

THE VALLEYS OF THE HIMALAYAS.

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A RECENT number of *Petermanns Mitteilungen* is devoted to a contribution* to the study of the origin of the existing geography of the Himalayas by Dr. K. Oestreich, who accompanied Dr. and Mrs. Workman in their expedition to the Central Himalayas as topographer in 1902. The paper contains the record of many observations of interest, especially as regards the so-called plains of Deosai; his description and photographs of this district leave no doubt, in accepting his conclusions, that the existing relief must have originated at a much lower level than the present elevation of the region, which is characterized by broad open valleys and a comparatively small height of the intervening ridges of hills, and is in process of conversion to the deep-cut valleys and high hills of the outer Himalayas.

Besides giving an account of his observations, Dr. Oestreich devotes the concluding section of his paper to a discussion of the vexed question of the origin of the Himalayan drainage system, and gives a detailed account of what he conceives to be the history of its development. It would be unprofitable to discuss these views, which are necessarily speculative and merely a modification of those already published by others in detail, but a review of the present state of the question cannot be without profit, in view of the interest of the problem.

The two leading features to be explained are, firstly, the fact that two great rivers rise within a short distance of each other, on the northern side of the line of highest peaks, and, after flowing parallel to the range, turn abruptly to break through it and escape southwards as the Indus and Brahmaputra rivers. The second is the fact that most of the great rivers, flowing southwards from the Himalayas, rise to the north of the line of highest peaks and break through it in deep and narrow gorges.

The earliest explanation attributed the valleys to gaping fissures, opened by forces acting in the interior of the Earth; this explanation has been rejected and ignored ever since it was recognized that valleys are shaped, and often originated by causes acting on the surface of the Earth, but it contained an element of truth, inasmuch as it recognized that the course of a valley may be determined by causes acting from within. Leaving this explanation on one side, we have firstly the views of the late Mr. H. B. Medlicott, who was the first to establish, by actual observation, the fact that a river may be able, by cutting down its channel, to preserve its course across a rising range of hills. He applied this principle to the great river-valleys of the Himalayas,

* 'Die Täler des nordwestlichen Himalaya.' Beobachtungen und Studien von Dr. Karl Oestreich. *Petermanns Mitteilungen*, Ergänzungsheft 155. Gotha, 1906.

which he regarded as relics of an earlier drainage system of rivers flowing from north to south across the Himalayan area, these rivers having cut down their valleys through the rising range, and continued to drain more or less of the country to the north of the main axis of elevation. The longitudinal valleys of the upper Indus and Sanpo were attributed to cutting back of the valleys of tributaries of these rivers along the strike of more easily removed rocks, whereby the transverse river-valleys were robbed of more or less of their upper waters.

As the interior of the range became better known, it was found that everywhere along the watershed there seemed to be evidence of its northward recession, and of an encroachment of the southern drainage area on the northern. This led to the promulgation of a fresh explanation, according to which the valleys of the upper Indus and Brahmaputra are structural, formed along a band of lesser upheaval, whose drainage escaped round the ends of the rising range in rivers which were able to preserve their course across the rising range in consequence of the volume of flow, resulting from the extent of their upper waters. Between these two cross-valleys the primitive watershed was regarded as having been practically coincident with the line of maximum upheaval, which again is that of the existing highest peaks; as the range grew in height, the difference in rainfall on its southern and northern slopes became more marked, the volume of the southward-flowing streams increased while that of the northward-flowing ones diminished, and the former began to cut back, till in some cases they were able to penetrate the main range and invade the territory previously occupied by the latter.

Our present knowledge of the interior of the Himalayas is not sufficient to enable us to balance these opposing explanations against each other, or to decide how far each has been the prevailing cause, yet some facts are known which suggest rather than establish the prevalence of one or the other. So far as the valleys of the upper Indus and Sanpo are concerned, we have the capital fact that the valleys of several of their principal tributaries join the main valley at an acute angle directed up-stream. This does not necessarily imply, though it very probably indicates, that these tributaries originally belonged to a different drainage system, and have been added to that which they now belong to by capture, that is to say, it is at first sight evidence of the truth of Mr. Medicott's explanation. It does not, however, exclude the alternative one, for a large part of the area now occupied by the Himalayas must have been dry land at the time when they first began to rise as a mountain range, and this dry land must have possessed a drainage system, probably different from the existing one. The immediate cause of the alteration of this drainage into the two longitudinal valleys of the upper Indus and the Sanpo may have been cutting back and capture of the headwaters of other streams, the cutting back being in part controlled and directed by the occurrence of bands of easily removed rock, but it

may well have been directed and determined, in even larger degree, by the upheaval of the Himalayan range, which would raise a barrier across any rivers flowing from north to south, diminish their power of lowering their channels, and possibly, as has recently been suggested by Colonel Burrard, lead to their being dammed up and finding a fresh outlet to one side instead of along their original course. If this be the case, the longitudinal valleys would be as truly structural as if they had been originally determined by unequal movements of upheaval at the time when the Himalayan region first rose from the sea.

