the party.

[1] In Chapter XIX I have tried to correlate the observations of the Duke on the region east of the Baltoro with those of the only other explorer of these parts, Col. Sir Francis Younghusband.

CHAPTER XVI.

FROM THE BASE OF K² TO THE FOOT OF BRIDE PEAK.

THE UPPER BALTORO GLACIER.

K² as surveyed by the Expedition. — Lanfafahad, Chiring or Chogo ? — Weather during June — Early Monsoon of the Karakoram. — Bride Peak, the new Goal of the Duke. — Return to Base Camp. — Changes in the Glaciers and Mountains. — The Camp moved to Concordia. — Sella's Work. — The Duke sets out for Bride Peak. — Moraines of the Southern Branch of the Baltoro. — Camp at the Foot of Golden Throne. — Landslides and Avalanches. — Hidden Peak and the Eastern Slopes of Bride Peak. — Mustagh Tower. — Weather during July. — Melting of the Glaciers. — The Snow Limit. — Sunsets.

Our work in the neighbourhood of K² and the glacier basin of the Godwin Austen was at an end. The Duke had explored the mountain in detail, its glaciers and surrounding ranges on the south, west and east ; he had seen and photographed the outline of its northern wall, perhaps the most precipitous of all. Despite unfavourable atmospheric conditions, despite the mists and fogs that persistently covered the peaks and walls, Sella and Negrotto, by taking advantage of every brief interval of fair weather, had succeeded in getting views of the valleys and mountains about the monarch, and in completing a network of photogrammetric panoramas and of angles read on the tacheometer.

K^2 now stood revealed in detail, and it became possible to make accurate drawings of its outlines, its ridges and the inclination of its walls. The mountain is a quadrangular pyramid, the corners being formed by four main crests meeting at right angles—the south-west and north-east, the north-west and south-east. The first two are prolonged in long and powerful buttresses, proportionate in size to the mass which they sustain. The other two are cut off short and

K² FROM THE SOUTH.

precipitously—one at Savoia Pass, the other at the shoulder of the mountain, where it divides into a southern and an eastern branch. These four ridges outline irregular walls, which are orientated to the four cardinal points and are cut by secondary ridges. The western and northern faces are rocky. The southern is likewise rocky, but the De Filippi glacier runs across it obliquely. The eastern face is all armed with ice, and has a great shoulder two-thirds of the way up, upon which the terminal peak rears itself, a cone over 3,000 feet high.

It is quite certain that K^2, from whatever point one looks at it, has one peak and one only. It is not clear how some observers can have managed to see two. In Drew's book[1] is a drawing of K^2 seen from

[1] F. Drew, *Jummoo and Kashmir*. 2nd ed. London 1877. p. 370.

The Peak of K², seen from the south

(Telephotography)

the south-west from more than 62 miles away, showing it with two distinct points divided by a broad saddle. Sir Martin Conway also believed he had seen a twin peak. On the other hand, Godwin Austen distinctly affirmed the contrary, and he was right.[1] It is perhaps the great eastern shoulder seen from certain points of view that has created the false impression.

I know no other mountain which has such diverse aspects when seen from its different sides. The plates showing it from west, south, east and north-east[2] display its extraordinary variety of form, and show, too, how all its sides are equally fortified with the most formidable defences against the attack of the mountain climber. After weeks of examination, after hours of contemplation and search for the secret of the mountain, the Duke was finally obliged to yield to the conviction that K^2 is not to be climbed. Its height is not a factor in the case. It is the obstacles peculiar to mountain climbing and familiar to the mountaineer that close the paths of ascent to K^2. I know how hard it is to-day to win belief for a statement of the inaccessibility of a mountain without the most exhaustive evidence. And I hasten to add that such a sentence applies to K^2 not altogether in an absolute sense, but very much as a result of the remote situation of the giant, the impossibility of camping near its base for more than a few weeks, and finally the unfavourable climatic conditions. If K^2 were in the Alps it is possible that a siege of several years would end in conquest, provided that the height did not form *per se* a physiological obstacle not to be overcome. Step by step a way would be gained up one of the ridges—ropes and refuges would be placed. The giant would probably claim its victims, but in the end would yield perhaps to repeated assaults.

The Baltis gave us a new name for K^2, as they had done also to our predecessors. They appeared to agree in calling it Lanfafahad or Lanpapahad. They were equally unanimous in speaking of it to Conway under the designation Chiring, while to Guillarmod they called it Chogo. The last is common to various peaks of the Karakoram. There is only one conclusion to be drawn from all these names—that K^2 has had none given it by the natives. The fact is not surprising.

[1] See *Geog. Jour.* 3, 1894, pp. 431 and 527.

[2] Compare Plates opposite pp. 232, 248, 258, 288 and frontispiece.

Rather it would be strange if the natives who live on the slopes of the Karakoram, who have left unchristened numberless peaks which they see every day, had had the idea of giving a name to a particular one six days' journey from their villages beyond the much-dreaded glaciers, in a region to which they have been dragged solely by the insatiability of European curiosity. The brothers Schlagintweit made a vain search for a native name both in Baltistan and Turkestan, and afterwards proposed the name of Depsang, because they had had so splendid a view of the mountain from the plateau of that name near the Karakoram pass. K^2 is actually indicated by this name in various atlases, chiefly German ones. It has not, however, so far as I know, any official sanction. It is strange that others among the many visitors to the Karakoram pass, either before or after the Schlagintweits, do not mention having seen K^2 from there or the vicinity, not even those who have given us a minute description of the view.

During the whole month we had spent on the Godwin Austen the weather had been exceedingly unfavourable. Only once did we have three consecutive days of good weather. The wind blew almost constantly from the west and south-west, and grew stronger and colder the higher up we went. We had frequent though not very heavy snowstorms. It was seldom that the air remained clear or the peaks uncovered for a whole day at a time. With the exception of one single occasion, and then only for a few hours, we never found ourselves on a level with or above the mists and clouds. They were always very high, like the wind, from 23,000 feet up. The usual classification of the clouds into nimbus, cumulus, cirrus and stratus, based on the shapes assumed at various heights, holds good for the Karakoram, by putting each type some 7,000 feet farther up.

The regular persistence of the wind points to the conclusion that it must be the monsoon, which would be blowing very high up during this month. We followed for whole days the rapid course of mists and clouds 1,000 feet above the peak of K^2, when in the valleys the air would be calm. This may explain the fact that in Kashmir and the Punjab plain one is not conscious of the monsoon before July and August, when it blows much lower, hurling itself against the barrier of the Himalaya. If, as meteorologists consider, the monsoon is caused by the super-heated air of the desert of Gobi and the other arid Asiatic regions, when the sun is north of the equator, it is natural that the consequent reverse current of air would be apparent earlier in the Karakoram than in the far-off plains.[1]

Whatever may be the cause of it, the persistent bad weather imposes a fatal obstacle upon the mountain climber. The fresh snow, falling at such frequent intervals, covers the rocks with a permanent crust of ice (verglas). Moreover, it never has a chance to solidify on the walls or the glaciers, thus there is no season when one is safe from avalanches nor when the crevasses are covered with firm snow. Yet after all, in the month of June, the worst enemy is indubitably the wind, which blows up continual tourmentes and makes the cold well nigh unendurable.

I have said that all the explorers of the various regions of the Karakoram suffered like ourselves from the inclemence of the weather. But I ought to mention that in 1908 the Workmans enjoyed two months (July and August) of almost uninterrupted fair weather, with clear warm days. From this fact explorers may draw encouragement to plan new expeditions to the Karakoram.

Though our work about K^2 was finished, the Duke had no intention of making an end of the campaign. He did not give up the hope of climbing some other peak of the region which should be higher than any altitude yet attained, thus satisfying what had been the chief purpose of the expedition. The encouraging features were the fact that the season was not yet far advanced, the excellent record the guides had made on the high slopes, and the good health we were all in, for beyond a certain amount of loss of flesh, accompanied by a slight diminution of strength and powers of resistance, none of us seemed really the worse for our life above 16,500 feet. Alessio Brocherel, indeed —the most experienced guide we had after Giuseppe Petigax—lost so much by his few days' illness and seemed so weakened, that he could not be depended upon for the rest of the campaign. The experience of those who had come before us was to the effect that in the month of

[1] Sir A. Cunningham (*Ladakh and Surrounding Countries* London 1854) asserts on the authority of A. Gerard and of his brother, J. Cunningham, that in Ladakh and Baltistan the wind blows all the year round from west or south-west, without the alternation of the south-west (summer) monsoon with the north-east (winter) one. The author found that in Ladakh there is a daily alternation, a steady breeze blowing from the north at night, which at dawn shifts to the north-east and during the day veers to south-west or west—probably a wind entirely unconnected with the monsoon and caused by the local daily radiation due to the high solar temperature of the plateaus. We observed nothing similar in the Karakoram, conditions being absent which could give rise to this periodic oscillation.

July, now close at hand, weather even more unpropitious than that of June was only to be expected. But this prospect was not definite enough to put an end to the campaign.

The great difficulty lay in the choice of the mountain. The mere sight of that immense cordon by which we were surrounded was enough to put the mountain climber into a mental state of awe and doubt. All the peaks between 26,000 and 27,000 feet were of such formidable aspect, that it seemed impossible to plan an ascent giving any reasonable hope of a successful issue. The Duke was driven by sheer necessity to turn his thoughts toward Golden Throne and Bride Peak, the snowy mountains which rise at the end of the southern arm of the Baltoro. The first, with its mighty glaciers and slopes of moderate inclination, Sir Martin Conway had already essayed. But it is only 23,590 feet high, almost 400 feet lower than Kabru in Kinchinjunga, which had been ascended two years before by the Norwegians Rubenson and Monrad Aas. There remained Bride Peak, 25,110 feet high, as yet untried, and possessing the great advantage that it had been selected as a trigonometric point and measured by the Indian Trigonometrical Survey. From our camp we had looked with admiration, almost amounting to desire, at the beautiful outline of this peak. The great northern wall seemed to show an easy, if tedious route to the summit.

The ascent of Bride Peak was decided upon as early as June 22nd, and the Duke had discussed with us the mode of carrying it into execution. On the 23rd, while he set off in violent weather to Windy Gap for his second attempt upon Staircase Peak, Sella went down to the base camp at the foot of K², taking with him Alessio Brocherel, and assisting him on the way. On the morrow Negrotto and I broke up the intermediate camp, leaving a single tent for the use of whoever came up later to get the luggage from the camp at Windy Gap. We, Botta, Bareux and fifteen coolies, then joined Sella at the base camp.

We descended the incline below the camp by a much more tortuous route than on our ascent, because the numerous crevasses were all laid bare by the melting of the snows. This passed, we stood astonished before the great alteration which time had worked in the glacier. The melting process had gone on vigorously. Over the surface were sprinkled little clear blue lakes and a network of rivulets ran everywhere. Two large and ancient avalanches from K² had spread great expanses of rugged snow, each of them some half a mile broad and grey with dust and detritus, obliquely across the glacier, almost to the foot of Broad Peak. Everywhere else the ice was bare and corroded by fusion. The front of the De Filippi glacier was much lower, and the séracs along it, unevenly melted by the sun, had taken on fantastic shapes. Below it the centre of the Godwin Austen was filled with a broad moraine between the band of green séracs at the foot of the rocks of Broad Peak and the wide front of the Savoia glacier. The surface of this latter was all grey with dust.

The hollow where the base camp had been was shallower than before, owing to the flattening of the surface of the glacier. The walls of the chains could now be seen from it almost to their bases. The mountains, divested of their thick coating of snow, seemed shrunken and lean, and their glaciers were confined within ribs of rock. Live ice gleamed from all the gullies. The Vigne glacier had been very white; now it wound up its broad valley in stripes of moraine. Only Bride Peak and its satellites had kept their whiteness unsullied. The former, on its northern wall, is cut with crevasses, betrayed by their deeper shadow; they must be of enormous size. On the rocks back of the camp some lean tufts of grass had sprung up.

The day ended in a sunset of indescribable beauty. Now that we had accepted our defeat, the mountain seemed to throw off its hostility and become serene once more. We could not see the western sky for the south-western spur of K^2, at whose feet we were; but the southern heavens seemed to mirror every ray of the declining sun. Perhaps Bride Peak acted as a reflector to fling back the western light. The pale blue sky became softly tinged with rose, then turned a delicate mauve, to end in a metallic turquoise, like tempered steel. The great snowy wall showed a pale saffron, then a waxen pallor like a tea-rose, then a deep pure white. There was no violent colour. The splendour of the summer skies in the Alps, which tint the snows with purple, gold and red, was all quite lacking here. One by one the light left the surrounding heights, forsaking last of all the three great summits of Broad Peak. Finally, the tranquil moonlight and a profound stillness and peace reigned over the scene.

The sunrises of this region are even more delicately coloured than its sunsets. The brilliantly pure light merely increases in intensity, the sky has a clear gleaming pallor, and there is not a tinge of colour reflected anywhere upon the snows.

The present fair weather, for the one and only time during our stay on the Baltoro, was unbroken for three days. We proceeded in this time with the carrying out of the Duke's plans. On June 25th Sella left us at the base camp and went down to the mouth of the Godwin Austen, taking with him Botta and fifteen loaded coolies. He sent back the latter directly, and on the day following they made the journey down and back a second time, a march of nearly nine hours. We rewarded this extra work and their docility in performing it by some presents of biscuits, a little tea and sugar, chocolate or butter, all of which we had gradually persuaded them to accept. We were astonished to have some of them ask for soap and wash themselves, nearly nude for the purpose, in the icy rivulet between the camp and the moraine.

On the 27th we made the last photogrammetric station on the Godwin Austen, at a point below the mouth of the Savoia glacier. This done, we sent fourteen coolies up to the intermediate camp, under the escort of Bareux. Next day they went on to Windy Gap to bring down the equipment of the high camp. That afternoon the fine weather showed signs of breaking. Light flakes of mist came and went on the ridges, grew more permanent, and by sunset the whole sky was dotted with clouds. Next morning it was snowing. Enrico Brocherel, Giuseppe Petigax and Savoie came down in the forenoon and the Duke in the afternoon in one stage from Windy Gap. Finally, towards evening our party was increased by the arrival of twenty-three coolies from Rdokass, the Duke having sent for them to help carry the camp to Bride Peak.

The storm continued all the next day, the 29th; but the Duke set off for the Concordia notwithstanding with the guides and all the coolies. Only Bareux and Alessio Brocherel stayed with us; the latter had given us some anxiety after his return to the base camp. His cough and the pain in the chest had come on again, accompanied by a slight feverishness. Then he began to improve to such an extent that we thought he might be taken down to Concordia by the next day. We made a sort of chair with the long alpenstocks and one of the load-carriers, upon which he might be carried on the level stretches. That evening all the coolies were once more united at the camp, frisking and playing like children, undepressed by the lowering weather and heavy, gloomy sky.

Bride Peak, from Camp III

We were up betimes on the 30th, and finished breaking up camp in a heavy snowfall. The air was still. Four coolies were told off to carry Brocherel's chair, and we had all the others start off, ourselves following. After getting on the moraine we turned back for a last look at the spot which had been our shelter for the past month and more. It had never looked so forlorn as now. The heavy snow obliterated in a short time all traces of the camp that had once stood there. One of our friendly crows was perched on the little level—his companions had all deserted us some days before.

We went on very slowly, as Brocherel was with us, covering on foot the distance across the two moraine ridges. When he decided to begin to use the chair we found, to our disappointment, that the coolies—though with the best will in the world—were unable to carry him. They were not used to working in concert nor keeping step together, and they were not strong in the arms, so that their exertion was out of all proportion to the burden, and they had to stop for rest every few steps. Brocherel, who was finding his strength greater than he had thought, finally decided that he could make most of the way on foot by proceeding slowly. So we continued, at the pace of a funeral cortège.

We followed the median moraine of the glacier, which begins at the mouth of the De Filippi, and is shortly increased by the confluence of the Savoia. During the past month the level of the glacier had fallen considerably, and the arrangement of the moraines had increased in evenness and regularity. The long central spine, formed by the median moraine, now marked by numerous glacial lakes, stood several feet above the rest of the glacier, which was all corrugated with longitudinal ridges and furrows, among which ran smaller moraines and noisy surface torrents of water. Some of the ridges of ice were in the form of long parallel rows of notched and irregular blocks with cuttings between them. Here and there the ice terminated on the edge of the moraine in rows of rounded lumps, which looked like surf suddenly arrested and frozen upon a beach. We observed several times a phenomenon never felt to anything like the same degree on other glaciers—the frequent sharp and violent concussion due to fissures opening in the mass, accompanied by distinctly perceptible quaking of the ice beneath our feet, which sometimes amounts to an actual undulating movement. The phenomenon is certainly not caused by earthquake shock.

The moraine grows broader and flatter as we go down, till it looks like a wide road in the middle of the valley. In its centre the stones are small and broken. The larger ones are collected at the edges, forming rows of glacier tables. The walking was so easy that we made Brocherel mount his chair again, and he was carried for longer distances than at first, thanks to the help of Bareux's broad shoulders.

K² FROM THE GODWIN AUSTEN, NEAR CONCORDIA.

All the moraines of the Godwin Austen run in straight lines toward the Concordia basin, until they meet the glacier that comes down from the western flank of Broad Peak. There they make a wide symmetrical curve to come into line with the moraines flowing from the upper Baltoro, and they all proceed westward in parallel rows in the narrow stretch between Mitre Peak and Marble Point, which stand sentinels to the entrance to the lower valley. We found the tents set up where the curve of the moraine begins, not far from the Concordia, near the largest boulder we had seen on the glaciers of the Karakoram. Enrico and Emilio Brocherel came a half-hour's distance from camp to meet us, and with their help we were able to cover the rest of the distance at a good pace and to spare the invalid further fatigue, so that he reached camp in good condition. The snow had almost stopped, and a fresh wind was blowing, as usual, from the south-west.

The once more united forces now exchanged their experiences of the past few days. Sella had profited by the two exceptional fine days to make highly successful photographic excursions. On the 26th he

K² AT SUNSET, SEEN FROM THE LOWER GODWIN AUSTEN.

climbed the rocky corner between the Baltoro and the Godwin Austen, reaching a shoulder 17,239 feet high on the black and broken schists from which rises the marble peak. Thence he took panorama C. The next day he crossed the glacier to the foot of the great western ridge of the Gasherbrums, and made a difficult way up the rocks and icy gullies to a ledge 17,917 feet high, just about opposite to his position of the day before. Here he took panorama D. These two panoramas are all that could be desired in the way of showing the whole amphitheatre and its surrounding mountain chains. Sella also collected and photographed some Alpine plants growing in sheltered places on the heights up to nearly 18,000 feet.[1]

[1] These plants are classified and illustrated in the Botanical Index of Prof. Pirotta and Dr. Cortesi. In the Nanda Devi group in Gahrwal Longstaff found plants only up to 16,500 feet.

The weather steadily improved: the heavy clouds were dispersed, and the day closed with another scene of unforgettable splendour. It was, in fact, the extraordinary rapidity and variety of the atmospheric changes in this region which contributed most largely to the æsthetic pleasure of a sojourn there. The terminal peak of K² stood out above a wreath of cloud that was faintly rosy in the twilight. The moon, almost at full, burst through the vapours to the south-east and seemed to sweep them before it. The group of gradually descending summits between Bride Peak and the Vigne glacier were all floating in a bed of down. Twilight and moonlight combined in strange and beautiful effects of light and shade upon the walls and heights. Finally, the calm brilliance of the moon replaced the daylight, all the surrounding snows taking reflections from the clear air, while the walls that lay in shadow showed dark and mysterious by contrast with their radiance.

On July 1st the Duke, Sella, the guides and all the coolies left camp to ascend the upper Baltoro. Negrotto and I stayed behind with Lorenzo Petigax and Alessio Brocherel, until the coolies should return. We remained for five days, which we spent in concluding the topographical work with two last panoramas and in making two short excursions on the glacier. Brocherel meanwhile went on improving and gaining in strength.

The high bastion of moraine upon which we were now encamped, near the entrance to the Concordia, was a fine post of observation. Just opposite us to the west was the Marble Peak, standing upon its black foundation, which is likewise veined with white marble. It looked rather like a huge magnolia bud about to burst. It is confronted on the east by the large glaciers of the ridge joining Broad Peak and the Gasherbrums—they unite behind a long and narrow screen of rock which flanks the Godwin Austen on the left, and flow together into the Concordia. On the south the vision traverses the wide Concordia basin, a series of high ridges and deep furrows, bare ice and moraine alternating, and reaches up within the southern Baltoro and the valley of the Vigne, which appear to converge high up at the base of Bride Peak. K² at this distance has all its old impressiveness. We were too near Broad Peak to get a good view of it—it looks from where we are a huge misshapen mass. By descending the moraine for a short distance one can see the opening and the long vista of the lower Baltoro, with the beautiful peak of Paiju rising at the end.

K², from the Concordia Amphitheatre

All these giant mountains gain in size and impressiveness as one gets farther away from them; for the valleys, wide as they seem, are really disproportionately narrow to the heights above them, so that one sees all the outlines dwarfed and distorted by foreshortening. Contrasting with the snow are rocks of bold design in a great variety of colours—black schists, granites, gneiss in all shades of grey, which when the sun strikes them look brown and give out red, blue and yellow gleams; while the limestones, white or creamy, blood-coloured or greenish, run a whole gamut of varying shades. Sometimes we arrive at a consciousness, even if a dim one, of the wonderful harmony of form, the perfect balance and proportion of this seeming chaos; but oftener we give up all analysis of our sensations, and rest in a vague and silent contemplation.

On this side and on that of the median moraine, the glacier has a relatively smooth strip, and then becomes more and more disturbed and upheaved as one approaches the marginal moraines. The screen of rocks at the foot of Broad Peak is not easy to reach. The course of the waters has curved great furrows and ditches between the moraines and ice ridges. We have to make long détours in order to go around these, as well as to avoid the steeper slopes. Between the marginal moraine and the strip of ice nearest it lay a charming little arctic landscape in miniature, composed of the bluest of small lakes all running in between the thousand narrow inlets of the undermined and jagged banks. Blocks of ice reduced by melting to the most fantastic shapes mirrored themselves in these little lakes. Everywhere one heard the sound of dripping, bubbling and rushing waters coming down all the surrounding slopes, accompanied by the dull and heavy undertone from the underground torrents and the splashes made by ice breaking off and falling into the water. We were only some 600 or 700 feet below the base camp; but this slight difference gave us a distinct sense of well-being, to which probably the improvement in the weather contributed. It was quite mild and calm, and one could stay for hours in the sun on the warm stones of the moraine. It was most welcome refreshment for eyes fatigued by weeks of reverberation from the snows. During the midday hours currents of warm air vibrated above the moraine, as on a desert. None of us ever suffered from too great intensity of the sun—certainly at Windy Gap it was far preferable to the shade. Later I will make some comparison between our observations of solar radiation and those brought back by other expeditions.

There were not enough tents to shelter all the extra coolies sent up from Rdokass, so they had improvised a sort of open-air camp for themselves, building a low circular wall enclosing a flat space a few yards in diameter. This they paved by ingeniously fitting slabs of stone together. A little beyond they had constructed a sort of terrace,

BRIDE PEAK, FROM THE GODWIN AUSTEN, NEAR CONCORDIA.

and at 8 or 10 yards' distance from this set up a stone pyramid to mark the west and the direction of Mecca. To this platform they would go one by one to say their prayers and make their prostrations. It was the first time we had seen any of them perform any act of devotion: they seem, in general, rather lukewarm Mohammedans. The Kashmiri, as I have said before, are Sunnites, and they accuse the Shiite Baltis of practising all sorts of bloody rites, including human sacrifice; and the Baltis retort the charge upon their accusers. It is probably the result of sectarian prejudice, without foundation on either side.

We started up the Baltoro ourselves on July 6th, the coolies carrying our tent, beds and a few other things. We took to the foot of Bride Peak only so much equipment as was needful for fifteen days, the rest was left at Concordia in charge of Alessio Brocherel. He was now quite convalescent, but not sufficiently strong for the strain of the high mountain work. Later on a party of coolies carried all the stores left with him back to Rdokass directly from Concordia, and Brocherel went with them.

The snow had been falling since the day before, and the moraines were covered with a heavy layer. It showed no sign of abating on the morning of our start, and the coolies told us they could not walk in the soft snow in their pabboos, which they were now wearing to save their boots from the moraine. We waited a few hours hoping a pause would come, and thus did not set out until toward noon. We followed the moraine for a short distance to the point where it takes a more pronounced westward curve; then we left it for an irregular tract belonging to the glaciers flowing into Concordia from the west. There were alternate slopes of moraine and bare ice, separated by furrows and ditches sometimes as much as 100 feet deep, where there were little azure lakes, or else rushing streams that wound a tortuous course between their steep banks of ice, the latter all ragged and undermined and sharp at the edge. We had to keep going back and forth, and climbing up and down steep slopes, so that it was impossible to take account of the ridges and moraines which had looked from a distance so very regular in their arrangement. We crossed the western glacier of the Gasherbrums without seeing any of the high imposing wall of the mountain itself, wrapped in thick mist, and reached a furious torrent running deep between steep ice walls. Along this we had to go for some distance before we found a place where a jutting piece of ice permitted us to cross over. Beyond were the moraines of the upper Baltoro itself, which we crossed at the point where they curve westward parallel to those of the Godwin Austen. The first was the large right-hand moraine, a beautiful composition of limestones, coloured marbles and conglomerates in the greatest variety, forming a gaily coloured mosaic by means of a sort of reddish silicacious substance which acted as cement. Next came a file of séracs running lengthwise between the right-hand moraine and the various stripes of the median one; these were composed first of a streak of thin black slaty schists, then more coloured limestones mixed with schists and quartzes.[1]

I have already explained how we were able from the appearance of the moraines to analyze the structure of the chains whence they came. Now our conclusions were strengthened by the appearance of the rocks themselves, which showed a clear contrast between the light-coloured sedimentary and calcareous formations, and the black and

SURFACE TORRENT OF THE UPPER BALTORO. GOLDEN THRONE AND CHOGOLISA SADDLE IN THE BACKGROUND.

grey schists and granites. This alternation of material in the upper Baltoro is clearly displayed in Sella's panorama M, taken from the crest between the Vigne and the upper Baltoro. The centre shows the black stripe formed by the right-hand moraine of the Vigne and the left-hand of the Baltoro. It is all composed of granites and quartzes from the Bride Peak chain. Next, on the right, is a second band (coming from the right-hand lower corner of the panorama). Its source is the confluence of the eastern glaciers of Bride Peak. It has the same colour as the first, and like it is composed of crystalline rocks. Still farther toward the right comes a pale grey stripe formed of

[1] Specimens of rocks collected on the various moraines are given in two coloured plates included in the geological appendix of the results of the expedition; they present an idea of the great richness and variety of colouring.

The Baltoro at the confluence of the Vigne

limestones from Golden Throne, a thin streak of solid black composed of scales of slate from the northern spurs of Golden Throne; then another pale grey band of limestones from Gasherbrum I or Hidden Peak; and finally, the right-hand marginal moraine, running at the base of the right valley wall—this last composed of light grey sedimentary rock from the Gasherbrum range.

THE VIGNE GLACIER AND ITS TRIBUTARIES OF THE LEFT BANK.

There was a lightening of the atmosphere in the west, and we could tell that we had reached the level of the mouth of the Vigne glacier. A little farther on, where the end of its right-hand spur abuts on the valley, we made our camp, yielding to the importunities of the coolies, who were tired and discouraged with the bad weather. A little afterwards we were joined by five coolies from Rdokass, who brought us post and provisions, and stayed the night with us.

July 7th was cloudy, foggy and snowy, like the preceding day. We went on to the camp at the foot of Golden Throne, seeing nothing all the way except the stones we walked on where these were not covered with snow. The glacier was heaved up in waves right and left of us, as far as the foot of the lateral spurs of the valley. For this stretch the reader should look at panoramas N and K. As we neared the foot of Golden Throne the median moraine spread out like a fan, and the central stripes rayed out till they reached the base of the rocks, where a little series of marginal lakes was formed. A curious fact which we were unable to explain was that the laminated formations, like slates, which had been at first lying flat, were here disposed vertically and formed wide stretches made of these thin and narrow edges, tiresome to walk over. It looked as though the stones were thus heaved up by pressure due to the meeting of the Baltoro with the eastern glaciers of Bride Peak.

SCENE AT SUNSET, LOOKING NORTH FROM THE UPPER BALTORO. K [2] ON THE RIGHT, MUSTAGH TOWER ON THE LEFT.

We cut obliquely across the top of the moraine toward the west, and reached its left-hand margin at no great distance from the angle of rock which bounds on this side the great terminal fall of the Chogolisa glacier. Here the Duke had set up Camp XI, base camp for the new campaign, 16,637 feet high. There was a little lake between the camp and the rocks. It was near here that Conway had camped when he attacked Golden Throne (Footstool Camp).

As we had anticipated, the tents were empty; but about an hour later we were surprised to see Sella, Savoie, Botta and the coolies coming down the glacier behind the camp. Sella told us of the Duke's new plans, of the great difficulty they had encountered climbing up the séracs toward Chogolisa Saddle, of the wretched weather, etc. But all this I will recount in its proper place. The Duke wanted provisions, and we sent the coolies back with them as soon as possible, in charge of Savoie and Lorenzo Petigax.

Negrotto and I were in this camp for thirteen days, Sella staying with us till July 11th, when he took advantage of a party of coolies going down to Rdokass to leave us and make a temporary shelter for himself with a tarpaulin, near the meeting of the Vigne and the Baltoro, expecting to make this a base for photographic expeditions.

THE NORTHERN WALL OF GOLDEN THRONE, FROM THE MEDIAN MORAINE OF THE UPPER BALTORO.

The days were long and lonely. We had not even the crows to distract us, as they had apparently deserted the high regions early in July. Our only diversion was that of going on short excursions about the neighbourhood with the purpose of making topographical stations with the tacheometer. But many more days were spent in idle contemplation of the bad weather, in passive waiting for news from the Duke, who was snowed up somewhere on the high glaciers of Chogolisa Saddle, surrounded by thick clouds, confronting with what patience he might the relentless hostility of the sky. More than once during the long period of inaction we were assailed by feelings of anxiety for the safety of the exploring party. Only once, on the 13th, did we have news of them. A party of coolies with three of the guides came down for supplies and brought us a letter from the Duke, telling us of the first attempts at an ascent, frustrated by the bad weather, saying that he was still resolved to continue in his undertaking.

Two days after we had made camp the sun for the first time got the better about midday of the clouds and fog, and showed us the scene by which we were surrounded, to which we had come in the dark, as it were, without getting an idea of the composition of the picture. Panorama O gives an excellent idea of it. The camp lay at the foot of a very steep rocky incline 3,000 or more feet high, terminating the northern spur of Golden Throne. The rock strata are clearly marked, and show various colours—yellow, white, grey, violet and green—being the source of the polychrome limestones of the median moraine of the Baltoro. The cliff is furrowed with gullies large and small, and high up on it hangs the broken end of a glacier coming down from the lofty peaks we cannot see. Avalanches fell continually from the wall, fed from the uninterrupted heavy snows, during the whole time of our stay here. They were not so stupendous as those from Broad Peak, but much more frequent. The first ray of sunshine was enough to dislodge the snow, and it fell in cataracts, in cascades, in streams, in rivulets, swift and gleaming white, down all the ravines and crannies of the rocks, and rose up in iridescent showers above every obstacle that impeded its course. The heavy rumble of the falling mass was punctuated with sharp knocks and cracklings from the rolling stones, or drowned altogether by the deafening tumult made by a downfall of séracs, or a rock breaking off with a tremendous crash and raising up clouds of dust in its course. In the warm part of the day it seemed as though the whole mountain were actually falling apart, so huge were the masses of ice, rock and snow that hurled themselves down from it.

In front of us we had a glacier lake similar to the Concordia one, though smaller. The swelling stream of the Baltoro bends eastward, becoming broader and broader, and rising at a moderate grade to the foot of Hidden Peak, the highest of the Gasherbrum group (26,470 feet), which up to now none of us had seen except Sella and the Duke. The former got a glimpse of it when he crossed the eastern chain of the upper Godwin Austen, and the latter when he was on the ridge of

Staircase Peak. It was Conway who gave the name Hidden Peak to this remote and splendid height. It resembles in shape, on a larger scale, Gasherbrum IV at the head of the Concordia basin. Its western side is covered with glaciers which unite and flow into the Baltoro. The Baltoro itself finally bends southward and disappears from sight between Hidden Peak and a snowy pyramid of Golden Throne.

HIDDEN PEAK.

Facing Hidden Peak on the west is the eastern wall of Bride Peak, quite clothed in glaciers falling from a height of some 5,000 feet, great foaming white cataracts like frozen Niagaras. From our station we could only see the western peak, which is the highest, and shaped like a sharp narrow tooth. Two long crests run from it to northward and eastward, embracing in the sweep of their wings the most formidable glacial basin which a single mountain could possibly show. The northern ridge, which is partly rocky, is prolonged in a massive spur, behind which a glacier emerging from the northern wall of the mountain empties into the Baltoro with a high and steep cascade. It is this northern wall of the mountain which we saw from our base camp at

K². The eastern crest is mantled with ice and edged with a wide cornice. From 2,000 to 2,200 feet below the peak this crest shapes itself into a large shoulder like a great dome of ice, beyond which it slopes down at a more gentle incline to Chogolisa Saddle. A rib of ice runs out at right angles from its foot, and comes down toward the Baltoro, ending in a rocky promontory. Between this and the buttress

EASTERN WALL OF BRIDE PEAK.

of Golden Throne, at whose base we had set up our camp, a glacier from the snows of Kondus and Chogolisa tumbles down in a perfect torrent of séracs.

Opposite our camp the Baltoro flows down the valley northward, occupying the centre of the view. Turning one's eyes in that direction one beholds the strangest conceivable apparition of a mountain, so singular in its form that it is not to be compared to any other known peak. It stands in the background of the scene, to the right of the black tooth of Mitre Peak, and rears its mighty tower against

Mustagh Tower

the sky, its sides smooth like surfaces formed by cleavage, its angles clean and sharp like those of an obelisk. This mountain, of course, is the Mustagh Tower. It is about 24,000 feet high, and stands isolated from other peaks on a somewhat narrow base marked by sharp ridges. It appears, and perhaps is, a true monolith, a rocky mass of a single formation, without traces of breaks or divisional planes—no other, of any comparable size, is known to exist on the globe. Words would be

MITRE PEAK. MUSTAGH TOWER.

MITRE PEAK AND MUSTAGH TOWER FROM OUR CAMP AT THE BASE OF GOLDEN THRONE.

incapable of giving a just idea of it without the accompanying picture. Panorama L, taken by telephotography,[1] shows it, as well as the background of the Baltoro glacier formed by the chain which runs from Mustagh Tower to K^2, with its great snowy peaks, among which penetrates the Savoia glacier. Crystal Peak, Marble Point and all the other heights along the side of the glacier, are mere secondary spurs of this great chain, which is the actual watershed of the region. The left side of the upper Baltoro is formed of lesser mountains of brownish red rock, like Bride Peak. Of this side we get a foreshortened view as

[1] Owing to a mistake, the site from which panorama L was taken is marked on the sketch of the triangulation and Sella's photographic stations as being on the right side of the Baltoro, at the foot of the southern buttress of the Gasherbrums. Instead of this, it was taken from Camp XI, like panorama O. Sella did take a panorama from the point indicated, but it is not reproduced in this book.

far as Mitre Peak, which looks two-pronged from our point of view, and very like, indeed, to the bishop's cap, from which it is named. The right side of the valley is formed by the large mountain group which occupies the angle between the three Gasherbrums (invisible from the camp) and Hidden Peak. It has two peaks over 23,000 feet high. The formation is light-coloured rock, with low outlying spurs of dark brown. It is this wall which now cuts off K² from our view.

GROUP OF MOUNTAINS BETWEEN GASHERBRUM AND HIDDEN PEAK.

July 10th was a beautiful day, the only really perfect one during the whole of our stay here. On the next the fine weather broke again. A slender pennant of cloud appeared over Mustagh Tower. It presently covered the Tower, and wrapped it round with one of its ends, broadening and spreading and enveloping the top of the mountain as in a mesh, which soon thickened into a huge solid cap. Heavy clouds appeared on the low saddles at the sides of the Tower, and all the ridges flew thin streamers of translucent cloud that appeared and disappeared again. Cirrus clouds dappled the sky, growing and accumulating and hanging motionless over the valley, till at length they mingled to form a dense opaque grey covering, from which the snow began presently to descend again, quietly and steadily.

The weather was quite different from that we had experienced in June. The air was quieter, the temperature higher; but the precipitation was almost uninterrupted. However, it did not quite keep pace with the melting process, which went on at a considerable

CAMP XI, AFTER A SNOWFALL.

rate, even in cloudy weather. We heard a thousand voices from the glacier—continuous dripping, murmur of little streams, the deadened noise of distant torrents, the rattle of detritus down icy slopes, the sharp cracks of opening fissures. Now and then these lesser sounds would be drowned by the roar of an avalanche. In a few days the surface of the glacier lowered so much that the tents stood on little ledges a foot or more high; and melting must have gone on also at their level, though to a smaller degree.[1] Little waterfalls were flowing all over

[1] On their last campaign (1908) the Workmans measured the melting of the snows on the Hispar glacier—or rather on a snow-field of one of its tributaries, the Kanisabar glacier, 16,650 feet high. In ten days of cloudy weather, during which some snow fell, they registered a lowering of 27·5 inches—that is, 2·7 inches per day. In fine weather the rate was 3·7 inches per day.

the rocks behind the camp, disappearing at the tops of the great cones of snow formed at the bottom of every couloir. By July 17th the snow turned into an unpleasant drizzle, which the next day became heavy rain—this was at an altitude of 16,637 feet.

The data given by various travellers as to the snow line in the Karakoram region are all very uncertain and contradictory. On only one point do they seem to be in accord—namely, that in the Himalaya and adjacent mountain systems the snow line is lower on the southern than on the northern slopes, due to the greater precipitation on the former, which I have already mentioned. But there are no precise statistics,[1] and only a long stay and repeated observations at various seasons could decide the point. It seems likely that the high degree of precipitation, due to the summer monsoons, would make it hard to establish an invariable figure for the height at which the precipitation would just balance the melting. Probably such a line varies from year to year.

To the heavy vapours of July we owed some of the finest sunsets in our experience. For the first time we saw the skies set on fire with the glow, the brilliant contrasts of gold, azure and violet clouds, and the snows illuminated by the reflected light. The sun would bury itself in the storm-clouds which never left the western horizon. Mustagh Tower would be immersed in rosy vapours until the last ray faded, when it emerged a black and austere height guarding the whole strange region like a sentinel.

It only remains for me to recount the measure of success which attended the enterprise of the Duke on Bride Peak, and the close of our campaign.

[1] Sir J. D. Hooker, R. Strachey, F. Drew, S. G. Burrard and H. H. Hayden, T. G. Longstaff and others, in the works already cited, all state that the snow line gradually rises as one goes from the southern toward the northern chains. Sir J. D. Hooker and Col. Tanner are of opinion that it is not possible to fix, even approximately, the limit of eternal snows in the Himalaya. In the western Karakoram Drew and Burrard put it at 18,000 feet; Guillarmod at 18,700 to 19,000 feet—but we have seen that the estimated heights of the latter are always in excess of the actual figure. According to the Workmans, the line on the Chogo Lungma and the Hispar would be lower than in the Baltoro basin—from 13,100 to 17,000 feet. However, they observed great variation from one summer to another in the same places.

From Camp XII. Evening on the Baltoro

CHAPTER XVII.

BRIDE PEAK.

The Plan of the Ascent. — The Glacier Fall below Chogolisa Saddle. — Camping among Séracs. Difficult Ice and Bad Weather. — Excursions. — Sella returns to the Base Camp. — The Camp placed above the Cascade of Séracs. — Chogolisa Saddle. — First Attempt upon the Peak. — Driven back by the Storm at 23,458 feet. — Snowed in at Chogolisa. — Golden Throne. — Topography of the Region surrounding the Head of the Baltoro. — The Kondus and Siachen Glaciers. — The Watershed. — Climate. — Absence of Electric Phenomena. — Second Attempt. — Camp at 22,483 feet. — The Eastern Ridge of Bride Peak. — Two Hours at 24,600 feet. — Retreat. — Analysis of Results. — The Significance of the Exploit. — Ascensions above 23,000 feet in the History of Mountaineering. — Deductions and Prognostications. — The Return to the Base Camp.

On July 1st the Duke had left the camp at the mouth of the Godwin Austen in the Concordia basin, and accompanied by Sella and the caravan had covered in two stages the distance to the foot of Golden Throne. There he set up his base camp, and began operations upon Bride Peak.

He was obliged to alter the plan of campaign originally formed. The great snowy slope of the northern wall had looked from K² to be the easy and natural way of ascent to the peak. But a closer examination gave quite a different result, showing it to be very difficult of approach. It rises above a high glacial basin, separated from the Baltoro by a long, steep fall of séracs. This looked as though the coolies would never be able to mount it, and without their help it was useless to think of a climb of some 9,000 feet. The crest on the right of the cascade, which forms the lofty eastern edge of the northern wall, gave no more encouraging promise, for it was very long, its cornices were dangerous, and it looked full of unreckonable obstacles. The experience of the expedition up to now had begun to make the party more cautious in their plans as well as in their hopes. The Duke and his guides then

BRIDE PEAK, FROM THE MEDIAN MORAINE OF THE UPPER BALTORO.

considered the possibilities of the eastern ridge of the peak, which descends to the wide shoulder I have mentioned, and thence to Chogolisa Saddle. If it could be managed to put a camp on the saddle, by climbing up the séracs of the glacier (Conway had succeeded in climbing part way up them), there might be some hope of a comparatively easy ascent the remainder of the way.

Accordingly, on the morning of July 3rd, which proved to be fine, the extra coolies were sent back to Rdokass, and the party left the Baltoro glacier with the remaining ten, who carried the supplies for the high camps, the two Whymper and Mummery tents, their own equipment and a few days' provisions. No one of the party had any suspicion of difficulty in getting on the saddle, and they reckoned it to be a work of two days at most. But once more hopes which seemed well and securely founded were doomed to disappointment. What ought to have been merely a brief preliminary to the actual undertaking proved a long and difficult task, demanding eight days of hard work for its accomplishment.

CAMP XII, AND THE CREST AND EASTERN SHOULDER OF BRIDE PEAK.

They began at once to climb up the broken surface of the glacier, which at the very start was covered with snow and composed of small séracs, so that there was no great hindrance to rapid progress. But too soon the snow grew deep and soft, and they walked in it above their knees, with infinite labour at each step. The glacier was broken up into large blocks, between which were wide and treacherous openings disguised by the snow. They could never tell whether the latter would be firm beneath their tread, or whether a bottomless gulf would open where they set their feet. The coolies proceeded with much effort and fatigue. Very little distance was covered because of the continual going back and forth to avoid crevasses. The guides were aiming at the top of the spur which closes the glacier on the left, but the way grew more and more difficult. About noon the coolies were worn out, and a stage was made, the tents being set up at less than 1,350 feet above the base camp on a strip of ice cut in every direction by crevasses and covered with snow, into which one sank up to the waist. The spot

SÉRACS OF THE CHOGOLISA GLACIER.

was at about half the distance up the first cascade. Above it the glacier was a chaos of blocks running in every direction and piled up in confusion. No route showed itself. Sir Martin Conway had likewise experienced great difficulty in finding a route, on his attempt in 1892, and had been obliged to camp among the blocks of ice. The inclination of the valley is not steep enough to account for such a huge disruption of the ice. The Duke had observed this same fact when he climbed the centre of the Savoia glacier. Conway found that the brokenness of the glaciers throughout the Karakoram was out of proportion to the slope of the valleys, and he attempted to explain the fact with the hypothesis of a vertical stratification of the rocks of the valley bed, whose angles and sharp protuberances would thus fracture the ice flowing above it.

There was a rib of ice near the camp which gave a marvellous view of all the upper Baltoro and the Godwin Austen, with the chain of the watershed from Mustagh Tower to K^2 for a background (panorama P). The westernmost peak of the Gasherbrum group just shows its head above the eastern spurs of the Baltoro. The ample glacier-lined curve beneath Bride Peak is one splendid cascade. The eastern shoulder of the mountain looks like a great icy dome, connected with the ridge by a rather pronounced depression. It was this depression which the climbers must reach, by going around back of the shoulder, for on this side it was inaccessible.

