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Prominent Features of Its Structure: Discussion

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process may, in rare instances, be assisted by the action of water as in variety VII.

NOTE.—For a detailed consideration of this subject, which is only indicated in a very condensed form here, *vide* a paper entitled "A study of *Nieves Penitentes* in Himalaya," Paper No. 2, by William Hunter Workman, M.A., M.D., in the *Zeitschrift für Gletscherkunde*, Band III., Heft. IV., May, 1909. Also for a somewhat less detailed description *vide* "Peaks and Glaciers of Nun Kun," by Fanny Bullock Workman and William Hunter Workman, pp. 163–199.

Sir MARTIN CONWAY: Before making one or two remarks on this interesting paper, I should like to return my very cordial thanks to Dr. and Mrs. Workman for the delightful pleasure they have enabled me to enjoy to-night, in revisiting, by aid of their beautiful photographs, this perfectly glorious region, second to none of the mountain regions of the world, for beauty and interest. Mrs. Bullock Workman referred to the nomenclature of the glaciers of the Hispal basin. Of course, travelling very rapidly through a country, as a first pioneer must do, it is not possible to do more than collect such names as the natives present give. My experience is that it is very difficult indeed to place much reliance upon those names. Certainly the glacier which was called Kanibasar on my map appears to be next to the one called Kanibasar on Dr. and Mrs. Workman's map. I have no doubt they may have obtained a more correct location for the name; but when I was there, only a few of the oldest coolies had been up the Hispal glacier before, and none of them were quite sure of where some names should be located. Names float about in those very remote places, and, as a matter of fact, they may not become firmly fixed until the map-maker comes and fastens them down. I found a similar uncertainty as to the names of some of the tributaries of the Baltoro glacier.

The second point I would refer to, is the question of the Cornice glacier. Dr. and Mrs. Workman have proved clearly, by their photographs, that the place where I put the exit of the Cornice glacier is barred across by a rock wall. When I was on the spot, that rock wall was hidden under clouds. By some peculiar divination, for which I give myself great credit, I must have discovered that there was a glacier behind that wall, for my only reason for marking the glacier on the spot where I did, and where the Cornice glacier is actually situated, was because on that foggy day I thought I saw it. Now it appears I did not, and therefore, frankly, I know nothing at all about the Cornice glacier. I wish, however, to call attention to the very remarkable fact, which Dr. and Mrs. Workman have put on record. They have looked down into the Cornice glacier basin from various points. This glacier basin lies at a level approximately 17,000 or 16,500 feet above sea-level, and the wall on the side where they showed us the photographs cannot be above 1000 feet above glacier-level. So that you have a glacial basin entirely surrounded by mountains, at one place only 1000 feet high, and this glacier basin has no exit whatsoever. There it is, and there it has been, I suppose, for thousands of years; and into that basin there must have been pouring snow all that time, and yet it is not full up: 1000 feet of snow would fill it, and to make a thickness of 1000 feet of snow would certainly not take above two hundred years of snowfall, and it has had a great deal longer than that. Now if there is no exit anywhere, how does the snow get away? Why has it not filled up and overflowed the low gap that opens to the Biafo glacier? My conclusion is that there must be an exit somewhere; and I think that after Dr. and Mrs. Workman's repeated journeys of exploration, they have got to go back again once more. They have got to climb into this glacier and find its outlet.

Finally, I would refer to Dr. Workman's most interesting remarks and observations

