

On the Origin of the Great River-Gorges of the Himalayas, as Evidenced by the Distribution of Fishes. *

By Sunder Lal Hora, D.Sc., F.R.S.E., F.N.I.
(Zoological Survey of India, Calcutta.)

IT is a general feature of the mountain ranges of Asia that they are cut across by rivers which form stupendous gorges. Geographers and Geologists have suggested many explanations of the origin of the great river-gorges, but no one explanation has yet been accepted by all. It is, however, generally recognised that the gorges have been slowly carved by the rivers themselves during the course of ages. Some of the views regarding the origin of the Himalayan gorges are thus summarised by Burrard, Hayden and Heron (1933, p. 261):

“A gorge may be carved by water across a range in many different ways. Firstly, as a new-born range is rising slowly out of the ocean, it may be cut across at intervals by the sea and divided into a series of islands; the channels cut thus in early times may subsequently develop into river-gorges. Secondly, the snow and rain falling on the front slopes of a range may create glaciers and rivers, which slowly cut back by head-erosion and eat through the mountains. Thirdly, the snow and ice accumulating on the crest may gravitate towards the lowest points of the range, and thence flow off in opposite directions and wear away the rock on both flanks simultaneously. Fourthly, a river may be antecedent or older than the mountains, and have maintained its path across the latter as they rose. Fifthly, the flow of a river may be dammed by the rise of mountains across its path, and the waters of the lake so formed may eventually overflow and carve a gorge across the barrier range.”

According to the latest paper on the subject by Wager (1937), there are only two alternative theories which are being discussed at the present day to account for the existing drainage pattern of the Himalayas. He states:

“One of the theories postulates that at an early age the Himalaya had ordinary consequent drainage, the rivers flowing north and south from the crest. This simple drainage pattern is considered to have been modified to its present form by some of the south-flowing rivers cutting back through the range and capturing rivers on the Tibetan side. The much greater precipitation on the south side of the range and the

much steeper fall and therefore greater erosive power are put forward as possible reasons for the unusual behaviour of the south-flowing rivers. The alternative theory postulates that the Arun and similar rivers always had their present courses which, when they were inaugurated, were the easiest routes down an irregular surface sloping towards the Gangetic plain. Subsequently the Himalayan range is considered to have arisen up across the rivers, but so slowly that by vigorous erosion they were able to keep open their original channels.”

The distribution of Himalayan fishes, both on the Tibetan and the Indian sides, sheds considerable light on this controversial problem. Day (1878), Stewart (1909) and the writer (1937) have shown from a comparison of the fish-faunas of the northern and southern faces of the great Himalayan range that the two faunas are very distinct. The writer has also indicated the probable origin of these faunas and concluded that though the Central Asiatic and the Indian faunas are derived from the same source, somewhere in Southern China, possibly Yunnan, the former became differentiated at a somewhat earlier age when the parent stock was of a generalised nature, whereas the fauna of the southern face appears to have been derived from a younger and more vigorous stock which had already become specialised in south-eastern Asia for life in torrential streams. At any rate, there is no indication that the two faunas had a chance to intermingle since their origin and the reason for their isolation is to be looked for in the origin and the present form of the Himalayas.

It is generally recognised that the whole length of the great Himalayan range is of one geological age. There are indications, however, that the Punjab Himalayas arose at a somewhat later date than the other three portions of the range, viz., Assam Himalayas, Nepal Himalayas and Kumaon Himalayas. This would indicate that when the present-day fresh-water fish-fauna migrated from Southern China to India probably in the post-Eocene period, a barrier had already been created between the forms that spread toward north-west and those that spread toward south-west. The distribution of fishes shows that the drainage of the

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Himalayas in the earlier stages was from east to west along both the faces. In the north the Tsangpo probably flowed into the present-day head-waters of the Indus and the combined river thus formed probably drained north-westwards into the Oxus; while in the south the Tertiary "Indobrahm" of Pilgrim (1919) and Pascoe (1919) had a similar course and drained into the Arabian Sea.

It seems that in the beginning the rise of the Himalayan foot-hills was probably of a more or less uniform nature, which permitted the formation of long longitudinal valleys in the foredeeps of the rising range; but later orogenic movements were certainly more marked in some portions of the range than in the others. These differential movements caused the dismemberment of the primary simple drainage pattern, the streams on the northern and the southern faces draining into their respective longitudinal basins. I have indicated in another place (1937a) how the distribution of fishes shows the evolution of the present-day sharp hydrographical divisions of the southern face of the Himalayas. A continuous stream of migration of forms like *Garra* Hamilton, *Glyptothorax* Blyth, *Amblyceps* Blyth, *Nangra* Day, etc., was checked by a sharp rise of the sub-Himalayas in the region of the principal peaks of the range near the border of the Assam and the Nepal Himalayas and diverted along the Satpura trend to the Western Ghats and thence to the hills of the Peninsula. Such a route of migration could only explain the occurrence of *Bhavana* Hora (Family: Homalopteridæ), *Parapsilorhynchus* Hora (Family: Cyprinidæ), *Silurus* Linn. (Family: Siluridæ), etc., in the extreme south of India on the one hand and of their close allies, such as *Balitora* Gray (Family: Homalopteridæ), *Psilorhynchus* McClelland (Family: Psilorhynchidæ), *Parasilurus* Bleeker (Family: Siluridæ), etc., in Eastern Himalayas and South-eastern Asia on the other. In this case we have a clear proof of the sharp rise of the Himalayas not only in the cluster of high peaks found in this region, but in the barrier that was created against the migration of fishes to the western portions of the range and the dismemberment of the mighty river into the Brahmaputra Drainage System and the combined Indo-Gangetic System. Another differential earth movement, probably of a much later date,