Under these circumstances, with the difficulties of the way aggravated by the fatigue of marching in deep snow, the idea of going on all together with the luggage was given up, and the Duke decided to explore the glacier beforehand with the guides, and then to send on the caravan, giving the coolies the advantage of an already beaten path. Accordingly at dawn on the 4th two porters and eight coolies were sent back to the base for another tent and some provisions, while the Duke with Sella and the four guides went on up the séracs. Giuseppe Petigax and Enrico Brocherel went ahead, seeking a route through the labyrinth. Great transversal crevasses cut across their path. Between these the blocks were piled up in inextricable confusion and the openings of dark caverns and icy abysses yawned among them. The ice blocks resembled those on the Newton glacier in Alaska, in having their edges and corners rounded off and blunted by the heavy layer of snow, which was crystalline in its composition, and quite dry and powdery. It was only after the sun had been hot during the day that a little crust would form in the cold of the night, making the walking easier for a few hours early the next morning. But by nine o'clock it would no longer support the foot, and the snow-shoes proved of very little use.

A way was forced across the first barrier of séracs behind the camp. Then the party had to round a gigantic block, after which they began to climb an icy prominence which seemed to offer them a route. However, after a little distance this path also was blocked by a crevasse, and they had to go back and strike farther to the right. After some very rough going they reached a furrow where the séracs were arranged in a sort of alley, allowing them to make some progress and gain a little height. About eleven they reached another barrier of blocks, apparently without any way of access through them. But the guides knew that

AMONG THE SÉRACS OF THE CHOGOLISA GLACIER.

the broad and gentle slopes which they had seen from below could not be very far away now, and there was no doubt that some means of conquering this last obstacle could be found. The snow had become unbearable. Satisfied with the progress thus far made, the Duke decided to turn back.

July 5th was foggy, and there was a little sleet. Sella took supplies for a light camp, seven coolies and the four guides, and retraced the previous day's route in order to profit by the path made in the snow. They went well enough to the point reached the day before. The guides then began to skirt obliquely upwards toward the left, searching out a tortuous path among the crevasses. Finally they found a prominence from which a fairly solid bridge led upon a sérac, and thence to a depression on the upper side of the obstacle. They went along the edge of this, always toward the left, and beginning to see a clear path toward the great slopes at the centre of the glacier. The coolies were utterly worn out. Moreover, the leader of the file had broken through a snow bridge and fallen up to his shoulders in a crevasse. He himself struggled to get free, and his companions pulled on the rope; but he was not released until two of the guides gave their help to liberate him from his awkward position, if not from his terror. This episode discouraged the others still more. Besides, it had begun to snow heavily, and Sella made the wise decision to set up the camp at this point. He sent back two guides and the coolies. A little reconnoitring confirmed the hope that the most difficult part was overcome. The glacier above the camp was even more broken than below, but the crevasses were covered for the most part, and the slope grew gradually less steep.

It continued to snow all night and all the next day, keeping the Duke inactive in the lower camp, as well as Sella in the upper one. No change came on the 7th, and the Duke sent three guides and four coolies to liberate Sella from his blockade. Thus the party was reunited at Camp XII. It was the fifth day, and they were still practically at the starting-point, some 1,300 feet above the Baltoro—prisoners, crowded two apiece into the tiny Whymper and Mummery tents on a narrow table of glacier surrounded by crevasses and buried in snow. This was only the beginning of a long siege.

It soon became necessary to think of replenishing the food supply. Sella, concluding that the hope of photographic work was very slight indeed, and feeling that the Duke ought to profit by all the forces of the expedition, made up his mind to go down himself to the base camp. He took Botta, Savoie and the coolies, and they had a most laborious journey through the snow, which had, of course, obliterated every trace of path. Negrotto and I met them at the camp, as before narrated. Next morning nine coolies set out on the return journey under the guidance of Savoie and Lorenzo Petigax. They never murmured or made a single objection. All day the bad weather held. The air was full of white semi-opaque mist, sky and snow were indistinguishable, and they could not see 100 yards ahead. It was the third day of crouching in the tents, hearing the light monotonous tapping of the snowflakes on the walls. It fell ceaselessly, relentlessly. Their only occupation was that of occasionally shaking the canvas to prevent their being buried.

Late in the evening there were signs of abatement. They even had a glimpse of sky over the valley through a rent here and there in the clouds. The peaks were all hidden, and dense clouds hung motionless over the Concordia. The weather was very long in clearing, the morning of the 9th being still disturbed. But gradually the mountains stripped off their mist, and came out one after another in purest and most dazzling white. Where the sun shone through the mists these were of a silvery brilliance, and the whiteness of the landscape enhanced the deep blue of the sky. Little spirals of snow-dust curled along the crests, lifted by the wind. Bride Peak was still shrouded in semi-transparent cloud, and the mountains about the Concordia remained in shadow.

Up above the Duke had left his camp accompanied by all his caravan, and, finding a route shorter than that taken by Sella, gained the spot where the latter had camped on the 5th. Thence he continued to ascend, making a wide circuit toward the centre of the glacier. until he was sure there were no more obstacles to be encountered, save that of the deep snow. Then he placed his camp 19,098 feet above sea level and some 1,650 feet below Chogolisa Saddle. The weather continued to improve all the afternoon, but not until four o'clock did the Mustagh Tower emerge from the mists clinging about it. K^2 and Gasherbrum rose high above the mountains in the foreground, showing the height to which the party had now attained.

On July 10th, eight days after leaving the base camp, the Duke succeeded in setting up camp on Chogolisa Saddle at 20,784 feet of altitude, after a march of five hours up easy snow-slopes, on a morning perfectly bright and cold. The tents were erected on the northerly slope of the saddle, just below its highest point, in a hollow filled with snow, which made a good shelter from the bitter wind that swept down from the brow of the saddle. The coolies were benumbed with cold, and were sent back to the lower camp. They had performed the work of real Alpine porters, coming up over the séracs with full loads of luggage, and had lived in camps on the snows without fires and contrary to all the habits of their normal lives, all of which proved how much they had been able to adapt themselves. and showed the influence we had gained over them.

Chogolisa Saddle is between the eastern crest of Bride Peak and a rounded icy dome 21,653 feet high. on the other side of which is Kondus Saddle, at the foot of Golden Throne. This saddle is a little lower than Chogolisa. The day was perfect, and the view which the Duke had from his station a very grand one. The three summits of Broad Peak were visible, likewise all four of the Gasherbrums, now seen together for the first time, rising between the spurs on the east of the Baltoro and the southern buttress of Golden Throne. Northward the horizon was closed by the great ridge stretching from K^2 to Mustagh Tower. The glaciers of Bride Peak flung themselves down to the Baltoro just beneath him. Opposite that mountain the western walls of Golden Throne completed the panorama, these also covered with glaciers from peaks to base. South of the saddle continued a series of complex chains, and the Kondus Valley, dominated on the west by heights easily recognizable as K^8, K^9, K^{10} and K^{11}, between 22,736 and 25,426 feet high, among an infinite host of unnamed mountains and unexplored valleys. Just as from the other cols climbed by the expedition, the view was nothing but ice and snow and rocky wilderness spreading out to the horizon. One felt as if the inhabited earth had been left behind for ever.

July 11th continued fair, and it was the part of wisdom not to lose an hour of the auspicious weather. No more than 4,326 feet of vertical distance remained between Chogolisa and the summit, a height which in the Alps one could be fairly sure of covering in a day. But failure would certainly have attended an attempt to finish the climb at a single stage, on account of the enormous quantity of soft snow. There was a good distance between the camp and the foot of the final height which had to be covered by walking in snow nearly up to the waist, a performance the fatigue of which cannot be measured by those who have never tried it. Thus the climbers would begin the actual ascent with forces already depleted, and very likely still further weakened by the increasing rarefaction of the air. On these grounds the Duke decided to set up an intermediate camp with the two Mummery tents and four sleeping-bags.

The party of seven left the shelter camp early in the morning. They described a broad curve in climbing to the top of the glacier, reaching the steep southern slope of the icy dome between Chogolisa and Bride Peak. This they traversed horizontally. The snow made very bad and uncertain walking, and they would plunge in half-way up the thigh. This was fearfully fatiguing to all the party, especially the porters. At half-past eleven they stopped, though they had not yet reached the foot of the depression between the dome and the crest, and set up the tents on the slope, levelling off a little ledge with their feet. The three porters went back to Chogolisa camp, leaving Giuseppe Petigax, Enrico and Emilio Brocherel with the Duke. They were now at 21,673 feet of altitude, only 3,437 feet remaining between them and the top. If the weather held another day, victory was in their grasp. The day was warm, still and fine, but toward the south-west were some gradually thickening vapours that boded ill. Threatening clouds rolled up on the hills, covering peaks and ranges. Then suddenly it seemed that the weather relented, the disheartening portents withdrew, leaving at sunset only a few insignificant mist wreaths here and there on the heights. The prospects for the morrow were very good.

At five o'clock on the 12th the party was on the way. It was a mild and foggy day, the air warm and relaxing, the snow already bad. The guides took turns at the head of the rope, in anticipation of the hard work that was to come. They were an hour and a half in reaching the foot of the depression, and as much more in climbing up to it at the base of the ridge. Two bergschrunds were safely crossed by means of heavy snow bridges. The mist grew denser and a little wind had sprung up, but not cold or strong enough to be annoying. At 23,000 feet they changed their snow-shoes for crampons, and began to ascend the ridge. They were obliged to cut the very steep slope on the side of the crest, despite the evident danger of avalanches from the snow, which was two feet deep and did not form compactly with the older layer beneath it, because they must avoid the still greater danger of the cornice curving widely out over the abyss to the right. For two hours and a half they went on at an even, slow and cautious pace. Meanwhile the fog grew worse and worse, and was now so dense that the party stopped on a projecting rock, and taking counsel together decided on the course which was, under the circumstances, the only wise one to pursue. The danger was too imminent, and it increased at every step. They must go back. They had reached 23,458 feet, walking with slow and even pace, not suffering serious difficulty in breathing, nor palpitation. They made the descent in weather steadily growing worse, and by the time they reached Chogolisa, taking with them the intermediate camp, it was snowing.

The fog lifted somewhat towards evening, and they could see the extent over which the storm raged. Masses of threatening black cloud were constantly rolling up from the lower Baltoro. The snows reflected their tones of deep violet and ash colour. The entire party slept heavily, being greatly fatigued, while the snow fell silently and ceaselessly outside.

The blockade lasted this time for four days. Sometimes there was a show of relief from this or that quarter of the sky, when a brief and sudden opening would break between the clouds. Of all such the Duke took advantage to study the region as best he might, and to repeat a series of observations to the surrounding mountains which he had made from Camp XIII. I have collected all these observations in Chapter XIX, in order not to burden the narrative with technical detail, and in this place will only describe the general disposition of the valleys and ranges at the head of the Baltoro, in so far as they may be derived from the necessarily limited and fragmentary observations made by the Duke from Chogolisa Saddle. The conclusions are merely general, and are not to be taken in an absolute sense; but they are worth recording, as they deal with a region as yet totally unknown, and may thus serve as a basis for the operations of future explorers.

The mass of Golden Throne looks much larger from this point of view than when seen from the north on the Baltoro glacier. Its five main peaks rise above an icy crest which runs from north-west to south-east. At the extremities of this crest are two other minor summits—21,207 feet on the Baltoro, and another, snowy like the first, south of the chain on the Kondus glacier. According to the angles read by the Duke, the highest peak of the central group would be the second from the north, 23,743 feet high (23,600 feet, Conway). A long snowy ridge descends thence to the glacier below Kondus Saddle. Upon it is Pioneer Peak, climbed by Conway in 1892, with Major Bruce, the guide Zurbriggen, and two Gurkas from Nepaul.

Gasherbrum II (26,360 feet) seems to be connected with Hidden Peak by a high crest with a slight depression or col in it, so that the chain is practically unbroken from Hidden to Broad Peak. The col probably leads to the Gasherbrum glacier of Younghusband. The large group of mountains at the angle between the western Gasherbrum and Hidden Peak must form a separate system, detached from the

GOLDEN THRONE AND PIONEER PEAK, FROM THE SÉRACS OF THE CHOGOLISA.

Gasherbrum. The Duke from his high camps, as well as we at our station at the foot of Golden Throne, saw several times the western ridge of Hidden Peak lighted very far down by the sunset rays, and argued from this fact that there is probably no ridge intervening between Peak 22,139 and the Gasherbrums, but very likely a valley instead, and that the large glacier descending to the Concordia basin probably gathers up the tributaries from the southern wall of the Gasherbrums.

From Hidden Peak to Golden Throne runs a crest with two distinct depressions in it, about equal in height. This crest closes in the Baltoro basin, separating it from the head of the Kondus glacier. On the maps of the Indian Survey the Kondus reaches to the southern base of

Chogolisa Saddle; but it really extends further eastward and northward, skirting the foot of Golden Throne, and ends in a wide basin confined on the west by the crest already mentioned between Hidden Peak and Golden Throne, and on the north by a chain parallel to Golden Throne. This chain probably joins on to the Gasherbrum range, Hidden Peak forming the connecting link. It contains a marked depression between peaks of considerable height, and just visible from Chogolisa, to the south-east of Golden Throne. By this one must have access to the Oprang valley, and from its position one would judge that it might be the pass seen by Sir Francis Younghusband at the head of the Urdok glacier.

Longstaff believed that he had identified this pass of Sir Francis Younghusband with a depression situated at the upper end of the Siachen glacier. But the latter lies farther beyond, and to the east-south-east. From Chogolisa one could see a large valley running between two parallel chains of high mountains on the other side of the Kondus basin; and this, to judge by its direction, must be the Siachen. It is probably separated from the Kondus by a ridge of no great height. The upper Siachen has thus no connection with the Baltoro, the head of the Kondus coming in between the two. The Kondus descends south-west, encircling Golden Throne, then southward in a deep channel at the foot of Kondus and Chogolisa Saddles. The southern wall of Chogolisa is very steep—that of the Kondus was not visible from the Duke's point of observation.

The watershed extends from Hidden Peak to the south-east, enclosing the Kondus basin to the north, and continuing in the northern ridge of the Siachen as far as Teram Kangri. Its course east of this to the Karakoram pass is still unknown.[1]

From July 13th to 16th bad weather prevented, as I have already said, any fresh assault on the peak. The wind was always south-west and snow fell at frequent intervals. The sky was usually covered with a uniform grey cloud; but great cumulus clouds were not lacking, of the sort which with us mean heavy storms usually accompanied with lightning. But we, as well as all our predecessors, can testify to the complete absence of electrical manifestations in the Karakoram. In all these stormy weeks we never once saw a flash of lightning or heard

[1] See in Novarese's geological appendix the important conclusions concerning the geology of the region and the distribution of the chains and mountain systems, which are based on these observations of the Duke.

thunder. On none of his many excursions to the rocky spurs about the Godwin Austen and the Concordia did Sella see fulgorites, neither did the Duke upon the rocks of Bride Peak. R. Strachey reports that storms with electrical accompaniment are very rare on the northern slopes of Kumaon-Gahrwal, but not on the Tibetan plateau. Thomson considers the infrequency of such phenomena north of the Himalaya to be due to the absence of cumulus clouds, but this explanation would not hold for the Baltoro. On the other hand, the atmosphere of the southern chains is so charged with electricity, even in the absence of storms, that it has been found necessary to equip the theodolite with a portable lightning-rod (Purdon). No satisfactory hypothesis has been produced for this peculiarity of the climate in the Karakoram. It is certain that the absence of electrical storms deprives the region of a distinct element of grandeur and fascination. Another peculiarity which I should mention, probably related in some way to the regularity of the periodic wind, is the stability of the barometer. It showed only slight variation, and gave no indication of approaching change in the weather.

The health of the party still remained good. Their experience was quite different from that of Dr. Workman, who believes it impossible to sleep at heights of over 20,000 feet. The Duke and all the guides slept well and uninterruptedly, not only at Chogolisa Saddle (over 20,600 feet), but also in the higher camps at 21,673 and 22,483 feet, despite the fact that they were crowded by twos into the two small Mummery tents. None of them had difficulty in breathing; there was no headache, and their pulses were normal.[1] The only sign of the unusual conditions under which they were living was the gradual loss of appetite, which, however, was not accompanied by any other abnormal symptoms. At the end of their campaign they were only able to eat lightly twice a day, and then with considerable distaste for the food. Negrotto and I had the like experience at the base camp, whence I argue that long sojourns at over 16,000 feet would probably

[1] List of observations made on the pulse of the party at Chogolisa Saddle, July 14th :—

	Before Eating, per Minute.	After Eating, per Minute.
H.R.H.	60	72
Giuseppe Petigax	70	70
Enrico Brocherel	70	80
Emilio Brocherel	74	84

have ultimately injurious results. Naturally, we all grew thinner, and suffered gradual diminution of energy.

On the 13th the three porters came down to the base camp for supplies. At Camp XIII among the séracs they picked up the coolies, who had been there alone since the evening of the 10th. Two of their number, unable to stand the continuous storms, the cold and loneliness, had roped themselves together the next day and succeeded in finding a way down among the labyrinth of crevasses. This was the only case of desertion in the entire campaign. The other seven coolies had stayed faithfully at their post. We only sent five of them back from the base camp, and they and the porters reached Chogolisa on the 16th.

The snow had ceased. The peaks were still heavily shrouded, but it seemed reasonable to hope that this improvement indicated a break in the long spell of bad weather. Experience had taught that the respite would be brief, and was to be profited by to the uttermost. With the purpose of expediting the march, the stores for the shelter camp were all carried up on the day before to the spot where the party had spent the night of the 11th. The evening was not promising. The top of Bride Peak freed itself, but above it were high stratus and cumulus clouds, and the sun set in the midst of long bands of cirrus. However, the die was cast. Next morning, despite uncertain weather, the Duke set out at half-past six with the guides and porters. They reached the point where the supplies had been deposited, took them up and went on, climbing the slope to the very foot of the saddle. It goes without saying that the snow was as bad as ever. The porters were sent back to Chogolisa, and the tents put up, 22.483 feet above sea level and only 2,627 feet below the summit of the peak. This figure is derived from the pressure readings with the Fortin barometer. No one before now had ever camped at such a height, except possibly Longstaff. In 1905 he passed a night in the open on the snowy crest of Gurla Mandhata, at a height tentatively estimated by him to be about 23,000 feet.

The snow began again; but the guides kept on, with the intention of breaking a path to facilitate the next day's ascent. It did seem as though fate intended to be kind at last, for all was clear at sunset, and a magnificent starry sky gave promise of a clear morrow.

At half-past five on the morning of July 18th the little party left their shelter. They all realized that the crisis was at hand, that the day would either see their efforts crowned with success or witness their final discomfiture. The air was lifeless, the sun weak and pale and surrounded by a watery aureole of clouds, a sight of most unfavourable augury. As far up as the shoulder the snow was fairly compact, and allowed good progress. In an hour they had reached the top of the shoulder, and stood at 23,000 feet. All about them the mist had closed in, a danger graver than any other for the mountain climber, concealing surrounding perils, and making it impossible to contend with obstacles by rendering them invisible.

They had reconnoitred on the 12th the first part of the route. Beyond this they guided themselves by their recollection of the ridge as it appeared from below. Thus they reached some rocks rising from the snow about two-thirds of the distance from the summit. They knew they had to keep in midway between the cornice and a great open crevice a little way below. The snow was very trying, being over two feet deep, and the grade was steep. The foot went down so far at every step that one felt there was no solid ground beneath. At every ominous creaking of the snow they were obliged to bear away obliquely toward the cornice, until the appearance of fissures and the breath of a cold wind from below warned them that they were hanging over the abyss. Again they would cut the slope farther down, until at no great distance from them an extent of snow would detach itself with a crack and slide rustling down toward the gap. The pickaxes sunk to the handle without meeting any resistance, so there was no hope of their being able to stop the snow from sliding. Nothing could be seen beyond a few yards, but they realized that bottomless gulfs opened on every side.

Thus they climbed for four and a half hours, slowly and evenly, making brief halts every fifteen minutes. They breathed quickly but not laboriously, and their fatigue was not very great, despite the steep grade, the heaviness of the snow and the lifeless air. By 11 o'clock they had gained the prominence of rock noted from below—24,278 feet up—and after a short rest they essayed to climb it. It was firm and solid rock coated here and there with verglas, but directly they had to climb with hands as well as feet great difficulty in breathing became apparent, and their progress was very slow. The rocks were conquered in two hours, and the Duke believed himself to be at last upon the terminal crest. Instead of this another tract of steep snow-covered slope stretched away vaguely into the mist above them. They knew the cornice was on their right, and on the left the mountain side fell precipitously, rugged with séracs just dimly seen. It would have been madness to go on blindly, over a slope of unknown inclination, even the general direction of which had not been made out from below, edged with a wide cornice and covered with deep and treacherous snow. The calm mild weather permitted them to stop awhile, in the faint hope that some fugitive wind would brush away the mists. The Fortin barometer registered $12\frac{9}{32}$ in., the temperature stood at 21° F., and the tension of aqueous vapour was $\frac{5}{32}$ in. These observations, corrected by reference to those of the stations of Srinagar, Leh, Skardu and Gilgit, gave a height of 24,600 feet.[1]

They waited for two hours. At half-past three the weather was unchanged, and the Duke was forced to give the order for retreat. There was a long and dangerous descent to be made before nightfall. Neither he nor any of his three companions noticed any ill effects from the rarefaction of the air. All their pulses were regular, only a little over 100. They had climbed to within 510 feet of the summit, and there is no manner of doubt that, given a clear atmosphere, even with the bad condition of the snow, they would have completed the ascent in a couple of hours and reached 25,110 feet.

Slowly and cautiously as they had come up, they returned, retracing their track in the treacherous snow. From the shoulder down they were able to proceed somewhat more rapidly. The porters and coolies were waiting for them at the tents. It was once more snowing hard, but the Duke was anxious to break camp and get down to Chogolisa, and the strength of all proved fully equal to the task. They reached Chogolisa Saddle at eight o'clock after a day of fourteen and a half hours. Of these, at least eleven had been spent in strenuous exertion between 22,483 and 24,600 feet.

The readings taken by the Duke on an aneroid barometer from time to time during the march allow us to estimate the vertical distance

[1] These barometric calculations could not be referred to the Rdokass base, because the observations were unfortunately broken off on July 15th (see the tables of Prof. Omodei in the Appendix). On the maps of the expedition first published by the Italian Geog. Soc. and the Ital. Alp. Club, the height gained by the Duke is given as 7,493 metres (24,583 feet). This and some other small variations between the present figures and those first published are due to the fact that the readings from the Gilgit Meteorological Station were only later introduced into the calculations, in addition to those of Leh, Skardu and Srinagar.

gained per hour. In seven and a quarter hours of marching they had made 2,117 feet of height, or 292 feet an hour. If we subtract from this the ascent of the rocks, which of itself took two hours, the result for the entire distance over the snows is 341 feet per hour. In the first hour 517 feet were gained. From then on the apportionment was as follows: between 23,000 and 23,458 feet, 396 feet per hour; between 23,458 and 24,278 feet, 273 feet; and in the last stretch, on the steep rocks, 160 feet. This last figure confirms the opinion of many mountain climbers that, unless there are snow slopes to march upon, the highest summits of the earth will never be conquered, as the climbing of rocks is too exhausting at the low atmospheric pressure of great altitudes. The average rate of the Duke is far below that made by Graham during his contested ascent of Kabru in 1883. He claimed to have covered a vertical distance of 5,400 feet, between 18,500 and 23,900 feet, with an average per hour of 650 feet. Longstaff ascended Trisul in 1906, leaving his camp at 17,450 feet and reaching the summit (23,406 feet) in ten hours, with an average approximately the same as that of Graham, 595 feet per hour. These, however, were both ascents made under favourable conditions of weather, snow, etc., and every mountaineer knows the vast difference between this and marching in deep soft snow. Thus it will not cause any surprise that in the ascent of Bride Peak the time taken to gain a like vertical distance was nearly double. It seems probable that in clear weather, and with the snow in good condition, the top of the peak could be reached from Chogolisa in about ten hours.

The circumstances under which the enterprise of the Duke was carried out give it an experimental value much more convincing than that possessed by any of the other known records. The latter have often been real over-strains, outside of the physiological field, and their success has been due to the presence of especially favourable conditions. First of all, the Duke and his guides have given the best evidence we have thus far of the resistance of human beings during long stays at the highest altitudes, and of the possibility of severe and continued exertion at such heights. He and his guides lived for thirty-seven days at or above 16,000 feet, and then for another seventeen were never below 18,000 feet, of which nine were spent at and above 21,000 feet—all this under the disadvantage of cramped accommodation, almost constant bad weather, and with nourishment reduced from want of appetite.

During this period they made two ascents, which meant four days of the most fatiguing work, sleeping at 21,673 and 22,483 feet, and reaching 23,458 and 24,600 feet of altitude.

The height attained by the Duke exceeds by 700 feet the greatest altitude up to then achieved by men upon the mountains. In 1883 Graham made a series of notable ascents in the Himalaya of Gahrwal, after which he went to Sikkim with the guides Emil Boss and Ulrich Kaufmann, and stated that he had climbed the Kabru up to the saddle a little below the summit, 23,900 feet high. Twenty-eight years before, the brothers Schlagintweit had reached about 22,250 feet in an ascent of Kamet in the Nanda Devi group in Gahrwal. During the interval no other approach to this height was made,[1] except by M. Wiener, who climbed Mount Illimani, in the Bolivian Andes, 21,224 feet high. Most mountaineers believed at that time that such ascents must invariably be attended by serious physical consequences. The ease which Graham asserted had marked his ascent of Kabru was considered to throw doubt on the actuality of the performance, and the incomplete and cursory account of the enterprise gave ground for much dispute among mountain climbers—dispute which only ceased when, in 1907, Rubenson and Monrad Aas climbed the Kabru, or at least the saddle between the two peaks. Their account seems at first blush to show more improbability than the succinct narrative of Graham. The undertaking was not the result of a deliberately concerted plan, but was rather of an almost casual nature. The two explorers were obliged to live for two weeks on reduced rations, and they made their ascent alone, up dangerous ice slopes, wearing shoes from which the nails had been removed to prevent their feet from freezing. They descended for the most part at night by moonlight, etc., etc. Yet no one cast a doubt upon their veracity. Nor do I wish for a moment to call it in question, convinced as I am that their account must inspire the most complete

[1] Some noteworthy climbing exploits performed between 1855 and 1883 by members of the Trigonometrical Survey, and until very recently buried among the official records, have been brought to light by Dr. Longstaff. In 1874 J. S. Pococke gained 22,000 feet in Gahrwal, and in the same year W. L. Johnson crossed a mountain crest of Ladakh at a height of 22,300 feet, and likewise, in 1865, climbed three peaks of the Kuen Lun chain, north of the Karakoram—E57, E58 and E61, whose respective heights of 21,767, 21,971 and 23,890 feet have been determined by triangulation. I will not dwell upon the doubts cast upon the authenticity of these climbs, merely referring to the article of Dr. Longstaff in *Alp. Jour.* 24, 1908 p. 133. See also *Mountain Sickness.* London 1906, by the same author; and A. L. Mumm, *Five Months in the Himalaya.* London 1909.

belief. But its acceptance by mountain climbers in general is the best evidence of the great change which has taken place in current opinion upon the possibility of ascending to great heights without marked physical disturbance. Beyond a doubt this change of ground is due to the conquest of high peaks which has been slowly going forward all the while.

In order to avoid a lengthened list I will confine myself here to ascents of 23,000 feet and over. In 1897 S. M. Vines, a member of the E. A. FitzGerald expedition, with the guide A. Burgener, climbed Mount Aconcagua, 23,100 feet high. In 1903 Dr. Workman reached a height of 23,394 feet on the ridge of a mountain at the head of the Chogo Lungma glacier. Longstaff climbed to a considerable height on the ridge of Gurla Mandhata in 1905—probably beyond 23,000 feet, though instrumental observations of the altitude were lacking. In 1906 Mrs. Workman climbed a peak of 23,264 feet in the Nun Kun group; and in the same year Longstaff conquered Trisul, 23,406 feet. Thus in twenty-six years, from 1883 to 1909, no one exceeded the height supposed to have been reached by Graham; and this, after the Norwegian achievement, became the official record.

However, the greatest importance of the Duke's ascent does not, I repeat, lie in its having surpassed by 700 feet this official record. Its significance lies rather in its having been made under such unfavourable conditions of snow and weather. This gives it a value above any of the others in relation to the problem of the possible ascent of our greatest peaks.

I would call attention, as especially worthy of remark, to the fact that the Duke was able to take the coolies up to the highest camp, 22,483 feet high, and that they lived under the most adverse conditions for more than two weeks among the snow and séracs of the glacier flowing down from Chogolisa Saddle. If the snow had been firm, the weather fine, and other conditions favourable there would have been no great difficulty in getting them to transport a camp even as high up as the eastern shoulder of Bride Peak (over 23,000 feet), an altitude from which it would be possible to reach to above 26,000 feet in one day.

Then as regards the physiological possibility of still higher ascents, the Duke's experience was such as to encourage other explorers. It is unlikely that any disturbance of the system caused by low atmospheric pressure under ordinary mountaineering conditions would appear suddenly and without warning, even without a previous loss of energy to a considerable degree. It is fair to conclude, from the good physical condition of the Duke and his guides at 24,600 feet and from the absence of any ill result of their long stay at this altitude, that if the feat had been attempted when the expedition first reached the Baltoro, with each member at the maximum of his powers and the mountains covered with old compact snow, it would probably have been crowned with complete success.

But between Bride Peak and the top of Mount Everest there is nearly 4,000 feet of difference in height. It would surely be idle to predict the outcome of an attempt on the latter. Only continued tests will solve the problem. The first thing to do is to select a peak of more than 26,000 feet, where natives will be available for portage, where it would be easy to get the camps up to a considerable altitude, and where, at least for the last few thousand feet, there could be found a route over snow, without great obstacles and not too steep. The highest peaks of the Karakoram are not adapted for the experiment, on account of their intrinsic difficulties. Kinchinjunga and Nanga Parbat are likewise very problematic; and if on closer examination their rivals of Nepaul present as great obstacles, there is little hope of our conquering any of the greatest giants of the earth by ordinary mountaineering methods.[1]

The campaign was at an end. There had been one single day of fine weather in the last two weeks, and there was little reason to hope for betterment. Under 16,000 feet the glaciers were being visibly consumed by melting, while on the high mountains the fresh snow piled higher with every day. Another factor was the decrease of our physical forces, due to repugnance to food.

On the morning of the 19th the tents and other impedimenta were put together, and in a heavy snowstorm the Duke abandoned Chogolisa Saddle with guides and coolies, and descended to the former camping place, among the séracs, covering two stages. The powerful radiation of the fog and snow had swollen and reddened the eyes of the Duke and Giuseppe Petigax. On July 20th, in the forenoon, Negrotto and I welcomed our returned leader to the base camp. He did not wait for

[1] I have included in Chapter XIX the conclusions which are to be drawn from the Duke's expedition with regard to the physiological aspect of the problem of high mountaineering.

even a day of rest. The camp was dismantled in a heavy rain, and the expedition took up the return march, carrying all the equipment, for which purpose thirty-five coolies had come from Rdokass on the evening of the 18th. The crash of avalanches from Golden Throne followed our retreat, like a last threat from the mountains, victorious but not yet appeased. The coolies were jubilant, and despite the rapid march, the rain and the heavy loads, they chattered incessantly, our faithful fifteen of the high mountains relating to their fellows from Rdokass the experiences of the past few weeks. But the rest of us were silent and depressed, under the evil fate that had snatched from the Duke the prize of so much labour and perseverance, after it had lain almost within his grasp.

CHAPTER XVIII.

THE RETURN TO SRINAGAR.

Summer on the Baltoro Glacier. — Rdokass. — Descent of the Biaho Valley. — Jhula Bridge over the Punmah. — Askoley. — Braldoh Bridge. — Skoro La. — Gorges of the Skoro Lumba. — Shigar. — Travelling on Zhaks. — Skardu. — Burgi La. — The Deosai Table-land. — Sarsingar and Stakpi La. — The Dards. — The Kishen Ganga Valley. — Rajdiangan Pass. — Bandipur. — On the Wular and up the Jhelum. — We enter Srinagar.

On July 20th we turned our backs upon the mountains. Sleet was falling, turning now and then to actual rain. The moisture gave brilliance and relief to the multi-coloured stones of the median moraines of the Baltoro. When we had about reached the level of the right-hand spur of the Vigne valley we made our camp, for the Duke and the guides had already that day made the descent from the séracs of the Chogolisa glacier, and, moreover, their eighteen days of hardship had left distinct marks upon them. Next day we followed the curve of the moraine into the Concordia, and thence to the mouth of the lower Baltoro, not getting a single fleeting glimpse of K[2] or Bride Peak, or any other of the splendid host that two months before had received us with such calm serenity. We soon forsook the median moraine to follow the strip of ice between it and the left edge, and then began the fatiguing business of climbing over the great wavelike inequalities of the surface. A stormy and violent torrent cut its course in a deep winding furrow between two moraines, but we were able to cross it by means of a massive ice bridge. In five hours of steady marching we had passed the mouth of the second left-hand tributary, and made our stage inside an immense conical depression, the bottom of which was occupied by a dull and turbid little lake. Opposite us was the wide Younghusband valley, back of which, toward evening, we had a view of Mustagh Tower, surrounded by heavy clouds. It looked from here entirely different, but was, as always, an imposing spectacle. The intemperate weather cut off all view of the rest of the landscape.

Quite unexpectedly the morning of July 22nd dawned clear and calm. The view we had before us was almost precisely that of panorama Q, which Sella took a few days earlier at a point somewhat higher up,[1] showing the tip of K^2, just to the right of Crystal Peak, the massive brow of Broad Peak behind Marble Point and Gasherbrum IV, next to which the snowy cone of Gasherbrum III is seen in profile. The panorama likewise gives a very good idea of the tall median moraine of the Baltoro. The moraines are, however, quite run together here, and the glacier seems to be uniformly covered with stones. We can hardly believe that the side spurs of the valley, now bare and black and dotted here and there with bits of vegetation, with only some vestiges of ice near the tops, are the same ones that two months before had looked so impressive in their winter mantles of snow. The tributary glaciers have become deeply imbedded in their valleys, and their fronts, that once stood up so high and white, are flattened and buried in moraine. Deep winding channels run down from their sides, filled with ice soiled by dust and detritus. The two glaciers Mundu and Yermanendu are the only ones to preserve their size and purity. They hang down like trailing draperies from the majestic Masherbrum, parted by a jagged rocky crest. We cut across the front of them in following the left-hand moraine of the Baltoro, which is formed of blocks and detritus of granites, gneiss and quartzes from all the length of the chain from Bride Peak to Masherbrum. It was a very wearying march. We passed valleys and deep pits 200 or 300 feet deep, full of surface water or running streams. Great blocks were poised on the ridges or ice pillars, looking as if a breath might dislodge them. On our way down we noticed the increase of rocks and stones with blunt and rounded angles and edges.

[1] This panorama, taken with panorama B and the small picture of the lower Baltoro inserted at p 194, gives the whole northern chain of the Baltoro in all its detail.

After a last laborious crossing of the slopes, we reached the bottom of a large furrow between the glacier and the buttress of Rdokass, and here quite suddenly we found ourselves walking on earth—soft, elastic and covered with high grass full of flowers. The change almost took our breath away. All our senses welcomed the wonderful phenomena of life to which we had been so long strangers—the odour of earth and grass and the delicate manifold scents pervading the air, the colours of the flowers and butterflies, the chatter and rustle of birds. even the clucking of hens and the bleating of the feeding goats. It all seemed like a miracle.

We were welcomed by Mr. Baines, rejoicing over the end of his long and lonely exile, by Alessio Brocherel, now quite restored to health, the Wazir of Shigar and the Shikari Abdullah. Our coolies of the high mountains went up one by one to salute the Wazir and Abdullah, bowing so as to touch the ground with their hands, then placing the latter on breast and forehead, and finishing by four or five close embraces, in which their heads came over each other's shoulders without touching. We meanwhile were slowly ascending the slope under a fire of salaams from the coolies lined up in rows on the boulders, and reaching the tents, where all manner of luxuries were waiting for us, chief among them, to our minds, being a bath of deliciously hot water.

Only Sella was absent, and soon after our arrival we looked for him with the telescope, and spied him on the snowy crest nearly 4,000 feet above camp, whither he had climbed with Botta and a coolie to take panorama B. He only rejoined us by nightfall, after a difficult and not altogether safe descent. Then we all gathered together around a brazier, and until late at night talked over the events of the campaign. Sella, on leaving the base camp at Bride Peak, had spent ten days on the Baltoro with Botta and a coolie, taking advantage of the caravans that went up and down to shift his simple outfit, which consisted of a sleeping-bag and a tarpaulin. He made two excursions from the upper Baltoro to the terminal crest of the right-hand spur of the Vigne, and had been successful in collecting a number of photographs, notwithstanding the almost continuous bad weather.

July 23rd was spent in rearranging all the equipment and disposing it for transport down the valley. We distributed among the coolies all the small presents we had left—needles, thread, string, coloured handkerchiefs, etc. Our faithful servants of the high mountains were presented with the outfit they had used in camp, and went to work at once to cut up and distribute the sail-cloth of the tents. Pure joy reigned among the coolies, whose number was now increased by 100 sent up from Askoley. The shepherds departed with their flocks and herds, now in much better condition than on their arrival. At night the coolies performed a strange ritual of prayer, consisting of high and rhythmic cries, accompanied by violent beating of the breast. We thought this might be a service of thanksgiving for escape from peril.

DETACHMENT OF COOLIES WHO WERE WITH US IN THE HIGH MOUNTAINS. IN THE CENTRE A JEMADAR.

A very long and tiring march on the 24th brought us down the rest of the Baltoro to Paiju. It took two hours to get the caravan ready for a start. Beside his load, each coolie carried a bizarre collection of objects—boxes, milk tins, mismated snow-shoes, etc., all the useless rubbish of the expedition, which to them was treasure of the highest worth.

The snows of May had all vanished from about Rdokass, and the bushes of the little glen near the camp had all been cut to feed the coolies' fires. We descended upon the glacier, and followed its left-hand moraine to the end, only leaving it once to traverse a short stretch of the slope near Rhobutse. Throughout all its length the side of the glacier fell steeply, forming a gorge where a brawling torrent flowed. The sky was overcast and the air somewhat heavy. The moraine surface was fearfully convulsed, immensely more difficult to walk on than it had been when we came up. Now and then torrents of considerable force twist and wind across our path, the lower banks of which, as Conway had noted, were all undermined by water and had overhanging edges. Eight hours of marching brought us to a point where we could see, from an elevation on the glacier, the valley of the Biaho, still far away. The last part of the march was the most trying, the waves all running transversely so as to necessitate continual climbing up and down over loose stones. Just above the snout of the glacier we crossed over to the right side, and had quickly climbed down the steep front at the same point where sixty-seven days before we had ascended it. It looked precisely the same, and showed no signs of having moved since May. Another hour, making ten in all, brought us to the oasis of Paiju. The coolies had held out splendidly. It was raining, and we speedily betook ourselves to our sleeping-bags, falling asleep to the murmur of the stream, a sound different indeed from the crashing of avalanches which had disturbed our slumbers in the high mountains.

We were unable to go down the wide sandy bed of the valley as we had come up, on account of the increased size of the river. It dashed stormily against the rocks of the right valley wall, carrying down loads of sand and frequent small blocks of ice, and we were obliged to cross over high on the slope, an inconvenient and tiresome route. Some of the alluvial terraces looked as though they might offer a level path, but when we reached them we found them cut with deep trenches and gullies, full of streams and showing evident traces of former mud streams. We only encountered one large torrent on our way, and happily it was divided into many branches, none of them too big to ford. The valley was remarkably barren, without a single stretch of verdure as large as that at Rdokass. We saw a few thorny bushes of astragalus, some artimesia, *myricaria* and *ephedra*, and a small potentilla. We camped near the mouth of the Punmah valley, where we had stopped on our upward march. At evening it rained again.

The Punmah, which in May we had forded without difficulty, had now become a boisterous stream, obliging us to climb up its valley for over two miles to a place where there was a jhula bridge across a narrow gorge. An easy path led to it, but was broken by a large stream which, at this season, could only be forded in the morning hours, when it was at its lowest. Here we found a number of coolies on the slope, with the little herd of goats. The bridge was in fair condition, though rather long and swaying. After crossing it, we stopped for nearly an hour to enjoy the sight of the passage of the caravan. Jemadars and

BRIDGE OVER THE PUNMAH.

chuprassis shouted deafening orders, and the men got from one bank to the other, moving with great caution but not awkwardly. After the loads were over, the little flock had to be transported, each goat riding on the shoulders of a coolie, carried in a sort of sling. It looked odd enough to see the goat's head with its curling horns rising like a helmet over the head of the coolie. Most of the animals let themselves be carried quite docilely, but a few bleated and wriggled with fear.

The usual summer route runs from the bridge to a pass in the Laskam spur, which forms the right side of the valley, 12,730 feet high, and descends thence directly to Korophon. But our Balti guides took us along the slope of the spur to its end, where it falls vertically to the

Bridge over the Punmah

river. Here we had a most diverting climb up and down steep cheminées, at some points of which stone slabs had been set in like steps, or crossing steep smooth rocks. The coolies took these much better than we did, thanks to their pabboos. We rounded the end of the spur about 700 feet above the river, and descended on the other side over broken schists scattered with garnets down to the flat valley bottom, where the great boulder stands that marks the stage of Korophon. It

BRIDGE OVER THE BRALDOH AT ASKOLEY.

was now noon, and we made our camp, though hardly more than a mile and a half beyond the opening of the Punmah valley, on the other side of which we had stopped the day before. In the afternoon we had a severe rainstorm, which confined us to our tents for several hours, the coolies meanwhile huddling in the lee of the great boulder. The full tide marking the daily period of maximum melting on the glaciers reached us between seven and eight o'clock, unexpected and severe, like a heavy flood. The river was at least twice its former volume, though we had not had a ray of sun for two days. Next day we were soon at the Biafo glacier, which gave us a couple of hours of marching very like that on the Baltoro. We found the Braldoh valley covered with bushes. The snow had quite disappeared from the sides, and every little nook on the high slopes was rich in pasturage for the ibexes. We went along the alluvial terrace, which was strewn with blocks from the rocky walls above. All the dignitaries of Askoley had come out a half-hour's journey from the village to greet the Duke, and the long way was lined with bowing and saluting natives. At a little before eleven we were once more ensconced in our old camping ground among the willows.

LEFT BANK OF THE BRALDOH, AT THE FOOT OF THE SKORO LA.

At Askoley we left the Braldoh valley, and instead of making the long détour around the chain of Mango Gusor, we crossed the Skoro La and went straight down to the Shigar valley. This saved us three days, but at the expense of considerable fatigue. The Skoro La is 16,716 feet high, 6,700 feet above Askoley.[1] The Duke and the guides were still imperfectly recovered from their exertions on Bride Peak,

[1] Altitude calculated from barometric readings, referred to the observations made at Skardu, Gilgit and Leh. According to Conway the Skoro La is 17,400 feet; according to the Workmans 16,975 feet. Guillarmod gives the highest figure, 17,716 feet.

perhaps also feeling some effects of the sudden change from lower to higher atmospheric pressure. But the Duke was unwilling to alter the itinerary already made, and thus we did not even stop for a day of rest at Askoley. On the afternoon of our arrival the equipment was made ready, with addition of the goods we had stored with the Zaildar on our way up, and we sent ahead a good proportion of the coolies to cross the same day the jhula bridge over the Braldoh. The loads being ready

CAMP BETWEEN ASKOLEY AND SKORO LA.

for distribution, there ensued an indescribable scene, more than a hundred coolies flinging themselves on the chests, bags, kiltas, etc., wrenching things away from each other like men possessed, until with the greatest difficulty we restored order and made the distribution. The day, like the foregoing ones, was gloomy, rainy and cold—in fact, during the week since we had left Bride Peak we had seen no reason to regret our departure.