about the surface forms of snow and ice, which he has grouped under a number of different heads. I would only quarrel with him about the name under which he unites them, that of *nieves penitentes*. In my opinion all the variety of forms he has identified and grouped under different headings include no *nieves penitentes* amongst them. It is, perhaps, a mere question of name. You can call them all *nieves penitentes* if you like; only that is not what *nieves penitentes* really are. *Nieves penitentes* is a name given in the southern part of the Andes to a particular snow formation, not just the snow pinnacles, but to a particular kind of snow pinnacle. It is a snow pinnacle of a quite definite kind. It is different in appearance from anything that was shown in those beautiful slides of Dr. Workman's. They all show you phenomena connected with the surface forms of snow—how it may be moulded into pinnacle shapes and ridges of several kinds, and produced by different processes; but the *nieves penitentes* of South America are different from all of them. We have seen actual *nieves penitentes* on that screen on many occasions. The characteristic of the *nieves penitentes* is that they are moulded out of a bed of snow by the peculiar action of the sun. They are all of them roughly pyramidal in form, of an oval-pyramid form, the major axis of the oval running approximately east and west, and all the pyramids dip towards the north in the southern hemisphere—towards the sun. Then those of one group are almost always of approximately the same height, and they look (and that is why they are so called) like a crowd of *penitentes* clad in white sheets on the hill-side, and the Spaniards in South America call them *nieves penitentes*. As the season advances, the hollows enlarge and deepen between them. The sun looks down into the hollows; the reflection concentrates heat at the bottom, and the hollows are melted deeper and deeper right down to the ground. The pinnacles of snow are finally left standing on the ground, each one separate from the other, very often in hundreds. Those are what in South America they call *nieves penitentes*. You may take the name, and by analogy apply it to various pinnacular forms of snow, only you would not be understood in South America if you did. I have never seen, either actually or in photographs, anything like them in the Himalayas, or the Alps, or in Spitsbergen, or in any other part of the world, and I should be very glad to know that, after Dr. and Mrs. Workman next year have made an expedition to Cornice glacier, they will make another expedition to the Andes of Chile and the Argentine, where they will find these *nieves penitentes*, and where Dr. Workman might continue to enlarge his observations on the various forms of sculptured snow surfaces, which he has already so carefully studied. I am not now criticizing his classification; I am merely suggesting that it would be better to keep the term *nieves penitentes* for the particular form for which the name was invented. I should like once more to thank Dr. and Mrs. Workman for their delightful paper, to congratulate them on the continued success of their great achievements, and to express the hope that we have not heard them here for the last time.

The PRESIDENT (after the paper): Any one travelling in such a region as this must often be tempted merely to focus their interest on feats of mountaineering. I believe I am right in saying that the feats accomplished by Mrs. Bullock Workman are more remarkable in the way of mountaineering than those which have been performed ever before by any one of her sex. Whether I ought to make that limitation or not, I am rather doubtful, but at all events, with that limitation, it will not be denied. But in spite of all the difficulties, our travellers have throughout the whole of their journeys kept their eyes steadily fixed on geographical work, and have therefore brought back with them ample stores of new information, both with regard to the topography of the districts visited, and concerning those interesting snow columns, whether they be called *nieves penitentes* or not. Therefore, I am sure

in the name of every one here present, we not only thank them for their extremely interesting papers, but wish them good luck the next time they go to these regions—good luck in conquering new peaks and traversing new icy fastnesses.

Dr. WORKMAN: I am greatly surprised at the assertion of Sir Martin Conway, that the formations I have shown on the screen to-night are not *nieves penitentes* at all. If they are not *nieves penitentes*, I would ask him, What are they? His conception of *nieves penitentes*, as he gives it, is too restricted to be up to date. In the light of the careful observations made during the last fifteen years in the Andes, in the Sierra of North America, in equatorial Africa, in Himalaya, and even in Iceland, it cannot be said to-day that this formation occurs only in the Andes, or only on one variety of basis, or that the pinnacles have any exclusive shape or size, or that their long axis or the lines in which they may stand orient only east and west.

Among others who have studied them elsewhere than in the Andes, Prof. Hans Meyer, than whom there is no higher authority on *nieves penitentes*, who has seen them in great quantity in various localities in the Andes, and who, therefore, according to Sir Martin Conway's standard, if any one, should be able to recognize them, asserts that he found typical *nieves penitentes* on Mount Kilimanjaro and in the crater of Kibo in Central Africa.

Sir Martin's argument to support his contention that an enclosed glacier cannot exist because the basin in which it lies would fill up with snow is not convincing. It is true that Nature furnishes a new supply of snow to feed a glacier each winter, but it is also true that, during the succeeding summer, it removes a large amount of such snow by melting and evaporation, even above the snow-line, and below it the waste exceeds the supply, till the glacier finally dies out.