As regards the other rivers which traverse the main range, Dr. Oestreich rejects the explanation that the feature is due to cutting back through the original watershed; but his arguments, based on his observations in the Sind valley, do not seem valid. He calculates that if the levels of the outlets of the Sind and Suru rivers, into the Kashmir and Indus valley respectively, remain unaltered, the recession of the watershed cannot extend beyond some 12 miles or so from its present position, and, believing that the amount of recession which has taken place is only a mile or two, comes to the conclusion that the watershed must have remained, and will remain, pretty constant in its position. To this we may reply, firstly, that the assumptions cannot be granted, and, secondly, that if they were, the argument would prove nothing; of countless horses foaled each year, it would be easy to prove that any one could not possibly win the Derby, yet every year the race is run and won. The simile is, in fact, an apt one, for of all the foals born only a small proportion are ever entered for the race, a still smaller proportion reach the starting-post, and only one each year is added to the list of winners; and similarly on the south side of the Himalayas are countless valleys which have never had a chance of reaching the central range, a few have had the chance, but been distanced by their competitors, and still fewer have succeeded in reaching and penetrating the main range. The Sind river is probably one of those which has been outdistanced in the race, and will never have a chance of cutting back through the range of highest peaks to the valley of the upper Indus, but it does not follow that other and greater rivers, such as the Sutlej or the Kosi, have not been able to do so.

Leaving on one side, then, all arguments of an abstract nature, and coming to the consideration of the evidence there is for or against the explanation as applied to the valleys of the larger Himalayan rivers, we have, firstly, the fact that they traverse the main range in deep-cut narrow gorges, where the rivers are pent in narrow rocky channels. This suggests, though it does not prove, that the rivers have undergone a recent increase of volume, which may reasonably be explained by an increase in the area drained by their headwaters; and this, added to the evidence of recent recession of the actual watershed, suggests that the gorges are not relics of an older drainage, but due

to cutting back and capture, consequent on the steeper slope and heavier rainfall on the southern side of the range. The suggestion is strengthened by the fact that the feature to be explained is practically confined to the eastern half of the range, where the rainfall on the southern slopes is both actually and proportionately much greater than on the northern; here the headwaters of the southward-flowing rivers drain large areas to the north of the main line of snowy peaks, while west of the Sutlej, where the rain and snowfall become less unequally divided between the two sides of the main range, the watershed of the Indus drainage practically coincides with the main orographic axis of a line of highest peaks.

There remains one other point for consideration. It has been assumed, by all who have treated this problem in the past, that the original drainage of the Himalayan area was, as at present, from north to south; but there is no direct evidence that such was the case, and what indications we have point rather to the opposite conclusion. To the south of the Gangetic plain the peninsula of India is a fragment of a very old land surface; to the north of the Himalayas is an area which was sea through long geological periods; and when this sea was converted into dry land by the uplift of its bottom, the original drainage of the new land would naturally, though not necessarily, be from south to north and not in the reverse direction. If, as seems possible, this drainage still persisted when the elevation of the Himalayas began, it is evident that no part of the existing drainage system can be either "antecedent" or "superimposed," but all must be "subsequent," and the origin of the cross-valleys, of those rivers which rise to the north of the main lines of snowy peaks, must be looked for in the cutting back of their headwaters from the steeper and wetter side of the range. Certainly there are peculiarities in the courses of the Indus and Brahmaputra rivers, especially the very sharp angle at which they turn southward to cross the range, suggesting that this, after all, is the true explanation, and that the whole of the Himalayan area, which now drains to the Indian ocean and the Bay of Bengal, once drained off along channels whose courses are unknown, and have probably been obliterated by the great earth-movements of late tertiary and post-tertiary times.

Such is the present position of the problem. Nothing can be certain till the topography and the geology of the Himalayan region is better known, but if there is no certainty of the process by which the Himalayan drainage has been elaborated, it seems certain that it is due to a modification of an older and different drainage system. It is too soon to attempt to trace either the course of this earlier drainage or the history of its replacement by the existing valleys, but it seems clear that two factors have been important: firstly, the great differences in uplift of different parts of the range, and, secondly, the great difference

in the rainfall on its opposite sides. The relative importance of these two factors must have varied from time to time, and from place to place, detailed observations and study alone can decide which has been more important in each case, and the conclusions drawn from the study of one valley can hardly be applied to another, still less extended to a different and distant part of the range.

MR. CECIL CLEMENTI'S JOURNEY ACROSS SOUTHERN CHINA.*

AN interesting journey across Southern China from east to west, in part by routes never before followed by a European, was made during the last three months of 1906 by Mr. Cecil Clementi, who carried out a route survey of most of the country traversed. This work was done with a prismatic compass, observations for latitude and time being also taken with a theodolite, while an aneroid was used for measurement of heights. The survey was plotted on the scale of one inch to the mile, covering three strips of tracing-paper with a total length of 15 yards. From these the map at the end of the present number has been constructed by the Society's draughtsman.

It will be seen that the route chosen by Mr. Clementi was of great interest, the middle part of it leading through one of the least known tracts of Southern China. The survey was begun at Hsün-chou-fu, at the confluence of the two main branches of the Si-chiang or West river, known respectively at the junction as the Pai Hoa or "North river," and the Yu-chiang or "Right river."† It was the latter which was followed by Mr. A. R. Colquhoun during his journey of 1882, and subsequently by a section of the French commercial mission to China sent out by the Lyons Chamber of Commerce under M. Brenier. The northern branch is in turn formed of two main components, the Hong-shue or "Red water" from the west, and the river of Liu-chou-fu—thought by M. Brenier to be the most important head-stream of the Si-chiang in point of volume—from the north. Its name, as given by Mr. Clementi, is Ching-shue ("Blue water"). This last river was traced by another section of the Lyonesse mission, and also about the same time by Mr. Consul Bourne, in the journey undertaken on behalf of the Blackburn Chamber of Commerce. More recently it was ascended as far as Liu-chou-fu by M. François (cf. *Journal*, vol. 23, p. 518). Mr. Clementi ascended the North river to the junction of the upper branches, and then went overland to Lui-chou Fu, his further route

* Map, p. 584.

† The name Hong-shue or Hong-shwei has usually been given to the northern branch, being the name of the arm which comes from the greatest distance.