At half-past six on the 28th we left Askoley, under a smiling sky and with a springlike atmosphere. We descended the great alluvial terrace, more than 300 feet above the river, by means of a path winding between fields of grain, beans, peas, etc. At the edge of the terrace a gully led directly down to the bridge. It is about 300 feet long and more than 100 feet above the foaming torrent coursing at the bottom of the narrow gorge between two vertical rock walls. The bridge was firm and in excellent condition, not a single cross-bar being lacking. Ten loaded coolies could cross it at a time, and our caravan, decreased by the number sent on the day before, were very shortly on the other bank. This also was covered with vegetation. Edelweiss were

ON THE WAY TO SKORO LA.

plentiful on the borders of the fields and even between the rows of grain, a botanical combination entirely new to us. We went a short distance along the bottom of the valley, then climbed obliquely across the slope to the edge of the opening of the Skoro La valley, 1,900 feet above the Braldoh.[1] At its mouth is a village of mountain huts, now deserted, because the herds have all been taken up to the high pastures. Southward opened the green valley, full of blossom, between two rounded grassy heights, like the beautiful shell-shaped dales of our

[1] The route is marked by a dotted line on the little panorama of the left side of the Braldoh valley.

own Alps.[1] We climbed along the left side of this valley for some four miles, and set up camp on a grassy level near the water. We were now at about 13,000 feet of altitude.

Next day we crossed the pass. A glacier comes down from it to within about 300 feet from our camp of the night before. We went first along the slope on the left, crossing remains of avalanches and detritus of landslides cut by torrents. Then we crossed the marginal

NORTHERN SLOPE OF SKORO LA.

moraine and walked on the ice. A series of moderate slopes brought us to the snow-covered tributary which leads to the pass, where we left the main glacier. The latter runs off eastward to a great amphitheatre surrounded by rocky and snowy summits. Dr. and Mrs. Workman climbed in 1899 the two peaks nearest the Skoro La, 18,600 and 18,450 feet high. We mounted in zig-zags over an excellent path. The ice ended some 10 yards below the rocky col, and at half-past ten we were on the top, in a narrow gap between two teeth of the rugged crest.

[1] The Botanical Appendix, by Prof. Pirotta and Dr. Cortesi, contains a list of the specimens found in this valley.

Mango Gusor, though more than 3,000 feet above us, had lost all its impressiveness. The day was fine, though the distant chains were still cloud-covered. Toward the south we looked down a bare gorge as far as the Shigar valley, beyond which lies the opening of the Indus valley. Still farther on the horizon was bounded by a misty chain which forms the main supporting buttress of the Deosai table-land. We stopped to rest and enjoy the view, while the coolies were still

LOOKING NORTH FROM SKORO LA.

climbing the steep snowy slope below us. A few of them were exhausted, and laid down their loads on the snow; but their stouter brethren already at the top went back to help them, and the whole caravan was soon over the pass.[1]

A wide rocky couloir runs precipitously southward from the col, covered with most insecure detritus loose upon the steep rocks. One had to go very carefully not to send down an avalanche on the heads of those below. The coolies were very sure-footed, walking cat-like and not disturbing a single stone; otherwise it would have been

[1] The Skoro La was crossed in 1856 by R. Schlagintweit, by Godwin Austen in 1861, by Conway in 1892, by the Workmans in 1899, and by some of the members of the Eckenstein–Pfannl–Guillarmod expedition in 1902.

impossible to get safely down such a wall with so numerous a caravan. Some 1,600 feet below the col we began to cut obliquely toward the right to gain a ridge which is the divisional line between this secondary valley and the Skoro Lumba. The latter is filled in its upper part by two glaciers, which break off abruptly high up on the walls. The slope is grassy, and sprinkled with flowers ; but it is very steep and extended, and cut by high steps which make the descent tedious and fatiguing.

SOUTHERN SIDE OF SKORO LA.

Along the way we kept meeting with Baltis bringing little baskets of delicious apricots, cherries, plums and cucumbers, the most acceptable gifts we could receive, after our months of tinned foods. We finally reached the bottom of the deep and narrow valley, after having descended in this way some 4,100 feet, and made our stage near a group of shepherds' huts, on a grassy plain full of great wild rose bushes, now in full flower and smelling delightful. Many herds were pastured in the neighbourhood, and we were abundantly supplied with fresh milk and also with eggs. We were welcomed to Baltistan by a violent sandstorm, followed rather unexpectedly by heavy rain. The coolies protected themselves as well as they could under the tarpaulins, the tent-bags and all the coverings they could get together.

Our nearness to the luxuriant oasis of Shigar, the paradise of Baltistan, put wings to our coolies' feet. When we set off at seven o'clock on July 30th they were nearly all under way. The mountains were covered. The path ran first among roses, junipers and thorny bushes, then climbed up on a spur at the right side of the valley. After this we descended once more to the river, and entered a narrow winding gorge between high vertical walls which bear the marks of both old and recent landslides. It was here that Colonel Godwin Austen, with his whole caravan, was nearly overtaken by a *shwa* in 1861, two great bursts of mud and stones coming down with a frightful crash. The Workmans were witnesses to a similar phenomenon on this very spot, probably resulting from a temporary obstruction of the torrent by a landslide from the side of the gorge. At certain points there is scarcely room for both the torrent and the path, and there would be no escape for any one overtaken by one of these mud streams. We emerged from the gorge into a broader space, where the valley met a tributary from the left, the Nang Brok, coming from Mango Gusor.

From here on the valley broadened gradually to its mouth, becoming more and more green and beautiful. On top of every boulder is stored up a great quantity of hay for the winter. About two miles from the end we saw the first ponies, brought by the Rajah of Shigar, who came to meet us in person with his brother and a numerous train. It was a pleasure to be once more in the saddle. At every step we met people who welcomed the Wazir and our coolies with affectionate demonstrativeness. Joy reigned, and the sense of reunion, of perils overcome and anxiety relieved was so infectious, that even we fell under its influence. When we emerged into the great Shigar valley the sun was scorching hot. The left side of the gateway is formed by a rock full of holes like a beehive, where innumerable sparrows had their nests and were piercing the air with their shrill chatter. The valley looked quite different from our memory of it—all the rocky slopes were bare, and snow and glaciers only came down to within 6,000 or 7,000 feet of us.

We crossed the stony delta and reached the oasis. It seemed to us like the promised land. The boughs of the apricot trees were weighted with luscious fruit, and we could fill our hands by merely rising in the saddle. The mulberry trees were black with their harvest, and the fields were full of ripe crops, which the natives were garnering. On the roofs of the terraces, on the ground, on the threshing-floors, everywhere great sheets of apricots were laid out to dry, and gleamed like cloth of gold in the sunshine. The old Chinese geographers were right when they called Baltistan "Tibet of the apricots" (Ujfalvy). We dismounted at the bridge outside of Shigar, and entered the town on foot. In front of one of the houses, probably the school, some fifty children were drawn up, and prompted by their master greeted us with three shrill hurrahs. The tents were erected in the cool shade of the venerable trees beside the polo camp, and the customary offerings of fruit, flowers and cakes were soon brought to us in abundance.

THE APRICOT CROP AT SKARDU.

The Wazir gave an afternoon tea to the expedition in the garden of his house, a great tent having been set up and a profusion of Oriental rugs stretched on the grass. He and the Rajah proffered various gifts to the Duke. It is usual to accept some of these, and to recognize the hospitality and the assistance rendered by the authorities of the district by sending them offerings in return through the official channels.

Between Shigar and Skardu we had the experience of a very interesting mode of conveyance, common to all the western Himalaya —the navigation of the river on zhaks. We had some of us already used them to cross the Braldoh where it flows into the Shigar valley.

but that was nothing compared to the actual voyage in them upon a swift and turbulent stream. We sent on the coolies by land with the guides and the luggage. Then we betook ourselves across the fields to the river bank, perhaps a mile from the village. Three rafts were in readiness for us. They looked like very fragile structures to contend with the violent stream, which runs a muddy and swollen course with billows that break and curl over at the top. Each zhak is made of twenty pig or goat skins filled with air and secured by ropes to a lattice-work of poplar or willow branches, with the legs sticking up between,

A ZHAK, TURNED OVER ON THE BANK.

tied tightly with cord to keep the air in.[1] We bestowed ourselves in pairs upon these primitive floats—the Duke and Mr. Baines, Negrotto and I, Sella and Botta. Sella tied a box to the wooden framework of the raft, on which he put the cinematographic camera, in order to take a record of this novel kind of travel. We sat cross-legged in the centre of the rafts. It was practically sitting in the water, except for some old pieces of felt (namdah) laid down on the lattice-work, for our weight made the rafts ride low in the water. At the corners four steersmen stood erect, with long poles to serve as oars.

Directly we pushed off we were seized by the current and given over to the mercy of the waves, veering now toward one bank, now the other,

[1] Moorcroft describes similar rafts in use on the river Sutlej, made of ox-hides, like those which Major Bruce says are used to navigate the Indus in Chitral. They are probably much larger, but cannot be nearly so easy to take apart for portage as these of Baltistan.

West side of the Shigar Valley from near Alchori

From the Skoro La, looking West

tossed about like corks, whirled in the eddies, lifted one moment on the back of a wave to a dizzy inclination and the next plunged into a valley with the nose of the raft under water for an instant before it rose on the crest of a fresh billow. The waves repelled by the front of the boat and the breakers which followed us behind raised up great sheets of water, which slapped and battered at us on every side. The four rowers used their poles frantically the whole time, but apparently

BOARDING THE ZHAKS.

exerted very little, if any, influence over the course of the zhak. Every now and then one of them leaned over and untied the string of a skin that had collapsed a little, blew it up again and resumed his post. Our three barks had pushed off at practically the same time, but in half an hour they were widely separated. Sometimes one of them would escape altogether from the control of the steersmen and make for some branch of the river, but fortunately these all intercommunicated, so it would soon get back into the main stream again. The river banks seemed to fly past us, our course was so rapid. Thus we followed the wide bend of the river round the promontory of Strongdokmo. Near the mouth the oarsmen were obliged to get out and help the rafts over the sandbanks, as they scraped on the bottom with an unpleasant grating.

We came out finally into the Indus, and made for its bank at about a mile below the rock of Skardu. In an hour and a half we had come down some 12 miles of river, not counting the idiosyncrasies of our course due to the current, a distance which it had taken us five hours to march, on the way up.

The Rajah of Skardu and his retinue received the Duke at the landing-place. Near by, beneath great poplar trees, a table was laid

ON THE SHIGAR.

in European fashion with seats, plates, cups, etc., and spread with beautiful fruit, cakes and tea in pots. Here we breakfasted, carrying on a conversation the while, with Mr. Baines as interpreter. Afterwards we entered the city. The Duke went at once to the meteorological station to get the readings for July 18th, necessary to make an approximate calculation of the height reached on Bride Peak; while the rest of us, restored to the blessing of the telegraph wire, sent off dispatches.

We were lodged in our former quarters, in the bungalow of the still absent civil engineer. The guides and coolies arrived a few hours after us, and we worked to prepare everything for the final stages of the journey. We paid off all the coolies and said good-bye to our sturdy and faithful servants of the late campaign. For the last time all the pieces of luggage were counted and sorted, evening falling while we were still engaged in the task. Administrative complications lasted late into the night, Mr. Baines wrestling with the greed of the Skardu merchants who had supplied us with flour, sacks to put it in, pabboos and other articles, and who, with their Oriental methods of temporizing and sophistry, prolonged the bargaining interminably. However, we were ready for the start next day.

As before stated, our return route was to be the summer one across the Deosai table-land, a decided short cut to Kashmir, in comparison with the Indus valley route. It is a very high region, with several passes to be surmounted, and thus is open to caravans for only a little over two months in the year, from July to the middle of September. A large part of the march lies through absolutely desert regions, where not a twig of wood is to be found, and fuel and provisions for several days must accordingly be carried. We were delayed by the local purveyors of supplies so as not to be able to set out until half-past eight. The road out of Skardu lies through the squalid bazar, on leaving which we entered upon the wide stony plain, crossing it diagonally toward the south-west and fording various branches of the Sutpa river, which flows out of a valley south of the city. Beyond the river a long avenue of willows leads to the narrow entrance of the Burgi La valley. When Vigne was here the opening was still barricaded by a wall erected by Ahmed Shah, perhaps afterwards swept away by a flood. The valley is steep, bald and stony at first. Farther up it becomes green with grass and bushes, owing to the humidity of the atmosphere at a certain height above the Indus. The stage called Pindoba lies about half-way up (11,211 feet high), and 3,708 feet above Skardu, on a sort of terrace rising in the centre of the gorge. The great spurs of the Indus valley and the Skoro La chain form a striking landscape of mountains framed by the walls of the valley. At this point the Wazir of Shigar took leave of us, having followed the expedition from Tolti onwards. The time of the campaign upon the glaciers he spent at Rdokass, placing at the service of the Duke the authority and control which he possessed over the coolies.

Above Pindobal the valley grew wider and less steep. The horses, however, having been poorly fed, did not take the climb well. There were several mares among them, followed by their colts, and the poor little things were taxed much beyond their feeble powers. The valley now grew stony again and full of detritus as far up as the snows descending from the col. The path crossed the snow for a good distance, and the ponies plunged in and stumbled along, but went bravely, their drivers using no force, but encouraging them with the voice. A little after ten we set foot on Burgi La, 15,847 feet high. During the latter part of the climb certain peaks and heights were detaching themselves and standing out from the chains on the north-eastern horizon, which gave us the hope of a farewell glimpse of the noble mountains among which we had spent such never-to-be-forgotten weeks. And our wish was granted. From the top of the pass we recognized at once the regular cone and great snowy shoulder of K^2, rising superb above the other heights. The sky was cloudy, and we could just distinguish through the mists to the right of K^2 a dim shape, which we knew to be the rocky pinnacle of Masherbrum. Sella's panorama R shows the extended view to be had from Burgi La. Sella perceived that a panorama taken by telephotography on a bright morning from some height near the pass would give an incomparable view of the whole system of the Karakoram; and, unable to resist the idea, he remained behind for one night with Botta, keeping one of the Whymper tents and horses with which to overtake us on the next day.

A short descent leads from Burgi La to a placid green vale, open and rounded in shape, with two little blue lakes fed by the near snows, one some 650 feet below the col. Beyond this valley we caught a glimpse of the rolling plains of Deosai. We came down through the nearly level basin, all tapestried with a profusion of gaily-coloured blossoms.[1] The great extent of luxuriant herbage caused us to feel surprised that there was no herd to profit by the excellent pasturage. Where the valley runs into the plain is the stage of Ali Malik ke-mur, marked by some prominent rocks, out of which the natives have made huts by the addition of some rough stone walls. The stage is 13,450 feet high. The

[1] The Botanical Appendix of Prof. Pirotta and Dr. Cortesi contains a list of the plants collected on the Deosai table-land.

clouds had been gathering over the chains, and a little after we reached the spot a furious rainstorm broke, accompanied by thunder and lightning, a spectacle to which we had long been strangers.

The undulating plain of Deosai is irregularly circular in form, somewhat more than 30 miles in diameter, and from 13,000 to 14,000 feet above sea level. It is girdled by mountains averaging about 17,500 feet with small glaciers and snowfields. Shallow valleys run into it, making a sort of shell-shaped expanse. Oestreich has called attention to the singular contrast between the flat monotonous plain and the strongly marked features of the surrounding region, all angles and corners, cut

THE DEOSAI TABLE-LAND.

and broken by deep valleys between steep walls and ragged crests. Drew offered the hypothesis that the plain might have originated in a filling up of the valleys with alluvial sediment during the glacial period. Conway seems to think that the process is still going on, largely through the medium of the mud streams. It may be that such a theory fits the conditions of the plateaus of Central Asia and Tibet, which are, in fact, composed of sedimentary matter. But the Deosai plain is a solid formation of granite and gneiss, as Vigne recognized. K. Oestreich and Ellsworth Huntingdon described it as an upheaval not yet shaped or furrowed by the action of water.[1] It is full of glacier marks and deposits, and must once have been entirely covered by a large glacier of the continental type.

The route crosses the plain in an absolutely straight line from north-east to south-west, traversing a number of broad streams. These were

[1] K. Oestreich (op. cit.); Ellsworth Huntingdon, *The Vale of Kashmir. Bull. Amer. Geog. Soc.* 38, 1900, p. 657.

clear and shallow with pebbly beds, running between low banks and uniting in the centre of the plain to form the Shigar river, the only emissary of the Deosai plain, and a tributary to the Dras river. It is said to be full of trout. There are many clear cold springs along its way. The soil is covered with stones and pebbles, grass growing profusely among them. It seemed to us like a beautiful meadow, after our months in arid Baltistan. However, we passed some Englishmen

OUR CAMP ON THE BORDERS OF THE DEOSAI PLAIN.

coming from Kashmir, and to them, as to Ujfalvy, it was a perfect desert of stones. The path is broad and hard ; for the route over the Deosai plain, while it is not the official highway used by the post, is traversed during the summer by a considerable part of the traffic between Srinagar and Skardu, and all the Englishmen take it who are bound on hunting expeditions in Baltistan. Marmots are numerous, and the earth along the roadside is perforated with their burrows. The little animals are larger than with us, and have pelts of about the same colour, tawny brown shading to yellow on the belly. On every side we kept hearing their shrill frightened squeak. The pasture lands of the Deosai are said to harbour a good many bears. Birds are scarce, likewise insects. We saw no crickets, bees or wasps, and but few butterflies, despite the rich grass and many blossoms. The species of the latter were in no way striking. There is a certain sort of gnat native to these parts, of very bad fame, said to be most annoying during the warm part of the day. We, however, were not troubled by it, and found the horseflies much more vexatious. Spiders were plentiful.

Sella overtook us at our second stage. not far from the western limit of the plateau. As we had feared, he was prevented by mists and bad weather from completing his photographic campaign in the Karakoram with a panorama which would have had greater illustrative value than any taken in the chains themselves. The disappointment was the more lamentable when the next day proved absolutely clear and brilliant.

SARSINGAR LAKE.

without a vestige of mist. To the west of us, back of the mountains bounding the plain, we saw far off the snowy peak of Nanga Parbat. This was our only glimpse of it.

Leaving the Deosai plain, we ascended the gentle valley which leads up to the col called Sarsingar, 14,042 feet high. Near it we passed a moraine lake, then on the summit of the col a second and larger one, which Drew and Workman consider to be likewise of morenic origin; but Oestreich calls it a watershed lake. The downward slopes were quite gentle, and had patches of snow coming down from heights that looked very moderate, but are really 16,000 feet or more. According to Oestreich the great glacier of Deosai must have come down over this col, but it probably had more than one outlet.

The head of another large valley, like a wide amphitheatre, called Chota Deosai, comes in between the real Deosai and the Burzil valley, through which we were to march. This amphitheatre is the source of the Shingo river, which runs into the Shigar farther down, thus contributing its volume of water to the Dras. We went down into the amphitheatre from Sarsingar, and found it clothed with rich pasture but entirely unoccupied. One crosses over it to gain a narrow defile which cuts between the mountains to the south, and by which one gains a second pass, the Stakpi La, 600 feet lower than Sarsingar.

PATH TO STAKPI LA.

The Naib Tehsildar of the district came to meet the Duke with a party of dignitaries, and they escorted us down from the col and into the Burzil valley. Now we began to see the forests—the birches highest up, and below them the deep green masses of the coniferous trees. The path ran among a tangle of flowers, a hundred kinds all familiar, yet seeming strange on account of their size—campanulas of every variety, fragrant forget-me-nots three or four feet high with long branches, marsh-mallows, larkspur, balsam, thistles—all these and many more growing with splendour and profusion and a riot of colour.

At Burzil we were quartered in a bungalow that seemed like a palace to us. The high road from Gilgit wound down before us, a splendid smooth and well-trodden path.

We had said good-bye to the rough paths, the long marches and the healthy fatigue of our mountain heights. The remainder of the journey was only too easy. Between flowering hedges we descended the Burzil valley to where it joins the Kishen Ganga. We noted the gradual giving way of summer to autumnal flora—the slopes were covered with asters, and the umbelliferous plants, as large as small trees, were full of seed-vessels. The path follows the right side of the valley. The left is clothed with evergreen forests, populated with black and brown bears. Cultivation begins a little before the Kishen Ganga—the same river which we saw at its meeting with the Jhelum, on our way from Rawal Pindi to Srinagar. The dwelling-houses here are built of tree trunks mortised together, and look like Swiss châlets except that they have flat terrace roofs instead of projecting gable ones. We had become so used to the small cattle of Baltistan that the herds here impressed us as being of gigantic size. The women in the fields were unveiled, and looked at us without embarrassment. The men are tall and well built —they are Dards, an Aryan people which inhabits the country between Kashmir and the Hindu Kush. They appear to have occupied this region since remote antiquity (Stein). They are mainly Sunnite Mohammedans, but there are a few Shiites and Ishmaelites as well.

There was a great deal of traffic on the road, long convoys of pack animals loaded with merchandise. We also met some detachments of well-equipped native troops, going to exchange with the garrison of the frontier post. In spring and winter, however, the route is, perhaps, even more dangerous than Zoji La, and there are many victims of avalanches.

We followed the Kishen Ganga for a space, and then pursued a tributary valley on the left, which took us up to our last pass, Rajdiangan or Tragbal, 11,562 feet high, a little more than Zoji La. On its right side is a trigonometrical station (11,950 feet), which must command an extended view of the mountains, among them the group of Nanga Parbat. It was too veiled in clouds for us to see it—not an unusual experience, apparently, for Sir Francis Younghusband crossed Rajdiangan six times and never had a view of it. The spreading plain of Kashmir was at our feet, shrouded in light mists, among which gleamed the waters of its rivers, lakes and canals. We came down to Bandipur, our route being a progress through groves of pine and fir, meadows and plains, rice fields and rows of mulberry trees. The air quivered with heat, and was filled with the hum of cicalas and crickets, and the voices of many birds. On the shores of the Wular were waiting the Government houseboats sent to meet the expedition, the members of which from now on were the guests of the Maharajah, Sir Pratab Singh. We were once more in the heart of Kashmir—noisy, garrulous, bombastic, servile, yet withal charming Kashmir.

ON THE JHELUM. THE RETURN TO SRINAGAR.

Our exertions were over. We let ourselves be borne across the lake and up the Jhelum, lazily enjoying the landscape, the tall vegetation on the banks, the branching splendour of the chenar trees, the lively colouring of the water-fowl—the little grey gulls, the gay kingfishers, the fish-hawks perched watchfully on the rocks or floating tree trunks, the ducks, the cranes and all the varied host of aquatic birds.

On August 11th the party re-entered Srinagar, and went to pay its respects at the Chenar Bagh. The expedition was at an end. All the anticipatory feelings of the past few days and the satisfying sense of labours completed gave way to a sense of flatness accompanied by actual longing for the vigorous and varied life of the past months of contact with nature.

CHAPTER XIX.

SUPPLEMENTARY NOTES AND CONSIDERATIONS.

The Explorations of Sir Francis Younghusband east of the Baltoro. — Height of the Peaks of Golden Throne. — Method employed in Determining Heights. — Discrepancy between the Barometric and Trigonometric Calculations. — Climate of the Karakoram. — Solar Temperature. — Observations made by the Workmans and by the Duke. — Temperature of the Air at Great Heights. — Physiological Experiments. — Deductions for the Mountain Climber. — Analysis of Results. — Physiological Effects of Altitude. — Limits of Adaptability and Endurance. — Rations and Alpine Outfit. — Optimistic Forecasts. — The Practical Problem.

I HAVE gathered into a single chapter a number of short notes on various topics which have already been presented or, at least, mentioned in the text, discussion of which, on account of their technical nature, was not easily included in the general narrative.

As described in Chapter XV, the Duke had from Sella Pass and the ridge of Staircase Peak a comprehensive view of the unknown territory lying east of the Baltoro and north of the Siachen. Over this tract extends a system of lofty chains, with corresponding deep valleys (see panoramas F and I), so complicated that it was impossible for the Duke to form a general idea of its topographical arrangement, even schematically, or to draw such conclusions as would be necessary to correlate his observations with those of Sir Francis Younghusband, the only explorer who has so far penetrated into the region.

The geographical problem will be best presented by confronting the Duke's observations and the results of the Younghusband expedition. I will therefore present these data as briefly as possible, premising them with the warning that they will not be easily intelligible without reference to Younghusband's maps.[1]

On his first expedition in 1887 Sir Francis Younghusband crossed the whole of China from Pekin to Yarkand, and returned to India by the old Mustagh pass and the Baltoro. It was during this journey that he first discovered and crossed the Aghil chain, which lies between the Kuen Lun and the Karakoram, separating the valleys of the Yarkand and the Oprang rivers.[2] Two years later, returning to the region by the Karakoram pass, he again crossed the Aghil range at the head of a small expedition sent out to get information upon the marauding raids of the Kunjuts of Hunza. He describes the Aghil mountains as running from north-west to south-east, some 125 miles long, composed of "bold upstanding peaks," among which are three beautiful snowy summits, the tallest of which is about 23,000 feet high.

After reaching the valley of the Oprang, Sir Francis Younghusband followed it up, hoping that it led to the Saltoro pass, a supposititious ancient route of communication between Baltistan and Kashgar, of which the people south of the ranges had some tradition but no dependable knowledge of its geographical situation.[3]

The valley, which runs from south-east to north-west, lies east of the Baltoro basin between the Broad–Gasherbrum range and the Aghil mountains. A large glacier, the Gasherbrum, comes down into it from the eastern slopes of the Gasherbrums, and stops abruptly at the river with a vertical wall of ice a mile and a half broad. This the explorer crossed, and went on up the valley to a second glacier, the Urdok, not so wide as the first, which runs in from the south between precipitous walls, coming from deep within the ranges to the east of Hidden Peak. The

[1] Sir F. E. Younghusband, *The Heart of a Continent*, etc. London 1904. 2nd ed. There are better maps in the articles by the same author in *Proc. Roy. Geog. Soc. N.S.* vol. 10, 1888, p. 485, and vol. 14, 1892, p. 205.

[2] The Aghil chain had been seen by G. W. Hayward as early as 1868, but he believed it to be the Mustagh or Karakoram. See *Journey from Leh to Yarkand and Kashgar. Proc. Roy. Geog. Soc.* 14, 1869, p. 41; and the article in *Jour. Roy. Geog. Soc.* 40, 1870, p. 33.

[3] The Saltoro pass was discovered by Longstaff in the summer of 1909, the year of the Duke's expedition. It does not cross the watershed, but gives access to the Siachen or Saichar glacier; hence it is not a way of communication between India and Central Asia, but merely a short cut between the lower Shyok and the upper basin of its tributary, the Nubra.

Oprang valley ends not far beyond to the south-east, dividing into two glacier-filled branches which form the sources of the river Oprang. At this point he left the main valley and followed up the Urdok glacier. It was entirely covered with moraine in its lower part. He went on climbing toward a sort of depression in the ridge at the head of the valley, thinking that this might possibly be the sought-for Saltoro pass. He went 18 miles up the glacier in three days, experiencing continued bad weather, so that he just barely caught glimpses of the peaks between the mists. On the third day there was a severe snowstorm. There was considerable danger from the snow-covered crevasses and the avalanches that came down on every side, and he was finally brought to a halt by a wide crevasse, probably the bergschrund, and forced to turn back.

Sir Francis Younghusband was merely making a rapid journey through an extended territory, and had neither equipment nor leisure for accurate topographical work; moreover, there were no points previously established by survey upon which to base his observations. He was able to establish the latitude of some of the points in his itinerary by astronomical observations, but not the longitude. The camping ground of Durbin Jangal in the Oprang valley, $11\frac{1}{2}$ miles below the Gasherbrum glacier, was one of these. Its position was established by calculation of the latitude and observation with the compass upon a certain striking peak which Younghusband believed to be K^2 (survey 183° Mg., 186° true). The situation of the Oprang valley is thus dependent upon that of Durbin Jangal camp. But in Younghusband's map the valley is so placed that one would be able to look from Windy Gap and Sella Pass, through short tributary valleys without glaciers, directly down into it where it lies considerably below the mouth of the Gasherbrum glacier. However, Sir Francis Younghusband, in discussing with the Duke the topography of the region during the first stay of the expedition at Srinagar, became persuaded that the peak surveyed from Durbin Jangal was not K^2 but Gasherbrum IV, and altered his map accordingly, putting the Oprang valley six miles farther east. Then the further difficulty arose that a straight line drawn from the new situation of Durbin Jangal to Gasherbrum IV would run directly across the mountain ridge to the north-east of Windy Gap, and thus the latter would probably cut off the view of Gasherbrum IV from a person situated about seven miles north of and nearly 10,000 feet below it.

The Duke was forced by the insecurity of the data to leave unsolved the problem of the topographical relation between the upper Oprang valley and the glacier basin explored by him. Nor were the factors established by the expedition enough to warrant the identification of the Aghil chain with the mountain range which the Duke had seen to the east, and which he and Sella had photographed. They had both taken with the prismatic compass the angles of Peaks X, Y and Z, and the point of observation of the Duke upon Staircase Peak was sufficiently well established. But that of Sella on the east side of the left-hand spur of the Godwin Austen was too uncertain, as he had as basis only the angles observed upon the Gasherbrums, which were too few and also too acute. Given the distance of these two stations from the points X, Y and Z, the slightest displacement would be enough to alter the situation of these peaks from one to the other side of the Oprang; and besides, it was impossible to say with certainty whether they were contained in one or two chains. Furthermore, no one of the larger glaciers shown in panoramas F and I exactly corresponds in direction with the Gasherbrum glacier, neither could any of them be followed with the eye for a sufficient distance to establish its identity with the latter.

In any case, the panoramas taken by Sella and the Duke depict an utterly unknown region between the Oprang valley, the upper Siachen glacier and the Broad–Gasherbrum range. It is to be hoped that it will be explored at some early time, either by crossing some col at the head of the Kondus glacier, or else by Sella Pass on the southern side of the Godwin Austen. Such an exploring expedition would probably collect enough data to bring into line with each other the maps of Sir Francis Younghusband, Dr. Longstaff and the Duke.

Before leaving the subject of topography, I will make mention of certain angles taken by the Duke from Camps XIII and XIV on the glacier and on Chogolisa Saddle. If he had been able to make a third station on the high ridge of Bride Peak, he would have had sufficient elements to add many topographical details to the map of the region at the head of the Baltoro. He was prevented by heavy mists from making this third station, and the distance between the two others was too small a base upon which to found a triangulation of any exactness.

Nevertheless, the reading of vertical angles permitted some altimetric calculations which I will set down here. They must, however, be taken as approximate, on account of the uncertainty of the distances between the peaks and the observation stations, due to the shortness of the base. According to these observations the height of the five largest peaks of Golden Throne, from north to south, would be 22,933, 23,743, 23,386. 23,563 and 23,375 feet high. The second peak would thus be the highest.[1]

Conway gives Golden Throne an altitude of 23,600 feet, a difference of only 143 feet between his calculation and that of the Duke; and to Pioneer Peak an altitude of 22,600 feet. He maintains, however,[2] that some 500 feet should be added to these figures, because on comparing the altitude deduced from barometric observations made at Junction Camp (on the Baltoro at the height of the mouth of the Vigne glacier) with that based on the readings of angles of K², he found the latter to be greater by 500 feet. The results of our observations do not agree with these deductions of Conway. First of all, according to our triangulation, the end of the right spur of the Vigne, about 1,100 yards away from Junction Camp and a little higher up, proved to be 15,738 feet high, hardly 70 feet more than the altitude given by Conway—in other words, the trigonometric calculation agrees with the barometric. Further, the observations of angles made from Camps XIII and XIV to points triangulated by the Indian Trigonometrical Survey gave differences of not more than from 150 to 300 feet in their heights, and always in excess; from which one may argue that the figures calculated for Golden Throne are likewise approximately correct, and in any case give a higher rather than a lower figure. I must, however, note that the observations of the Duke do not tally with those of Conway so well for Pioneer Peak as for the other points—in fact, one deduces from the angles taken a height of only 21,332 feet for it, 1,268 feet below Conway's figure.[3]

[1] Result of calculation. In his lecture before the Soc. Geog. Ital. and the Club Alp. (see *Boll. R. Soc. Geog. Ital.* Ser. IV, 11, 1910, p. 435; and *Revista C. A. I.*, Jan. 1910, vol. 29) the Duke stated that the highest peak was one of those to the south-east, meaning the fourth, which instead turns out to be 180 feet lower than the second. But this small difference is indecisive, as a slight error in the reading of the angles or in the calculation of the distance would be enough to produce it.

[2] Sir W. M. Conway, *Climbing in the Himalayas.* London 1894, p. 486; *Alp. Jour.* 27, 1894, p. 33.

[3] As was plain from Conway's map and description, Pioneer Peak is not visible from the Concordia nor from the Godwin Austen glacier; thus Guillarmod's critical observations on its height are without foundation.

The Duke also observed Mustagh Tower from the same camps, but its distance from the short base of observation was too great to rely upon the result. I should say, however, that the angles observed would give a height of between 23.950 and 24.950 feet. Conway had estimated it at about 25,000 feet.[1]

A few further observations upon the altimetric data brought back by the expedition may be in order here, with special reference to those of the region of which we made a topographical survey. They are of two kinds: those derived by intersection from the photogrammetric or tacheometric stations, and those deduced from the calculations of atmospheric pressure made by the Duke with the Fortin mercury barometers (taking into account temperature and tension of aqueous vapour), corrected and referred to the observations taken at the same time at the base station at Rdokass. As I have already said, the latter —137 in number—were collated with the memoranda of local observations made at the meteorological stations of Skardu, Gilgit, Leh and Srinagar. In constructing the map, the figures obtained by triangulation were naturally adopted, with the exception of a few which it was not possible to determine by triangulation, and of which the barometric calculation is given instead. These points are marked on the map by a small *b* after the number. All the results obtained by calculation of pressure are incorporated in the tables of Prof. Omodei (see Appendix). It will be seen that the height of some points was taken by both methods—by intersection and by comparison of barometric readings. Upon comparing these a discrepancy becomes apparent, as shown in the following table :—

Stations.	Height above sea level. (A) Inter-section.	Height above sea level. (B) Barom. readings.	No. of barometic obser-vations.	Difference between (A) and (B).
Camp III.	16,512	16,493	26	19
Camp V....	18,176	17,825	6	351
Savoia Pass	21,870	20,906	1	964
Camp VI.	18,602	17,760	10	842
Sella Pass	20,207	20,053	1	157
Windy Gap	20,449	19,361	8	818
Ridge of Staircase Peak	21,657	21,510	1	147
Camp XI	16,637	16,175	1	462

[1] If Mustagh Tower is above 23,000 feet high, it is certainly far from the 26,250 feet of Guillarmod's estimate.

The divergence is considerable and hard to explain satisfactorily. The calculations based upon barometric readings consistently give lower figures than the trigonometrical ones. Thus it is improbable that errors caused by local variation of pressure are responsible for the divergence. Moreover, these are excluded from consideration by the remarkable steadiness of the barometer in the Karakoram, and by the fact that all the calculations were obtained by reference to Rdokass, at no great distance away, in the same valley. The height of the latter had been determined by a long series of operations extending through a period of six weeks and referred to the four Kashmiri stations.

In truth, the singular fact that the variations between the altitudes calculated by intersection and those calculated by barometric readings are all in the same direction gives rise to a doubt whether some constant factor does not intervene, such as one might find, for instance, in the local conditions of gravity. It is known that gravimetrical observations have revealed a considerable nucleus of attraction in the Himalayan mass. It does not seem unreasonable to suppose that this fact might not only produce a local greater density of the atmosphere, but also give rise to the movement of a certain volume of air from the surrounding regions, in the same way that the attraction of the earth masses is the cause of the higher level of the sea on the coasts of the large continents. Obviously this absolute increase in mass of atmosphere would result in higher barometric pressure than would correspond to the local altimetric figures, and bring about a variation precisely in the direction indicated by the figures of the expedition.

I am aware of the fact that geodetic surveyors in general are disposed to place little reliance upon altimetric calculations based upon atmospheric pressure. But the Duke proved that the method, when employed with due caution, may give results differing very little from those obtained by triangulation. Witness the remarkable agreement between the result of Russell's triangulation of Mount St. Elias in Alaska and the barometric calculations of its height ; and the fact that the Duke's measurement of the seven principal peaks of the Ruwenzori, determined by observations of pressure, were almost precisely confirmed by the triangulation of the Boundary Commission appointed to define the limits between Uganda and the Congo. A much greater divergence has often been betrayed between two different triangulations of the same points.

On the other hand, the topographical survey was made by the method which secures the best control of results and the greatest guaranty of exactness, and which forms a permanent document to the work accomplished in the photogrammetric panorama made on the Paganini method. Nevertheless, the specific conditions under which the work was accomplished brought in their train inevitable causes of error. Of these, the chief is the necessity that existed of making all observations of very high mountains from the bottom of valleys very deep and relatively narrow. Such great perpendicular distances in combination with such small horizontal ones did not permit the exact collimation of many points. Thus, one was never sure of sighting the exact summit of the mountain in question, nor of seeing exactly the same point from the various stations. Naturally neither the trigonometrical peaks nor the others which were selected as base points for the determination of the stations had on top the signal which makes it possible to achieve an exact focus with the telescope. Thus it was impossible to be sure that a point collimated from various stations was always the same one, and not another either higher or lower or displaced horizontally. In addition, it was generally impossible to join up the different stations, because they were usually not visible one from another on account of the great surface irregularities of the glacier, even though they might be close together. The smallness of our numbers, the shortness of the time, the difficulties in the way of reaching and climbing the steep valley walls, prevented us from making stations at high points. These inconveniences are not inherent in the method of survey adopted, and would have operated adversely on any other that we might have chosen. For the reasons I have given, the survey of the expedition is called a "sketch," and not a topographical map.

With all these sources of error and uncertainty, it seemed to the Duke wisest to publish both sets of height statistics. They would have lost all significance if we had given merely the arithmetical mean between them. As it is, when the causes of error are finally understood, one of the two sets will be confirmed and have a definite value.

The meteorological observations made by the Duke serve another purpose beside that of determining height. Taken in connection with the data of other explorers, they will give some general indications of the climate of the region, interesting from more than one point of view.

It is already evident that the high glacial basins of the Karakoram have a special climate, quite different from that of the regions round about. It suffices to mention the enormously high rate of atmospheric precipitation as contrasted with the extreme dryness of the surrounding country. This is certainly caused by the mighty ranges which reach up into the upper air and snatch from the south-west monsoon all the moisture that has escaped the lower Himalayan ranges.

A point which has attracted the attention of several explorers is the great intensity of the sun's rays at these lofty heights. R. Strachey called attention to it as early as 1851,[1] and Sir A. Cunningham gives some comparative readings of solar temperature made in 1850. He noted at Gualior, in the plains, a maximum solar temperature of 132·8°; at Simla (7,500 feet) of 133·3°; and at Rupshu, on the plateau of Ladakh (15,500 feet) of 144° and 158° F.[2]

The Workmans contend that the solar temperature varies proportionately with the altitude. From several of their publications I have compiled the figures given in the following tables. They show, indeed, that the high altitudes have higher temperatures than the plains, but scarcely evidence a regular progression from low to high.

Solar Temperatures Observed by W. Hunter and F. Bullock Workman, in 1899, on the Chogo Lungma Glacier.[3]

Month.	Place.	Altitude.	Maximum solar temperature.
June	Skardu	7,503	201 F.
June	Shigar	7,516	206
July	Chogo Lungma	14,057	190
August	Chogo Lungma	14,067	196
July	Chogo Lungma	17,322	204·5

During the summer of the same year the maximum solar temperature observed at Calcutta was 162° F., and at Lahore 172·6° F.

[1] R. Strachey, *On the Physical Geography of the Provinces of Kumaun and Gahrwal*, etc. *Jour. Roy. Geog. Soc.* 21, 1851, 57.

[2] Sir A. Cunningham, *Ladakh and Surrounding Countries.* London 1854.

[3] W. Hunter Workman and F. Bullock Workman, *In the Ice-World of Himalaya* London 1901.

Solar Temperatures Observed by W. Hunter and F. Bullock Workman, in 1906, in Suru and the Nun Kun Group.[1]

Month.	Place.	Altitude.	Maximum solar temperature.
June	Kargyl	8,787	199° F.
June	Chalis Kot	9,000	203
June	Suru	10,850	206
August	Suru	10,850	219
July	Rangdum Valley	12,900	204·5
July	Zulidok...	13,270	205
July	Shafat Naia	13,325	200
August	Glaciers of Nun Kun... ...	15,100	183
August	Glaciers of Nun Kun... ...	21,300	142

It is hardly permissible to compare, as the Workmans do, the highest solar temperature with the minimum atmospheric, the two things being quite distinct. and the solar temperature varying quite independently of the atmospheric.

The solar temperatures given by the Workmans are higher than any noted by our expedition. I have tabulated our results likewise. They also show that there is not a constant relation between altitude and temperature. I have not included the lowest records taken on days of cloud or bad weather. Moreover, the exceedingly variable and uncertain conditions prevented our making regular observations, hence

Solar Temperatures Observed by the Duke.

Date.	Place.	Altitude.	Minimum and maximum solar temperature, Fahrenheit.
		Feet.	
May 9-17 ...	Shigar, Braldoh, Biaho Valleys ...	10,013–11,000	105·8–138·2°
„ 25–31 ...	Camp II	16,512	108·5–123·8
June 1–19 ...	„ III	16,512	90·4–123·8°
„ 5–8 ...	„ V	18,176	123·8–141·8°
„ 12–23 ...	„ VI	18,602	114·8–131°
„ 15 ...	„ VII	20,449	140°
„ 29–July 5	„ IX	15,817	109·4–116·6°
July 3–8 ...	„ XII	17,959	120·2–134·6°
„ 10–16 ...	„ XIV	20,784	114·8–140°
„ 11 ...	„ XV (1)	21,673	123·8°
„ 17 ...	„ XV (2)	22,483	152·6°

[1] W. Hunter Workman, *Exploration of the Nun Kun Mountains*, etc. *Geog. Jour.* 31, 1908, 12; W. Hunter and F. Bullock Workman, *Peaks and Glaciers of the Nun Kun.* London 1909.

the fragmentary character of the data. The reading of the solar thermometer was done at 8, 10 and 4 o'clock, at the same time as the observations made at Rdokass and in Kashmir. Thus the midday record—which would naturally be the highest—does not appear. According to the Workmans the maximum was attained between 12 and 2 o'clock. At no place or time did we have excessive heat or feel such consequences of it as headache, dizziness, &c.

Next, as regards the temperature of the air, I need only record the relative mildness of the month of July, at heights between 20,000 and 23,000 feet. The lowest temperature registered at Chogolisa Saddle was 3° ; on the ridge of Bride Peak (24,600 feet) at 2 o'clock on a day of heavy fog the temperature was 21°. These are also about the records for the month of June on the Savoia glacier and at Windy Gap. The fact has some importance, on account of its bearing upon the problem of ascents to great heights, since one of the adverse arguments often adduced is the extreme and intolerable cold that must exist at such altitudes. In reality there does not obtain upon the mountain slopes an actual proportionate relation between the rise of the altitude and the fall of the thermometer, because other factors, such as the radiation from the earth and the warm currents rising from the valleys, always intervene to modify the temperature.

In the Introduction I have tried to bring out the impossibility of applying to mountain climbing the theoretical physiological limit derived by scientists from experiments on the effects of reduced atmospheric pressure upon the human system. Such experiments simply serve to establish the general fact that the system is capable of enduring for a short time, without serious consequences, an atmospheric pressure that would correspond to an altitude three times as great as that of Mount Everest. But the simple conditions of artificially reduced pressure in a closed chamber hardly exist under natural circumstances—for instance, in balloon ascents the effect is entirely different. Altitudes of between 29,500 and 36,000 feet—in other words, a condition of atmospheric pressure far less reduced than that easily endured in the closed chamber—have been known to cause serious organic disorders and even death to some experimenters. Yet in such ascents the only additional factor, not present in the former experiment, would seem to be the cold of the high altitude. It is plain that there is no useful deduction to be drawn from these facts for the field of mountain climbing, where so many and various factors are present, the chief of them being (1) the muscular exertion and (2) the incomparably longer duration of the experiment.

The work of Angelo Mosso and his school has stimulated modern physiologists to undertake a systematic study of the effects of high altitude upon the human organism, with the aid of all the most recent analytic methods. The establishment of the observation hut Margherita on the Gnifetti Peak of Monte Rosa (15,100 feet) sprang from the initiative of Angelo Mosso, and has been carried out by the Italian Alpine Club. To-day, enlarged by the addition of new buildings, it has become an important scientific station for biological research and physical experiments at high altitudes. It is gradually producing a series of results which will materially assist in solving the problem of life at great heights.[1] This is not the place to enter upon more details, since the results thus far achieved do not contribute to the precise matter in hand—the problem of the greatest height to which man can ascend. On this point only purely empirical evidence exists, such as is embodied in all the narratives of mountain climbing which we possess. And unfortunately the experience of mountaineers varies to such a degree and the effects attributable to altitude alone are such inconstant factors and so hard to distinguish, that it is almost impossible to gather any general conclusions from them.