which elevated the Putwar basin into a plateau (Wadia, 1932) led to the further dismemberment of the "Indobrahm" into the Indus and the Ganges Systems of the present-day drainage pattern of the Himalayas. This division is reflected in the distribution of such genera as *Semiplotus* McClelland, *Chaca* Gray and *Erethistes* Müll. and Trosch., which are common to the Assam Himalayas and the Nepal Himalayas but are absent from the Punjab Himalayas. It is thus seen how a continuous westerly flowing river at the foot of the young Himalayas became dismembered into three drainage systems through sharp, localised orogenic movements. These movements also seem to have affected the drainage on the northern face of the Himalayas and established an easterly-flowing Tsangpo and the westerly-flowing Indus. Some of the changes in the drainage pattern of the Central Asiatic tributaries of the Indus studied by de Terra (1934) may have been contemporaneous with the rise of the Putwar basin or of that of the Pir Panjal.

From the above the following conclusions may be drawn with regard to the evolution of the present-day drainage pattern of the Himalayas, and consequently of the origin of the great river-gorges.

The distinctness of the northern and the southern fish-faunas of the Himalayas definitely favours the view that at an early age the Himalayas had ordinary consequent drainage, the rivers flowing north and south from the crest. Had the Himalayan range risen up across the river so slowly as to enable the rivers to keep open their channels by vigorous erosion there should have been very little difference between the fish-faunas of the Cis- and Trans-Himalayan portions of such rivers as the Brahmaputra, the Arun, the Sutlej, the Indus, etc. There is every reason to believe, on the other hand, that the rise of the Himalayas was in sharp, sometimes localised, orogenic movements so that the fishes of the southern face of the range were unable to adapt themselves to very turbulent waters and have, even to this day, remained confined along the southern face of the range to low valleys and are rarely found above an elevation of four to five thousand feet.

In this connection it may also be remembered that the so-called Indian monsoon conditions—south-west for four months and

north east for three or four months—had begun before the Himalayas started to rise, as in the late Cretaceous period open seas of great extent existed to the south of India and some land had been formed to the north. The rise of the Himalayas had a great influence on the distribution of rain fall, for most of the moisture is now precipitated on its southern face, and there is practically no rainfall on the northern face of the Himalayas. Consequently, the rivers along the southern face are very turbulent while those on the northern face are placid, broad valleyed and deep. Very different sets of ecological conditions were thus produced on the northern and southern faces of the Himalayas and these became accentuated as the mountains rose higher and higher.

When the south flowing rivers, mainly through their erosive actions, captured the rivers on the Tibetan side it was natural that some of the fishes on the Tibetan side should have been washed down on the southern side, but they had to pass through such precipitous channels before reaching congenial conditions that with the exception of one genus of the Schizothoracinae—*Oreinus*, a specialised member of the subfamily fully adapted for life in rapid mountain streams—no other member of the Central Asiatic fauna has been able to colonise the southern slopes of the Himalayas.

The migration of torrential fishes along the southern face of the Himalayas and from the Eastern Himalayas to the Hills of the Peninsula shows that the process of river capture or river deflection was a fairly common phenomenon in this territory and also in the region of the contiguous hill ranges to the east. The distribution of specialised hill stream fishes strongly suggests that in South eastern Asia, as a rule, the rivers on the west beheaded the rivers on the east (Gregory, 1925) and thus effected the transference of the fish fauna from the east to the west.

Summary

A summary of the views regarding the origin of the great river gorges of the Himalayas is given. It is pointed out that the fish faunas on

the northern and the southern slopes of the Himalayas are quite distinct, and that an explanation of this fact is to be found in the origin and the present form of the Himalayas. The evolution of the present day drainage pattern of the southern face of the Himalayas is traced from the evidence afforded by the distribution of fishes and it is concluded that the early drainage of the Himalayas was from east to west along both the faces, and that it underwent considerable changes due to differential orogenic movements in the region west of the Tista drainage system and of the Putwar Plateau. The distinctness of the northern and the southern fish faunas of the Himalayas favours the view that at an early age the Himalayas had ordinary consequent drainage the rivers flowing north and south of the crest. The distribution of fishes along the southern face indicates that the rise of the Himalayas occurred in sharp, sometimes localised earth movements so that the fishes always remained in the valleys and were unable to colonise the precipitous higher reaches. A reference is also made to the influence of the monsoons on the southern face, and to the process of river captures that probably played a great part in the distribution of fishes from the east to the west.

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