There is no reason why an enclosed glacier should not die out within its own basin without having an outlet on another glacier, provided its basin falls to an altitude sufficiently below the snow-line. The question of the life of a glacier is simply one of supply as compared with waste, irrespective of its connection with any other glacier or of its basin with any other basin.

Cornice glacier in question, from its origin on the west Biafo wall, occupies the bottom of a deep narrow valley, or nala, with precipitous sides. Its reservoir is therefore small, and the amount of snow which collects to feed it limited. From its head it descends speedily to a level of 15,000 feet, and then considerably lower than that, *i.e.* to a level much below the snow-line of the region. Further, the valley and glacier run from east to west, and the sun pours its rays into the former upon the latter for many hours during the long summer days with a heat of from 180° to 210° Fahr., the melting effect of which is increased by the confining of the heat by the perpendicular enclosing walls, which exclude all wind. The singeing heat experienced in such valleys is well known to those who have travelled through them in Himalaya during the warm hours of the day. Under these circumstances the wastage from melting and evaporation equals at least the increment from the winter snow-supply, and in fine-weather seasons must exceed it, and is sufficient to keep the glacier, as we saw it, at the very bottom of its nala.

When we looked down from the col at the head of the Hoh Lumba (overhanging Cornice glacier not a great distance below its origin) upon Cornice glacier beneath us in the middle of June, its surface even at that point and at that early season consisted of fully formed glacier-ice, cut up by crevasses, entirely denuded of winter snow and *nieve*, which had already melted away. This was six to eight weeks before the maximum of melting takes place in that region, and, with the sun exerting its destructive effect upon that narrow surface of ice for another eight weeks, it is easy to judge what the chances are of that glacier filling up the chasm 2000 to 3000 feet deep, at the bottom of which it lies.

The noteworthy facts, that this glacier lies at a much lower level than the corresponding portions of other glaciers around it, that it is composed of fully formed ice, while they are deeply covered with snow and *névé*, and that it is enclosed on all sides by high mountain walls, in which the direct observation of those who have been entirely around it has disclosed no opening, as well as the indications afforded by the condition and size of the glacier itself, supply more conclusive evidence that it is enclosed only by and ends only in its own basin, than the disbelief of Sir Martin Conway, who has never seen the glacier nor any of its barriers, except the south Hispar wall, which, according to his own testimony, has no opening at this part.

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## A NATURALIST'S TRAVELS ON THE CONGO-ZAMBEZI WATERSHED.\*

By S. A. NEAVE, M.A., B.Sc. Oxon.

THE following notes are the result of more than four years' wanderings in Northern Rhodesia and the Katanga region of the Congo Free State. Some of the country here discussed has already been dealt with by Mr. L. A. Wallace, the present administrator of North-West Rhodesia, in the *Journal* of this Society for 1907, pp. 369 *sqq.* He has there described the main geographical and geological features of the country very fully. It may, however, be of some interest to supplement his excellent account with some notes on the faunistic features of this part of Africa—more especially as I was fortunate enough to travel some considerable distance through a contiguous area in the Congo Free State, a region which does not come within the scope of Mr. Wallace's paper.

Before dealing with the local conditions, it is necessary to shortly review the general distribution of the fauna of Africa south of the equator. The South African subregion has usually been considered to be bounded to the north by the Zambezi river, on the east, and by the Cunene river on the west, and this is, no doubt, roughly correct. It is, however, of great interest to observe that whilst the tropical species of the equatorial zone (I am here more particularly referring to butterflies and other insects) have spread down the east coast as far as Durban, they do not on the west extend much below the Kwanza river in Angola, a difference of 20° of latitude. This is no doubt mainly due to the high central plateaus on the eastern side of the African continent in this latitude being remote from the sea-coast, whilst on the west, in Angola, the lowlying coast-belt is vastly narrower. On the west side the advance of a tropical fauna to the south is also much checked by the very dry climate which obtains on the coast-belt in southern Angola and to the south of it. This great central plateau is often hundreds of miles wide, and in this latitude its long

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\* Read at the Royal Geographical Society, November 22, 1909. Map, p. 224.