One strange and unexplained fact is that on certain mountains and in certain regions ascents to great heights almost without exception cause what we call mountain sickness, varying in symptoms and intensity according to the individual, whereas other regions are apparently free. Mont Blanc has always had an evil fame in this regard, and all the accounts of mountain climbing in the Andes lay stress upon the sick-

[1] Among the principal works dealing with the subject, beside the well-known book of ANGELO MOSSO, *La fisiologia dell'uomo in montagna*, see H. ZUNTZ, A. LOEWY, F. MÜLLER and W. CASPARI, *Hohenclima und Bergwanderungen*, etc. Berlin 1906; and the latest publications of R. F. FUCHS in *Sitzungsb. d. physik.-mediz. Sozietät in Erlangen*, vol. 40, 1908, and vol. 41, 1909. DR. T. G. LONGSTAFF has brought out in his monograph *Mountain Sickness* (London 1906) the bearing which these scientific researches have upon mountain climbing in its practical aspect, and the conclusions to be drawn from them relative to the phenomena of mountain sickness. He gives a succinct history of mountain climbing from this point of view, and the lessons to be drawn from it. See also two articles by MALCOLM HEPBURN, *The Influence of High Altitudes in Mountaineering*. *Alp. Jour.* 20, 1901, p. 368: and *Some Reasons why the Science of Altitude Illness is still in its Infancy*. *Alp. Jour.* 21, 1902, p. 161.

ness caused there by high altitude.[1] However, since the repeated ascents of Mount Aconcagua,[2] the highest peak in the world outside the Indo-Asiatic chains, this fact has lost all practical importance. The problem of altitude has now concentrated itself upon the Indo-Asiatic ranges. And it looks thus far as if this, the most wonderful field of activity for the mountaineer that exists on the face of the globe, were also the field where the bad effects of rarefaction upon the human system are less to be apprehended than elsewhere.

The progressive history of mountain climbing, from its inception down to the present day, seems to show that man's power of endurance and capacity for exertion at great heights have steadily increased. There was a time when every ascent of Mont Blanc meant serious suffering—severe headache, dizziness, nausea, debility, disturbances of the respiration and circulation, sometimes hæmorrhage. To-day no trained mountain climber ever thinks of such possibilities when making the ascent, and we have conquered 23,000 feet of altitude without sufferings in any way comparable to those we read of in the early days of Alpine climbing.

One would say that mountain sickness, once a necessary evil of mountain climbing, is gradually disappearing, in the same way that scurvy has ceased to be the inevitable accompaniment of polar expeditions. The reason doubtless lies in the development and perfecting of the equipment, and in the gradual increase of knowledge as to the best plan of life and work under conditions of high altitude. Such knowledge reduces to a minimum the exertions, the fatigues and the dissipation of energy, and leaves the climber in the best condition for the actual achievement of his feat of conquest.

The Duke's expedition offers the clearest proof that men can live for extended periods of time, in possession of healthy functional activity of all their organs, at an atmospheric pressure little more than half of normal. Twelve Europeans and fifteen coolies lived for about two months at above 17,000 feet of altitude, working regularly and not showing a single case of illness, even of the most fleeting character, attributable to mountain sickness. At the end of our campaign seven

[1] See in general the volume of E. Whymper, *Andes of the Equator*. London 1892, and *The Highest Andes*, by E. A. FitzGerald (London 1899); also articles by the same author in *Geog. Jour.* 12, 1898, p. 469, and *Alp. Jour.* 19, 1898, p. 1.

[2] S. Vines, *Aconcagua and Tupungato*. *Alp. Jour.* 19, 1898, p. 565

Europeans spent nine days at a height of more than 20,700 feet, during which time four of them camped for the night at 21,673 and 22,483 feet, and this without even the inconvenience of sleeplessness. They likewise made two steep ascents, through deep soft snow, to 23.458 and 24.600 feet, without exhaustion, without lowering of morale, without exaggerated difficulty of breathing, palpitation or irregularity of the pulse; and with no symptoms of headache, nausea or the like. The fact of their immunity admits of but one interpretation—*rarefaction of the air, under ordinary conditions of the high mountains, to the limits reached by man at the present day* ($12\frac{9}{32}$ *inches*) *does not produce mountain sickness.* Moreover, rarefaction of the air is not incompatible with mountaineering work, if this is done very slowly and methodically. From this it follows that the phenomena which have to this day been considered to be the result of rarefaction are, in reality, phenomena of fatigue, or merely incapacity (temporary or permanent) of the system to sustain the exertion of climbing, manifesting itself with special symptoms under the presence of the particular external conditions which prevail in the mountains.

None the less, the experience of the expedition was not one of absolute immunity. The atmosphere of those heights did work some evil effect, revealing itself only gradually, after several weeks of life above 17,000 feet, in a slow decrease of appetite and consequent lack of nourishment, without, however, any disturbance of the digestive functions. It was possible for the lack of appetite to increase and become almost absolute repugnance to food, if after its appearance one moved and established oneself at a greater height. Thus, at Chogolisa Camp the Duke and the guides had given up meat and lived on soups, coffee, tea, chocolate and biscuits. In the two ascents above 23,000 feet their only food all day was a little chocolate, although they suffered no nausea or other unpleasant sensations. Of course, in the long run, this insufficient nourishment would cause a lowering of vitality, loss of flesh and a certain amount of anæmia. However, the process is so slow that we were still at the end of two months in condition to make long marches without experiencing excessive fatigue.

The Eckenstein-Pfannl-Guillarmod expedition seems to have suffered the same decrease of appetite and strength, which Guillarmod attributes to the use of tinned foods. All the former experience of the Duke was against this explanation. On the expeditions to Alaska (Mount St.

Elias) and Africa (Ruwenzori) and on the much longer polar expedition, there was never any repugnance to the tinned foods nor any evil traceable to their use. They were chosen for the Karakoram campaign with the same care as on the other occasions, and came from the same factories. There is no reason to suppose that of themselves they would have any different effect. I am of opinion that the loss of appetite is due instead to incomplete oxidation of waste products or their slower elimination. In either case there would be a gradual accumulation of noxious products in the system, sufficient to explain the symptoms that showed themselves. This theory would also account for the difficulty, already mentioned, with which even a very robust system regained its balance after a slight disturbance, and for the distinctly bad effects of inactivity. Whether the conversion of products were incomplete or only sluggish, movement would be the best stimulant to proper metabolism.

The gradual depletion of force which I have described gives a negative answer to the much debated question on the subject of acclimatization. Perfect adaptation to surroundings is not possible above 17,000 feet. In this view both Schlagintweit and Longstaff concur. The latter mentions that the highest altitudes inhabited by man are the goldfields of Thok Jalung, in Western Tibet, 16,500 feet high, and certain Llamaist monasteries of the same region, 15,000 feet above sea level, from which it would seem that some 17,000 feet would be the limit of permanent endurance.

A curious fact showing how up to a certain point the system undergoes modifications adapting it to life at great heights, is that the people of upper Ladakh are averse to descending lower than 10,000 feet, and positively refuse to go below 7,000 feet for fear of illness. This is mentioned by Knight, and I had the opportunity of verifying the fact. Perhaps there exists such a thing as "mountain sickness" caused by abrupt change from lower to higher pressure. To it may possibly be attributed, at least in part, the exhaustion of the Duke and the guides on the way from Chogolisa Saddle to Askoley. Conway relates that he had more difficulty in breathing when he went down the Baltoro after climbing Pioneer Peak than he experienced during the whole ascent.

I give here a table showing the composition of our daily ration :—

Foodstuffs.	Weight in grammes.	Albuminoids.	Fats.	Carbo-hydrates.	Calories.
Biscuits	500	50·0	1·5	400·0	1,859
Soup paste	100	12·0	0·3	75·0	358
Meat	365	73·0	32·0	—	597
Butter	125	0·7	104·8	0·5	980
Condensed milk (without sugar)	87	8·9	10·0	2·0	138
Cheese	50	15·5	14·0	—	193
Chocolate	41	2·0	5·0	28·3	171
Sugar	120	—	—	105·2	431
Pea flour...	42	4·8	—	12·0	69
Preserves	38	—	—	15·0	61
		166·9	167·6	638·0	4,857

To these were added Liebig's extract, coffee, tea, onions, salt, pepper and mustard. We used ship's biscuits, which take the place of bread excellently well, even for long periods. They were made in Italy, and specially prepared without salt, as they keep better so. Our soup paste was very small, for cooking at 175° F., at which temperature water boils at an atmospheric pressure half of normal. Our meats were Australian, of two or three kinds, but always very simply prepared. In such enterprises the complicated, so-called appetizing cookery employed in most of the tinned foods of commerce is very much better avoided.

We took with us some whiskey to use medicinally or in occasional celebration of some special achievement. But alcohol was excluded from our habitual diet. I cannot concur in the opinion of Conway and Guillarmod that it is necessary to well-being and a useful stimulant.[1]

Next to the question of food, that of clothing as protection against the cold is of importance. A double sleeping-sack (of eiderdown and pelt) is a necessity. With it one is protected from cold of several degrees below freezing, even when the tent is set up on ice and snow. The usual weight of woollens used for mountaineering is sufficient, worn double if necessary. Special attention must be paid to the shoes.

[1] On this point I desire to mention Dr. L. Schnyder's *Alcool et alpinisme* (Geneva 1907), containing the results of a thorough enquiry made among mountain climbers, the large majority of whom gave their opinion against the use of alcohol in mountain climbing. This agrees with the scientific researches which have resulted in the classification of alcohol among the depriments rather than among the stimulants. True stimulants are tea, coffee, cocoa. If one has ample portage facilities one may carry a small quantity of alcohol to use after the day's work is done—but it ranks as a luxury, not as a necessity.

Mountain climbing at exceptional heights is attended with a long record of frozen feet, the cause of which may be, as many believe, retarded circulation. On our expedition we all wore a special sort of boot, devised by the Sellas for winter climbing on the Alps. There is a piece of coney skin between the lining and the leather. The nails must be driven in at the edge of the sole, in such a way that the point comes outside of the upper leather, and thus cannot conduct any heat away from the foot. In their ascent of Kabru Rubenson and Monrad Aas they had to remove the nails from their boots to keep their feet from freezing. On exceptionally cold mornings we wrapped our feet and legs in pieces of woollen stuff held in place by the straps of the crampons. We had no cases of frost-bitten feet throughout the campaign.

I have mentioned that none of us felt any ill effects from the solar radiation, but we all wore our solar helmets all the time. Neither did we suffer to any great extent from snow rashes or *eritema solaris*—of course, this varied with the individual, but all of us were able to keep it within bounds by using lanoline.

I have already emphasized the experimental value possessed by the Duke's expedition on account of the special conditions under which it was made. Thus it is unnecessary for me to discuss in detail the opinions of various other explorers on the question of attaining high altitudes. They are almost all more optimistic than formerly. In 1892 Conway still doubted that it was possible to reach 24,000 feet, but he has surrendered to the accomplished fact. Dr. and Mrs. Workman are the greatest sceptics, and their view has weight because both of them have ascended to over 23,000 feet in the Himalaya and the Karakoram. Yet an analysis of the arguments upon which they base their opinion shows them all to be contradicted by the experience of our expedition. It has disproved their assertion that it is impossible to sleep properly or protect oneself from cold at and over 21,000 feet ; or that rapid diminution of strength appears above 20,000 feet, or serious mental incapacity, loss of will power, etc. Dr. Workman has compiled a set of statistics showing that of the fifteen Europeans who took part in their various expeditions, twelve reached 21,000 feet, seven 22,570 feet, six 23,000 feet, five 23,300 feet, and only three 23,480 feet. These figures could have value only if they had been obtained for fifteen persons starting at the same time in equally good condition of health and vigour to make the same ascent. Unfortunately, parties of fifteen persons cannot make ascents above 23,000 feet, on account of the obvious impossibility of transporting the necessary equipment.

Putting aside all these objections, the logical conclusion to be derived from our expedition is that, under present conditions, altitude is not to be considered as in itself an obstacle to an ascent. Our experience rather tends to prove that, if there is a physiological limit, we are still far from reaching it. The real difficulty to be confronted and solved is the one of transport. In this respect conditions in the Himalaya are most favourable. It has been said that the coolies form one of the great difficulties to be wrestled with in an expedition to the Himalaya. But our experience is quite the contrary—namely, that without their excellent qualities as porters it would be impossible to organize expeditions in this region. Their uncommon strength and powers of resistance, their temperateness, their amenable and gentle dispositions, and their capacity for hard work have already been recognized by all those whom they have served from one end of the Himalaya to the other. A single dissenting voice has little weight in the verdict in their favour.

Our expedition can heartily concur in this verdict as far as the Baltis are concerned. We succeeded in persuading them to camp for several days running above the snow line, and there is no doubt that they would adapt themselves to living without fire if they were supplied with alcohol or paraffin stoves to boil their water and tea. We also induced them to eat some of our food, such as biscuits and butter—a fact not without practical bearing on the subject under discussion. The Baltis are good rock climbers, and quickly learn to walk on the glaciers and steep snow slopes. When they are properly equipped, and if one meets half way with a little sympathy and humanity their natural fears and timidity, one can do anything one likes with them.

Major C. G. Bruce, who is probably better acquainted than any other European with the peoples of the western Himalaya, has recently written some words of wisdom, which I take pleasure in quoting here, for they contain excellent counsel to all future travellers to those regions :—

" The transport question throughout the Hindu Koosh and Himalaya is undoubtedly a difficulty, but in my opinion should not be so great a one as many recent travellers have found it. They, however, are generally handicapped by being unable to communicate direct with the people and by not understanding their point of view. The different native races are much worse fed, certainly worse clothed, and probably more superstitious regarding the great mountains than the Swiss were 100 years ago, and yet there was considerable difficulty at that period in getting even the best chamois hunters to undertake any new bit of exploration. What would have happened if a whole village had been ordered to send every available man with some unknown Englishman, and to stay with him for a fortnight above the snow line, is better imagined than described, yet this is what must necessarily occur in the Himalaya. It will therefore be understood that to get the best work out of men who cannot be expected to go, as a body, anything but most unwillingly, requires tact, sympathy and understanding kindness towards them, as well as considerable assistance in the matter of extra food and clothing, if they are to be employed for any length of time."[1]

It is not only the coolies who need education. Mountaineers and guides have to train their senses to understand and measure the new conditions of a world built upon proportions so incomparably larger than those of the familiar Alps that the judgment even of the most expert is found wanting. They have to learn to estimate the obstacles, the inclination of the slopes and ridges, the height and nature of the rocks, the complications of the ice and snow, all the chances and difficulties of mountain climbing, which can only be successfully met if they are recognized before one enters upon the conflict with them.

The history of mountaineering in the Himalaya is only just begun. Perhaps a time will come when new De Saussures and new Whympers will appear in the field and repeat the story of the conquest of the Alps.

[1] Major the Hon. C. G. Bruce, *Twenty Years in the Himalaya*. London 1910.

APPENDICES.

Appendix A.

PHOTOGRAMMETRIC SURVEY

On the scale of 1 : 100,000

IN THE

KARAKORAM (WESTERN HIMALAYA).

Comprising Part of the Upper End of the Baltoro Glacier and the Godwin Austen and Savoia Glaciers.

BY

FEDERICO NEGROTTO CAMBIASO,
Ship's Lieutenant.

PHOTOGRAMMETRIC SURVEY.

I.—Selection of the Method followed in the Execution of the Survey.

THE Godwin Austen glacier, the two branches of it which surround to west and east the main mass of K², and the buttresses that enclose these, were surveyed by photogrammetry. This special method, invented by the geographer Comm. Pio Paganini, formerly an officer in the Royal Italian Navy, has been adopted by the Military Geographical Institute of Florence for the surveying of high mountains. Thanks to the painstaking studies of many years and to the instruments devised and perfected by Comm. Paganini, his method has attained the highest degree of simplicity and practical utility, and may with advantage replace all other topographical methods in difficult or inaccessible regions. It is especially adapted to steep mountains and large glaciers, to places beyond the frontier or such as are occupied by the enemy; to unhealthy districts; finally, to any place where long and tiresome marches leave little time for surveying with the plane table, tacheometer and theodolite.

In surveying high mountainous regions with the plane table, the Military Geographical Institute has abandoned the use of the tape. The same may be said of the tacheometer, which under the circumstances serves as a theodolite. The points for the survey are always determined by intersection. Then all the directions at points useful for the survey must be observed and noted on the spot, either with the plane table, the tacheometer or the theodolite, and supplemented by numerous sketches to help later in making the map. The method of the plane table, although it has the advantage of enabling one to reproduce natural features on the spot, takes, on the other hand, more time at each station. Moreover, in case of bad weather it is not easy to keep the drawing from being injured in the process of execution, and finally the apparatus is difficult to transport in the high mountains.

With the photogrammetric method all the required directions to the points may be obtained afterwards from the photographs taken from properly chosen stations. The photographic apparatus is provided with special measuring devices to furnish the photographic perspectives with the elements needed for the survey. In the field the only point of similarity between this method and earlier ones is the determination of the stations by taking bearings to surrounding trigonometrical points. This determination may if necessary be made at home with the panoramic views, provided the points are well defined, as is the case in the high mountains, where they usually consist of sharp and conspicuous summits. Thus with the photogrammetric method all that has to be done out of doors is the adjusting of the instrument, the taking of the panoramic views and the noting in the field book the orientation and bearings to the trigonometrical points necessary to determine the station. Other notes may be taken: as of the directions which may help to determine with greater precision such distinctive points as may be useful points of reference for subsequent stations; or to fix the perspective when the number of trigonometric points is insufficient; or to obtain at once a trigonometrical net connected with one or more bases measured directly. This would be necessary in lands where no measurements had previously been taken. The photogrammetric method consists in taking in the field a series of views from different stations, and these pictures serve later as the basis of all those operations which under any other method must be performed on the spot. There is further the advantage that we can determine as many points as we want according to the scale adopted and the amount of detail we wish to give to the map. The Paganini apparatus supplies vertical topographical perspectives, upon which are traced two orthogonal axes. The intersection of these axes coincides with the principal point of the perspective, which by construction is also the meeting of the optical axis of the lens or of the camera with the plane of the image. Of the two perpendicular axes traced on the negative and thence transferred to the positive, one is the line of the horizontal plane which passes through the view-point of the perspective, and thus represents the horizon of the station; the other is the line of the vertical plane which contains the optical axis of the camera; hence also the view-point and the principal point of the perspective itself. This holds good, of course, only when the necessary adjustment of the apparatus is made previously. In order to use the photographic perspectives thus obtained for mapping the ground which they represent, it is necessary to know the distance of the view-point from the plane on which they are formed—in other words, the length of the perpendicular line drawn from the said point to this plane. As in our case we are dealing with photographic perspectives in which the ground shown can be considered to be at infinity,[1] their point of view coincides with the second nodal point of the lens, and the principal focal length of the latter represents the length of the aforesaid distance. The lens

[1] Cf. Paganini, *Fotogrammetria*. Milan U. Hoepli 1901.

of the Paganini apparatus is provided with a graduated scale in millimetres and tenths of millimetres, in order that this length may be taken with precision. It is determined once for all at the beginning of work, by bringing into the focal plane distant points and making a series of observations in order to arrive at a mean value approximating the true one. With the help of the graduated scale it is easy to keep this value constant in all the perspectives obtained during the survey. Paganini calls this value the "indicated focal length," to distinguish it from the one determined afterwards at home for the perspectives on paper, which serve for the actual construction of the map. For further particulars the reader is referred to the hand-book mentioned above. This factor is most important because it establishes the relation between the dimensions of the objects and those of the corresponding images on the perspectives. It must be determined therefore with the greatest care and, when necessary, corrected by calculations before setting to work on the survey.

Another element which must be established upon the spot is the orientation of the perspective: that is, the horizontal angle made by the optical axis of the camera (in other words, the perpendicular line from the view-point to the perspective) with the direction to a previously determined point in the field of operations; or, failing this, the azimuth of the optical axis, given by a compass attached to the apparatus. The outdoor work, therefore, is reduced to the following steps: (1) The adjustment of the instrument; (2) the rectification of the level or of the verticality of the axis of rotation; (3) the execution of the panorama (preferably in the first perspective intersecting with the vertical wire some signal point or conspicuous point previously fixed, in order to orientate the panorama with as great precision as possible); and (4) the observations of zenith and azimuth —or of the latter alone, as in the case of the apparatus used by the expedition— of the surrounding trigonometrical points necessary to fix the position of the station, with the addition at most of certain conspicuous points which may later be of value as reference points for locating other stations in cases where geodetic points are unavailable.

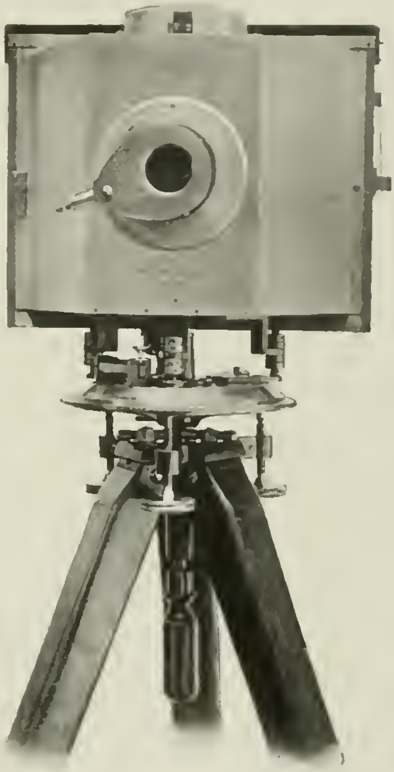
II.—Description of the Apparatus.

Paganini has invented various types of photogrammetric apparatus for the use of the Italian Military Geographical Institute. They are manufactured by the Galileo Company, of Florence. However, when the expedition wished to furnish itself with an instrument, this firm had only one on hand, a model of 1897, arranged by Comm. Paganini for surveys on the scale of 1 : 50,000 and 1 : 100,000 in Erithrea. This model, however, though less in weight, bulk and price, and possessing the greatest simplicity and ease of manipulation, is not altogether adapted for work in very high mountains. We had to content ourselves with it, none the less, as the time was too short for the construction of a new instrument.

Paganini has recently invented a marvellously ingenious one, which unites all the advantages I have mentioned with that of the higher degree of precision possessed by the model furnished with the vertical circle, which was an earlier invention.

The pattern of 1897 has a short focal length (18 centimetres) and takes plates 18 by 24 centimetres (7 by $9\frac{1}{2}$ inches), with the larger side horizontal in order to take in the entire horizon with an equipment of six plates. It may be employed successfully in Erithrea, and has given brilliant results in Russian work in Transbaikalia and Transcaucasia, where the district is less rough and the differences of level less pronounced than in the Alps and the Himalaya. But in the photogrammetric work executed on the Baltoro and Godwin Austen glaciers the panoramic views could not all include the highest peaks, as was, of course, desirable, because the vertical dimension of the plates was too limited to embrace the enormous difference of height between the stations and the surrounding summits. Moreover, the instrument was not furnished with the vertical circle and telescope, as in the other Paganini models; thus the bearings to the most important points had to be taken by means of the vertical wire as seen through the ground glass; and others, as also the heights of the points, had to be determined at home by the co-ordinates x and y of their images measured on the perspectives. These facts simplified the outdoor work very much, but increased the labour afterwards in obtaining the data for the construction of the map. Undoubtedly this apparatus enables the work to be done very quickly on the mountains, and reduces to a minimum the time spent by the operator while exposed to discomfort and bad weather. He must note the indispensable data. These are recorded in a field book, together with such subsidiary observations as sketches to facilitate the locating of the points in the panoramas, names, routes followed, time of exposure and other miscellaneous information. The apparatus has also the great advantage of maintaining unaltered for a long time the adjustments made before beginning work — a fact which contributes much to the success of the observations. A brief description of the apparatus will make this plainer.

It consists of a rigid camera, made of aluminium, in form a right prism, the base of which is an isosceles trapezium. The back of the camera, which is perpendicularly placed upon the largest of the parallel sides of the trapezium, consists of a frame holding the ground glass or the sensitive plate. The front of the camera has fixed at its centre a tube, inside which runs another tube adjustable by means of a screw with a millimetre thread. To this the lens is fixed. A graduated scale in millimetres, which has as origin the focal plane—that is the surface upon which the images are received—is marked externally along the fixed tube, while to the movable tube carrying the lens is attached a ring with a sharp edge which comes into contact with the fixed tube. Thus, turning the inner tube in order to move the lens backward and forward causes the edge of the ring to cut the graduated scale, and thus serves as fiducial line or line of collimation, indicating on the scale itself the distance of the lens from the focal plane. The bevelled edge of the ring is divided into ten equal parts in order to read upon it the divisions of the movable tube—in other words, the tenths of the thread of the screw. This, added to the whole number of millimetres read on the fixed tube, gives in millimetres and tenths of millimetres the distance of the second nodal point of the lens from the focal plane. This value, the "principal indicated focal length," is determined at the beginning of the campaign, and in all subsequent operations care must be taken that the line of collimation of the tube carrying the lens is so adjusted as to give always the same value. This was carefully determined upon the apparatus of the expedition before leaving Srinagar, and gave a result of 180·3 millimetres.



PAGANINI PHOTOGRAMMETRIC APPARATUS, 1897 MODEL.

The objective is a Zeiss anastigmatic and belongs to a special series of wide angulars for photogrammetric work. With a small diaphragm we obtain a clear image 40 centimetres in diameter; with the f–35 diaphragm it produces a clear image free from distortions upon a plate of 20 by 26 centimetres. Thus the plate 18 by 24 centimetres used with this camera took very clear images over its entire surface, even when a large aperture diaphragm was employed; while the luminosity is so great that it is better to use plates of only medium rapidity, or, better still, orthochromatic ones, as we did.

The perspectives thus obtained have a horizontal field of 67° and a vertical one of 54°. In this way, with six perspectives with a displacement of the optical axis of the camera about the vertical axis of the apparatus of 60° for each of them, a panorama is obtained which comprises the whole horizon, plus a narrow vertical band—a horizontal field of 3° 30′ between each one and the next. This vertical band in excess is indispensable, to ascertain the correctness of the panorama, to determine the distance of the point of view from the perspectives, and to join the positives accurately to one another in order to form the panorama. As the vertical field is 54°, one can measure from the perspectives and vertical angles up to 27°. Owing to the enormous differences in level with which the expedition had to contend, a larger vertical field would have been more advantageous. In the new apparatus of Comm. Paganini it is possible to adjust the camera so as to have the larger dimension of the plate (24 cm.) run vertically, giving angles of height or depression up to 33° 30′. To make the entire circle of the horizon eight plates would be necessary, with a horizontal displacement of 45° of the optical axis, giving a vertical band of 4° 30′ between each two contiguous pictures. The new instrument, being capable of reduction to telescope and being furnished with the vertical circle, can, even without the reversible movement I have described, take the angle of peaks whose summits fall outside the upper margin of the plate. This arrangement, too, would have been very useful in the construction of the map.

In all the Paganini apparatus the optic axis of the lens is fixed in a direction perpendicular to the plane of the image. The intersection of the above axis with this plane is marked photographically by the intersection at right angles of two very thin silver hairs stretched before the ground glass on the back of the camera in such a way that they can be easily withdrawn or replaced in case of breakage. The horizontal silver hair, once adjusted, serves, as I have said, to indicate the horizon line upon the photographic perspective. Below the camera are three arms bent at right angles, one anterior and the others posterior. Each has a hole in its end, through which passes an adjustable shaft fixed perpendicularly to the movable plate or alidad of the horizontal circle. The camera can be fixed rigidly at the required position upon the alidad by means of nuts and bolts screwed on to the shafts. This position remains, if possible, invariable throughout all the outdoor work. Its stability is very important, since the said position must satisfy the requirement that the plane containing the optic axis of the camera and the axis indicating the horizon of the station is exactly horizontal as soon as the rotation-axis of the alidad or of the instrument has been vertically disposed. Thus the only adjustment to be made of the instrument in the different stations is to correct the level placed on the alidad, at the same time arranging vertically the rotation-axis of the apparatus.

The azimuthal circle of the apparatus has a diameter of 14 centimetres and its edge is graduated from 0° to 360°, each degree being subdivided into two equal parts, each of which embraces 30′. The vernier is fastened to the movable plate or alidad, and permits us to read the minutes and to appreciate even the 30″. In addition to the three shafts and a level, the alidad is provided with a magnifying lens to use with the vernier and a regulating-screw to use for the small adjustments of collimation. The verticality of the rotation-axis of the instrument is attained by means of three levelling-screws, which pass through the top of the tripod and hold the horizontal circle. This is fixed upon the tripod by means of a clamping-screw with a spring and a handle, which, passing through the head of the tripod from bottom to top, is screwed into a movable support shaped like a half-sphere, fastened by means of a ring under the horizontal circle.

A compass of the Dixey or the Smalcalder type is mounted upon the top of the camera. It can be so adjusted that the vertical visual plane of its bearings coincides with the direction of the optic axis of the camera. Thus it becomes possible to use the compass to orientate the panorama when it is not possible to aim at trigonometric points or at any others of which the position is known. The tripod may be taken to pieces; each foot is in two parts[1] which can be solidly fastened together when the apparatus is set up. We have seen that the most important adjustment consists in fixing the camera upon the alidad in such a way that the plane containing the optical axis and the silver hair which traces the horizon-line upon the perspectives are perpendicular to the rotation-axis of the instrument; and reciprocally, when this rotation-axis is adjusted vertically the plane of the optical axis will be horizontal. In the other apparatus of Paganini this result is attained by means of the telescope of the acclimeter, which may be inverted (pattern 1884), or by the same camera obscura reduced to a reversible telescope (pattern 1889). In the model employed by the expedition the horizontal adjustment is made as follows:—

The three arms of the camera are first placed at approximately the same height upon the movable plate by turning the lower screws with the pins belonging to them, having previously raised the upper ones in order to give free motion to the arms on their respective shafts. Then looking through the ground glass of the camera under the black cloth, and moving to right or left and up or down as necessary, by adjusting the screws, distant points are brought to coincide with the point of intersection of the wires, until by moving the camera in both directions around the rotation-axis, a point is made to run all along the horizontal thread from one extreme to another, without passing above or under the thread. If the rotation-axis is vertical, this coincidence of a point with the horizontal thread in its whole length can only take place when the plane of the optical axis and the wire which traces the horizon-line on the perspective are horizontal. If the plane is not horizontal, and accordingly the plane of the ground glass is not vertical, one observes that in moving the camera to right or left the image gradually diverges from the horizontal wire, describing the segment of a hyperbola either above or below the wire, according as the point cited is situated above or below the horizon.

In practice the following method will secure the horizontal adjustment of the wire and the plane of the optical axis:—

First turn the screws which support the posterior arms of the camera, operating in such a way that by revolving the camera all the way through its field some distant point which is covered by the wire on one of its ends coincides with the other end of the wire. Thus the horizontality of the wire will be fixed. If this point is not on the horizon, it will be seen to describe a curve during the revolving of the camera, passing above or below the intersection of the wires according to the inclination of the optic axis downwards or upwards. The vertex of the hyperbola will be found upon the vertical thread, and it will be easy to estimate the

[1] In the original instrument the feet are in one piece.

convexity of the said curve. Then the screw controlling the anterior arm of the camera will be turned, and the latter raised or lowered until the image of the point is brought to coincide with the intersection of the wires. By making observations of successive points continually approaching the horizon, the right position will soon be arrived at, when all the screws are tightened in order rigidly to maintain it.

III.—Calculations and Construction of the Map.

The panoramic view obtained under the above conditions gives an image of all the field seen from the station. Together with other panoramic views obtained in like manner at suitable stations, it gives the elements necessary for the execution, on any scale, of the map of that tract of land which they represent. Each perspective of the series is considered separately in constructing the map. The focal distance is equal for all, and all are furnished with the horizon-line and the line of the vertical plane, the latter containing the visual point and the principal point of the perspectives.

Paper positives are used for making the survey, it being possible to allow for the alteration undergone by one single quality of paper and to use a focal length corrected accordingly. This focal length is obtained before proceeding to the survey. It is independent of the "indicated focal length," and is called the "real focal length." All the directions to the points represented in each picture may be easily determined by means of the co-ordinates x and y of their images referred to the perpendicular axes traced on the picture itself, through the following very simple equations:

$$tang\ \omega' = \frac{x}{f} \qquad (1)$$

where f is the real distance of the view-point from the perspective, the orientation of which ω' is known, being an element obtained at the station; and ω' is the angle made by the horizontal direction to a point (x, y) of the perspective with the perpendicular to it from the view-point.

$$tang\ \alpha = \frac{y \cos \omega'}{f}, \qquad (2)$$

where α is the angle that the direction to the image of the point observed makes with its projection upon the horizon, that is to say, with the horizontal direction of the point itself. But also it is

$$tang\ \alpha = \frac{L}{D},$$

where L is the difference of level between the point considered and the station and D the horizontal distance between these points. Hence

$$L = \frac{D\ y \cos \omega'}{f} \qquad (3)$$

After having obtained by formula (1) the bearings of the various points useful for the survey, which are visible on the panoramic views taken from two or more stations, the position of these may be obtained by intersection.

By formula (2) we get their angular elevation; then, having the distance and the difference of level between the points and the station, by means of tables in use at the Military Geographical Institute, one can finally obtain directly the vertical difference by means of formula (3).

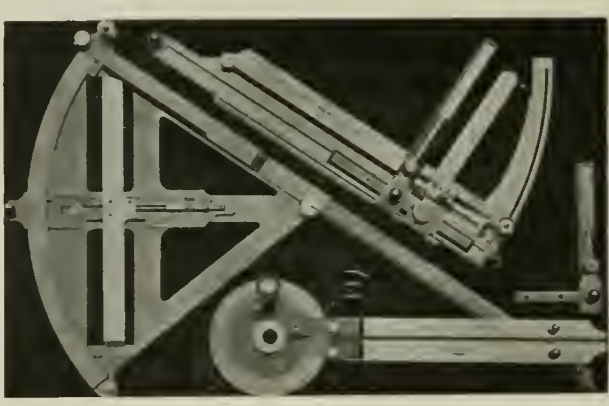
But this is a very long method, and in order to solve the equations given above it is necessary to have the numerical value of the co-ordinates x and y and the distance D. These numerical values are very useful when the survey is on a very large scale, as in civil or military operations; whenever it is a question of data for finding points on the ground. But they are superfluous for a topographical map on a small scale, as in the construction of the map these values would have in any case to be reproduced graphically.

IV.—Simplifying the Survey by means of Special Drafting Instruments.

By the Paganini photogrammetric method adopted by our Military Geographical Institute, the position of the points and their elevation can be taken mechanically and rapidly by means of special drafting instruments, the construction of which is based upon the above formulæ, and upon which the distance D and the co-ordinates x and y are transferred directly with the compass and upon the scale of the map, making it unnecessary to know the numerical value of these measurements.

The construction proceeds in the following manner: the trigonometric points are fixed at the desired scale by means of their rectilinear co-ordinates. Then with the special instrument called by Paganini "*rapportatore ad origine variabile,*" the photogrammetric stations are put in place, as well as whatever other special points have been selected for the purpose of adding to the points of reference in a number proportionate to the scale of the survey. With this instrument the various directions can be traced directly on the transparent paper just as they were read at the time of the outdoor operation on the horizontal circle of the photogrammetric apparatus or the theodolite. With the transparency thus made are placed the stations and the directions from them to the other images necessary to determine further points of reference in addition to the trigonometric ones. With this instrument it is possible to assume any one of the bearings observed as origin of the horizontal circuit and to proceed by degrees, by means of the alidad, to the other readings. In this way is obviated the necessity of all the mathematical calculations to reduce to zero the readings made out of doors, as is the case when the ordinary finders are used—a very long operation when there is a large number of points to be located.

When the stations and all the points intersected by them have been put on paper, we proceed to the determination of the secondary points, or detail, all chosen beforehand for the purpose of the draft. After the various elements of the panoramic views have been corrected, a selection is made from them (taking them two by two, at contiguous stations) of points useful to the survey; either for the purpose of tracing contours, or for determining the lie of various ridges, the direction of streams, the limits of glaciers, bases of rocks, &c. The operation is regulated for the number of points chosen according to the scale that is desired, the precision required, and the time at the disposition of the operator. All these points have been registered in the notebook, according to the station from which they were taken, and marked on the relative panoramic views with numbers or letters written in red ink.



PAGANINI DRAFTING INSTRUMENTS USED IN CONSTRUCTING THE MAP.

The tracing on the design of all directions to these secondary points used to be a very long and monotonous operation and far from accurate. The modern process is quick and simple, thanks to a special drafting instrument based upon the formula (1) quoted above, and called the "graphical sector for the directions to secondary points of the perspective." By its means the horizontal projection of each perspective is traced successively upon the design, carefully orientated, with its principal point at the effective distance from the station point, in such a way that, by transferring with the compass the abscissæ of the various points taken on the views to a scale cut on a metal ruler, the corresponding horizontal directions may be easily drawn by means of a movable plate (or alidad) furnished with a metal ruler, moving about the station point.

With another instrument, specially designed for drawing the elevations, based upon formulæ (2) and (3), differences of level are obtainable, and therefore also the elevations of the stations and of the secondary points of the perspectives. When the apparatus is provided with vertical circle and telescope the angular elevations of the trigonometrical points are read directly on the ground. In this case one obtains the elevation directly from reading the instrument, by means of the distance on the design between the station point and the trigonometrical point of which the altitude is known and from the station point to the observed angle α .

But without the vertical circle the determination of the heights depends upon the value of the abscissæ and the ordinates of the trigonometric points of the perspectives, the height of which is taken with the compass on the perspectives themselves, likewise their graphic distances ; so that the differences of level between them and the station point, and also the height of the latter, may be read directly upon the instrument. In the same manner, once the height of the stations is obtained, the difference of level is determined, and therefore the height of the secondary points of the perspective considered useful to complete the survey. As in the case of all the other methods, corrections must, of course, be made of all these apparent differences of level, on account of the refraction of the light and the roundness of the earth. Tables compiled for the purpose are used.

V.—Topographical Work of the Expedition and Construction of the Survey.

In a little more than a month—in other words, from May 25th to July 2nd—the expedition executed twenty-two photogrammetric stations, using 106 negatives. On account of the limited number of plates at our disposal, not all the panoramic views embraced the entire horizon. The region surveyed includes the Concordia amphitheatre of the Baltoro glacier, the Godwin Austen glacier up to Windy Gap and the Savoia glacier, which flows about the western side of K^2.[1] It was a pity that lack of plates prevented our extending the survey southward, upon the arm of the Baltoro as far as Bride Peak, the ascent of which was one of the aims of the expedition. The work was supplemented, it is true, by compass and tacheometer and with barometrical stations ; but among the innumerable peaks of such strange appearance the eye becomes easily confused in passing from one station to another. The numerous sketches taken on the spot did not give all the information really desirable for map-drawing, and are certainly inadequate to give all the characteristic detail of this rugged, broken and largely inaccessible region. Sella's numerous photographs and panoramic views were, on the other hand, of great assistance in making the design, as some of them were taken from high and commanding elevations and under conditions making it possible to determine approximately the photogrammetric elements, so that they served, if not for measurements of altitude, at least for sufficiently exact azimuthal directions. With this end in view, Sella marked his stations by setting up cairns visible from the photogrammetric stations, so that they could be included in the network of stations of reference or geodetic points upon which the survey was based.

It is possible that instead of glass plates we might have used films, which are so much more convenient because of their small bulk and weight. Comm. Paganini, however, does not consider their use advisable, as no good results have been

[1] See the heliotype reproduction of the photogrammetric panorama (S) given on a natural scale a an example of the work done.

obtained with them in three previous campaigns. They easily undergo changes in the celluloid, owing to their sensitiveness to heat, cold, moisture and the chemicals used in developing; so that the image varies in a way which would not be noticeable in ordinary photographic work, but which is sufficient to cause errors in the measurements, which must be corrected to the tenth and hundredth of a millimetre.

The Military Geographical Institute was authorized to execute the topographical representation of the region surveyed by the expedition. It confided the work to Comm. Pio Paganini. The scale chosen for the map was 1 : 100,000. The work proved somewhat arduous, especially at the beginning, on account of the deficiency of well-defined geodetic points, which necessitated referring the survey to several conspicuous points determined by intersection—in other words, concluded from vertices of the secondary triangulation executed for Kashmir, which is, in its turn, connected with the North-western Himalayan series of the primary triangulation of India. A double chain of triangles (quadrilateral and diagonal) of the secondary triangulation of Kashmir extends along the course of the Indus from south-east to north-west, from a point very near its sources to as far as Skardu, where it bends southwards in order to join up with the main system of the Indian survey. From the vertices of this portion of the trigonometric chain (Upper Indus triangulation) were intersected the highest summits of the Karakoram, including the two Masherbrums, Peak No. 8 or Bride Peak, Peak No. 9 or Hidden Peak, Nos. 10, 11 and 12 of the Gasherbrum range, and lastly and highest of all Peak No. 13 or K^2—all these summits surrounding the tract which was to be mapped. But we must consider that these points were intersected at distances of 50 and 100 miles with cross-bearings meeting at acute angles and taken from relatively low points, while there were no signal stations to mark with precision the points aimed at, and thus it was not possible to determine their position otherwise than approximately. However, the following table shows the elements of the points which were used for the purpose in question. It was not always easy to recognize them as they appeared on the perspectives. They were measured also with the tacheometer from several stations, as is shown on the sketch of the triangulation.

Points observed.	Latitudes N.	Longitudes E.G. (old determ.)	Height.	Height.	No. of the determined visuals.		Difference per mile in common sides of triangles.
					Position.	Height.	
			feet	metres			feet
Masherbrum East ...	35° 38′ 36″·4	76° 90′ 57″·9	25,660	7,821·3	9	7	0·4
Peak No. 8 : Bride Peak	35° 36′ 44″·0	76° 36′ 50″·0	25,110	7,653·6	6	4	1·5
Peak No. 9 : Hidden Pk.	35° 43′ 30″·0	76° 44′ 15″·0	26,470	8,068·5	6	4	1·6
Peak No. 10 } Gasherbrum	35° 45′ 31″·0	76° 41′ 42″·0	26,360	8,034·6	6	2	2·4
Peak No. 11 } Gasherbrum	35° 45′ 36″·0	76° 41′ 00″·0	26,090	7,952·3	6	2	2·0
Peak No. 12	35° 45′ 38″·0	76° 39′ 29″·0	26,000	7,924·9	6	2	0·8
Peak No. 13 : K^2 ...	35° 52′ 55″·0	76° 33′ 18″·0	28,250	8,610·7	10	9	2·7

We see that the figures most to be trusted are those for Masherbrum East ; the other Peak, or South-east, was omitted because it was invisible from the region surveyed, being masked by the first, which is only about 1,000 feet from it. The tract surveyed was comprised within a square formed by Masherbrum, Bride Peak, Hidden Peak and K². Thus a point was chosen for the origin of the rectilinear co-ordinates which was the approximate centre of this square—that is to say, about at the intersection of the meridian 76° 35′ E. with the parallel 35° 45′. The graduation of the longitude in the final survey was put 2′ 30″ farther east, according to the correction made in 1877 to the longitude of Madras, upon which are based the longitudes of the triangulation of India.

The most distant point, Masherbrum, is about 15 miles from the origin of the co-ordinates ; as the origin itself has the latitude of 35° 45′, nearly the same as the southern end of Italy, the elements for the calculation of the rectilinear co-ordinates are already to be found in the appropriate tables.[1] They result from the formulæ :

$$x = I_0 \cos L \, \Delta \, P''$$

$$y = II_0 \, \Delta \, L'' + III_0 \, (\Delta \, P'')^2$$

in which L is the latitude and P the longitude of the point ; I_0, II_0 and III_0 are constants which depend upon the origin of the co-ordinates of latitude L and longitude P. The value of these constants is obtained from the aforesaid tables and calculated with the Bessel ellipsoid elements :

$$I = N \sin 1''$$

$$II = \rho \sin 1''$$

$$III = \frac{1}{4} \, N \sin 2 \, L \sin^2 1''$$

N and ρ are respectively the great normal and the radius of curvature of the meridian ellipsis for latitude L. For the points before mentioned, with the relative geographical co-ordinates given by the catalogue contained in Vol. VII (Division E, Group I, No. 13), Triangulation of Kashmir, the following rectilinear co-ordinates were obtained :—

Masherbrum East	x =	− 21333·8	(69992·8)	y =	− 11796·0	(38700·7)
Bride Peak	,,	+ 2768·1	(9081·7)	,,	− 15285·0	(50147·6)
Hidden Peak	,,	+ 13946·2	(45755·2)	,,	− 2757·4	(9046·6)
Gasherbrum I.	,,	+ 10097·6	(33128·6)	,,	+ 949·6	(3115·5)
,, II.	,,	+ 9042·5	(29667·0)	,,	+ 1114·0	(36548·5)
,, III.	,,	+ 6756·7	(22167·6)	,,	+ 1173·7	(38507·2)
K²	,,	− 2558·1	(8392·7)	,,	+ 14638·7	(48027·2)

[1] See *Istituto Geografico Militare. Istruzione per la resoluzione di alcuni problemi riguardanti e relazioni di posizione fra punti dati per le loro coordinate geografiche.* Florence. Barbèra, 1896.

Thus it was possible to fix the above points on the drawing on the scale of 1 : 100,000, proceeding afterwards to the necessary adjusting by means of the sides, using the well-known formula :

$$S = \frac{\rho_0 \Delta L''}{\cos \phi} \sin 1'',$$

where the angle ϕ is given by the formula :

$$tang\, \phi = \frac{N_0 \cos L_0}{\rho_0} \frac{\Delta P''}{\Delta L''}$$

This formula may also be used for distances over 30 miles. S is the length or side unknown : $L_0 = L_m + \epsilon$ where L_m is the mean latitude and ϵ a little correction omitted in case of distances under 25 miles. N_0 and ρ_0 are the principal radii of the ellipsoid, in correspondence with latitude L_0. Thus were obtained the following distances :—

K² – Masherbrum East	32424·0 metres	(106377·9	feet)
,, – Bride Peak	30395·0 ,,	(99721·1	,,)
,, – Gasherbrum I	18641·0 ,,	(61158·1	,,)
,, – Hidden Peak	23985·0 ,,	(78690·9	,,)
Hidden Peak – Masherbrum East	36418·0 ,,	(119481·6	,,)
,, ,, – Gasherbrum III	8197·1 ,,	(26893·4	,,)
,, ,, – Bride Peak	16787·0 ,,	(55075·4	,,)
,, ,, – Gasherbrum II	17559·0 ,,	(57608·3	,,)

The circuits of the horizon, executed from different stations and transferred to the drawing by means of the finder, serve also to fix on the design the photogrammetric and tacheometric stations, and also to determine those other significant points which are to be used as points of reference for further stations and for the orientation of the perspectives. This was indispensable, for the photogrammetric stations scattered over the Savoia and Godwin Austen glaciers, not all of which could take in three points of the Indian Triangulation, could by this means be located with sufficient exactness on the drawing.[1]

Two positives were printed of each of the panoramic views, one for composing the panoramas themselves, the other to measure with the compasses the co-ordinates of the points useful in the survey, after having chosen and distinguished them on the views. The effective distance of the perspective view-point was then determined on the unmounted prints. All these being taken under the same conditions and with a constant indicated focal length, and the same quality of paper being used for printing, always cut the same way of the fibre, the result must be a constant value for the effective distance, in all the printed positives. This value is determined by getting the mean of various measurements made on several

[1] See the sketch of the triangulation, whereon are marked all the points which served for the construction of the survey.

perspectives and for different panoramas[1]. The focal length indicated by the lens in our case was 180·3 millimetres, and the true focal length determined at Florence was 180·6 millimetres. After having chosen and marked in red on the perspectives the various secondary points to be mapped, and transferred their abscissæ upon the sector in accordance with the directions already described, and properly orientated on the drawing, the directions to the said points of the various stations are traced, and by intersection their position in the survey is obtained. Some 300 points were determined in this way.

Finally, in the same way, by carrying the abscissæ and ordinates upon the finder for altitudes the heights of the said points were determined by at least two derivations. With the help of all these points and the stations and references fixed upon the panoramas, it was possible to complete the map, inserting the details and forms of the region—in which the panoramas were of the greatest assistance.

The difficulty of the ground, the scarcity of trigonometric points, the impossibility—owing to the enormous differences of level—of accurately sighting trigonometric summits unprovided with signals, the short time at our disposal, the limited number of photographic plates, all this prevented us from gathering sufficient elements for a true topographical survey. However, we may feel some satisfaction over the result achieved under such conditions. It has at all events sufficient accuracy to serve as point of departure for other explorers making a more extended survey in the same field.

In conclusion, I must express our gratitude to Comm. Paganini, to whose methods and whose instruments we are almost wholly indebted for the work executed on the spot, and to whose experience and assistance we owe the execution of the map. My zeal to make known an admirable topographical method, remarkable for its simplicity and its suitability for high mountain work, has led me to describe it in considerable detail. For, despite the fact that this method has been employed in Italy, with the best results, since 1876, and has been introduced also in certain foreign countries, the English Royal Geographical Society does not mention it, even in its most recent publications (*Hints to Travellers*, 9th ed., 1906; and *Maps and Map Making*, E. A. Reeves, 1910); and, in fact, considers the application of photography to topography to have a very limited and subordinate value. The June number of the *Geog. Jour.*, 1911, has an article by A. O. Wheeler, of the Topographical Office of the Canadian Government, in which full justice is rendered to the photogrammetric method, and which will no doubt contribute toward making it better known in England.

[1] For description of this determination see the monograph already cited and the *Manuale* of Comm. Paganini.

APPENDIX B.

METEOROLOGICAL DESCRIPTION

AND

ALTIMETRIC CALCULATIONS

From Observations made by the Expedition of
H.R.H. THE DUKE OF THE ABRUZZI

IN THE

KARAKORAM

AND

WESTERN HIMALAYA.

BY

Prof. DOMENICO OMODEI.

Appendix B.

I.—LIST OF INSTRUMENTS USED.

The expedition was equipped with the following instruments for making the more important meteorological observations, especially those used for computing heights :—

I. One mercurial Fortin barometer, No. 3314, with graduated scale from 240 to 520 millimetres.

Id. No. 3313, with graduated scale from 240 to 520 millimetres.

Id. No. 3312, with graduated scale from 210 to 490 millimetres.

Id. No. 1, with graduated scale from 200 to 400 millimetres.

II. Two aneroid barometers furnished with three graduated scales for altitudes to 29,000 feet.

III. One hypsometer with three pairs of thermometers :—

1st from 58° to 78° in tenths.
2nd ,, 65° ,, 88° ,,
3rd ,, 72° ,, 102° in half-tenths.

IV. Two pairs of thermometers maximum and minimum self-registering.

V. Four mercurial thermometers.

VI. Two standard thermometers.

VII. Four thermometers with bulb blackened in vacuum.

All the above instruments were verified at the National Physical Laboratory at Kew, with the exception of the hypsometers. Of these the pair from 72° to 102° had already been used on the Ruwenzori expedition, and the others were manufactured and corrected in Geneva.

The correction of some of the mercurial Fortin barometers remained uncertain for lack of apparatus with which to compare them at such unusually low pressures; but this was compensated for by making numerous comparisons under low pressures in the mountains. In this way it was possible to use all the barometers.

These instruments, in consequence of their special construction, are very fragile, and unfortunately the damage is not easily discovered by external marks, so that the observations may be very erroneous if not taken with great caution. It is necessary for this reason to submit them to continual comparison in order to give assurance of their regular working. A great many of these comparisons were made both with the barometers and the hypsometers—in fact every time the opportunity arose—and always with reference to No. 3314, of which the exact correction was known. Especial care was taken to preserve this barometer from deterioration.

In order to render the following table more concise, only those results are given which were obtained from the various series of comparisons, some of which were made before the highest ascents, some at the most elevated points and some during the descent.

No.	Dates of comparison.	Number of observations.	Extremes of pressure. mm.	Correction. mm.
	Barometer N. 3313.			
I.	May 13th, 20th, 26th, 27th, 29th and June 2nd	8	from 414·09 to 536·13	+ 1·215
II.	July 19th, 20th, 23rd and 28th ...	8	,, 393·90 ,, 471·13	+ 1·205
			Mean	+ 1·215
	Barometer N. 3312.			
I.	May 20th...	3	from 468·99 to 469·32	+ 1·180
II.	July 23rd and 28th	3	,, 468·71 ,, 471·30	+ 1·040
			Mean	+ 1·110
	Barometer N. 1.			
I.	May 31st, June 1st, 6th, 8th and 13th	9	from 399·39 to 398·60	+ 1·150
II.	July 8th, 9th and 10th	3	,, 354·47 ,, 391·07	+ 1·220
			Mean of means	+ 1·810

The table shows that despite the difficulty of transportation, the correspondence of the barometers was very satisfactory, so that the results obtained are quite reliable. It is important to note that the greatest number of observations were taken with barometers Nos. 3314 and 3313 (No. 3312 was used in the base camp at Rdokass); and that the observations with the hypsometer were always taken at the same time (with two, and sometimes with four thermometers) to avoid all chance of error. The readings of the thermometers (within the limits of approximation of the instrument) were always in accordance with those of the barometers.

Only limited use was made of the aneroids. However, they were compared from time to time with the mercurial Fortin barometers in order to keep them ready in case of need. The experience acquired in Africa on the Ruwenzori, as well as on the present expedition, has positively demonstrated that one cannot rely upon the indications given by the aneroid barometers, however accurate their construction, on account of the unavoidable shaking up they get in transportation. The hypsometer was carried as a substitute for the mercurial barometers in case of breakage, and also for those ascents on which it might not be possible to carry the barometers. The hypsometer certainly gives a less degree of precision than the mercurial barometer. The error of one-tenth of a degree (which is not unlikely to occur owing to the difficulties attending the observations) would cause a corresponding error in the pressure of about two millimetres, an error not possible to the readings of the mercurial barometer.

To ensure the greatest possible degree of accuracy, the use of the hypsometer was constantly associated with that of the mercurial barometers; because, though no doubt the results it gives have a smaller degree of precision, it may be useful in detecting the presence of any disturbing agent in the Fortin barometers—the penetration of an air bubble, for instance, which is the commonest and the most to be feared. With few exceptions, use was made of the sling-thermometers for measuring the temperature of the air. These are certainly preferable to the stable ones, although long usage proved fatal to several of the instruments. They enabled us to obtain the measurement of the tension of vapour and of the humidity of the air, their bulbs being covered with a sheath of cotton soaked in water.

In order to get an approximate idea of the intensity of the sun's heat, thermometers with the bulb blackened in vacuum were used.

In providing the above instruments, the Duke was perfectly aware of the just criticism usually made by scientists upon determinations of this nature. But he contented himself with little, not being able to obtain the best.[1]

The carrying of a meteorological cage would have been difficult, and its advantage was problematical. Therefore the following arrangement was adopted for the exposure and reading of the instruments.

At Rdokass, where the period of the observations was most extended, the instruments were hung on a cross-piece about three feet high, held up by two stakes, while a waterproof cap of convenient height served to protect them from rain and sun at every hour of the day. For the other stations a wooden tripod was employed, covered with a strong canvas cap, under which the instruments were suspended in such a manner as to secure free circulation of air.

The hours of observations indicated in the following tables correspond always to the local time at which the observations were taken in the observatories of India, the data of which were considered as terms of comparison.

[1] On the Ruwenzori expedition the Duke had carried among other instruments an excellent Ängström attinometer, but owing to its bulk and the great difficulty of its management, which required a reflecting galvanometer, he was unable to make use of it as he had hoped.

The greatest accuracy was aimed at in taking the observations—as far as the sometimes very difficult circumstances would permit. The comparison of barometers, which I have described above—which might satisfy the requirements of a laboratory rather than the conditions of an arduous campaign—is sufficient demonstration of the care and circumspection practised. In the tables that follow are given all the observations taken by the expedition from Gund to Tragbal, between April 25th and August 8th.

The readings of the barometers have been corrected for instrumental error, reduced to 0°, and for gravitation; corresponding corrections for all the other readings being made in the same way.

The tables showing the observations as they were entered in the note-book on the spot, though they refer to only a limited period of time, form a valuable and interesting addition to our knowledge of the climatology of these distant and still little known regions.

II.—TABLE OF RESULTS.

A.—From Srinagar to the Baltoro Glacier.

Date. Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature. Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
GUND (stay from 11.30 a.m. of the 25th to 7.30 a.m. of the 26th).											
April...	25	4 p.m.	—	—	18·0	6·82	44	20·0	6·5	—	Half overcast sky, cirri-strati.
SONAMARG (from 2 p.m. of the 26th to 6.30 a.m. of the 27th).											
April...	26	4 p.m.	—	—	6·8	6·52	88	—	—	—	Sky covered.
BALTAL (from 10.30 a.m. of the 27th to 2 p.m. of the 28th).											
April...	27	4 p.m.	540·35	Hyps.	4·3	5·52	89	12·0	2·0	—	Sky covered, rain at intervals.
MUTAJUN (from 3 p.m. of the 28th to 4 a.m. of the 29th).											
April...	28	4 p.m.	516·24	Fortin	9·4	2·67	30	11·0	2·0	—	Clear sky.
DRAS (from 10 a.m. of the 29th to 7 a.m. of the 30th).											
April...	29	4 p.m.	—	—	11·5	7·07	70	—	—		Sky covered in a.m., clear with strong west wind in p.m.
KARBU (from 2 p.m. of the 30th to 7 a.m. of May 1st).											
April...	30	4 p.m.	—	—	18·0	10·87	71	—	—	—	Partly cloudy, dull, wind S.W. to W. 3.
KARAL (from 12 m. of the 1st to 7 a.m. of the 2nd).											
May ...	1	4 p.m.	—	—	11·0	6·21	63	—	—	—	Clear and calm in a.m., dull, strong S.W. wind in p.m.
OLTHINGTHANG (from 12 m. of the 2nd to 6.30 a.m. of the 3rd).											
May ...	2	4 p.m.	544·45	Hyps.	14·8	8·0	64	18·0	5·0		Clear in a.m., overcast in p.m, gusts of wind from W.

A.—From Srinagar to the Baltoro Glacier. (*Contd.*)

Date.			Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature.			Weather notes.
Month.	Day.	Hour.						Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	
TARKUTTA (from 10 a.m. of the 3rd to 6.30 a.m. of the 4th).											
May ...	3	4 p.m.	561·15	Hyps.	16·8	0·96	7	26·0	7·0	—	Clear, gusts from S.W. in p.m.
KHARMANG (from 12 m. of the 4th to 6.30 a.m. of the 5th).											
May ...	4	4 p.m.	565·35	Hyps.	18·9	0·78	5	—	—	—	Clear, gusts in p.m. from W. to S.W.
TOLTI (from 10.45 a.m. of the 5th to 6.30 a.m. of the 6th).											
May ...	5	4 p.m.	569·55	Hyps.	15·8	0·0	0	—	—	—	Clear, gusts from W. in p.m.
PARKUTTA (from 12.30 p.m. of the 6th to 6.15 a.m. of the 7th).											
May ...	6	4 p.m.	—	—	19·5	0·76	4	23·0	5·5	—	Clear and calm early, then half overcast, wind from W. 2, cirri-strati.
GOL (from 10.30 a.m. of the 7th to 3.30 a.m. of the 8th).											
May ...	7	4 p.m.	—	—	17·0	3·17	22	19·7	7·5	—	Overcast in a.m., cum.-strati, wind from W. 4, p.m. clear, wind from W. 2.
SKARDU (from 12 m. of the 8th to 7 a.m. of the 9th).											
May ...	8	4 p.m.	—	—	19·0	2·54	16	—	—	—	Clear and calm.
SHIGAR (from 11 a.m. of the 9th to 6.30 a.m. of the 10th).											
May ...	9	4 p.m.	577·40	Hyps.	22·9	1·19	5	28·5	5·8	54·2	Clear and calm.
KUSHIMUL (from 12 m. of the 10th to 6.15 a.m. of the 11th).											
May ...	10	—	578·63	Hyps.	23·4	0·89	13	30·0	4·0	57·0	Cirri-strati, wind from S.W. 2.
DUSSO (from 12 m. of the 11th to 6.30 a.m. of the 12th).											
May ...	11	4 p.m.	570·03	Hyps.	20·9	2·46	13	23·0	8·0	57·0	Clear, calm, cirri-strati, wind from W. 3.

A.—From Srinagar to the Baltoro Glacier. (Contd.)

Date. Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature. Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
GOMBORO (from 12 m. of the 12th to 6.15 a.m of the 13th).											
May ...	12	4 p.m.	560·05	Hyps.	18·4	1·65	10	22·0	—	41·2	Clear, calm, in p.m., ¾ covered, strat.-cum., wind from S.W. 3.
CHONGO (from 11 a.m. of the 13th to 6.30 a.m. of the 14th).											
May ...	13	4 p.m.	532·50	Fortin	12·4	3·06	28	18·5	4·0	42·5	¾ covered, cirri.-cum., wind bet. S. and S.W. 2.
ASKOLEY (from 10 a.m. of the 14th to 6 a.m. of the 16th).											
May ...	14	10	527·64	Fortin	12·9	2·76	24	17·0	2·0	41·0	a.m. ½ covered, cir.-strat. p.m.
		4 p.m.	526·45	,,	9·9	6·76	74				strat.-cum.
,, ...	15	8	528·43	,,	8·9	1·19	14				
		10	528·21	,,	12·9	0·68	6	19·5	3·0	50·0	a.m. ½ covered, cirri. p.m. ¾, gloomy,
		4 p.m.	528·24	,,	10·9	2·38	24				gusts from W.
PUNMAH (from 11.30 a.m. of the 16th to 6 a.m. of the 17th).											
May ...	16	4 p.m.	522·54	Fortin	13·4	3·54	31	19·0	7·0	—	
PAIJU (from 12 m. of the 17th to 6 a.m. of the 18th).											
May ...	17	4 p.m.	508·83	Fortin	12·7	1·81	16	20·5	5·0	59·0	a.m. gloomy, ¾ covered, cir.-cum. Light S W. wind.
Between LILIGO and RHOBUTSE (from 11.30 a.m. of the 18th to 6 a.m. of the 19th).											
May ...	18	4 p.m.	486·87	Fortin	9·9	1·08	12	17·0	0·0	54·0	½ covered, strati, wind from W. 2.

B.—Rdokass.

Date.	Hour of obs. 8 a.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	10 a.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	4 p.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	Weather Notes.
May 29	471·34	5·8	2·50	36	471·69	8·8	1·19	14	470·79	9·8	0·50	7	
30	—	—	—	—	472·33	8·8	2·57	30	471·19	10·3	0·49	5	
31	471·51	5·3	1·85	27	472·14	8·3	2·87	35	470·50	11·8	1·27	12	
June 1	469·76	6·8	1·91	25	469·85	11·3	1·57	15	469·32	8·8	2·57	30	
2	469·22	4·8	4·06	62	469·18	5·8	3·86	55	468·34	4·8	4·75	73	
3	468·99	2·4	3·58	65	469·84	5·3	4·15	62	469·67	2·8	3·81	67	Storm; very cloudy.
4	471·05	6·3	1·26	17	470·81	8·8	0·71	9	470·01	1·73	0·00	0	
5	470·11	3·8	2·12	35	469·49	7·8	0·83	10	467·81	9·1	0·53	6	Fine all day, windy in p.m.
6	468·18	5·3	4·65	69	468·29	7·8	0·37	5	467·66	10·3	0·00	0	
7	469·99	5·8	0·65	9	469·86	7·8	0·00	0	467·86	12·7	0·00	0	
8	469·61	4·3	1·43	23	469·45	8·3	0·00	0	469·17	10·8	0·87	9	Fine, cloudy in p.m.
9	470·06	4·8	1·17	18	470·01	9·3	0·00	0	468·96	12·3	0·00	0	
10	468·77	4·8	1·69	26	468·41	8·3	0·54	7	466·74	9·8	0·59	7	
11	—	—	—	—	—	—	—	—	467·41	7·8	1·79	22	
12	468·59	4·3	2·92	47	469·86	7·3	2·57	33	469·22	9·8	2·47	27	
13	471·86	3·8	4·17	69	472·11	9·3	1·77	20	472·11	10·8	0·87	9	
14	471·65	7·3	2·96	38	471·90	11·8	2·29	22	471·29	10·3	1·67	17	
15	471·53	6·3	2·68	37	471·57	8·3	1·98	24	470·56	12·7	0·24	2	
16	470·53	6·1	2·32	33	470·41	9·3	0·89	10	470·27	5·3	3·28	49	Storm-wind, rain, sleet.
17	469·86	4·3	2·44	39	469·49	8·3	1·49	18	467·24	11·8	1·27	12	
18	468·14	6·8	0·50	7	468·41	9·1	1·21	14	466·53	12·7	0·00	0	
19	467·11	7·3	0·66	8	466·88	9·8	1·47	16	466·00	8·8	2·07	24	Cloudy.
20	466·26[1]	3·8	4·17	69	466·15	7·3	2·57	33	466·26	7·8	2·66	33	
21	468·26	4·8	3·57	55	468·00	8·3	2·36	29	466·88	12·7	0·69	7	
22	468·33	6·3	1·73	24	468·08	10·3	0·78	8	467·66	12·7	0·00	0	
23	468·46	6·3	3·56	50	—	—	—	—	467·11	13·7	0·00	0	Fine.
24	470·22	5·8	2·50	36	470·41	8·3	1·49	18	469·66	14·7	0·00	0	Fine.
25	472·83	5·3	1·85	27	472·90	10·3	0·30	3	471·86	14·7	0·00	0	Fine.

[1] Not included in computing the average, because the corresponding date was lacking for Srinagar.

B.—RDOKASS. (Contd.)

Date.	Hour of obs., 8 a.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	10 a.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	4 p.m. Pressure, mm.	Temperature, cent.	Tension of Vapour, mm.	Humidity.	Weather Notes.
June 26	471·51	7·3	1·61	20	471·36	11·8	0·00	0	469·92	16·2	0·00	0	Fine.
27	468·08	7·3	1·61	20	468·01	11·8	0·00	0	466·48	16·7	0·00	0	Fine.
28	466·49	5·3	2·80	42	466·44	5·3	5·16	77	465·81	9·3	3·08	35	Heavy rain during the night.
29	466·47	4·8	4·45	69	466·55	8·8	3·07	36	466·19	11·8	1·27	12	Fine, warm and sunny.
30	—	—	—	—	468·41	5·8	4·86	70	467·91	8·8	4·09	48	Fine.
July 1	468·37	6·8	1·62	22	468·43	10·3	0·78	8	466·80	14·2	0·00	0	Fine.
2	466·81	7·8	1·31	16	467·85	10·8	0·49	5	466·71	14·7	0·00	0	Fine.
3	468·61	6·8	1·91	25	468·81	11·3	0·58	6	467·47	15·7	0·00	0	Fine.
4	469·61	8·3	3·37	41	460·39	12·7	2·82	25	468·56	15·2	0·00	0	Cloudy, rain in evening.
5	469·56	5·8	6·42	92	—	—	—	—	467·51	13·2	2·52	22	Rain in a.m., showers all day, heavy rain at night.
6	468·93	4·8	5·46	84	468·53	7·8	4·18	53	467·79	5·8	5·38	77	Persistent rain all day.
7	467·88	3·8	5·35	88	467·86	5·8	4·86	70	466·98	10·3	2·17	23	
8	466·47	6·3	3·17	44	466·56	6·3	2·68	37	466·37	1·0	4·94	100	
9	469·21	2·4	4·53	82	469·56	5·3	3·77	56	468·99	10·3	1·67	17	Fine.
10	470·26	4·3	2·44	39	470·10	8·8	0·71	9	467·98	13·7	0·00	0	Fine.
11	469·49	6·8	1·91	25	469·40	10·3	1·67	17	467·72	15·7	0·00	0	Fine.
12	468·20	8·3	3·88	47	468·22	11·8	2·29	22	467·75	14·2	2·99	24	Cloudy.
13	468·01	7·3	6·60	86	468·43	9·3	5·40	61	467·99	10·3	5·90	63	Cloudy, slight showers.
14	469·13	8·8	4·09	48	469·11	10·3	4·26	45	469·10	11·8	3·90	37	Cloudy, slight showers.
15	468·49	7·3	5·52	71	—	—	—	—	468·09	12·7	5·02	45	Cloudy, slight showers.

Average of { Pressure ... ... 468·95 mm.
Temperature ... ... 8·6° cent.
Tension of Vapour ... ... 2·14 mm. }

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers.

Date. Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature. Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
					CAMP II.						
May	24	4 p.m.	434·04	Fortin	3·0	1·34	24	12·0	9·5		Light breeze from N.
					CAMP III.						
May	25	10	416·85	Fortin	1·0	2·39	48	9·0	−10·0	49·0	Clear, N. wind.
		4 p.m.	416·72	,,	0·0	3·13	100				
,,	26	4 p.m.	417·08	,,	1·0	0·77	16	16·0	− 9·0	42·5	Clear, light wind from N.E.
,,	27	10	—		2·0	2·69	51	15·2	− 4·0	44·5	Clear in a.m., partly cloudy in p.m., light wind from S.W.
		4 p.m.	417·60	,,	6·0	0·00	0				
,,	28	8	416·88	,,	− 3·0	0·00	0	15·0	− 9·5	37·0	Sleet. Dull.
		10	417·08	,,	0·5	2·65	56				
		4 p.m.	417·28	,,	− 2·0	3·64	74				
,,	29	8	417·60	,,	− 1·5	2·03	51	12·0	− 6·0	44·0	Wind from S.W. Sleet and hail in p.m.
		10	417·05	,,	5·4	1·39	21				
		4 p.m.	417·55	,,	3·0	2·17	38				
,,	30	8	418·45	,,	0·0	3·96	100	13·5	− 9·5	51·0	Half overcast, wind from S.W., sleet in p.m.
		10	418·41	,,	7·1	4·24	56				
		4 p.m.	418·48	,,	3·0	1·34	24				
,,	31	8	417·50	,,							Clear, very light wind from S.W., partly cloudy in evening.
		10	417·58	,,	3·0	1·34	24	13·0		44·0	
		4 p.m.	437·43	,,	3·0	2·17	38				
June	1	8	416·36	,,							Partly cloudy, S.W. wind, sleet at intervals.
		10	415·88	,,	3·5	1·08	19	17·0	− 4·0	48·0	
		4 p.m.	416·02	,,	3·5	1·91	32				
,,	2	8	415·56	,,	− 1·7	2·32	70	8·0	− 3·0	35·0	Same.
		10	415·33	,,	2·5	2·43	44				
		4 p.m.	414·83	,,	3·5	1·91	32				
,,	3	8	414·80	,,	0·0	3·74	85	13·0	− 5·5	51·0	2–3 in. snow, soon melted. Dull weather and light wind from N.E. in evening. Clear night, with brisk wind in gusts from S.W.
		10	415·25	,,	1·0	3·22	65				
		4 p.m.	415·76	,,	0·0	3·74	81				
,,	4	8	416·10	,,	0·0	4·16	91	12·0	− 9·5	42·5	Fair, calm upper air, S.W. 3.
		10	416·32	,,	3·0	2·17	38				
		4 p.m.	416·50	,,	3·0	0·93	17				
,,	5	8	414·96	,,	2·0	1·04	20	12·0	− 9·0	49·0	Wind S.S.W. Sky half overcast, peaks clear.
		10	415·62	,,	5·1	1·07	17				
		4 p.m.	415·13	,,	2·0	1·04	20				
,,	9	8	416·40	,,				11·0	− 8·3	38·0	Fair, light S.W. wind.
		10	416·50	,,	3·5						
		4 p.m.	416·36	,,		0·29	05				
,,	10	8	414·81	,,	0·0	2·09		10·5	− 4·0	44·8	Fair in a.m., then sky covered, S.W. wind.
		10	414·77	,,	6·1	1·44	20				
		4 p.m.	414·19	,,	4·0	1·64	27				

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers. (Contd.)

Date. Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature. Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
June	11	8	413·90	Fortin	– 2·0	2·39	59	10·0	– 7·0	43·0	
		10	413·72	,,	4·0	1·04	27				
		4 p.m.	414·17	,,	1·0	1·17	23				
,,	24	4 p.m.	417·05	,,	7·0	—	—	12·0	– 6·5	39·8	Light wind from S.W., peaks uncovered.
,,	25	8	419·46	,,	6·0	—	—	10·0	– 6·0	42·0	Fair, calm, very clear atmosphere.
		10	419·56	,,	7·0	—	—				
		4 p.m.	419·85	,,	6·0	—	—				
,,	26	8	418·69	,,	8·0	—	—	17·2	– 4·5	49·0	Same.
		10	418·35	,,	11·0	—	—				
		4 p.m.	418·60	,,	11·0	—	—				
,,	27	12	415·16	,,	12·0	—	—	15·0	– 8·0	44·0	Fair, calm; in p.m. wind from S.W., fresh high up, peaks uncovered.
		4 p.m.	414·40	,,	11·0	—	—				
,,	28	8	413·13	,,	– 4·0	—	—	5·0	– 3·5	29·0	Sleet, thick fog in valley, peaks covered; light wind from S.W.
		10	413·10	,,	1·0	—	—				
		4 p.m.	412·88	,,	4·0	—	—				
,,	29	8	413·00	,,	0·0	—	—	9·0	—	46·0	Snow early in a.m., half-covered sky.
		10	413·18	,,	3·0	—	—				
		4 p.m.	413·40	,,	5·0	—	—				

CAMP IV.

Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Maximum, cent.	Minimum, cent.	Black bulb, cent.	Weather notes.
May	31	8	391·16	Fortin	– 2·0	1·18	30	—	—	—	
		10	390·85	,,	– 2·0	1·04	20	—	—	—	
		4 p.m.	390·55	,,	– 1·0	1·04	24	—	—	—	
June	1	8	389·07	,,	– 1·0	1·82	43	—	—	—	
		10	389·78	,,	1·0	1·18	23	—	—	—	
		4 p.m.	388·85	,,	– 1·0	1·04	24	—	—	—	

CAMP V.

Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Maximum, cent.	Minimum, cent.	Black bulb, cent.	Weather notes.
June	5	4	394·05	Fortin	−3·0	2·86	78	8·0	—	51·0	Sleet; strong tourmente from N. during night.
,,	6	8	393·36	,,	−8·0	1·39	56	9·0	−15·0	61·0	Sky partly cloudy, light N. wind.
		10	393·42	,,	−2·0	3·96	100				
		4	393·82	,,	−2·5	2·21	58				
,,	7	4	393·17	,,	—	—	—	12·0	−13·5	52·0	Light wind from N.N.W.
,,	8	8	395·34	,,	−5·0	1·27	40	9·0	−15·0	51·0	Clear, light S.W. wind.
		10	395·42	,,	−3·0	2·09	57				

SAVOIA PASS (W. gl'cr., W. col.).

Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Maximum, cent.	Minimum, cent.	Black bulb, cent.	Weather notes.
June	7	5.15	349·70	Fortin	−9·0	—	—	—	—	—	

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers. (*Cont'd.*)

Date.			Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature.			Weather notes.
Month.	Day.	Hour.						Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	
					CAMP VI.						
June	12	10	395·71	Fortin	−2·0	2·34	59	4·0	− 6·0	38·0	Sleet; dull weather, S.W. wind.
		4	396·04	,,	−3·0	—	—				
,,	13	8	397·37	,,	−1·0	3·43	80	8·0	− 4·5	50·2	Peaks covered; S.W. wind; in p.m. wind from N.W. and S.W.
		10	397·65	,,	3·0	2·17	38				
		4	397·94	,,	0·0	3·74	81				
,,	14	8	397·64	,,	2·0	—	—	8·0	− 4·0	—	Calm in valley; S.W. wind on the heights.
		10	397·88	,,	3·0	—	—				
		4	397·90	,,	0·0	—	—				
,,	15	4	397·53	,,	1·0	—	—	8·0	− 7·0	—	
,,	16	8	397·13	,,	−6·0	—	—	3·0	−10·0	—	Fair and calm; peaks uncovered.
		10	396·52	,,	8·0	—	—				
		4	396·38	,,	3·5	—	—				
,,	17	8	395·41	,,	−4·0	—	—	13·0	− 8·0	51·0	Sky covered; light wind from S.W.
		4	395·54	,,	3·0	—	—				
,,	18	8	396·27	,,	−4·0	—	—	12·0	− 7·5	52·0	Fair in a.m.; light wind from E.N.E.; in p.m. sky overcast, light S.W.
		10	395·48	,,	−2·0	—	—				
		4	395·09	,,	4·0	—	—				
,,	19	10	394·16	,,	1·5	—	—	8·5	− 7·5	52·0	Wind N.E. and S.W.; sleet, sky overcast, peaks covered.
		4	393·71	,,	4·5	—	—				
,,	20	8	393·21	,,	−1·0	—	—	8·5	−10·0	55·0	Heavy weather; calm upper air, light S.W. wind in valley.
		10	393·56	,,	0·5	—	—				
		4	393·41	,,	0·0	—	—				
,,	21	8	394·23	,,	−6·0	2·89	100	8·0	− 9·0	50·0	Light W.N.W. in a.m., peaks uncovered; p.m. half overcast, light S.W.
		10	394·50	,,	−1·0	1·82	43				
		4	394·15	,,	6·0	0·59	8				
,,	22	8	395·42	,,	−3·0	1·33	36	9·0	− 7·5	46·0	Fair, wind from S.W., colder above.
		10	395·25	,,	1·5	2·12	41				
		4	395·76	,,	0·5	1·04	22				
,,	23	8	394·75	,,	−4·0	1·85	55	9·0	− 8·0	51·0	Sleet; strong wind, gusts S.W.–S.S.W.; peaks covered.
		10	395·25	,,	5·0	—	—				
		4	395·44	,,	0·0	—	—				
					SELLA PASS.						
June	15	11.15	353·85	Fortin	−3·0	—	—	—	—	—	
					CAMP VII.						
June	14	4	373·51	Fortin	−6·5	2·04	74	—	—	28·0	Tourmente, strong S.W.; sky overcast.

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers. *(Contd.)*

Date: Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature: Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
June	15	8	373·40	Fortin	−7·0	1·22	46	—	—	60·0	Strong S.W., peaks covered.
		4	373·28	,,	−4·5	1·37	42	—	—	—	
,,	16	10	372·71	,,	−3·0	2·09	57	—	—	—	Fair early, then overcast.
,,	17	4	370·08	,,	−5·0	—	—	9·0	−10·0	—	
		8	—	,,	−9·0	—	—	—	—	—	
,,	18	10	372·18	,,	−7·0	2·67	100	—	—	—	
		4	370·85	,,	−4·0	2·61	77	—	—	—	
,,	19	4	369·43	,,	−6·0	2·89	100	—	—	—	Wind W.S.W.
,,	20	8	369·04	,,	−9·0	2·26	100	—	—	—	
					CAMP VIII.						
June	24	4	360·78	Fortin	−6·0	1·77	61	—	—	—	
					STAIRCASE.						
June	25	1 p.m.	348·30	Fortin	6·0 (1)	—	—	—	—	—	
					CAMP IX.						
June	29	4	430·96	Fortin	7·0	—	—	15·0	−2·0	44·0	Wind S.W., half overcast.
,,	30	8	432·34	,,	3·0	—	—	12·0	−5·0	46·0	Sky overcast, wind S.W., snow at intervals.
		10	431·81	,,	2·0	—	—				
		4	431·91	,,	8·0	—	—				
July	1	10	431·33	,,	11·0	5·04	52	16·0	−3·0	47·0	Very fine and calm.
		4	431·33	,,	12·0	3·36	32				
,,	2	8	431·23	,,	4·0	3·54	60	17·0	−4·0	46·0	Fair in a.m., then cloudy, cirri-strati, peaks free, W. wind in upper air.
		4	431·33	,,	15·0	4·85	38				
,,	3	8	432·69	,,	4·0	3·16	52	16·0	−2·0	43·0	Fair and calm; light S.W. above, freshening in p.m. and veering W.N.W.
		10	432·65	,,	11·0	2·83	29				
		4	432·56	,,	14·5	2·87	23				
,,	4	8	433·55	,,	7·0	3·30	44	17·5	−1·5	45·4	Half overcast and cirri-strati in a.m.; strong S.W. above; high peaks covered; overcast in p.m.; gusts from S.W.
		10	434·49	,,	9·0	3·11	36				
		4	434·35	,,	11·5	3·06	30				
,,	5	8	433·01	,,	2·0	3·41	64	11·0	−2·0	42·5	Sleet, peaks covered, S.W. above.
		10	433·27	,,	4·0	5·09	83				
		4	432·95	,,	10·5	6·40	67				
					CAMP X.						
July	1	—	428·30	Hyps.	5·0	—	—	—	--	—	

(1) Uncertain.

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers. (Contd.)

Date.			Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature.			Weather notes.
Month.	Day.	Hour.						Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	
					CAMP XI.						
July	7	—	418·34	Fortin	4·0	—	—	—	—	—	Snow at intervals, peaks covered, light S.W.
„	8	—	—	—	—	—	—	—	—	—	Snow at intervals, peaks covered, calm below. Heavy snowfall in evening.
„	9	—	—	—	—	—	—	—	—	—	Sky covered, some peaks free.
„	10	—	—	—	—	—	—	—	—	—	Very fine, evening light S.W., peaks uncovered.
„	11	—	—	—	—	—	—	—	—	—	Very fine, S.W. above.
„	12	—	—	—	—	—	—	—	—	—	a.m. sky half overcast, p.m. overcast. Sleet, wind from S.W.
„	13	—	—	—	—	—	—	—	—	—	Snow during night, snow and sleet day, sky covered, calm.
„	14	—	—	—	—	—	—	—	—	—	Calm low down, sky covered, dull weather, sleet, half clear at sunset.
„	15	—	—	—	—	—	—	—	—	—	Calm low down, sky and peaks covered. Sleet.
„	16	—	—	—	—	—	—	—	—	—	Calm low down; half covered. Cirri-strati. High peaks covered.
„	17	—	—	—	—	—	—	—	—	—	Calm below, mostly fair, peaks partly free. In p.m. clouded over, rain.
„	18	—	—	—	—	—	—	—	—	—	Calm; sky and peaks covered; rain. N.N.E. above.
„	19	—	—	—	—	—	—	—	—	—	Calm, sky and peaks covered. p.m. half clearing. Fine sunset.

C.—Godwin Austen, Savoia and Upper Baltoro Glaciers. (Contd.)

Date. Month.	Day.	Hour.	Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Temperature. Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	Weather notes.
July	20	9.40	417·46	Fortin	7·0	—	—	—	—	—	Snowfall during night and a.m.; low mist, calm.
		10	417·23	,,	8·0	—	—				
		12	417·31	,,	6·0	—	—				
					CAMP XII.						
July	3	4	393·87	Fortin	8·0	4·12	51	19·0	– 6·0	57	
,,	4	4	395·37	Hyps.	2·0	4·82	91	22·0	– 1·0	22	Snow all day, W. wind high up; peaks covered; clear below.
,,	5	4	393·65	Fortin	7·0	3·20	43	25·0	– 6·0	51	Snow and sunshine at intervals.
,,	6	8	—	,,	3·0	—	—	22·0	– 6·0	51	
		10	392·98	,,	12·0	2·23	21				
		4	392·38	,,	7·5	2·90	37				
,,	7	8	—	,,	7·5	—	—	17·0	– 5·0	49	Intervals of snow and sunshine, clearing at sunset.
		10	392·53	,,	11·0	2·83	29				
		4	—	,,	8·0	4·22	53				
,,	8	10	391·09	,,	–2·0	—	—	12·0	– 9·0	—	Snow; calm.
		4	390·30	,,	+2·0	—	—			—	
					CAMP XIII.						
July	9	5	377·71	Fortin	8·0	0·31	—	16·0	–17·0	51	
					CAMP XIV.						
July	10	1.30	354·00	Fortin	1·0	—	—	4·0	–16·0	46	Fair and calm.
		4	354·40	,,	3·0	0·52	9				
,,	14	10	354·10	,,	3·0	2·17	38	4·0	–10·0	60	Wind from S.W.; snow at intervals; sun.
		4	354·35	,,	1·0	4·01	81				
,,	15	8	—	,,	2·0	—	—	3·0	– 8·0	57	Snow; light S.W.; intervals of sun.
		10	354·40	,,	1·5	—	—				
		4	—	,,	–1·0	—	—				
,,	16	8	—	,,	0·0	—	—	6·0	– 7·0	58	Light S.W.; peaks covered, clear below; intervals of sun.
		10	353·93	,,	5·0	—	—				
		4	—	,,	12·0	—	—				
					CAMP XV (I).						
July	11	4	342·12	Fortin	0·0	–	—	30	–13·0	51·0	Fair, light S.W.
					CAMP XV (II).						
July	17	4	335·74	Fortin	5·0	—	—	—	—	67·0	Cloudy.
					NEAREST BRIDE PEAK.						
July	18	2.30	312·33	Fortin	6·0	4·18	57	—	—	—	

D.—Observations Made on the Return Journey.

Date.			Pressure, mm.	Instrument used.	Temperature, cent.	Tension of vapour, mm	Relative humidity.	Temperature during the 24 hours.			Weather notes.
Month.	Day.	Hour.						Maximum, cent.	Minimum, cent.	Indicated by the thermometer with black bulb, cent.	
					CAMP ON N. SIDE OF SKORO-LA.						
July ...	28	4	470·34	Fortin	15·8	1·43	11	—	—	—	Fair, light S.W.
					SKORO-LA.						
July ...	29	11	413·27	Fortin	6·4	—	—	—	—	—	Partly fair.
					CAMP BETWEEN BURGI-LA AND SKARDU.						
August	1	4	504·63	Fortin	19·4	5·84	35	—	−9·0	—	Storm from S.W. in p.m.
					BURGI-LA.						
August	2	9.50	427·65	Fortin	9·4	—	—	—	—	—	
					II. CAMP ON THE DEOSAI TABLE-LAND.						
August	3	4	469·81	Fortin	15·3	4·66	36	—	0·0	—	Three - quarters covered, strong S.W.
					SARSINGAR.						
August	4	9.50	455·81	Fortin	11·9	—	—	—	—	—	Fair and calm.
					STAKPI-LA.						
August	4	12.50	470·61	Fortin	18·9	—	—	—	—	—	
					BURZIL.						
August	4	4	505·22	Fortin	19·9	6·77	39·0	—	10·0	—	Fresh S.S.W.
					PASHWARI.						
August	5	4	570·07	Hyps.	19·9	—	—	—	—	—	Rain in p.m. Wind S.W.
					GURAIS.						
August	6	4	591·28	Hyps.	15·8	11·93	89	—	13·0	—	Showers from S.W., fresh wind.
					GORÈ.						
August	7	4	546·42	Hyps.	15·8	10·54	79	—	—	—	Cloudy weather, calm.
					RAJDIANGAN PASS.						
August	8	9	497·59	Fortin	12·8	5·02	45	—	—	—	Fair above, mists below.
					TRAGBAL.						
August	8	4	540·38	Hyps.	20·9	—	—	—	—	—	Fair and calm.

III.—ALTIMETRIC CALCULATIONS.

Beside the results obtained by his own observations, which are given in the preceding pages, the Duke gathered a very large harvest of data from the meteorological observatories of India, in order to get the terms of reference required for the calculation of the altitudes. As results from the above data, a first base station was fixed at Rdokass, at an altitude of about 13,000 feet, well up on the Baltoro glacier, on which were taken observations of pressure, temperature and humidity for a period lasting from May 29th to July 15th.

Afterwards a second base was fixed at an altitude of about 16,000 feet (Camp III) at the very foot of K^2, beside other secondary ones, in order to secure nearer points of reference for the calculation of the height of the points reached in the various ascents. These calculations were made on the following basis :—

For all the stations before Rdokass and for those from Bride Peak onward the calculation of the various heights was made by comparing them with the simultaneous readings taken at the stations of Leh, Skardu, Gilgit, and in some cases with those taken at Srinagar as well. All observations taken at stations higher than Rdokass (from May 29th to July 15th), which formed the principal objects of the expedition, were compared with those taken simultaneously at Rdokass, except for the two last, after July 15th, when owing to a misunderstanding the observations at Rdokass were discontinued.

For the station near Bride Peak, which was the highest point reached, comparison was made with the readings taken at the four stations of Leh, Srinagar, Skardu and Gilgit.

Of the results given in the foregoing pages, those were especially taken into consideration for which the simultaneous data of reference were secured, these being complete (that is to say, not only the pressure but also the temperature of the air and the tension of vapour were known). In some isolated cases the hour of observation was not the same as that of the reference station ; in this case the readings were compared with those taken at the nearest hour, without attempting to obtain values by interpolation, which would necessarily have been unreliable.[1]

[1] The observations at the most elevated point, near the top of Bride Peak, were taken at half-past two p.m. on July 18th, and for the calculations the comparisons were made with observations taken at 4 p.m. in Leh, Srinagar, Skardu and Gilgit. From the data given by these observatories it follows that on July 18th the pressure for Leh, Srinagar, Skardu and Gilgit respectively was at 10 a.m. 497·15, 623·94, 575·15 and 631·66 millimetres, and at 4 p.m. 493·96, 619·90, 572·20 and 627·78 millimetres. Thus the pressure at 2 p.m. was presumably much higher than at 4 p.m. assumed for the calculations, and hence the altitude of the highest point reached is probably some 66 feet higher than the figure obtained. But this supplementary computation was not made, because it was a question of an isolated observation, and also because little was known of the daily variation of the pressure in those regions.

When all the necessary data were known for the two stations of reference—in other words, the pressure, the temperature and the vapour tension—the well-known formula of Rühlmann was employed to calculate the differences of level :—

$$Z = 18400\ (1{\cdot}00157 + 0{\cdot}00367\ \theta) \left(\frac{1}{1 - 0{\cdot}378\ \frac{\phi}{\gamma}} \right) \times$$

$$\times\ (1 + 0{\cdot}00259\ cos\ 2\lambda)\ 1 + \left(\frac{Z + 2z}{6371104} \right) log\ \frac{H_0}{H},$$

in which

Z = the difference of level between the two stations;
H_0 = the corrected pressure at the lower station;
H = „ „ „ upper station;

$\theta = \frac{t_0 + t}{2}$ the mean between the temperature of the air at the lower station and at the upper station;

$\phi = \frac{f_0 + f}{2}$ the mean between the vapour tension at the lower station and that obtained at the upper station;

$\gamma = \frac{H_0 + H}{2}$;

λ = the latitude;

z = the height of the lower station above sea level.

The calculations were made by means of the *Tables météorologiques internationales,* Paris, 1890.

In those cases where only the pressure and the temperature of the air were known, the tension of vapour not being determined, the formula used was that given in the *Annuaire pour l'an* 1909 *publié par le Bureau des Longitudes,* in which are also included some tables that facilitated the calculations. The formula is as follows :—

$$Z = (A^1 - A) \left(1 + \frac{t_0 + t + 1{\cdot}32\ cos\ 2\lambda}{1000} \right)$$

in which

$$A^1 = 18382 \cdot log\ \frac{760}{H} + \frac{1}{6366000} \left(18382\ log\ \frac{760}{H} \right)^2,$$

$$A = 18382 \cdot log\ \frac{760}{H_0} + \frac{1}{6366000} \left(18382\ log\ \frac{760}{H_0} \right)^2,$$

the symbols having the same meaning as before.

In this approximate formula no account is taken of the humidity of the air, but to make up for this we have assumed 0·004 as the coefficient of expansion of the air instead of 0·00367.

When it is only a question of isolated observations, we consider this formula more than sufficient in consequence of the uncertainty of the law of decrease of temperature with increase of altitude.

For further proof, and to show more clearly the value that we can attribute to the individual observations in the pages that follow, we give in addition to the observations taken by the Duke those obtained simultaneously at the reference stations, drawn as far as Leh and Srinagar are concerned from the data obtained from the central observatory at Simla, and for those of Skardu and Gilgit from the observatory of Srinagar.

It is not necessary to enter here into the value of the barometric method in calculating altitudes. If this method is not on the whole to be compared with the geodetic in precision, still, used with care, it may lead to very satisfactory results.

We give in the following table the measurements obtained by the Duke in 1906 in the Ruwenzori group by means of barometric measurements and those taken two years later with the geodetic method by Major R. G. T. Bright,[1] during the labours of the Boundary Commission for the delimitation of the boundaries of the Congo Free State:—

Mountain.	Boundary commission.		H.R.H.		Differences.	
	Feet. *a*	Metres. *f*	Feet. *c*	Metres. *d*	Feet. *c − a*	Metres. *d − f*
Margherita	16794	5119	16815	5125	+ 21	+ 6
Alessandra	16726	5098	16749	5105	+ 23	+ 7
Elena	16345	4982	16388	4995	+ 43	+13
Savoia	16421	5005	16339	4980	− 82	−25
Umberto	15754	4802	15988	4873	+234	+71
Krepelin	15724	4793	15752	4801	+ 28	+ 8
Weissmann	15163	4622	15299	4663	+136	+41

Practically identical results were also attained in the determination of the altitude of Mount St. Elias:—

Altitude determined by the Duke with barometric method, 18,090 feet.

Id. by Russel (by triangulation), 18,100 feet.

Id. by I. K. MacGrath, U.S. Coast Survey (by triangulation), 18,024 feet.

But there is no doubt that the best results are those obtained from a long series of observations, and that greater uncertainty remains in the case of those based on isolated observations, especially when the tension of vapour has not been determined.

The last table contains a summary of all the altimetric data.

[1] *Survey and Exploration in the Ruwenzori and Lake Region, Central Africa.* By Major R. G. T. Bright, C.M.G., *Geog. Jour.* Aug. 1909, XXXIV, p. 128.

DATA OF OBSERVATION AND COMPARISON.

A.—From Kashmir to the Baltoro Glacier.

No.	Date. Month and day.	Date. Hour.	Station of observation. Place.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Instrument used for measurement of pressure.	Simultaneous data of comparison. Of the stations of	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.
1	27 April	16	Baltal ...	540·35	4·3	5·52	Hyps.	Srinagar	627·88	20·4	13·26
								Leh ...	495·52	11·3	1·94
								Skardu	574·85	18·6	0·96
								Gilgit ...	633·18	23·3	10·12
2	28 ,,	16	Mutajun ...	516·24	9·4	2·67	Fortin	Srinagar	628·39	21·7	13·57
								Leh ...	497·50	13·2	1·00
								Skardu	576·63	19·3	0·00
								Gilgit ...	633·33	27·3	3·68
3	2 May	16	Olthingthang	544·45	14·8	8·00	Hyps.	Leh ...	496·10	15·2	0·00
								Skardu	576·43	19·1	0·00
								Gilgit ...	632·72	23·1	1·49
4	3 ,,	16	Tarkutta ...	561·15	16·8	0·96	Hyps.	Leh ...	495·17	15·7	0·00
								Skardu	576·12	18·1	0·00
								Gilgit ...	632·72	23·1	1·49
5	4 ,,	16	Kharmang ...	565·35	18·9	0·78	Hyps.	Leh ...	496·34	15·7	0·00
								Skardu	577·26	18·1	0·00
								Gilgit ...	633·92	20·7	2·70
6	5 ,,	16	Tolti	569·65	15·8	0·00	Hyps.	Leh ...	496·64	15·7	0·00
								Skardu	577·21	18·1	0·00
								Gilgit ...	636·64	19·8	2·30
7	9 ,,	16	Shigar	577·40	22·9	1·19	Hyps.	Leh ...	498·64	15·1	0·00
								Skardu	578·51	23·1	0·00
								Gilgit ...	634·53	29·8	3·27
8	11 ,,	16	Dusso ...	570·03	20·9	2·46	Hyps.	Leh ...	498·47	17·9	0·83
								Skardu	577·19	23·3	0·05
								Gilgit ...	635·97	31·3	3·05
9	12 ,,	16	Gomboro ...	560·05	18·4	1·65	Hyps.	Leh ...	497·78	16·7	0·00
								Skardu	576·89	22·5	0·00
								Gilgit ...	634·86	25·8	6·12
10	13 ,,	16	Chongo ...	532·50	12·4	3·06	Fortin	Leh ...	496·76	17·4	0·00
								Skardu	577·04	20·5	0·00
								Gilgit ...	636·41	22·3	7·42

A.—From Kashmir to the Baltoro Glacier. *(Contd.)*

No.	Date.		Station of observation.				Simultaneous data of comparison of the stations of								
			ASKOLEY.				SKARDU.			GILGIT.			LEH.		
	Month and day.	Hour.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Instrument for measurement of pressure.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.
11	14 May ...	10	527·64	12·9	2·76	Fortin	577·40	16·2	4·11	635·02	17·7	6·74	498·57	11·3	1·94
		4	526·45	9·9	6·76	„	575·46	19·8	1·60	633·59	22·3	6·86	497·78	7·4	1·99
	15 „ ...	8	528·43	8·9	1·19	„	578·05	12·0	4·71	635·78	19·4	7·15	499·08	4·6	4·24
		10	528·21	12·9	0·68	„	577·85	16·1	3·37	635·92	21·7	6·27	499·05	9·9	3·49
		4	528·24	10·9	2·38	„	576·22	20·5	2·11	633·33	22·4	6·26	497·45	9·4	1·67
	Mean ...		527·79	11·1	2·75		577·00	16·9	3·18	634·73	20·7	6·66	499·99	8·5	2·67

A.—From Kashmir to the Baltoro Glacier. (Contd.)

No.	Date. Month and day.	Hour.	Place.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Instrument for measurement of pressure.	Simultaneous data of comparison: Of the stations of	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.
12	16 May	4	Punmah ...	522·54	13·4	3·54	Fortin	Leh Skardu Gilgit	497·02 575·06 632·32	12·5 19·9 25·6	4·90 1·54 5·83
13	17 „	4	Paiju... ...	508·83	12·7	1·81	Fortin	Leh Skardu Gilgit	497·71 576·48 634·53	10·6 19·8 22·9	1·09 1·71 8·03
14	18 „	4	Between Liligo and Rhobutse	486·87	9·9	1·08	Fortin	Leh Skardu Gilgit	498·74 576 43 632·90	12·1 22·8 29·9	3·03 0·00 4·63

The four tables which follow give the data from observations made May 29th to July 15th at the stations of Srinagar, Leh, Skardu and Gilgit, which served as reference to the observations carried on during the same period at Rdokass (see pages 400–401).

B.—Srinagar.

Hour of observations—	8 a.m.				10 a.m.				4 p.m.			
Date.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.
29 May	629·30	17·4	11·81	80	629·45	21·3	14·45	77	627·21	29·2	22·38	74
30	—	—	—	—	629·83	24·2	16·88	75	627·62	27·8	20·43	73
31	628·54	18·8	12·57	78	628·64	23·0	15·72	83	625·99	26·8	19·31	74
1 June	627·22	19·7	13·69	80	627·60	21·9	15·05	77	626·12	23·4	16·33	76
2	629·12	16·6	11·87	84	628·58	19·7	12·92	76	628·43	17·9	11·94	78
3	629·60	16·3	12·05	87	629·80	18·8	13·62	84	626·81	24·1	17·29	78
4	628·01	17·7	12·06	80	628·23	21·3	14·29	76	624·85	27·2	20·02	75
5	625·90	19·4	13·10	78	625·64	23·0	15·72	75	624·47	24·8	18·11	78
6	626·12	17·4	11·81	80	626·01	21·6	15·23	79	622·71	26·9	19·63	75
7	624·75	18·6	12·70	80	624·83	23·6	16·72	77	621·95	29·8	22·42	72
8	626·10	19·7	13·22	77	625·79	24·3	16·82	74	623·56	30·1	21·61	68
9	625·79	20·2	13·85	79	625·84	24·6	16·99	74	623·42	30·0	22·93	73
10	624·91	21·3	14·93	79	625·06	25·6	17·62	73	623·79	27·5	21·20	78
11	—	—	—	—	—	—	—	—	625·23	22·6	15·97	78
12	627·52	18·0	12·17	79	627·60	22·4	14·92	74	626·06	28·5	21·59	75
13	629·83	19·7	13·22	77	629·91	24·4	17·29	76	627·77	27·7	20·29	73
14	630·95	20·5	14·14	79	631·18	24·4	17·29	76	627·67	28·9	20·93	71
15	628·74	20·2	13·38	76	628·76	24·7	17·63	76	625·36	30·6	22·75	70
16	627·24	20·5	13·67	76	626·83	21·9	14·57	75	627·23	21·1	13·93	75
17	627·88	16·6	11·45	81	627·60	19·8	13·48	78	624·93	25·7	19·03	78
18	625·90	18·0	12·17	79	625·96	22·2	13·42	67	623·32	28·5	21·99	76
19	624·07	19·7	13·22	77	624·22	22·3	15·51	77	624·62	22·7	15·73	77
20	—	17·4	12·24	83	626·15	21·6	15·41	80	624·03	26·7	17·67	68
21	626·07	19·7	13·69	80	626·12	24·4	16·76	74	623·47	28·8	20·60	70
22	626·12	20·5	14·14	79	626·25	24·8	17·75	76	624·29	28·1	20·83	74
23	627·12	17·2	11·50	79	—	—	—	—	624·95	28·7	21·87	75
24	627·14	20·2	13·85	79	627·19	24·2	17·94	80	625·44	31·1	24·39	73
25	628·16	19·7	12·92	76	627·93	25·3	17·81	74	624·74	32·4	26·04	72
26	626·51	21·3	14·93	79	626·12	26·1	17·50	69	622·95	33·1	26·53	70
27	624·19	22·7	15·90	78	623·96	27·5	19·45	71	620·57	33·7	25·69	66
28	625·18	18·8	13·47	83	625·71	20·0	14·45	83	623·40	24·6	16·63	72
29	624·37	19·7	13·22	77	624·14	23·6	16·55	76	622·23	26·9	19·24	73
30	—	—	—	—	624·64	25·3	17·81	74	621·73	30·3	24·02	75
1 July	623·73	22·4	15·58	77	623·40	26·4	18·79	73	620·20	31·9	25·22	72
2	622·03	22·7	15·40	75	622·08	27·5	19·83	73	619·85	32·3	25·42	71
3	623·81	24·1	16·94	76	624·27	27·7	22·90	83	622·05	31·6	24·97	72
4	625·91	23·3	16·91	80	626·17	28·2	21·17	74	625·03	30·3	22·74	71
5	626·42	22·4	16·60	82	—	—	—	—	624·52	28·9	21·94	74
6	626·91	19·1	13·59	83	627·06	21·4	15·36	81	624·44	25·0	17·09	73
7	626·01	18·0	12·17	79	626·20	20·9	13·42	73	623·30	28·3	19·92	70
8	624·44	17·4	11·81	80	626·91	15·8	11·23	84	627·08	15·7	10·73	81
9	628·84	16·3	11·34	82	628·96	18·6	12·70	80	625·99	25·0	18·17	77
10	627·72	19·4	13·41	80	627·88	22·2	16·04	81	624·09	28·1	21·04	74
11	625·49	21·3	14·93	79	625·52	24·2	16·71	74	623·00	29·3	22·53	74
12	624·49	21·9	13·60	70	624·59	25·7	18·47	75	622·82	26·4	19·17	75
13	624·62	21·1	14·58	79	625·00	26·5	19·30	75	622·90	29·7	21·86	71
14	625·15	22·4	15·58	77	625·25	27·2	20·21	75	623·56	26·7	19·75	76
15	624·80	21·3	14·93	79	—	—	—	—	622·13	28·3	21·10	74

Calculated mean of
- Pressure... ... 625·72 mm.
- Temperature ... 23·5° c.
- Tension of vapour 16·90 mm.

Leh.

Hour of observations—	8 a.m.				10 a.m.				4 p.m.			
Date.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.	Pressure, mm.	Temperature, cent.	Tension of vapour, mm.	Relative humidity.
29 May	501·66	12·7	1·92	17	501·51	16·7	1·44	10	498·54	21·0	0·00	0
30	—	—	—	—	501·79	17·3	1·86	12	499·08	20·5	1·64	9
31	501·13	12·9	2·44	22	500·98	17·7	1·84	12	497·81	21·3	2·70	14
1 June	499·25	13·2	2·26	20	498·90	17·4	2·47	16	496·05	22·4	0·00	0
2	498·98	14·1	3·11	26	498·44	17·3	3·69	25	494·91	23·5	3·12	14
3	497·95	13·5	4·15	36	497·93	14·6	3·25	26	496·61	17·9	3·68	24
4	499·41	11·3	3·40	34	499·20	15·7	2·82	21	499·55	19·1	2·02	12
5	498·03	12·9	3·84	35	497·63	17·8	2·46	16	495·27	21·6	0·00	0
6	496·73	11·8	2·78	27	496·66	17·8	1·56	10	494·40	20·9	1·28	7
7	498·10	14·1	2·57	21	497·98	17·4	1·46	10	494·43	22·3	0·00	0
8	498·10	14·6	1·63	13	498·03	18·9	0·00	0	495·75	22·8	0·00	0
9	498·39	14·6	1·42	11	498·13	19·1	1·91	11	495·27	24·1	1·37	6
10	497·34	14·3	2·99	24	496·94	18·8	1·98	11	494·10	22·7	1·74	8
11	—	—	—	—	—	—	—	—	494·71	20·7	1·76	10
12	497·49	13·8	3·08	26	497·68	19·1	2·84	17	495·87	22·4	0·00	0
13	500·93	13·5	2·94	25	500·93	17·9	1·84	12	498·31	22·9	1·61	8
14	500·77	16·3	3·36	24	500·64	19·5	2·47	13	497·70	23·4	2·79	13
15	500·37	14·3	3·67	30	500·29	18·9	2·85	17	497·25	23·8	0·00	0
16	499·30	13·8	3·63	31	498·95	17·9	2·29	15	496·10	23·5	0·00	0
17	497·39	14·6	3·14	25	494·50	18·2	2·57	16	495·47	19·3	0·65	3
18	497·91	12·7	3·96	36	500·03	17·4	2·70	18	494·98	20·8	2·29	12
19	496·25	12·9	4·51	40	495·51	17·5	5·00	33	494·53	16·4	4·94	35
20	—	9·3	6·00	69	496·43	13·8	5·80	49	494·15	17·9	3·57	23
21	497·73	12·1	4·10	39	497·47	16·0	3·54	26	494·96	22·4	0·00	0
22	498·08	14·6	3·14	25	497·75	18·4	3·38	21	494·76	24·1	2·00	9
23	498·21	13·8	3·97	33	—	—	—	—	495·17	23·5	3·37	16
24	499·76	12·4	2·95	27	499·78	17·3	2·08	14	497·55	23·9	1·13	5
25	501·44	14·1	3·79	31	501·39	19·6	2·06	12	497·81	25·5	2·16	9
26	500·17	14·6	4·16	34	499·66	20·7	2·35	13	496·25	26·7	2·59	10
27	497·17	15·7	4·07	31	496·58	21·0	2·76	15	492·80	25·9	3·07	12
28	495·22	14·6	4·74	38	494·53	20·4	4·24	23	492·29	23·4	4·07	19
29	496·39	13·2	3·99	35	496·35	16·2	3·65	26	493·90	18·7	4·27	26
30	—	—	—	—	496·48	21·2	3·38	18	493·01	23·1	3·61	17
1 July	496·27	15·7	4·42	33	496·27	20·1	3·43	19	492·77	24·3	5·11	23
2	495·47	15·2	5·08	39	495·39	20·4	3·00	17	492·34	24·8	4·13	18
3	496·76	15·7	4·42	33	496·94	19·7	5·92	35	494·38	25·2	5·93	25
4	498·34	17·4	5·43	36	498·00	21·2	5·53	29	495·55	23·5	5·86	27
5	498·20	16·8	5·79	41	—	—	—	—	496·61	22·1	6·44	33
6	497·44	15·7	6·70	50	497·17	19·5	7·09	42	493·82	25·1	5·44	23
7	497·09	14·1	5·04	42	496·66	18·9	5·14	31	493·61	22·7	5·14	25
8	496·22	14·1	5·04	42	495·60	18·5	5·00	32	493·59	19·0	5·96	36
9	498·90	12·4	4·14	38	498·64	16·6	4·82	34	495·44	22·3	4·86	24
10	498·90	12·9	4·51	40	498·59	17·9	4·15	28	495·27	24·0	6·24	28
11	498·13	14·1	4·47	37	497·93	19·9	3·67	21	494·68	23·9	5·62	26
12	497·05	16·3	7·09	51	497·00	18·8	8·45	52	494·20	24·1	6·73	30
13	496·92	15·4	7·63	59	497·19	19·5	8·02	48	496·66	20·6	8·87	49
14	497·98	15·4	2·05	69	498·08	18·8	7·90	49	495·14	23·3	9·68	46
15	497·63	15·2	8·39	65	—	—	—	—	493·87	23·4	8·44	39

Calculated mean of { Pressure ... ... 497·12 mm.
Temperature ... 18·3° c.
Tension of vapour 3·59 mm.

Skardu.

Hour of observations—	8 a.m.				10 a.m.				4 p.m.			
Date.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.
29 May	580·21	19·6	6·56	39	579·70	22·3	4·99	25	577·23	27·5	1·46	5
30	—	—	—	—	580·61	22·2	5·18	26	577·45	25·3	1·52	6
31	579·58	18·7	6·53	40	579·19	22·3	4·86	24	575·75	27·0	1·25	5
1 June	576·63	18·6	5·19	33	576·84	20·8	4·11	22	575·13	24·9	3·41	15
2	576·84	18·3	6·91	43	576·75	19·5	5·65	34	574·30	24·3	5·50	24
3	577·97	16·3	8·77	64	577·67	20·4	8·16	46	575·28	23·8	3·44	16
4	577·72	19·4	7·28	43	577·32	23·1	5·03	24	573·97	27·7	3·05	12
5	578·07	20·3	5·17	29	575·13	23·8	2·30	10	572·61	26·5	1·17	4
6	574·50	20·1	5·04	29	574·04	23·6	2·04	9	572·09	27·6	3·11	11
7	576·23	19·2	3·26	19	575·72	22·9	2·35	11	572·04	29·7	1·43	4
8	576·23	20·0	3·37	19	575·97	23·7	3·50	16	573·66	29·2	1·46	4
9	576·48	19·9	4·91	28	576·23	23·7	2·49	11	573·31	29·1	2·59	8
10	574·81	19·9	3·43	20	574·46	24·3	3·53	16	571·89	27·9	2·40	8
11	—	—	—	—	—	—	—	—	573·80	23·7	4·21	18
12	576·23	18·8	6·21	38	576·07	23·7	4·14	19	574·53	26·6	1·74	7
13	579·12	20·4	6·28	35	578·81	23·3	4·91	23	576·15	28·7	1·91	6
14	578·67	23·7	4·02	18	578·49	25·2	3·75	16	575·95	27·4	2·56	9
15	578·21	20·4	5·50	31	577·80	24·2	5·03	22	575·69	27·7	3·31	12
16	576·23	20·2	5·36	30	576·28	24·9	4·21	18	574·78	26·3	2·57	10
17	575·46	19·2	5·96	36	575·11	22·6	4·81	23	572·70	27·0	2·94	11
18	574·70	20·8	6·17	34	574·35	24·3	3·78	17	571·32	30·0	3·29	10
19	575·11	21·1	5·72	31	572·16	24·9	4·60	19	570·36	25·5	3·84	16
20	—	21·4	4·00	21	575·36	23·7	5·80	27	573·13	22·6	3·53	17
21	575·72	18·2	7·35	47	575·21	21·9	5·11	26	572·04	28·6	2·63	8
22	575·08	20·4	4·86	27	574·65	24·2	3·20	14	572·85	28·9	1·65	5
23	575·11	22·6	4·42	22	—	—	—	—	573·31	28·2	0·00	0
24	576·88	20·5	3·91	22	576·94	24·7	3·40	15	574·37	30·6	1·42	4
25	579·32	22·2	2·53	13	578·89	25·8	2·61	11	576·15	33·2	0·00	0
26	577·60	23·1	4·25	20	577·11	25·8	1·97	8	573·20	32·2	1·12	3
27	573·74	23·2	3·80	17	573·26	26·9	2·86	11	569·80	31·8	1·50	4
28	572·67	21·3	6·12	33	572·32	23·6	5·00	23	569·70	27·1	3·67	14
29	572·97	21·4	6·87	36	572·66	23·8	5·68	26	570·10	28·1	2·81	10
30	—	—	—	—	574·91	21·5	5·48	29	571·58	28·2	1·55	5
1 July	573·79	21·5	3·82	20	573·48	25·3	3·83	16	570·21	31·6	2·31	6
2	572·52	22·5	4·22	21	572·48	26·3	2·18	8	569·80	33·1	0·00	0
3	573·89	21·9	3·95	20	573·79	26·8	2·40	9	571·38	21·5	8·60	45
4	574·47	24·4	4·78	21	573·97	27·1	5·05	19	572·59	31·3	3·35	10
5	575·26	23·2	4·71	22		—	—	—	572·29	29·2	2·81	9
6	575·26	18·2	8·14	52	575·57	19·7	7·23	42	574·35	25·1	5·85	25
7	575·67	16·3	8·63	62	575·82	17·6	7·98	53	572·49	27·3	4·79	18
8	572·77	19·6	6·11	36	573·43	20·3	5·95	34	575·36	16·3	7·72	56
9	578·61	15·6	8·67	66	578·56	17·6	7·46	50	575·13	25·4	3·77	15
10	576·97	19·8	6·12	35	576·68	23·1	4·38	21	573·20	29·8	2·58	8
11	575·26	20·6	4·62	25	574·91	24·3	4·05	18	571·53	32·4	1·82	5
12	573·05	23·4	5·66	26	572·90	28·0	5·92	21	570·87	31·9	2·98	9
13	573·53	23·4	8·01	37	573·66	25·6	8·12	33	572·24	29·3	7·52	25
14	574·40	21·1	6·64	35	574·27	26·9	5·59	21	572·70	26·0	5·86	23
15	573·84	20·8	10·02	55	—	—	—	—	572·54	28·6	5·85	20

Calculated mean of { Pressure ... ... 574·83 mm.; Temperature ... 24·0° c.; Tension of vapour 4·7 mm. }

Gilgit.

Hour of observations—	8 a.m.				10 a.m.				4 p.m.			
Date.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Relative humidity.
29 May	636·36	26·7	7·30	28	635·80	29·4	5·96	19	632·14	33·6	6·29	16
30	—	—	—	—	636·56	29·9	6·10	19	632·40	34·7	3·46	8
31	634·49	26·1	6·94	28	634·73	29·7	5·33	17	630·47	31·6	8·30	24
1 June	633·28	24·8	8·75	38	632·55	27·7	7·29	26	632·53	25·6	8·72	35
2	634·56	20·3	9·89	56	631·79	21·3	10·15	54	630·87	20·3	14·75	83
3	636·21	18·9	12·80	79	633·26	22·6	10·25	50	631·53	30·2	6·66	21
4	634·56	24·1	10·39	47	633·82	28·1	5·86	21	629·99	34·6	4·12	10
5	632·07	25·7	5·35	22	631·61	29·2	4·47	15	630·24	34·4	4·09	10
6	631·76	27·8	4·62	17	631·30	30·9	2·60	7	628·56	34·3	1·51	4
7	632·37	26·7	5·29	20	631·05	27·6	5·17	19	627·49	36·4	4·26	9
8	632·29	27·2	5·41	20	631·02	31·4	4·00	11	629·30	36·7	3·00	6
9	632·40	28·0	4·23	15	630·92	32·9	3·22	8	628·39	36·1	5·70	12
10	630·47	26·7	9·72	37	629·96	31·8	3·76	10	626·07	33·9	6·74	17
11	—	—	—	—	—	—	—	—	625·72	32·3	5·23	15
12	631·18	27·1	8·10	30	626·78	30·4	5·34	17	624·95	35·7	3·30	7
13	634·63	27·1	8·40	31	632·85	30·9	7·15	22	630·38	35·0	5·43	12
14	634·60	26·7	11·46	44	633·92	32·8	7·25	20	631·30	33·9	5·01	12
15	633·94	27·3	7·98	30	633·36	31·1	7·18	21	629·52	34·4	5·02	13
16	632·45	27·3	9·35	35	630·67	29·9	7·15	23	628·76	32·4	3·97	11
17	631·27	27·2	9·42	35	631·10	30·1	7·95	25	629·16	34·8	4·00	9
18	630·57	27·2	8·04	30	629·24	32·7	6·84	18	625·84	37·6	4·79	10
19	628·25	28·8	6·77	23	626·10	32·4	5·94	16	625·64	33·7	6·23	16
20	—	27·0	8·01	30	628·89	30·2	6·66	21	627·95	29·0	5·16	17
21	631·33	25·6	8·86	36	630·82	29·4	6·55	21	628·20	37·2	3·61	8
22	631·08	27·2	6·42	24	628·73	31·3	5·93	18	627·89	32·3	9·50	27
23	630·87	29·4	8·08	26	—	—	—	—	627·79	34·4	5·48	13
24	633·21	26·6	11·20	43	631·84	30·3	6·15	19	626·98	37·8	3·40	7
25	634·32	26·7	11·14	43	633·74	32·2	4·26	12	630·13	39·2	3·65	7
26	630·64	30·8	5·10	16	630·84	33·9	4·56	11	627·71	40·6	3·76	7
27	627·69	30·0	8·18	26	626·65	34·1	5·35	13	622·97	39·8	4·24	8
28	626·07	30·0	5·88	19	625·14	31·1	5·81	18	623·27	34·9	7·10	17
29	626·47	27·6	6·17	22	628·46	29·2	6·82	22	630·11	32·5	4·36	12
30	—	—	—	—	630·89	30·3	7·21	22	630·97	34·1	7·25	18
1 July	629·65	27·6	5·45	20	628·86	31·8	3·61	10	625·03	37·8	2·16	4
2	628·51	29·0	5·90	20	626·30	32·6	2·98	7	624·01	39·2	4·29	8
3	628·25	29·0	8·32	28	628·18	33·4	3·96	10	625·33	36·8	5·93	12
4	629·32	31·1	7·65	23	629·06	33·0	6·82	18	626·73	36·2	6·13	13
5	630·08	27·9	10·24	37	—	—	—	—	630·23	29·2	5·79	19
6	630·62	24·0	10·76	49	630·57	24·1	11·11	50	628·20	29·4	8·54	28
7	629·35	25·9	9·13	37	629·40	29·6	7·95	26	627·03	30·7	8·53	26
8	629·37	22·2	8·74	44	624·81	17·6	13·61	91	632·77	19·9	13·88	80
9	636·78	19·7	11·72	69	635·06	22·6	12·23	60	630·64	30·8	8·00	24
10	632·16	24·8	9·21	39	631·50	26·4	11·65	45	627·95	34·9	6·77	16
11	629·81	27·6	9·48	34	627·54	29·4	11·29	37	625·61	36·8	0·00	0
12	628·46	27·2	10·67	40	627·84	27·9	12·37	44	627·69	28·3	14·00	49
13	627·89	24·0	12·32	56	622·79	25·0	11·74	43	625·61	36·1	0·00	0
14	629·11	30·5	9·30	29	628·91	34·0	6·21	16	626·65	36·8	5·76	12
15	628·61	27·8	10·95	39	—	—	—	—	629·22	28·2	8·80	31

Calculated mean of { Pressure ... ... 629·83 mm.
Temperature ... 30·05° c.
Tension of vapour 7·0 mm.

C.—Comparison of Simultaneous Observations.

Date.	Hour.	Camp III. Pressure mm.	Camp III. Temperature cent.	Camp III. Tension of vapour.	Camp III. Humidity.	Rdokass. Pressure mm.	Rdokass. Temperature cent.	Rdokass. Tension of vapour.	Rdokass. Humidity.	Skardu. Pressure mm.	Skardu. Temperature cent.	Skardu. Tension of vapour.	Skardu. Humidity.
29 May ...	8	417·60	−1·5	2·08	51	471·34	5·8	2·50	36	580·21	19·6	6·56	39
	10	418·05	5·4	1·39	21	471·69	8·8	1·19	14	579·70	22·3	4·99	25
	4	417·55	3·0	2·17	38	470·79	9·8	0·50	7	577·23	27·5	1·46	5
30 ,, ...	10	418·41	7·1	4·24	56	472·33	8·8	2·57	30	580·61	22·2	5·18	26
	4	418·48	3·0	1·34	24	471·19	10·3	0·49	5	577·45	25·3	1·52	6
31 ,, ...	10	417·58	3·0	1·34	24	472·14	8·3	2·87	35	579·19	22·3	4·86	24
	4	417·43	3·0	2·17	38	570·50	11·8	1·27	12	575·75	27·0	1·25	5
1 June ...	10	415·88	3·5	1·08	19	469·85	11·3	1·57	15	576·84	20·8	4·11	22
	4	416·02	3·5	1·91	32	469·32	8·8	2·57	30	575·13	24·9	3·41	15
2 ,, ...	8	415·56	−1·7	2·32	70	469·22	4·8	4·06	62	576·84	18·3	6·91	43
	10	415·33	2·5	2·43	44	469·18	5·8	3·86	55	576·75	19·5	5·65	34
	4	414·83	3·5	1·91	32	468·34	4·8	4·75	73	574·30	24·3	5·50	24
3 ,, ...	8	414·80	0·0	3·74	85	468·99	2·4	3·58	65	577·97	16·3	8·77	64
	10	415·25	1·0	3·22	65	469·84	5·3	4·15	62	577·67	20·4	8·16	46
	4	415·76	0·0	3·74	81	469·67	2·8	3·81	67	575·28	23·8	3·44	16
4 ,, ...	8	416·10	0·0	4·16	91	471·05	6·3	1·26	17	577·72	19·4	7·28	43
	10	416·32	3·0	2·17	38	470·81	8·8	0·71	9	577·32	23·1	5·03	24
	4	416·50	3·0	0·93	17	470·01	13·7	0·00	0	573·97	27·7	3·05	12
5 ,, ...	8	414·96	2·0	1·04	20	470·11	3·8	2·12	35	578·07	20·3	5·17	29
	10	415·62	5·1	1·07	17	469·49	7·8	0·83	10	575·13	23·8	2·30	10
	4	415·13	2·0	1·04	20	467·81	9·1	0·53	6	572·61	26·5	1·17	4
9 ,, ...	4	416·36	5·0	0·29	5	468·96	12·3	0·00	0	573·31	29·1	2·59	8
10 ,, ...	8	414·81	0·0	2·09	45	468·77	4·8	1·69	26	574·81	19·9	3·43	20
	10	414·77	6·1	1·44	20	468·41	8·3	0·54	7	574·46	24·3	3·53	16
	4	414·19	4·0	1·64	27	466·74	9·8	0·59	7	571·89	27·9	2·40	8
11 ,, ...	4	414·17	1·0	1·17	23	467·41	7·8	1·79	22	573·80	23·7	4·21	18
Mean	...	416·05	2·6	2·00		469·74	7·8	1·91		575·32	23·1	4·29	

Camp III (second base-camp).

Date.	Hour.	Srinagar. Pressure mm.	Temperature cent.	Tension of vapour.	Humidity.	Leh. Pressure mm.	Temperature cent.	Tension of vapour.	Humidity.	Gilgit. Pressure mm.	Temperature cent.	Tension of vapour.	Humidity.
29 May ...	8	629·30	17·4	11·81	80	501·66	12·7	1·92	17	636·36	26·7	7·30	28
	10	629·45	21·3	14·45	77	501·51	16·7	1·44	10	635·80	29·4	5·96	19
	16	627·21	29·2	22·38	74	498·54	21·0	0·00	0	632·14	33·6	6·29	16
30 „ ...	10	629·83	24·2	16·88	75	501·79	17·3	1·86	12	636·56	29·9	6·10	19
	16	627·62	27·8	20·43	73	499·08	20·5	1·64	9	632·40	34·7	3·46	8
31 „ ...	10	628·64	23·0	15·72	83	500·98	17·7	1·84	12	634·73	29·7	5·33	17
	16	625·99	26·8	19·31	74	497·81	21·3	2·70	14	630·47	31·6	8·30	24
1 June ...	10	627·60	21·9	15·05	77	498·90	17·4	2·47	16	632·55	27·7	7·29	26
	16	626·12	23·4	16·33	76	496·05	22·4	0·00	0	632·53	25·6	8·72	35
2 „ ...	8	629·12	16·6	11·87	84	498·98	14·1	3·11	26	634·56	20·3	9·89	56
	10	628·58	19·7	12·92	76	498·44	17·3	3·69	25	631·79	21·3	10·15	54
	16	628·43	17·9	11·94	78	494·91	23·5	3·12	14	630·87	20·3	14·75	83
3 „ ...	8	629·60	16·3	12·05	87	497·95	13·5	4·15	36	636·21	18·9	12·80	79
	10	629·80	18·8	13·62	84	497·93	14·6	3·25	26	633·26	22·6	10·25	50
	16	626·81	24·1	17·29	78	496·61	17·9	3·68	24	631·53	30·2	6·66	21
4 „ ...	8	628·01	17·7	12·06	80	499·41	11·3	3·40	34	634·56	24·1	10·39	47
	10	628·23	21·3	14·29	76	499·20	15·7	2·82	21	633·82	28·1	5·86	21
	16	624·85	27·2	20·02	75	499·55	19·1	2·02	12	629·99	34·6	4·12	10
5 „ ...	8	625·90	19·4	13·10	78	498·03	12·9	3·84	35	632·07	25·7	5·35	22
	10	625·64	23·0	15·72	75	497·63	17·8	2·46	16	631·61	29·2	4·47	15
	16	624·47	24·8	18·11	78	495·27	21·6	0·00	0	630·24	34·4	4·09	10
9 „ ...	16	623·42	30·0	22·93	73	495·27	24·1	1·37	6	628·39	36·1	5·70	12
10 „ ...	8	624·91	21·3	14·93	79	497·34	14·3	2·99	24	630·47	26·7	9·72	37
	10	625·06	25·6	17·62	73	496·94	18·8	1·98	11	629·96	31·8	3·76	10
	16	623·79	27·5	21·20	78	494·10	22·7	1·74	8	626·07	33·9	6·74	17
11 „ ...	16	625·23	22·6	15·97	78	494·71	20·7	1·76	10	625·72	32·3	5·23	15
Mean	...	627·06	22·6	16·07		498·03	1·79	2·28		632·09	28·4	7·25	

D.—Comparison of Observations Made on the Godwin Austen, Savoia, and Upper Baltoro Glaciers.

No.	Date.		Station of observation.					Simultaneous data of comparison.			
	Month and day.	Hour.	Place.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Instrument used for measurement of pressure.	Of the station of	Pressure mm.	Temperature cent.	Tension of vapour mm.
	31 May	10	Camp IV ...	390·85	2·0	1·04	Fortin	Camp III	417·58	3·0	1·34
		4		390·55	− 1·0	1·04	,,		417·43	3·0	2·17
	1 June	10		389·78	1·9	1·18	,,		415·88	3·5	1·08
		4		388·85	− 1·0	1·04	,,		416·02	3·5	1·91
			Mean...	390·00	0·2	1·07			416·72	3·2	1·62
	31 May	10	Camp IV ...	390·85	2·0	1·04	,,	Rdokass	472·14	1·3	2·17
		4		390·55	− 1·0	1·04	,,		470·50	11·8	1·27
	1 June	10		389·78	1·0	1·18	,,		469·85	11·3	1·57
		4		388·85	− 1·0	1·04	,,		469·32	8·8	2·57
			Mean...	390·00	0·2	1·07			470·45	10·0	2·07
	5 ,,	4	Camp V ...	394·05	− 3·0	2·86	,,	Camp III	415·15	2·0	1·04
	5 ,,	4		394·05	− 3·0	2·86	,,		467·81	9·1	0·53
		8		393·36	− 8·0	1·39	,,		468·18	5·3	4·65
	6 ,,	10	Camp V ...	393·42	− 2·0	3·96	,,	Rdokass	468·29	7·8	0·37
		4		393·82	− 2·5	2·21	,,		467·66	10·3	0·00
		8		395·34	− 5·0	1·27	,,		469·61	4·3	1·43
	8 ,,	10		395·42	− 3·0	2·09	,,		469·45	8·3	0·00
			Mean...	394·23	− 3·9	2·30			468·50	7·5	1·16
	7 ,,	5.15	Savoia Pass...	349·70	− 9·0	—	,,	Rdokass	467·86	12·7	0·00
	12 ,,	10		395·71	− 2·0	2·34	,,		469·86	7·3	2·57
	13 ,,	8		397·37	− 1·0	3·43	,,		471·86	3·8	4·17
		10		397·65	3·0	2·17	,,		472·11	9·3	1·77
		4		397·94	0·0	3·74	,,		472·11	10·8	0·87
	21 ,,	8	Camp VI ...	394·23	− 6·0	2·89	,,	Rdokass	468·26	4·8	3·57
		10		394·50	− 1·0	1·82	,,		468·00	8·3	2·36
		4		394·15	6·0	0·59	,,		466·88	12·7	0·69
	22 ,,	8		355·42	− 3·0	1·33	,,		468·33	6·3	1·73
		10		395·25	1·5	2·12	,,		468·08	10·3	0·78
		4		395·76	0·5	1·04	,,		467·66	12·7	0·00
			Mean...	395·90	− 0·2	2·15			469·32	8·63	1·85
	15 ,,	11.15	Sella Pass ...	368·85	− 3·0	—	,,	Rdokass	471·57	8·3	—
	14 ,,	4		373·51	− 6·5	2·04	,,		471·29	10·3	1·67
	15 ,,	8		373·40	− 7·0	1·22	,,		471·53	6·3	2·68
		4		373·28	− 4·5	1·37	,,		470·56	12·7	0·24
	16 ,,	10	Camp VII ...	372·71	− 3·0	2·09	,,	Rdokass	470·41	9·3	0·89
	18 ,,	10		372·18	− 7·0	2·67	,,		468·41	9·1	1·21
		4		370·85	− 4·0	2·61	,,		466·53	12·7	0·00
	19 ,,	4		369·43	− 6·0	2·89	,,		466·00	8·8	2·07
	20 ,,	8		369·04	− 9·0	2·26	,,		466·26	7·8	4·16
			Mean...	371·80	− 5·8	2·14			468·88	9·1	1·62
	24 ,,	4	Camp VIII...	360·78	− 6·0	1·77	,,	Rdokass	469·66	14·7	0·00
	25 ,,	1	Staircase ...	348·30	6·0	—	,,	Rdokass	471·86	14·7	—

D.—Comparison of Observations Made on the Godwin Austen, Savoia, and Upper Baltoro Glaciers. (Contd.)

No.	Date. Month and day.	Date. Hour.	Station of observation. Place.	Pressure mm.	Temperature cent.	Tension of vapour mm.	Instrument used for measurement of pressure.	Simultaneous data of comparison. Of the station of	Pressure mm.	Temperature cent.	Tension of vapour mm.
	1 July	10		431·33	11·0	5·04	Fortin		468·43	10·3	0·78
		4		431·33	12·0	3·36	,,		466·80	14·2	0·00
	2 ,,	8		431·23	4·0	3·54	,,		466·81	7·8	1·31
		4		431·33	15·0	4·85	,,		466·71	14·3	0·00
	3 ,,	8		432·69	4·0	3·16	,,		468·61	6·8	1·91
		10	Camp IX ...	422·65	11·0	2·83	,,	Rdokass	468·81	11·3	0·58
		4		432·56	14·5	2·87	,,		467·47	15·7	0·00
	4 ,,	8		433·55	7·0	3·30	,,		469·61	8·3	3·37
		10		434·49	9·0	3·11	,,		469·39	12·7	2·82
	5 ,,	4		434·55	11·5	3·06	,,		468·56	15·2	0·00
		8		433·01	2·0	3·41	,,		469·56	5·8	6·42
		4		432·95	10·5	6·40	,,		467·51	13·2	2·52
			Mean...	432·62	9·3	3·74			468·19	11·3	1·64
	1 ,,	4	Camp X ...	428·30	5·0	—	Hyps.	Rdokass	466·80	14·2	—
	7 ,,	4	Camp XI ...	418·34	4·0	—	Fortin	Rdokass	466·98	10·3	—
	3 ,,	4	Camp XII ...	393·87	8·0	4·12	,,	Rdokass	467·47	15·7	0·00
	5 ,,	4		393·65	7·0	3·20	,,		467·51	13·2	2·52
	6 ,,	10		392·98	12·0	2·23	,,		468·53	7·8	4·18
		4		392·38	7·5	2·90	,,		467·79	5·8	5·38
	7 ,,	10		392·53	11·0	2·83	,,		467·86	5·8	4·86
			Mean...	393·08	9·1	3·05			467·83	9·7	3·39
	9 ,,	5	Camp XIII	377·71	8·0	0·31	,,	Rdokass	468·98	10·3	1·67
	10 ,,	4		354·40	3·0	0·52	,,		467·98	13·7	0·00
	14 ,,	10	Camp XIV ...	354·10	3·0	2·17	,,	Rdokass	469·12	10·3	4·26
		4		354·35	1·0	4·01	,,		469·10	11·8	3·90
				358·28	2·3	2·20			468·73	11·9	2·72
	11 ,,	4	Camp XV (I)	342·12	0·0	—	,,	Rdokass	467·72	15·7	—
	17 ,,	4	Camp XV (II)	335·74	5·0	—	,,	Skardu ...	572·11	30·4	—
	18 ,,	2.30	Nearest Bride Peak	312·33	6·0	4·18	,,	Leh ...	494·99	24·9	10·51
								Srinagar	622·85	29·1	22·65
								Skardu ...	571·45	31·9	7·65
								Gilgit ...	627·08	31·9	14·11

Comparison of Observations Made on the Return Journey.

No.	Date. Month and day.	Date. Hour.	Station of observation. Place	Station of observation. Pressure mm.	Station of observation. Temperature cent.	Station of observation. Tension of vapour mm.	Instrument used for measurement of pressure.	Simultaneous data of comparison. Of the station of	Simultaneous data of comparison. Pressure mm.	Simultaneous data of comparison. Temperature cent.	Simultaneous data of comparison. Tension of vapour mm.
	28 July ...	11	Northern camp of Skoro-La	470·34	15·8	1·43	Fortin	Leh ...	497·27	20·7	10·51
								Skardu	573·48	29·2	3·37
								Gilgit ...	628·69	36·2	0·00
	29 ,, ...	11	Skoro-La ...	413·27	6·4	—	,,	Leh ...	497·39	18·4	—
								Skardu	573·73	25·1	—
								Gilgit ..	613·89	32·3	—
	1 August	4	Camp between Skardu and Burgi-La	504·63	19·4	5·84	,,	Leh ...	496·92	23·5	8·10
								Skardu	573·84	31·1	6·26
								Gilgit ...	631·23	30·2	12·84
	2 ,,	9.50	Burgi-La ...	427·65	9·4	—	,,	Leh ...	498·45	20·9	—
								Skardu	574·78	28·9	—
								Gilgit ...	630·41	31·9	—
	3 ,,	4	Chundu-Kut	469·81	15·3	4·66	,,	Leh ...	495·02	23·3	8·07
								Skardu	571·65	27·2	6·86
								Gilgit ...	626·30	33·9	7·06
	4 ,,	9.50	Sarsingar...	455·81	11·9	—	,,	Leh ...	497·84	20·6	—
								Skardu	575·11	23·9	—
								Gilgit ...	630·69	29·7	—
	4 ,,	12.50	Stakpi-la ...	470·61	18·9	—	,,	Leh ...	497·84	20·6	—
								Skardu	575·11	23·9	—
								Gilgit ...	630·69	29·7	—
	4 ,,	4	Burzil ...	505·22	19·9	6·77	,,	Leh ...	494·61	22·7	7·59
								Skardu	571·19	30·7	6·35
								Gilgit ...	625·43	35·9	10·91
	5 ,,	4	Pashwari ...	570·07	19·9	—	Hyps.	Leh ...	495·98	21·6	—
								Skardu	573·33	24·4	—
								Gilgit ...	629·29	28·1	—
	6 ,,	4	Gurais ...	591·28	15·8	11·93	,,	Leh ...	494·54	20·1	6·33
								Skardu	572·72	23·0	11·06
								Gilgit ...	610·06	27·9	14·08
	7 ,,	4	Gorè ...	546·42	15·8	10·54	,,	Leh ...	494·69	23·9	6·16
								Skardu	573·68	25·4	9·14
								Gilgit ...	629·98	26·7	15·17
	8 ,,	8	Rajdiangan Pass	497·59	12·8	5·02	Fortin	Leh ...	497·48	17·9	6·75
								Skardu	575·57	16·1	10·77
								Gilgit ...	622·50	21·2	14·41
	9 ,,	4	Tragbal ...	540·38	20·9	—	Hyps.	Leh ...	494·33	23·5	—
								Skardu	574·90	27·4	—
								Gilgit ..	629·01	29·7	—

Final Summing-up of Statistics of Height.

No.	Stations. Of observation.	Stations. Of reference.	No. of observations.	Instrument used.	Height above sea level of stations of reference. z metres.	Difference in height between stations of observation and of reference. Z metres.	Height above sea level of stations of observation. z + Z metres.	Height above sea level of stations of observation. Metres.	Height above sea level of stations of observation. Feet.
1	Baltal	Srinagar	1	Hyps.	1,586	1,266	2,852	2,822	9,259
		Leh ...			3,506	– 716	2,799		
		Skardu ...			2,287	518	2,805		
		Gilgit ...			1,490	1,342	2,831		
2	Mutajun... ...	Srinagar	1	Fortin	1,586	1,527	3,113	3,194	10,479
		Leh ...			3,506	– 309	3,197		
		Skardu ...			2,287	935	3,222		
		Gilgit ...			1,490	1,753	3,243		
3	Olthingthang ...	Leh ...	1	Hyps.	3,506	– 789	2,717	2,758	9,049
		Skardu ...			2,287	487	2,774		
		Gilgit ...			1,490	1,292	2,782		
4	Tarkutta ...	Leh ...	1	,,	3,506	– 1,063	2,443	2,493	8,179
		Skardu ...			2,287	225	2,512		
		Gilgit ...			1,490	1,034	2,524		
5	Kharmang ...	Leh ...	1	,,	3,506	– 1,110	2,396	2,446	8,025
		Skardu ...			2,287	179	2,466		
		Gilgit ...			1,490	985	2,475		
6	Tolti	Leh ...	1	,,	3,506	– 1,162	2,344	2,396	7,861
		Skardu ...			2,287	114	2,401		
		Gilgit ...			1,490	952	2,442		
7	Shigar	Leh ...	1	,,	3,506	– 1,258	2,248	2,291	7,517
		Skardu ...			2,287	17	2,304		
		Gilgit ...			1,490	830	2,320		
8	Dusso	Leh ...	1	,,	3,506	– 1,153	2,353	2,400	7,874
		Skardu ...			2,287	108	2,395		
		Gilgit ...			1,490	963	2,453		
9	Gomboro ...	Leh ...	1	,,	3,506	– 1,006	2,500	2,540	8,333
		Skardu ...			2,287	255	2,542		
		Gilgit ...			1,490	1,089	2,579		
10	Chongo	Leh ...	1	Fortin	3,506	– 588	2,918	2,968	9,738
		Skardu ...			2,287	684	2,971		
		Gilgit ...			1,490	1,525	3,015		
11	Askoley	Leh ...	5	,,	3,506	– 451	3,056	3,052	10,013
		Skardu ...			2,287	753	3,040		
		Gilgit ...			1,490	1,501	3,060		
12	Punmah... ...	Leh ...	1	,,	3,506	– 422	3,084	3,107	10,194
		Skardu ...			2,287	816	3,103		
		Gilgit ...			1,490	1,643	3,133		
13	Paiju	Leh ...	1	,,	3,506	– 185	3,321	3,350	10,991
		Skardu ...			2,287	1,062	3,349		
		Gilgit ...			1,490	1,892	3,382		

FINAL SUMMING-UP OF STATISTICS OF HEIGHT. *(Contd.)*

No.	Stations. Of observation.	Stations. Of reference.	No. of observations.	Instrument used.	Height above sea level of stations of reference. z metres.	Difference in height between stations of observation and of reference. Z metres.	Height above sea level of stations of observation. $z + Z$ metres.	Metres.	Feet.
14	Between Liligo and Rhobutse	Leh ...	1	Fortin	3,506	201	3,707	3,727	12,228
		Skardu ...			2,287	1,436	3,723		
		Gilgit ...			1,490	2,261	3,751		
15	Rdokass ... ... 1st base camp	Leh ...	137	„	3,506	492	3,998	4,025	13,206
		Skardu ...			2,287	1,734	4,021		
		Gilgit ...			1,490	2,540	4,030		
		Srinagar			1,586	2,465	4,051		
16	Camp III ... 2nd base camp	Rdokass	26	„	4,025	994	5,019	5,027	16,493
		Leh ...			3,506	1,500	5,006		
		Skardu ...			2,287	2,728	5,015		
		Srinagar			1,586	3,464	5,050		
		Gilgit ...			1,490	3,556	5,046		
17	Camp IV ...	Camp III	4	„	5,027	536	5,563	5,561	18,245
		Rdokass	4		4,025	1,535	5,560		
18	Camp V	Camp III	1	„	5,027	419	5,446	5,433	17,825
		Rdokass	6		4,025	1,396	5,421		
19	Savoia Pass ...	Rdokass	1	„	4,025	2,347	6,372	—	20,906
20	Camp VI ...	Rdokass	10	„	4,025	1,388	5,413	—	17,760
21	Sella Pass ...	Rdokass	1	„	4,025	2,097	6,112	—	20,053
22	Camp VII ...	Rdokass	8	„	4,025	1,876	5,901	—	19,361
23	Camp VIII ...	Rdokass	1	„	4,025	2,150	6,175	—	20,260
24	Staircase ...	Rdokass	1	„	4,025	2,531	6,556	—	21,510
25	Camp IX ...	Rdokass	12	„	4,025	659	4,684	—	15,368
26	Camp X... ...	Rdokass	1	Hyps.	4,025	715	4,740	—	15,551
27	Camp XI ...	Rdokass	1	Fortin	4,025	905	4,930	—	16,175
28	Camp XII ...	Rdokass	5	„	4,025	1,449	5,474	—	17,960
29	Camp XIII ...	Rdokass	1	„	4,025	1,796	5,821	—	19,098
30	Camp XIV ...	Rdokass	3	„	4,025	2,310	6,335	—	20,784
31	Camp XV (I) ...	Rdokass	1	„	4,025	2,581	6,606	—	21,674
32	Camp XV (II) ...	Skardu ...	1	„	2,287	4,566	6,853	—	22,484
33	Nearest Bride Peak	Leh ...	1	„	3,506	3,932	7,438	7,498	24,600
		Srinagar			1,586	5,958	7,544		
		Skardu ...			2,287	5,209	7,496		
		Gilgit ...			1,490	6,023	7,513		

Final Summing-up of Statistics of Height. *(Contd.)*

No	Stations. Of observation.	Stations. Of reference.	No. of observations.	Instrument used.	Height above sea level of stations of reference. z metres.	Difference in height between stations of observation and of reference. Z metres.	Height above sea level of stations of observation. z + Z metres.	Metres.	Feet.
34	North Camp of Skoro-La	Leh ...	1	Fortin	3,506	477	3,983	4,010	13,156
		Skardu ...			2,287	1,721	4,008		
		Gilgit ...			1,490	2,549	4,039		
35	Skoro-La ...	Leh ...	1	„	3,506	1,555	5,061	5,095	16,716
		Skardu ...			2,287	2,789	5,076		
		Gilgit ...			1,490	3,658	5,148		
36	Camp between Skardu and Burgi-La	Leh ...	1	„	3,506	134	3,372	3,417	11,211
		Skardu ...			2,287	1,131	3,418		
		Gilgit ...			1,490	1,970	3,460		
37	Burgi-La ...	Leh ...	1	„	3,506	1,300	4,806	4,830	15,847
		Skardu ...			2,287	2,546	4,833		
		Gilgit ...			1,490	3,360	4,850		
38	Chundu-Kut ...	Leh ...	1	„	3,506	451	3,957	3,987	13,081
		Skardu ...			2,287	1,703	3,990		
		Gilgit ...			1,490	2,523	4,013		
39	Sarsingar ...	Leh ...	1	„	3,506	751	4,257	4,280	14,042
		Skardu ...			2,287	1,992	4,279		
		Gilgit ...			1,490	2,813	4,303		
40	Stakpi-la ...	Leh ...	1	„	3,506	485	3,991	4,049	13.284
		Skardu ...			2,287	1,741	4,028		
		Gilgit ...			1,490	2,639	4,129		
41	Burzil	Leh ...	1	„	3,506	− 185	3,322	3,359	11,021
		Skardu ...			2,287	1,080	3,367		
		Gilgit ...			1,490	1,897	3,387		
42	Pashwari ...	Leh ...	1	Hyps.	3,506	− 1,205	2,301	2,331	7,648
		Skardu ...			2,287	50	2,337		
		Gilgit ...			1,490	866	2,356		
43	Gurais	Leh ...	1	„	3,506	− 1,537	1,969	2,008	6,588
		Skardu ...			2,287	276	2,011		
		Gilgit ...			1,490	554	2,044		
44	Gorè	Leh ...	1	„	3,506	− 861	2,646	2,695	8,842
		Skardu ...			2,287	423	2,710		
		Gilgit ...			1,490	1,240	2,730		
45	Rajdiaugan ...	Leh ...	1	Fortin	3,506	− 2	3,504	3,524	11,562
		Skardu ...			2,287	1,236	3,523		
		Gilgit ...			1,490	1,920	3,546		
46	Tragbal	Leh ...	1	Hyps.	3,506	− 776	2,730	2,796	9,173
		Skardu ...			2,287	543	2,830		
		Gilgit ...			1,490	1,337	2,287		

D. OMODEI.
Genoa, January, 1910.

APPENDIX C.

GEOLOGICAL RESULTS

OF THE

KARAKORAM EXPEDITION

OF

H.R.H. THE DUKE OF THE ABRUZZI,

BY

INGEGNERE VITTORIO NOVARESE,
Of the Italian Geological Survey,

AND

R. D. OLDHAM, F.R.S., F.G.S., &c.,
Formerly of the Geological Survey of India

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THE fundamental outlines of our knowledge of the geology of the Karakoram range and of Baltistan are still, in the main, those drawn by the labours of Col. H. H. Godwin Austen and of R. Lydekker; but though the map published by the latter in 1883, and reproduced on a smaller scale in the second edition of the *Manual of the Geology of India*, published in 1891, was coloured geologically up to the supposed watershed of the Karakoram range, exploration had not in fact been pushed so far and the sources of the Baltoro were, at that time, in every way unknown.

Later explorers had made no noteworthy contributions to the geology of the region if we except the record of limestones on the Crystal Peak and the sedimentary rocks of Golden Throne reported by Sir W. M. Conway; and the good fortune—one may say merit—was reserved for the expedition led by H.R.H. the Duke of the Abruzzi, of collecting observations which are not only new but to a great extent unexpected, because, notwithstanding their importance and obviousness, they had escaped the notice of previous travellers. Moreover, they form a complement to those which were almost simultaneously being made by Dr. Longstaff's expedition at a distance of about 30 miles to the south-east, in the valley of the Siachen glacier, and hence come to throw great light on the nature and constitution of that little-known portion of the heart of the great Asiatic continent.

In working out the geological results of the Italian expedition, the observations and reports made by its several members have been utilised, as well as the lithological material collected by them. The greater part of the specimens, indeed almost the whole, were obtained from the glacier moraines, for the approach to the rock-walls of the Upper Baltoro, though not impossible, is frequently dangerous on account of the avalanches of snow and rocks precipitated at every moment from these precipices, which measure not hundreds but thousands of feet in height. The points where the rocks are directly accessible are therefore somewhat rare, and consequently the specimens collected from rock *in situ* are few in number.

Fortunately the material obtained from the moraines was not fortuitously collected, but the moraines running along a transverse section at the junction of the Upper Baltoro with the Godwin Austen glaciers were consecutively numbered and the more characteristic material collected from each of them. Since it is possible to determine the origin of the material forming the principal moraines in this part of the glacier, a tolerably good idea may be formed of the constitution of the slopes from which each is derived. Further on will be found a list of these moraines and their lithological composition as reported by Dr. F. De Filippi.

The rocks of which specimens were procured belong to the two categories of crystalline schists and sedimentary deposits, with the addition of certain specimens of serpentine. Apart from this last there are no representatives of eruptive rocks, although granite is highly developed in the mountains of the Baltoro valley; evidently the abundance of limestone and other sedimentary rocks attracted and particularly engaged the attention of the Italians.

A.—Schists and Crystalline Rocks.

The specimens of crystalline schists are few in comparison with those of sedimentary rocks, but fortunately the more important of them were collected *in situ*, and the place of origin is consequently known.

Along with the crystalline schists will be described certain specimens of mineral veins, which must traverse them, and the noble serpentine, although this should be associated stratigraphically with the more recent rocks, rather than with the crystalline schists.

I. *Biotite gneiss.*—The specimen was collected by H.R.H. the Duke of the Abruzzi on Bride Peak, from the last rock of the eastern ridge at an altitude of 24,600 feet, on July 18th, 1909.

It is a slightly biotitic gneiss, dark coloured, of fine grain, but not sufficiently so for it to become cryptocrystalline, and showing banded structure. It is probably flaggy, though the smallness of the fragment prevents this being affirmed with certainty. The grain is homogeneous and uniform. The biotite does not form continuous sheets, but appears in isolated flakes. To the naked eye small greenish spots are noticeable, due to amphibole.

Under the microscope the rock is seen to be composed of quartz, felspar, biotite and amphibole, and as subordinate and accessory constituents, sphene, zircon, apatite, as well as occasional calcite.

The quartz occurs in granular aggregates, frequently drawn out in the form of lenticles lying parallel to the foliation; quantitatively it is subordinate to the felspar, and shows neither undulate extension nor mechanical fracture.

The felspar is of two kinds. Orthoclase is the predominant form always slightly opaque through incipient alteration. Cleavage is very distinct and always visible. From a study of the disposition of the cleavage planes and their relative frequency in sections cut parallel or transverse to the foliation it is evident that the individual crystals are arranged with the axis of the two directions of cleavage (001) (010) parallel to the foliation.

The orthoclase individuals have irregular outlines, are always larger than those of quartz, of which they sometimes enclose rounded granules. The maximum dimension of the granules of orthoclase attains 0·6 millimetre, but, on the average, is rather less than half this figure. Small plates of mica are commonly found in the intervals between the separate granules.

The other felspar is marked as albite by its polysynthetic twining and the index of refraction being less than that of quartz. It is very rare in comparison with the orthoclase.

The biotite occurs without any crystal faces, except the basal plane; the flakes have a very irregular outline as seen in a thin section, much elongated in the direction of the basal plane. The maximum dimensions are 0·55 millimetre in the direction of c and 0·70 millimetre in the direction perpendicular to this, that is to say, parallel to the basal plane.

The biotite occurs in two sizes. The larger lie along the foliation planes and are arranged in similar orientation. The smaller, which have already been noticed when speaking of the felspar, occur in extremely minute flakes and lying in any direction in the interstices of the aggregate of quartz and felspar forming the ground mass of the rock.

The biotite is brown and exhibits the following pleochroism :—

$$n_p = \mathfrak{a} = \text{pale yellow}$$
$$n_m = \mathfrak{b} = \text{brown}$$
$$n_g = \mathfrak{c} = \text{brown.}$$

There is very little difference between n_m and n_g, the absorption parallel to the basal plane is not great, as the mineral has preserved its transparency and pale brown colour ; it is sensibly uniaxial in convergent light.

The mica in general is quite fresh and shows no sign of chemical alteration or mechanical deformation.

The amphibole has the habit of actinolite, always in rather slender prisms, for the most part grouped in bundles with their axes parallel to the foliation. It is constantly associated with mica, but, notwithstanding this connection, does not seem to be derived from the latter, which, as has been mentioned, is always quite fresh.

The angle of maximum extinction is almost exactly 15°, but not greater. The pleochroism is as follows :—

n_g = $\mathfrak{c}$ = blue green with notable absorption
n_m = $\mathfrak{b}$ = bright green with a slight tendency to brown
n_p = $\mathfrak{a}$ = very pale green
$\mathfrak{a} < \mathfrak{b} < \mathfrak{c}$.

The maximum length of the groups of prisms is 1 millimetre, the mean width of each prism 0·05 to 0·06 millimetre.

Among the accessory minerals sphene is abundant and in comparatively large grains. The calcite is certainly of secondary origin.

The structure of the rock is interesting, particularly as seen in sections perpendicular to the foliation, on account of the regular distribution of the coloured constituents, especially the mica, which is much more abundant than the amphibole, and of a certain uniformity of dimension of the grains of quartz and felspar: this is a type of hornstone structure, characteristic of rocks metamorphosed by contact with granite. In the sections examined no mineral characteristic of contact metamorphism, as, for instance, andalusite, was seen but the structure and character, especially of the biotite, convey the impression of a rock of this character. Should future observation confirm this it will have to be admitted that the granite of the Baltoro neighbourhood is more recent than the crystalline schists which are in contact with, and have been metamorphosed by, it.

II. *Noble Serpentine.*—Typical specimens of this were collected along the whole course of the Baltoro. They were also found in the moraines of the upper reaches and it is probable that it is intrusive in the sedimentary rocks. Lydekker records this mineral as occurring in the Shigar region in the supra-Kuling series, of mesozoic, perhaps upper mesozoic age; it was also determined by Prof. T. G. Bonney and Miss A. C. Raisin[1] in specimens collected by Sir M. Conway from White Fan Pass, a little east of Crystal Peak.

III. *Vein Quartz.*—In variety. Two specimens were collected by His Royal Highness on Bride Peak. along with the biotite gneiss already described, others in the moraines of the Baltoro. The latter enclose pyrites and arsenical pyrites or mispickel; these very common minerals would be of no importance but that they may indicate a possible origin of the gold which near Skardu and elsewhere is found in small quantities in the alluvium of the Upper Indus and its tributaries, possibly in doubly derivative occurrence, as Lydekker found traces of gold workings in the alluvial terraces at about 120 feet above the present level of the Indus. Probably the pyrites of the quartz veins is sufficiently auriferous to give rise on its decomposition to the scanty gold which is met with in these river gravels.

[1] *Proc. Roy. Soc.* LV, p. 486 (1894).

B.—Sedimentary Rocks.

The rocks of palpably sedimentary origin, collected in the Baltoro moraines, fall into two principal groups: one composed of schists and siliceous anagenites,[1] the other of most various limestones, dolomites and calcareous breccias.

The first group contains many types, which, individually, seem tolerably different from each other, but, considered as a whole, yield so many intermediate types as to suggest an origin from one and the same series of strata. The prototype is a rock composed of small rounded fragments of quartz imbedded in a micaceous matrix, and may be described as a reddish violet anagenite with the quartzose component generally of small dimensions, and of white, reddish and greenish colour, imbedded in a distinctly schistose micaceous (sericitic) matrix. With the disappearance of the quartz fragments this rock passes into a thoroughly typical violet-coloured sericite schist. At times the quartz grains increase in size and abundance till the rock, being strongly cleaved, assumes a characteristically gneissose appearance; at others the sericitic cement becomes so cryptocrystalline as to assume a wax-like appearance. Occasionally the whole rock seems to have undergone an alteration which has given it an argillaceous appearance, recalling that of some porphyrites or porphyritic tuffs, which have been altered into argillites.

Less abundant as compared with these rocks, all more or less reddish in colour, are others, quite analogous, of greenish grey colour, which probably alternate with the former because, except for the colour of the micaceous matrix, they consist of the same elements.[2]

The calcareous group presents an extraordinary wealth of varieties and can be divided into three sub-groups: limestones, comprising also dolomites and dolomitic limestones, coloured marbles, and breccias, the latter more abundant than all the other rocks.

The first sub-group includes white, grey and black-banded limestones, and whitish and yellowish dolomites. One crystalline limestone in particular deserves special mention: it is a fine-grained, almost waxy looking limestone, sometimes marbled with fine grey lines, sometimes having the appearance of cipolin, which is probably derived from lenticular masses included in the gneiss or mica schist.

[1] This word, which is not used in England or mentioned in English text books, is in common use by French and Italian geologists for a rock composed of small rounded fragments, or pebbles, of quartz scattered through a fine grained micaceous matrix. Rocks of this kind are common in the Alps, as also in parts of the Himalayas, and since there is no word in common English use to describe them the term has been retained.—R. D. O.

[2] The rocks described by Prof. F. G. Bonney and Miss Raisin from the collection made by Sir M. Conway under the names of grit, schistose grit, and to some extent quartzite, include many which would here be described as typical anagenites.

In the group of coloured marbles the prevailing variety is a very beautiful red marble with small white spots, and various other types, all having a red coloured base and white veins.

There comes finally the group of breccias, which presents no small variation, both in the nature of the fragments and in that of the cement, in the colour of one or the other, and so on. Noteworthy is a whole series of breccias of calcareous fragments, bound together by a reddish micaceous substance, quite analogous with the matrix of the anagenites. Better than any description as a help to an appreciation of the range of colours of these breccias, is the fact that they present many analogies with the varieties of marble from the Apuan Alps and other parts of Italy.

Certain specimens, intermediate between the breccias and marbles, are formed of a soft, dark red, calcareous schist, seamed with veins of calcite, which gives place, when associated with white limestone, to a white marble with violet-coloured amygdaloidal patches, and dark red veining, and to a dark red and white marble breccia with green variegation, altogether similar to the *rosso di Levanto;* but while the latter is a typical ophicalcite, as much cannot be said of the Baltoro specimens, in which the green is due to variegation of the schistose portion. It is, however, to be noted that we are not impossibly dealing with an extreme form of true ophicalcite, as fragments of noble serpentine are found in the moraine along with this breccia.

The specimens collected at the camping grounds of the explorers are insufficient for an attempt to arrange the various types in their order of geological sequence. The only hypothesis which can be hazarded is that probably some of the calcareous breccias with micaceous cement come from the contact zone of the schists and anagenites with the limestone and dolomite. In the Apuan Alps very similar breccias (*mischio di Saravezza*) occur at the contact between the lower limestones (*grezzoni*) and the underlying schists, which have been ascribed to the permian, others, on the contrary, occur at the contact of the said *grezzoni* with the zone of marbles, etc. All these breccias appear to be due to mechanical action and are consequently referable to crush breccias.

Owing to the absence of organic remains among the material collected by the Italian expedition, no direct determination of the geological age of the formations is possible, and the only way to arrive at even a very approximate determination is by comparison of the specimens collected with the rocks already studied and known in other parts of the district. According to the work of Lydekker and Godwin-Austen, confirmed by later observation, a great complex of formations occurs in a syncline, between Shigar and Askoley, in Baltistan, and in the range rising west of the Biafo glacier. This complex, formed by alternations of schist, limestone, dolomite containing serpentine, and, according to Col. Godwin-Austen, also quartzites, may well be the equivalent of the formations met with in the Upper Baltoro valley. Mr. Lydekker gives two sections across this formation and mentions

dolomitic limestones, blue and white mottled limestones, pure white and blue limestones with red veins, green and black schists, the latter carbonaceous and calcareous, and so forth, besides brown grits, which may be the reddish anagenites and identical with the quartzites of Colonel Godwin-Austen. In short the rocks are all such as are present in the moraines of the Upper Baltoro glacier. Mr. Lydekker also mentions dolomites and limestones with characteristic red stains, identical with those found in the supra-Kuling series of Chang-cheng-mo.[1] It is not, therefore, too risky to assume that the same formations, but with a much greater development of limestones in comparison with the other rocks, are repeated to the east of K² and form the Broad–Gasherbrum–Golden Throne group of mountains.

The beds of the series forming the above-mentioned, so-called[2] Baltistan–Braldoh syncline are ascribed by Mr. Lydekker, on account of their resemblance to other fossiliferous rocks of the district, to his Zànskàr system, named after a district in Kashmir, and attributed to a carbon-mesozoic age. The series which is fossiliferous at Shigar, and comparable with that met with on the Sasser Karakoram track, certainly includes the permian and trias, together with older beds at the base and newer ones above. With all reservation necessary in the present case, we may, provisionally, accept a similar correlation for the sedimentary series of the Upper Baltoro, all the more so as I shall shortly set forth other arguments in favour of this hypothesis.

A sufficiently clear idea of the topographical distribution of these sedimentary rocks in the mountains of the Upper Baltoro may be formed from the series of moraine ridges immediately below the confluence of the Baltoro with the Godwin-Austen glacier, along a line drawn from north to south.[3]

According to Dr. De Filippi the succession is as follows :—

1. A large moraine of granite, gneiss, and crystalline rocks, derived from the range on the left of the glacier from Bride Peak to Masherbrum.
2. Moraine of limestone fragments, rich in coloured marbles and limestone breccias, which have fallen from the western flanks of Golden Throne.
3. Narrow moraine of schistose slaty rocks, which unites with the preceding one a little lower down.
4. A great moraine of calcareous fragments, coloured marbles, breccias and anagenites of various colours, with a predominance of wine red, which descends from Hidden Peak and the southern buttresses of Gasherbrum.

    With this moraine the contribution of the Upper Baltoro ceases and gives way to that of the Godwin-Austen glacier.

[1] *Mem. Geol Surv. Ind.* XXII, pp. 188, 189.

[2] E. Suess, *Das Antlitz der Erde*, III. pt. i, p. 350.

[3] These moraine ridges are very clearly visible in the Panorama M, taken from the rock crest between the Vigne and Baltoro glaciers.

5. Moraine of limestone fragments collected along the slopes of Broad Peak.
6. Median moraine, coming from the southern and western slopes of K^2, the prevailing constituents being granite and crystalline schists with some scattered fragments of limestone.
7. Right hand marginal moraine, with the same composition as the preceding, but becoming richer in limestone fragments below the white limestone peak, which rises to the south-east of Crystal Peak, at the confluence of the Baltoro and Godwin-Austen glaciers.

The observations made by Dr. De Filippi, the beautiful photographs of Vittorio Sella, and the material determined and discussed in the preceding pages, make it possible to draw the outlines of a sketch of the geological constitution of the mountains of the Upper Baltoro and to study their relations to other districts geologically known.

From the end of the glacier near Paiju up to the confluence of the Godwin-Austen glacier, the Baltoro valley is opened through the gneisses and granites of the Baltistan massif, according to the unanimous description of all explorers. It is possible, however, that crystalline limestone might be intercalated in this series of crystalline schists, for Lydekker mentions[1] having met with it in the Hushe valley, which descends southwards from Masherbrum in the heart of the gneissic area.

Certain of Sella's photographs, however, led me to entertain some doubt of the entirely gneissic character of the Lower Baltoro valley. In the preliminary account of the journey, published by the Italian Geographical Society,[2] it is mentioned that the mountains on the right of the Baltoro in front of Rdokass are gigantic, with vertical flanks, and peaks of superb and fantastic forms, sometimes of formidable towers, at others of sharply pointed pyramids. As the photographs and telephotographs show, these irregular forms are confined to the upper parts of the mountains and seem to be the remnants of an enormous, nearly horizontal layer superimposed on the massive gneiss. The forms, in short, of these mountains reproduce the appearance of the dolomitic towers of the Alps, so that it is at least justifiable to doubt whether there may not be, in this part of the Mustagh, the remains of a capping of sedimentary rock regularly covering the gneiss and forming what is known in modern terminology as a "lambeau de recouvrement," composed of dolomites, overthrust on to the gneiss and granites of Baltistan.

Apart from dolomite, the only rock, with which I am acquainted, capable of assuming such forms is the protogene, a special form of granite, of Mont Blanc.

[1] *Loc. cit.*, p. 312.
[2] *Boll Soc. Geog. Ital.* series iv, XI, p. 444, April 1910.

Since four glaciers descend from the cliffs in question it will be easy for a later examination to confirm or refute this hypothesis by an examination of the moraines.[1]

Ascending the valley, the mountains suggest no change of character till the confluence of the Godwin-Austen glacier is approached. On the right of the Baltoro, opposite and north of Mitre Peak, a marble crag rises from one of the buttresses of Crystal Mountain, and is marked in the map of the Italian expedition by the figure 20088. The peak is most recognisable because the summit, composed of pure white marble, rises from a base of dark-coloured schists. The dip of the schists, though steep, is distinctly eastwards above, but lower down becomes perfectly vertical, where the beds are seen plunging perpendicularly into the Godwin-Austen glacier.

As it was not possible to secure authentic specimens, either of the schists of the base or of the marble, we must have recourse to conjecture. In the material of the moraine the only white marble is a saccharoid limestone of very fine grain, with suggestions of cipolin, derived from the moraine on the Baltoro in direct correspondence with this peak. Is this mass of marble simply a great lenticular inclusion of crystalline limestone in the Baltistan gneiss, like that of Masherbrum, or, does it belong to the overlying group forming the massif opposite to it, from which it seems separated by some local accident of structure or sculpture? The material for answering these questions is not to hand.

West of the marble peak lies a saddle named by Sir W. M. Conway, White Fan pass, beyond which rises his Crystal Peak, not that so named on the Italian map, but one of its minor peaks. Among the specimens collected by Sir W. M. Conway, on the ascent of his Crystal Peak, Prof. T. G. Bonney and Miss A. C. Raisin identified[2] a fine-grained gneiss, a calcitic quartz schist, a dark-coloured mica schist, a dolomite. and a limestone. both crystalline. From the White Fan pass came a mica syenite and a fine-grained crystalline dolomite. All these are rocks of a crystalline series and. except the syenite, of the schistose group. The presence of unaltered sedimentary rocks in the Baltoro moraines, opposite Crystal Peak, led Prof. Bonney and Miss Raisin to propose the hypothesis that sedimentary formations were represented in the rock forming this mountain. Now that we know that sedimentary rocks form the whole of Gasherbrum. from which the greatest part of the moraine material of the Baltoro is derived, Prof. Bonney's conjecture becomes baseless, and the presence of sedimentary rocks in the vicinity of Crystal Peak problematical.[3]

[1] It is worth noting that the illustrations to Sir W. M. Conway's book, and to that of Dr. Jacot Guillarmod, indicate the existence of a very similar feature in the mountains of the Masherbrum range. to the south of the Baltoro valley.—R. D. O.

[2] *Scientific Results*, p. 72.

[3] See, however. the remarks on p. 445.

The formation of schists, anagenites, limestones and dolomites shows up in its full development in the terminal mass, lying between the Godwin-Austen and Upper Baltoro glaciers, which is crowned by the three peaks Broad, Gasherbrum and Hidden, rising to heights of more than 26,500 feet (8,000 metres). The limestones predominate in the high portion of the Broad and Gasherbrum mountains, the base of schists is seen to fringe the foot of these mountains along the whole of the left bank of the Godwin-Austen and eastwards along the right bank of the Upper Baltoro glaciers, to almost opposite Mitre Peak. Beyond this point the limestones extend down to the base, and on the left of the photographic view of Bride Peak from Camp III the mass of limestones, bristling with peaks and pinnacles, is seen to rise from the glacier.

The boundary between the limestones and schists is, consequently, covered by ice in the valley, but certainly rises towards the dip between the calcareous Golden Throne and the gneissic Bride, and probably crosses Chogolisa pass.

Among the specimens collected by Sir W. M. Conway on the second pinnacle of Pioneer Peak, one of the peaks of Golden Throne, is a purple schistose grit with small pebbles, mentioned by Prof. Bonney and Miss Raisin[1], which may be identical with the anagenite of this report.

As appears from specimens collected by His Royal Highness, at a height of 24,600 feet, Bride Peak is composed above of gneiss, and at the base of the granites and granitoid gneisses, so extremely abundant, according to the observations of the members of the Italian expedition, in the moraines of the glacier which descends from this mountain.

In the Upper Godwin-Austen glacier the boundary between the gneiss and the beds of the palæo-mesozoic series must lie to the south of Windy Gap, as the Staircase is made of coarse-grained, light greyish gneiss.

The base of the highest peak of the neighbourhood, K[2], ought, according to the reports of various expeditions, to be formed of light-coloured granites or granitoid gneisses. But the several photographs taken from south, east and west show a well marked stratification with gentle dips of about 15° to 20°, which is greatest in the terminal pyramid; it is probably due to layers of gneiss analogous to those of Bride Peak. Colonel Godwin Austen, who noticed this peculiarity in the photographs brought back by the Italian expedition, expressed the opinion[2] that the stratified summit of K[2] might be more recent than the granite base. I cannot accept this opinion of the illustrious and learned explorer without reservation. The mere fact of superposition is not enough to establish the relative age of two formations in a highly disturbed region, all the more so as the granite may be intrusive.

[1] *Scientific Results*, p. 73.
[2] *Geog. Jour.* xxxvii, p. 26.

The scarcity of specimens obtained from rock *in situ* leaves many questions obscure. Are the schists of the base of Broad Peak the same as those of the Marble Peak? Do they belong to the crystalline schists as Dr. De Filippi believes, or to the palæo-mesozoic series? At present no answer is possible.

One other question remains unsettled, the direction of the dip of the contact between the schists and limestones at the base of Broad Peak. The course of the junction from Windy Gap to the Chogolisa pass, taking into account the difference of level, is nearly north and south, but none of the photographs have enabled the dip to be determined. Taking into account what is seen on the Marble Peak it is probable that the dip is very high and nearly vertical, with a tendency towards inversion to an apparent easterly dip.[1] From Mr. Lydekker's observations we know that at Askoley, in the Braldoh valley, the contact between the sedimentary series and the gneiss of Baltistan hades to the east, that is to say, the gneiss is inverted over the more recent rocks. If this explanation is rejected we must believe that there is a superposition in normal chronological order.

Notwithstanding the great gaps, which yet remain in our knowledge of the geology of the mountains of the Baltoro glacier, one fact of greatest importance has been established. The valley of the great glacier is closed on the north by a very elevated massif, composed of sedimentary rocks of upper palæozoic and mesozoic age, prevailingly calcareous and, therefore, differing widely from the mountains of the rest of the valley, which are entirely, or prevailingly, granitic and gneissic.

This difference explains how the course of the junction between these types of rock has determined that of the longitudinal furrow, formed by two subsequent valleys, which give origin to the bifurcation of the valley into the two branches of the Upper Baltoro and the Godwin-Austen, descending, respectively, from the Chogolisa pass and Windy Gap. The valley of the Baltoro has, therefore, a certain analogy with that of the Upper Aosta, which ends in the two longitudinal valleys of the Allée Blanche and Ferret, meeting at Entrêves, at the foot of Mont Blanc, to form the strictly transverse valley of the Dora di Valdigne. Geologically and lithologically the Baltoro valley is, to a certain extent, the opposite of the Aosta, because, while the latter is formed of schistose limestone rocks and shut in by a granite mass, the former is cut through granitic and gneissic mountains

[1] The view of Bride Peak in the photographs, and the course of the boundary from the Chogolisa Pass along the whole of the lower part of the Godwin Austen glacier, seem to indicate a well-marked easterly or, more precisely, north-easterly dip. If this dip remained unaltered the boundary should rise along the base of K[2] to the Savoia pass. That the boundary is found at Windy Gap, much further east, indicates a stratigraphical disturbance, either fracture or secondary fold, causing either bodily displacement or a local change of dip, and determining the abrupt bend to the north-eastwards of the course of the upper Godwin-Austen glacier.

and closed by a mass of schists and limestones, which ought to be named after the Broad Peak, as this rising to 27,133 feet forms the highest point, rather than the customary Gasherbrum, which will be retained as it has become established by use.

From the distribution of morenic material in the glaciers of the group it seems fairly probable that the terminal peaks of Broad, Gasherbrum IV, Hidden and Golden Throne are all formed of limestone and dolomite. They will consequently be the first peaks of over or near 26,500 feet known to be formed of sedimentary rocks, whereas the loftiest summits previously known are composed of granitic, gneissic rocks, or else formed by volcanic cones. Allowing for difference of scale, the Broad group may be taken to represent, in the Karakoram, the Grand Combin, in the Alps—the only peak formed of sedimentary rocks (mesozoic calcareous schists of Piedmontese facies) which rises above 13,000 feet.

If we regard the general geological structure of the region, as shown by geological maps and descriptions, the discovery of the great mass of limestones of the Upper Baltoro appears clearly as the continuation, and harmonic complement, of the structural outlines which had been suggested, but left uncertain, by earlier exploration to the south-east. For a long time the presence of palæo-mesozoic rocks in the Chang-cheng-mo-Karakoram region of Eastern Ladakh has been known; they have been described by Dr. Stoliczka in 1878, and at a later date by Mr. Lydekker, who found dolomites with upper trias fossils. This palæo-mesozoic area forms an elongated strip running north-westwards parallel to the direction of the gneissic mass of Baltistan. It had been traced to Sirsil, between the Nubra and Shyok valleys, on the road to the Karakoram pass, but its ultimate course and end remained unknown. The calcareous dolomitic mass of Gasherbrum lies approximately on the north-west prolongation of this band, and the discovery, by Dr. Longstaff, of limestone in the median moraine of the upper Siachen glacier, at a place intermediate between Sirsil and the Upper Baltoro, is a weighty argument in favour of the continuity of this band of mesozoic limestone for some 90 miles, through a region which is yet unexplored, even geographically.

The importance of this discovery is not merely geological but also, and principally, geographical. The course of the watershed, between the Indus valley and the closed drainage area of Turkestan, from the Mustagh to the Karakoram pass, was uncertain and badly known, in spite of certain peaks having been trigonometrically fixed, as it had been barely seen and never crossed by the explorers who followed each other at long intervals.

The Italian expedition obtained, from Windy Gap, on 15th June, 1909, the first view over the unknown country east of the mountains bounding the Baltoro glacier, and saw, to the left of Gasherbrum, not the valley of the Oprang tributary of the Yarkand, seen a few days previously by His Royal Highness from the Savoia

pass to the west of K [2], but another valley, with a glacier draining to the south-east.

Almost simultaneously, on 16th June, 1909, Dr. Longstaff crossed the presumed watershed by the Saltoro pass and descended onto a glacier which, a couple of months later, was suspected on the suggestion of Colonel Burrard to be the upper portion of the Saichar or Siachen glacier, previously known only at its lower end, and believed to have a length of about 20 miles, instead of the 45 miles it is now known to reach. The source of the Siachen is thus pushed back to an untraversed pass, seen by Dr. Longstaff from an estimated distance of 12 miles, and supposed to be the same as that reported, from the northern side, at the head of the Urdok glacier by Sir F. Younghusband, in his exploration of the Oprang valley in 1889; a pass which seems to lie in about the same latitude as Golden Throne. In the mountains to the east of this pass, to which Dr. Longstaff gave the name of Younghusband, he noted the very lofty peak of Teram Kangri, whose height, estimated approximately at 27,610 feet, makes it one of the loftiest mountains of the world.[1]

Finally he noticed that the moraines on the left of this upper Siachen glacier, like those on the right of the upper Baltoro, were full of marbles and calcareous breccias, and saw, some ten miles off, the rocks of Teram Kangri gleam white, where not covered with snow; facts which led him unhesitatingly to the conclusion that this superb mountain was formed of limestone. This statement, which might appear rash, if unsupported, attains a certain probability from the observations and records of the Italian expedition in the Gasherbrum massif.[2] The mountain mass of Teram Kangri lies about south-east of Broad Peak, and on the line joining this with the limestone band recorded between the Nubra and Upper Shyok valleys and from its eastern declivities by Mr. Lydekker, to the south of the Sirsil or Sasser pass.

This unexpected extension of the Siachen glacier to the vicinity of the mountains at the head of the Baltoro gives great importance to the observations of the Italian expedition, whether from Windy Gap or the Chogolisa pass, as has already been briefly referred to in the addresses given by His Royal Highness and published in various scientific periodicals.[3]

As regards Windy Gap, this has already been dealt with. The camp on the Chogolisa pass commanded the valley of the Kondus, a glacier which was seen to intervene between the Baltoro and the recently discovered Upper

[1] More recent and rigid measurements by the Indian Trigonometrical Survey have reduced this figure. The final calculations are not complete but the height has been determined as about 24,489 feet, a figure which can be relied on to within 100 feet.—*Geog. Jour.*, XXXIX, Jan. 1912, p. 72.

[2] Dr. Longstaff has recognised Teram Kangri in a photograph, taken on 22nd June, 1909, by Vittorio Sella from Windy Gap. *Geog. Journ.*, January, 1911.

[3] *Rivista del Club Alp. Ital.* XXIX, pp. 26–35 (1910); *Boll. Soc. Geog. Ital.* ser. v, XI, pp. 454 and 460 (1910).

Siachen. The valley of the Kondus, dominated by the peaks K^7, K^8, K^9, winds tortuously, first to the east, then to the north, passing round the bases of Golden Throne and Hidden Peaks. This last is not the most easterly peak of the Gasherbrum group, for eastwards of Hidden Peak rises another, and only to the east of this does a deep gap form the true limit of the Gasherbrum massif, taken in a wide sense, and the head of the Kondus glacier. The Italian expedition believed that this was in truth the pass at the head of the Urdok glacier, seen from the Oprang side by Younghusband, and for this reason.

Beside this depression another was seen, formed by a low ridge, separating the Kondus from a wide, glacier-filled valley further east, which is probably none other than the Upper Siachen. The low crest just mentioned rises rapidly towards the south into the high mountains between the Kondus and the supposed Siachen, and to the east into other lofty mountains, which should be the easterly or northerly continuation of Teram Kangri, if not this mountain itself.

From the saddle at the head of the Kondus it seems possible to descend to the Oprang basin, and probably into the Urdok valley.

If the map accompanying Dr. Longstaff's account of his expedition is compared with the representation of the Kondus valley, which has just been set forth, it is evident that there are no irreconcilable differences. The Kondus and Siachen glaciers end in two depressions, separated by a low crest, which, seen from a distance, might be superimposed on each other by an effect of perspective, so as to give the impression of a single valley, especially from the relatively low point where Longstaff was upon the Siachen, at about 16,000 feet, an impression less probable from the camps of His Royal Highness on Chogolisa, at an elevation of 22,000 feet, equal to, if not greater than, that of the pass in question. From this it follows that the westernmost extremity of the Siachen valley will not communicate directly with the Urdok, but only with the Kondus, whose head intervenes, so to speak, between the valleys of the Siachen and Urdok; and that the pass seen by Sir F. Younghusband lies between this latter and the Kondus valley.

A discovery so important as that of the greater extension of the Siachen has given wide field for conjecture and hypothesis, and to considerable divergence of interpretation, a thing which is natural in view of the many uncertainties still existing. Dr. Longstaff, and still more distinctly Dr. Neve, his companion in part of the expedition, have expressed in their writings the opinion that the Siachen communicates with the Baltoro directly over a saddle at the base of Hidden Peak, or to the north of it, in the same way that the Biafo glacier in Baltistan communicates with the Hispar. In the first place this supposed continuity of the two glaciers does not exist. South of the Broad massif the Kondus glacier, as has been mentioned, is insinuated between them. The valleys which descend to the east and north of the massif are tributaries of the Oprang, either by means of the Gasherbrum glacier of Younghusband, or by the Urdok; consequently there can be no direct connection between the Siachen and Baltoro glaciers. Yet, broadly speaking, the notion implied by these authors might be extended across the gap formed by the Upper Kondus, and it might be maintained that the Baltoro and Siachen, in spite of a brief interruption, lie in the same tectonic furrow and so preserve the analogy desired by Dr. Longstaff. But not even in this way is it correct, for the Biafo-Hispar system is formed by two longitudinal valleys draining in opposite directions, in a furrow which is orographically, and geologically, a single well-marked feature. The Siachen-Baltoro system, on the other hand, would consist of a longitudinal valley draining to the south-east, joined by a series of gaps and valleys, found along its prolongation to the north-west, with the distinctly transverse valley of the Lower Baltoro. The supposed analogy therefore does not exist, even on this hypothesis; on the contrary, it is obvious that the Siachen furrow continues into the Urdok across the two contiguous saddles.

From the observations made by the two expeditions it results that the course of the water parting between the Indus and Yarkand basins is very different from what had been believed and shown on maps.

The Karakoram, like the Himalaya, of which it is the western portion, consists of a series of chains parallel to each other, and also approximately parallel to the course of the geological zones and leading tectonic features, ill-known as yet, of the whole great system. The rivers flow in open valleys between these chains; and narrow, deep-cut channels, frequently reduced to impassable gorges, by which the rivers pass from one valley to the next, sever the chains in pieces. Consequently, although the lines of peaks appear continuous on the map and exhibit a sensible parallelism, the principal watershed, and many of the secondary ones, have a very different course, proceeding by stretches as they pass from one range to another by means of transverse ridges, which separate the divergent slopes of each of the furrows contained between a pair of ranges.

On the whole then, as this passage of the watershed from one chain to the next takes place for long stretches in a regular manner, always from a more forward range to one further back, the complex course of the line of watershed cuts, at a very acute angle, the general direction of the ranges, so that it is easy, in ill-known parts of the system, to confound two quite distinct members with each other and regard them as only one. Just this confusion was made in all maps anterior to 1910 in the country between the Upper Baltoro and the Karakoram pass.

The discovery of the Upper Siachen, and of Teram Kangri, has shown the existence of a great longitudinal furrow, occupied by a glacier, and of a chain, parallel to that, well known and fixed, which runs from K^2 to Hidden Peak and, up to now, was called the main range of the Karakoram. The ridge by which the watershed crosses from this to that of Teram Kangri is formed by that saddle between the head of the Kondus and the Siachen which was seen from Chogolisa. The chain of K^2 is truncated by the Kondus valley, whose tortuous course in the upper part indicates a breach of continuity, filled with ice, but where this disappears, exhibiting itself as one of those impassable gorges in which the Karakoram is rich. It is probable that the continuation of the chain of K^2 is that in which the peaks K^9 and K^{10-11} are found, these latter over 25,000 feet in height, and in the Saltoro chain to K^{12} and beyond.

It is natural to enquire what may be the influence, on the morphology of the region, of the junction between the crystalline and sedimentary rocks, which, in the Upper Baltoro valley, determines the furrow extending from Windy Gap to the Chogolisa pass. Probably it crosses the Upper Kondus valley and cuts the ridge between this and the Siachen to the east of K^{10-11}, which present themselves, orographically, as the homologue of Bride Peak, in secondary alignment parallel to the principal range, and, geologically, as the continuation of the crystalline axis of K^2. If the depression along the plane of contact continues farther to the south-east, it should cross the Siachen valley and the Murgisthang pass, to reach the known boundary on the Sasser pass. It is evident therefore that, although this contact determines many and important orographical details, it does not correspond to any great valley, and still less to a furrow of primary rank, as is the case in the Biafo-Hispar valley.

In conclusion it is certain that the water parting between the Indus and the Central Asian drainage, after passing the peaks of K^2, Broad, Gasherbrum and Hidden, turns eastwards to a parallel range which bounds the Siachen on the east and probably culminates in Teram Kangri. A good part of this range was already known, for it runs from the Sasser pass, for more than 100 miles south-eastwards to the Pangong Lake, and is cut through by the precipitous gorge of the Shyok, in the reach which lies above the sharp elbow formed by this river, a little below its junction with the Chang-cheng-mo. The range of K^2 runs south-west of this, and although the complexity of its geological composition—for granites, schists and various sedimentary rocks take part in it—has a very sensible influence in multiplying and increasing the accidents of relief, it has not rendered less evident the orographical continuity, which is obvious enough in many parts.

The two chains of K^2 and Teram Kangri, are, therefore, well distinct, and the resemblance between the Karakoram and the double chain of the Hindu Kush, already suspected by some, has a real basis. The latest discoveries have revealed the importance of the Teram Kangri range, which is promoted from the position of a secondary spur of the presumed watershed range, to that of a primary range of the system. The continuation of this range, to the northwards, is certainly that row of peaks, which the Italian expedition observed from Windy Gap, and which will now become the object of fresh journeys of exploration.

Geological Survey Office, Rome, *July*, 1911.

Having been asked to undertake the translation and revision of the Appendix dealing with the geological results of the expedition made by His Royal Highness the Duke of the Abruzzi to the Karakoram, I find little left to be done as regards the latter half of the task. The facts, as set forth by Ing. Novarese, may be accepted, the interpretation follows, for the greater part, with logical certainty. Only in two parts of any importance do I find myself unable to accept unreservedly the opinions expressed in the note. The first of these concerns the limestones of Crystal Peak and the hills eastwards of it. In the note they are regarded, with very little hesitation, as belonging to the older gneissic series, and as lenticular inclusions in it. This interpretation is not impossible, but it seems to me that insufficient weight has been given to earlier observations, and that the case for regarding the limestones as belonging to the sedimentary series, either as a continuation of the Gasherbrum exposure or as an outlier, is stronger than is represented by the text. Sir W. M. Conway, in the description of his expedition, expressly states that on the descent from his Crystal Peak he came upon "a new set of rocks which gave a fresh character to the ridge separating the Baltoro and Godwin-Austen glaciers." These rocks are described as granites and hard limestones, light grey, buff and white in colour, of which seams were found in the rocks lower down the valley but here forming the mass of the mountains. His next camp up the glacier was pitched on a fan composed of fragments of white marble.[1] In the description of the rocks collected *in situ* on these hills it is stated that no record was kept of the order in which they were collected, but of the specimens one is described as gneiss, one as mica schist, and five as various forms of limestones; the other specimens are one of syenite and one of quartz associated with limestone breccia.[2] It may be noticed that the gneiss and mica schist were both collected on the ascent of Crystal Peak, and that these rocks are unrepresented in the collection from the White Fan pass; moreover, from the latter locality came a greyish crystalline limestone, veined with noble serpentine, recalling the presence of similar rocks among the moraine débris derived from the Gasherbrum group of mountains, and the occurrence of serpentine among the sedimentary rocks on the slopes of Mango Gusor.[3]

These facts render it at least possible that we have to deal with an exposure of the limestone series, penetrated by intrusive veins of syenite and gneissose granite, such as is not uncommon in the Himalayas. It may be that the boundary, between the areas occupied mainly by crystalline and by sedimentary rocks, after running down the Upper Baltoro valley, crosses the main glacier and passes up onto the mountains north of it, thence, turning north-eastwards near the Crystal Peak, it

[1] *Climbing in the Himalayas*, etc., pp. 465 ff.

[2] Prof. T. G. Bonney and Miss A. C. Raisin. *Proc. Roy. Soc.* LV, p. 486; also in W. M. Conway, *Climbing in the Karakoram Himalayas*, vol. II, Scientific Results, p. 73.

[3] *Mem. Geol. Surv. Ind.* XXII, p. 189.

would run down to the valley of the Godwin-Austen glacier, striking it near the sharp bend and following the general course of the upper part of this valley. As an alternative the Crystal and Marble Peak exposure of limestones may be an outlying area of sedimentary rocks, but in either alternative there is the possibility, which should be investigated by future travellers, of the occurrence of sedimentary limestones in the hills north of the Baltoro glacier.

The second point, on which something more remains to be said, is the minor classification of the mountain ranges. The view advocated by Drs. Longstaff and Neve is rejected on the ground that there is no structural continuity between the Siachen, Baltoro and Biafo valleys, such as would give them a geological unity and justify the mountains on either side being regarded as forming two separate ranges; but, if this argument is allowed to prevail, it would equally militate against the view which regards the mountains on either side of the Oprang-Nubra trough as forming a pair of parallel ranges, for this orographical depression certainly does not follow, but runs obliquely to, the general strike of the leading feature in the geological structure of the district, namely, the Karakoram syncline of sedimentary rocks.

This argument is not, however, final, for the movements of elevation, which have given rise to the mountains, were spread over a long period, and it may well be that the latest of them, those which determined the rows of peaks as they now stand, did not exactly follow the earlier ones, by which the leading features of geological structure were marked out. Moreover, the case for the classification adopted in the note is stronger than is there set forth, for not only is the Oprang-Nubra trough similar to the much larger depression formed by the Sutlej and Sanpo valleys on the northern side of the Himalayas, but there is an apparent connection between the two, for the former is continued south-eastwards by the Shyok valley up to the elbow, where it bends from a southerly to a north-westerly course, and thence by the lower part of the Pangong Lake to the Upper Indus, and by this to the Sutlej valley. To the south-east this line of valleys has been held to be sufficient reason for separating the Himalayas, on the south, from the mountains to the north, so that if Ing. Novarese errs in separating the Teram Kangri peaks from those of the K^2 and Gasherbrum group, he errs in good company. And if this view is accepted, then the series of peaks, labelled K with a number by the Survey of India, can no longer be regarded as belonging to the same range that is crossed by the Karakoram pass, and a different name, Mustagh for choice, would have to be given to them and to the mountains which have been repeatedly described as the Karakoram Himalayas.

It is, however, by no means certain that this view of the grouping of the peaks into ranges is correct. It is natural for geographers to seek a parallelism between the minor members of a great chain of mountains and the general direction of the whole, and the intricacy of the valley systems, cut back at times along the strike-line between minor ranges, and at others across and through them, makes it not impossible to find justification for dividing the mountain chain, as a whole, into a series of parallel ranges, running along the length of the chain. Yet, although it may be possible to adopt a nomenclature expressing this view, it does not follow that the names represent what really occurs in nature, and there is another aspect of the case which is at least equally worthy of consideration, that the individual members of the chain are ranged not along, but obliquely transverse to, the general direction of the whole, much like the arrangement of the individual birds in a flock of wild geese, or the individual regiments of an army ranged in echelon.

The study of areas of structural elevation, on a smaller scale, and of less complication, than a mountain range, shows that the principal anticline is often crossed by minor ones, ranged obliquely to it, so that the margin of the area of uplift is marked by a series of open folds, all pitching in the same direction and advancing one beyond the other. It is not unnatural to suppose that a similar feature may be found on a larger scale in great mountain ranges, and on this view the Teram Kangri and Gasherbrum peaks would fall into the same range, continued probably to K^2, and the Mustagh Peaks. Nor would the interruption of the range by the deep gap between Teram Kangri and Gasherbrum, or by the Godwin-Austen glacier valley between that and K^2, affect the structural unity of the range, for it must be remembered that the peaks are peaks because the agencies of denudation have not yet had time to remove them, though they have removed all the surrounding rock: on the other hand the peaks owe their elevation to the fact that the rock of which they are composed has been uplifted, and where we find a group of peaks rising much above those by which they are surrounded, we may conclude that this great elevation is due to the fact that the last episode, in the general uplift of the mountains, was a more rapid and greater upheaval of the particular region in which the high peaks are found.

It might be, of course, that there were two neighbouring areas of such special elevation, one marked by the Teram Kangri group of peaks, the other by the K^2, Broad, Gasherbrum and Hidden Peaks, and that between them lay a zone of lesser uplift. A more probable case, however, is that these two groups of very high peaks form parts of the same general area of special, recent, uplift, and this special upheaval may have determined the position of the watershed, which crosses the Oprang-Nubra trough. If this is the case, K^2 and the Mustagh Peaks are restored to that group of ranges crossed by the Karakoram pass, which together have come to be known as the Karakoram mountains.

That such widely divergent views of the classification of these mountains can be put forward, without any possibility of even indicating which is likely to be ultimately accepted, shows how little is really known as yet, and how much remains to be done before the structure of this region can be rationally discussed, much less said to be properly understood.

Horsham, *February 20th*, 1912.

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ROCK SPECIMENS COLLECTED ON THE BALTORO MORAINES.

PLATE I.

Fig. 1. Rose-coloured, veined limestone.

Fig. 2. Many-coloured breccia of limestone fragments and sericitic cement.

Fig. 3. Many-coloured breccia of limestone fragments and yellow calcareous cement.

Fig. 4. As Fig. 2, with the fragments more scattered and subordinate to the matrix.

PLATE II.

Fig. 1. Brecciated violet-coloured limestone (*pavonazetto*). The deeply coloured portion is schist.

Fig. 2. Marble blotched with red.

Fig. 3. Rose-coloured limestone (*persichino*), minutely brecciated.

Fig. 4. Brecciated violet limestone with greenish tinting. The deeply coloured part is a reddish violet schist; the green coloration is due to infiltration of the part originally white.

Appendix D.

BOTANICAL REPORT

BY

PROF. R. PIROTTA

AND

DR. F. CORTESI

UPON THE PLANTS GATHERED BY THE EXPEDITION.

Appendix D.

BOTANICAL REPORT

UPON THE PLANTS GATHERED BY THE EXPEDITION.

I.—LIST OF PLANTS GATHERED.

A.—Braldoh and Biafo Valleys.

EPHEDRA pachyclada Boiss.
Salix sp.
Clematis orientalis L. var. ?
Berberis vulgaris L. var. *aetnensis* Presl.
Cheiranthus himalayensis Camb.
Cleome sp. ?
Saxifraga imbricata Royle.
Colutea arborescens L. var. *nepalensis* L.
Astragalus sp.
Chesneya cuneata Benth.
Caragana polyacantha Royle.
Oxytropis microphylla DC.
Papilionacea, sp. indet.
Myricaria elegans Royle.
Hippophäe rhamnoides L.
Daphne oleoides Schreb.
Primula farinosa L.
Macrotomia perennis Boiss.
Nepeta discolor Royle.
Lonicera microphylla Willd.
Erigeron andryaloides C. B. Clarke.
Anaphalis virgata Thoms.
Artemisia sp.
Artemisia sp. aff. *Absinthium* L. ?
Chondrilla graminea Benth.

B.—Lower Baltoro and Rdokass.

Poa sp.
Festuca sp.
Lloydia serotina Rchb.
Oxyria digyna Hill.
Silene Moorcroftiana Wall.
Lychnis apetala L.
Stellaria graminea L. var. *montioides* Edgew. & Hook. fil.
Delphinium Brunonianum Royle.
Papaver nudicaule L.
Sedum aff. *atropurpureum* Turcz. ?
Potentilla albifolia Wall.
Potentilla sericea L. var. ?
Potentilla sp. ?
Astragalus Candolleanus Royle.
Oxytropis lapponica Gaud.
Oxytropis lapponica Gaud. var. *humifusa* Kar. et Kir.
Epilobium latifolium L.
Pirola rotundifolia L.
Primula farinosa L.
Gentiana aquatica L. var. ?
Gentiana detonsa Fries.
Gentiana sect. Comastoma sp.
Lonicera asperifolia Hook. fil. & Thoms.
Codonopsis ovata Benth.
Aster heterochaeta Benth.
Allardia nivea Hook. fil. & Thoms.
Chrysanthemum tibeticum Hook. fil. & Thoms.
Taraxacum officinale L.
Taraxacum officinale L. var. *eriopodum* DC.

C.—Upper Baltoro (above 15,000 feet).

Carex atrata L.
Lychnis apetala L.
Isopyrum grandiflorum Fisch.
Braya uniflora Hook. fil. & Thoms.
Saxifraga flagellaris Willd. var. *mucronulata* Royle.
Saxifraga imbricata Royle.
Potentilla fruticosa L. var. *pumila* Hook. fil. forma *grandiflora*.
Potentilla ochreata Lehm. ?
Mertensia primuloides Clarke.
Nepeta longibracteata Benth. ?
Leontopodium alpinum L. var. *nivale* Ten.
Allardia tomentosa Dcne. ?
Allardia vestita Hook. fil. & Thoms.
Sedum Rhodiola DC.

D.—Skoro-La.

Cystopteris fragilis Bernh. ?
Chenopodium album L.
Polygonum viviparum L.
Oxyria digyna Hill.
Silene Moorcroftiana Wall.
Lychnis nigrescens Edgew.
Cerastium trigynum L.
Cerastium vulgatum L. var.
Delphinium Brunonianum Royle.
Aconitum Napellus L. var. *rotundifolium.* Hook. f. & Thoms.
Arabis ?
Sedum Rhodiola DC.
Sedum Eversii Ledeb.
Saxifraga sibirica L.
Saxifraga flagellaris Willd. var. *mucronulata* Royle.
Potentilla multifida L. var. *angustifolia* Lehm.

Potentilla ochreata Lehm.
Potentilla bifurca L. var. *Moorcroftii* Wall.
Potentilla indica Th. W.
Rosa macrophylla Lindl. var. *minor* Lindl.
Oxytropis lapponica Gaud. var. *typica.*
Oxytropis mollis Royle.
Geranium pratense L. ?
Geranium sp.
Epilobium latifolium L.
Bupleurum longicaule Wall var. *himalensis* Klotsch.
Primula farinosa L.
Gentiana aquatica L. var.
Gentiana sp.
Pleurogyne carinthiaca L.
Mertensia tibetica Clarke.
Myosotis sylvatica Hoffm.
Thymus Serpyllum L.
Pedicularis pectinata Wall.
Pedicularis bicornuta Kl.
Lonicera microphylla Willd.
Valeriana dioica L.
Aster sp.
Leontopodium alpinum L. var. *nivale* Ten.
Erigeron alpinus L. ?
Anaphalis nubigena DC.
Tanacetum sp.
Artemisia sp.
Chrysanthemum Stoliczkae C. B. Clarke.
Saussurea Schultzii Hook. f. ?
Taraxacum officinale L. forma.

E.—Deosai Tableland (14,000 feet).

Carex nivalis Boott.
Polygonum affine Don.
Rumex sp.
Cerastium trigynum L.
Ranunculus nivalis L.
Thalictrum minus L. ?
Aconitum Napellus L. var. *multifidum* Hook. fil. & Th.
Papaver nudicaule L.
Corydalis ramosa Wall. var. *glauca* Hook.
Draba glacialis Adams.
Chorispora sabulosa DC.
Sedum Rhodiola DC.
Sedum aff. *atropurpureum* Turcz. ?
Saxifraga flagellaris Willd. var. *mucronulata* Royle.
Potentilla argyrophylla Wall.
Oxytropis sp.
Geranium aconitifolium L'Hérit. ?
Bupleurum falcatum L. var. *nigrocarpum* Jaquem.
Primula purpurea Royle.
Gentiana sp.
Swertia pedunculata Royle.
Eritrichium sp.
Stachys tibetica Vatke.
Thymus Serpyllum L.
Veronica alpina L.
Pedicularis pectinata Wall.
Pedicularis bicornuta Kl.
Pedicularis cheilanthifolia Schrenk.
Pedicularis rhinanthoides Schrenk.
Campanula modesta Hook. fil. & Thoms.
Aster himalaicus Clarke.
Leontopodium alpinum Cass. var. *nivale* Ten.
Anaphalis nubigena DC.
Tanacetum sp.
Senecio aff. *tibeticus* Hook.
Cremanthodium aff. *Decaisnei* Clarke.
Jurinea macrocephala Benth.
Saussurea sp.
Crepis glomerata Dcne. ?

II.—CLASSIFICATION OF SPECIMENS.

Polypodiaceae.

Cystopteris fragilis Bernh. ? Ascent of Skoro La, north side; 10,000–13,000 feet.

Gnetaceae.

Ephedra pachyclada Boiss. Between Dusso and Askoley, Braldoh valley (8,000–10,000 feet); 11–14th May, 1909.

Poaceae.

Poa sp. Rdokass; 13,025 feet; June–July, 1909.

Festuca sp. Rdokass; 13,025 feet; June–July, 1909.

Both these grasses are represented by fragmentary specimens, without rhizomes or basal leaves.

Cyperaceae.

Carex atrata L. Vigne glacier, at about 16,500 feet; 15th July, 1909.

This species is not indicated for the region in the publications of previous explorers.

Carex nivalis Boott. W. Hunter Workman and F. Bullock Workman: "The Call of the Snowy Hispar," p. 286. Deosai tableland; 14,000 feet; 2nd–3rd August, 1909.

The Workman expedition found this species (which is common in the Himalaya, Western Tibet and the Karakoram) on the Hispar glacier, between 13,000 and 15,500 feet.

Lloydia serotina Rchb. Sir W. M. Conway: "Climbing and Exploration in the Karakoram Himalayas, Scientific Reports," p. 83; W. Hunter Workman and F. Bullock Workman, op. cit. p. 286. Rdokass; 13,025 feet; June–July, 1909.

Allium odorum Linn. (No. 70 without locality !).

Conway (loc. cit.) cites for the Baltoro valley *A. senescens* Miq. = *A. tuberosum* Roxb. Our plant is without doubt *A. odorum* L., with the characteristic oblique rhizome covered with numerous whitish fibres, finely reticulated.

Salicaceae.

Salix sp. ind. Askoley; 15th June, 1909.

The leaves of this willow are covered with rounded reddish galls. It may be the species of *Salix* cited by Conway (p. 83) and by the Workmans (p. 286) as *Salix*, not determinable, gathered on the Hispar glacier at 13,000 feet.

Chenopodiaceae.

Chenopodium album L. Ascent of Skoro La, north side; 10,000–13,000 feet; 28th July, 1909.

Polygonaceae.

Polygonum viviparum L. Conway, p. 83. Ascent of Skoro La, north side; 10,000–13,000 feet.

Among the numerous examples of this species are some which may easily be referable to a minor form.

Polygonum affine Don. Conway, p. 83. Deosai tableland; about 14,000 feet; 2nd–3rd August, 1909.

Oxyria digyna Hill. Conway, p. 83; Workman, p. 287. Moraine of the Baltoro, below Rdokass; 16–17th May, 1909. Ascent of Skoro La, north side; 10,000–13,000 feet.

Rumex sp. Deosai tableland; about 14,000 feet; 2nd–3rd August, 1909.

In the absence of mature fruit a more precise identification is not possible.

Dianthaceae.

Silene Moorcroftiana Wall. Conway, p. 78. Moraine of the Baltoro, below Rdokass, 20th July, 1909; and ascent of Skoro La, north side, 10,000–13,000 feet, 28th July.

Lychnis apetala L. Conway, p. 78. Rdokass, 13,025 feet; Vigne glacier, at about 16,500 feet; 15th July, 1909.

Lychnis nigrescens Edgew. Ascent of Skoro La; between Askoley and the foot of the Skoro La glacier; 9,500–12,800 feet; 28th July, 1909.

Cerastium trigynum L. Conway, p. 78; Workman, p. 287. Deosai tableland; about 14,000 feet; 2nd–3rd August. Ascent of Skoro La, north side; 10,000–13,000 feet; 28th July, 1909.

Cerastium vulgatum L. var.? Ascent of Skoro La, northern slope; 28th July, 1909.

A fragmentary specimen; referable to one of the numerous forms of *C. vulgatum*.

Stellaria graminea L. var. *montioides* Edgew. & Hook. fil. Rdokass; 13,025 feet; June–July.

Ranunculus nivalis L. Deosai tableland; ca. 14,000 feet; 2nd–3rd August, 1909.

Isopyrum grandiflorum Fisch. Conway, p. 78. Rocks at the head of the Baltoro; western spur of Gasherbrum; 18,000 feet; 27th June, 1909.

A diminutive form, doubtless referable to this species, which is found at great heights, Conway's expedition having gathered it at some 16,000 feet above sea level.

Thalictrum minus L. ? Deosai tableland ; about 14,000 feet ; 2nd–3rd August, 1909.

Fragmentary specimen, only showing foliage.

Clematis orientalis L. var. ? Braldoh valley, among the stones of.

From the shape of the leaves this would appear to be *C. orientalis*, which is, however, a variable and polymorphous species.

Delphinium Brunonianum Royle. Conway, p. 77. Rdokass; 13,025 feet; June–July, 1909. Ascent of Skoro La, north side; 10,000–13,000 feet; 28th July, 1909.

A beautiful plant with large fine blue flowers, quite worth cultivating for ornamental purposes.

Aconitum Napellus L. var. *multifidum* Hook. fil. & Thoms. Deosai tableland ; about 14,000 feet ; 28th July, 1909.

Var. *rotundifolium* Hook. fil. & Thoms. Conway, p. 77. Ascent of Skoro La, north side ; 10,000–13,000 feet.

Berberidaceae.

Berberis vulgaris L. var. *aetnensis* Presl. pro specie. Braldoh valley between Dusso and Askoley ; 7,900–10,000 feet ; 11–14th May, 1909.

This specimen is doubtless to be referred to the form described by Presl, with the leaves obovate mucronulate, spinulose-serrulate, with the nervation prominent on the under side.

Papaveraceae.

Papaver nudicaule L. Conway, p. 77. Rdokass, 13,025 feet ; Deosai tableland, about 14,000 feet.

The specimen from the Deosai tableland is more hispid than those gathered at Rdokass.

Meconopsis aculcata Royle ? Rajdiangan or Tragbal ; 8th August, 1909.

The determination of this species is doubtful, because its characteristics do not fully correspond with those of *M. aculeata*, particularly with regard to the shape and appearance of the fruit, which seems similar to that of *Meconopsis sinuata*. With more abundant material for purposes of comparison we should have been able to decide if this form should be considered a new one.

Dr. De Filippi says the plant is common within a limited area, where it is called "Blue Poppy."

Corydalis ramosa Wall, var. *glauca* Hook. Deosai tableland ; about 13,000–14,000 feet.

Cruciferae.

Draba glacialis Adam. Conway, p. 78. Deosai tableland ; about 14,000 feet.

Chorispora sabulosa DC. Conway, p. 78. Deosai tableland; about 14,000 feet.

Cheiranthus himalayensis Camb. Between Dusso and Askoley, Braldoh valley; 7,900–10,000 feet.

Arabis ? Ascent of Skoro La, north side; 10,000–13,000 feet.

Braya uniflora Hook. fil. & Thoms. Rocks at the head of the Baltoro, about 18,000 feet, 29th June, 1909; and Vigne glacier, 16,500 feet.

Capparidaceae.

Cleome, ? Braldoh valley, between Dusso and Askoley; 7,900–10,000 feet.

FIG. I.—SEDUM RHODIOLA DC.
[Gathered at the end of the right-hand spur of the Vigne. 16,500 feet.]

Crassulaceae.

Sedum Rhodiola DC. Workman, p. 287. (Pro sphalm. *S. Rhaviala et S. Rhadiola.*) Ascent of Skoro La, north side, 10,000–13,000 feet; and Deosai tableland, about 14,000 feet; *fl. et fruct.*

Among the specimens gathered at Skoro La is one with a fasciation of the apex of the axis of the inflorescence and of the inflorescence itself. This beautiful plant is shown in Fig. I, as photographed.

Sedum sect. *Rhodiola* aff. *atropurpureum* Turcz.? Rdokass, 13,025 feet; Deosai tableland, about 14,000 feet.

Our specimens are probably closely related to, if not identical with *Sedum atro-purpureum* Turcz, of Central Asia. We have no means of comparison to settle the matter with certainty.

Sedum Ewersii Ledeb. Conway, op. cit., p. 80. Ascent of Skoro La, north side; 11,000–13,000 feet.

Cotyledon aff. *spinosa* L. (Without locality!)

Cotyledon? (Above Paiju.)

A single rosette of large fleshy leaves, much deteriorated by treatment with alcohol and hot water. Would appear to be a *Cotyledon*.

FIG. II.—SAXIFRAGA IMBRICATA ROYLE.

[Gathered on the rocks of the western spur of Gasherbrum, about 18,000 feet.]

Saxifragaceae.

Saxifraga sibirica L. Conway, p. 79. Ascent of Skoro La, north side; 11,000–13,000 feet.

Saxifraga imbricata Royle. Conway, p. 79. Braldoh valley, between Dusso and Askoley; 7,900–10,000 feet; according to photograph also on western spur of Gasherbrum, 18,000 feet.

The example representing this species in the collection is very poor, but it is supplemented by the fine photograph here reproduced (Fig. II).

Saxifraga flagellaris Willd. Conway, p. 79. Var. *mucronulata* Royle pro sp. Ascent of Skoro La, north side, 10,000–13,000 feet; Deosai tableland, 14,000 feet; moraine of the Baltoro, between 11,000–13,025 feet.

Our example must be referable to Royle's variety, on account of the ciliated and subspinulose edges of the leaves.

Rosaceae.

Potentilla fruticosa L. var. *pumila* Hook. fil. Conway, op. cit., p. 79; Workman, op. cit., p. 287; Th. Wolf: "Monogr. der Gattung Potentilla," p. 59. Vigne glacier; about 16,500 feet.

FIG. III.—POTENTILLA FRUTICOSA VAR. PUMILA HOOK. FIL.
[Gathered at the end of the right spur of the Vigne, ca. 16,500 feet.]

The example consists of a small fragment, but the identification is assisted by the fine photograph (Fig. III). According to what Wolf says in the Monograph cited above, the plant in the photograph having the flowers with long peduncles, must be referable to *P. fruticosa* var. *pumila* Hook fil. forma *grandiflora* Th. W.

Potentilla argyrophylla Wall. Conway, p. 79; Workman, p. 287. Deosai tableland, about 14,000 feet, 2nd–3rd August, 1909; Tragbal pass, 8th August, 1909.

Potentilla sericea L. var. ? Conway, p. 79 ; Workman, p. 287. Rdokass.

Our example, which is very poor, must surely be referable to a variety of this species, probably to *dasyphylla* Ledeb.

Potentilla multifida L. var. *angustifolia* Lehm. Skoro La, north side ; 9,500–12,800 feet.

Potentilla ochreata Lehm. ? Vigne glacier ; about 16,500 feet. Ascent of Skoro La ; 10,000–13,000 feet.

Potentilla bifurca L. Conway, p. 79 ; var. *Moorcroftii* Wall. Ascent of Skoro La, north side ; 10,000–13,000 feet.

Potentilla indica Th. W. Between Askoley and the foot of the Skoro La glacier ; 9,500–12,800 ft.

Potentilla albifolia Wall. = *Sibbaldia potentilloides* Camb. Baltoro moraine, between 11,000–13,025 feet ; also below Paiju, about 11,000 feet.

Potentilla sp. Vicinity of Rdokass camp, 13,025 feet.

Posa macrophylla Lindl. Conway, p. 79 ; var. *minor* Lindl. Ascent of Skoro La ; 9,500–13,800 feet.

Phaseolaceae.

Colutea arborescens L. Conway, op. cit., p. 79 : var. *nepalensis* L. Between Paiju and valley of the Punmah ; 25th July, 1909.

Astragalus sp. Paiju ; about 11,000 feet.

Specimen imperfect and without fruit.

Astragalus Candolleanus Royle = *A. Royleanus* Bunge. Conway, p. 79. Rdokass ; 13,025 feet, between Askoley and half-way between Korophon and Bardumal.

Chesneya cuneata Benth. Conway, p. 79. Between Askoley and half-way between Korophon and Bardumal.

Caragana polyacantha Royle. Conway, p. 79. Braldoh valley, between Dusso and Askoley ; 8,000–10,000 feet.

Oxytropis lapponica Gaud. Bullock Workman, p. 287 ; var. *typica* ? Ascent of Skoro La, north side ; 10,000–13,000 feet.

Var. *humifusa* Kar. et Kir. Rdokass, 13,025 feet.

Oxytropis mollis Royle. Ascent of Skoro La, north side ; 10,000–13,000 feet.

Oxytropis microphylla DC. Braldoh valley between Dusso and Askoley, 8,000–10,000 feet ; between Askoley and half-way between Korophon and Bardumal.

Oxytropis sp. Deosai tableland ; about 14,000 feet.

Phaseolacea. Braldoh valley ; 8,000–10,000 feet.

Example with leaves only, not determinable. Perhaps *Astragalus.*

Geraniaceae.

Geranium pratense L. ? Conway, p. 78. Ascent of Skoro La, 10,000–13,000 feet.

Geranium sp. Conway, p. 78. Ascent of Skoro La, 10,000–13,000 feet.

Geranium aconitifolium L'Hérit. ? Deosai tableland, about 14,000 feet.

Tamaricaceae.

Myricaria elegans Royle. Conway, p. 78. Biaho valley, between Paiju and the Biafo glacier, 10,000–10,650 feet, 26th July, 1909.

Elaeagnaceae.

Hippophäe rhamnoides L. Conway, p. 83. Valley of the Braldoh, between Dusso and Askoley.

Our specimens with thorny branches confirm once more the variability and polymorphism of this species.

Thymelaeaceae.

Daphne oleoides Schreb. Conway, p. 83. Valley of the Braldoh, between Dusso and Askoley, 8,000–10,000 feet.

Lythraceae.

Epilobium latifolium L. Rdokass, 13,025 feet; ascent of Skoro La, north side, 10,000–13,000 feet.

Apiaceae.

Bupleurum falcatum L. var. *nigrocarpum* Jaquem ? Conway, p. 80. Deosai tableland, about 14,000 feet.

Without specimens of fruit it is impossible to differentiate this from the similar species *B. diversifolium* Rochel.

Bupleurum longicaule Wall. var. *himalense* Klotsch. Ascent of Skoro La, north side, 10,000–13,000 feet.

Without fruit.

Apiacea sp. Deosai tableland, about 14,000 feet.

Apiacea sp. Rdokass, 13,025 feet.

Specimen with leaves only, noted in journal, No. 8A, as having *reddish flowers*.

Pirolaceae.

Pirola rotundifolia Linn. Rdokass, 13,025 feet, June–July, 1909.

Leaves only.

Primulaceae.

Primula purpurea Royle. Conway, p. 91; Workman, p. 287 (sub. *P. nivalis* Pall. var. *macrophylla* Pax). Deosai tableland, about 14,000 feet.

Specimens with simple floral or double superposed umbels.

Primula farinosa L. Conway, p. 81. cites the var. *caucasica* Reg. Between Dusso and Askoley, about the camp; Rdokass, 13,025 feet; ascent of Skoro La, north side, 10,000–13,000 feet.

Androsace villosa L. Conway, op. cit., p. 81. Rdokass, 13,025 feet; between Dusso and Askoley, Braldoh valley, 8,000–10,000 feet.

Androsace mucronifolia Watt. Deosai tableland, about 14,000 feet.

Plumbaginaceae.

Acantholimon lycopodioides Boiss. Conway, p. 81. Between Askoley and half-way between Korophon and Bardumal.

Example consisting only of rosettes of foliage.

Gentianaceae.

Gentiana aquatica L. var. ? Rdokass, 13,025 feet.

Must be referable to one of the varieties of *G. aquatica*; *G. pygmaea* Clarke and *G. humilis* Stev. are also very closely related to the species, and possibly belong to it as varieties.

Gentiana decumbens Linn. Ascent of Skoro La, north side, 10,000–13,000 feet.

Gentiana detonsa Fries. = *G. barbata* Froel. Rdokass, 13,025 feet.

Gentiana Sect. *Comastoma*. Rdokass, 13,025 feet.

We have here a very interesting plant related to *G. falcata* Turcz. and to the two species described by Murbeck (*Oest. Bot. Zeitschr.*, 49, 1899, p. 241) under the names *G. Hedini* and *G. cordisepala*. Ours is probably a new form.

Gentiana sp. Deosai tableland, about 14,000 feet.

Gentiana sp. Ascent of Skoro La, north side, 10,000–13,000 feet.

Pleurogyne carinthiaca L. Conway, p. 82. Ascent of Skoro La, 10,000–13,000 feet.

Pleurogyne sp. Rdokass, 13,025 feet.

Swertia petiolata Royle. Deosai tableland, ca. 14,000 feet.

Boraginaceae.

Macrotomia perennis Boiss. Conway, p. 82 (sub *M. endochroma* Hook. fil. & Thoms). Between Askoley and half-way between Konophon and Bardumal.

Onosma echioides L. Conway, p. 82. (Sine loco !)

Erytrichium sp. Conway, p. 82. Deosai tableland.

Absence of fruit prevents the precise determination of this plant.

Mertensia tibetica Clarke. Ascent of Skoro La, north side, 10,000–13,000 feet.

Mertensia primuloides Clarke. Vigne glacier, about 16,500 feet.

Myosotis sylvatica Hoffm. Ascent of Skoro La, north side, 10,000–13,000 feet; Rdokass, 13,025 feet.

Actinocarya tibetica Benth. ? Rdokass, 13,025 feet.

Lamiaceae.

Stachys tibetica Vatke. Conway, p. 82. Deosai tableland, about 14,000 feet.

Nepeta discolor Royle. Conway, p. 83. Between Askoley and half-way between Korophon and Bardumal.

Nepeta longibracteata Benth. ? Vigne glacier, about 16,500 feet.

The identification is somewhat doubtful, as the dimensions, particularly of the leaves, are smaller than those given in the descriptions we have consulted. Perhaps we have to do with a form of the species.

Dracocephalum heterophyllum Benth. ? Deosai tableland, about 14,000 feet.

Thymus Serpyllum L. Conway, p. 82. Deosai tableland, about 14,000 feet; ascent of Skoro La, north side, 10,000–13,000 feet; Vigne glacier, about 16,500 feet.

Scrophulariaceae.

Veronica alpina L. Deosai tableland, about 14,000 feet.

This species is not given in the *Flora of British India*, nor in later authors already cited; thus it is a new addition to the flora of the region. However, it is certain that we have here to do with *V. alpina* L., our specimen being very closely related to the forms of this species found in northern Europe (Norway, &c.).

Pedicularis bicornuta Kl. Ascent of Skoro La, 10,000–13,000 feet.

Pedicularis pectinata Wall. Conway, p. 82. Deosai tableland, about 14,000 feet; ascent of Skoro La, 10,000–13,000 feet.

Pedicularis cheilanthifolia Schrenk. Workman, p 287. Rdokass, 13,025 feet. Deosai tableland, about 14,000 feet.

Pedicularis rhinanthoides Schrenk. Deosai tableland.

Orobanchaceae.

Orobanche sp. aff. *Hansii* Kern. Conway, p. 82. (Sine loco.)

Caprifoliaceae.

Lonicera microphylla Willd. Conway, p. 80. Valley of the Braldoh, between Dusso and Askoley, 8,000–10,000 feet.

Lonicera asperifolia Hook. fil. & Thoms. Rdokass, 13,025 feet.

Possibly a distinct form of this species, but lack of material for comparison prevents certitude. Used for firewood on the expedition.

Valerianaceae.

Valeriana dioica L. Conway, p. 80. Between Askoley and the foot of the Skoro La glacier, 9,500–12,800 feet.

Campanulaceae.

Codonopsis ovata Benth. Rdokass, 13,025 feet.

Campanula modesta Hook. fil. & Thoms. Deosai tableland, about 14,000 feet.

Asteraceae.

Aster heterochaeta Benth. Bullock Workman, p. 288. Rdokass, 13,025 feet.

Aster himalaicus Clarke. Deosai tableland, about 14,000 feet.

Aster sp. Ascent of Skoro La, north side, 10,000–13,000 feet.

Possibly a smaller form of the preceding.

Leontopodium alpinum Cass. Conway, p. 80; Workman, p. 288; var. *nivale* Ten. Ascent of Skoro La, north side, 10,000–13,000 feet; Vigne glacier, about 16,500 feet; above Rdokass, about 14,750 feet; Deosai tableland, about 14,000 feet.

On the grounds given by Dr. Karl von Keissler in *Aufzählung der von E. Zugmayer in Tibet gesammelt Phanerogamen* (*Ann. KK. Naturhist. Hofmuseum von Wien*, Band XXII, 1907, p. 27) the forms of this species examined by us must be ascribed to var. *nivale* Ten. *Syll. Fl. Neapol.*, p. 426, and are closely related to the forms found in the high Apennines (Gran Sasso, Majella, &c.).

Erigeron alpinus L.? forma. Ascent of Skoro La, north side, 10,000–13,000 feet.

Erigeron andryaloides Clarke. Conway, p. 80. Between Askoley and half-way between Korophon and Bardumal.

Anaphalis virgata Thoms. Conway, p. 30. Paiju–Punmah.

Anaphalis nubigena DC. Conway, p. 80. Ascent of Skoro La, 10,000–13,000 feet; Deosai tableland, about 14,000 feet.

Tanacetum sp. Between Askoley and the foot of the Skoro La glacier, 9,500–12,800 feet.

Tanacetum sp. Deosai tableland, about 14,000 feet.

Artemisia sp. Valley of the Braldoh, sandy soil.

Artemisia sp. aff. *Absinthium* L.? Valley of the Braldoh between Dusso and Askoley, sandy soil.

Artemisia sp. Ascent of Skoro La, north side, 10,000–13,000 feet.

Chrysanthemum tibeticum Hook. fil. & Thoms. Rdokass, 13,025 feet.

Chrysanthemum Stoliczkae Clarke. Conway, p. 81. Ascent of Skoro La, north side, 10,000–13,000 feet.

Cremanthodium aff. *Decaisnei* Clarke? Deosai tableland, about 14,000 feet.

Senecio aff. *tibeticus* Hook. Deosai tableland, about 14,000 feet.

Allardia vestita Hook. fil. & Thoms. ? Vicinity of Rdokass, about 16,500 feet; 22nd July, 1909, in leaf; Vigne glacier, about 16,500 feet, in flower.

Allardia nivea Hook. fil. & Thoms. Moraine of the Baltoro below Rdokass, 24th July, 1909.

Allardia tomentosa Dcne. ? Vigne glacier, about 16,500 feet, 15th July, 1909.

Jurinea macrocephala Benth. Deosai tableland, about 14,000 feet.

Saussurea Schultzii Hook. fil. ? Ascent of Skoro La, 10,000–13,000 feet.

Saussurea Jacea Clarke ? Gorge of the Punmah; 26th July, 1909; between Askoley and half-way between Korophon and Bardumal, in leaf.

Saussurea sp. Deosai tableland, about 14,000 feet.

Crepis glomerata Dcne. ? Deosai tableland, about 14,000 feet.

Taraxacum officinale L. forma. Conway, p. 81. Ascent of Skoro La, 10,000–13,000 feet.

One of the many high-mountain forms of this ubiquitous and polymorphous plant.

Taraxacum officinale L. var. *eriopoda* DC. Rdokass, 13,025 feet.

Chondrilla graminea Benth. Bullock Workman, p. 288; var.? Between Paiju and the Punmah.

Must be a variety of this species which is cited tentatively by the Workmans.

Lactuca tatarica C. A. Meyer. Conway, p. 81; Workman, p. 388. (Sine loco.)

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