

# COMPARISON OF THE FISH-FAUNAS OF THE NORTHERN AND THE SOUTHERN FACES OF THE GREAT HIMALAYAN RANGE.

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When Stewart<sup>1</sup> wrote a short article under the above title in the series of reports on a collection of aquatic animals made by him in Tibet during the year 1907, he was probably not aware that Day<sup>2</sup> had already compared in some detail the fish fauna of the highlands of Central Asia with that of the contiguous regions. In this connection Day made a survey of the fishes of Afghanistan, Western Turkestan, Eastern Turkestan, Yarkand, Tibet and Hindustan and concluded as follows (p. 25) :

“ The conclusion, I think, we may fairly arrive at after examining the fishes of Yarkand and the adjoining countries, is that we find a peculiar group of Carps (*Schizothoracinae*) which has spread almost due east and west from the cold and elevated regions of Eastern Turkestan, but of which the southern progress has been barred by the Himalayas. ”

“ If we look to the south, we see, as it were, that a wave of tropical forms of fishes has, at a prehistoric period, expanded over that portion of the globe where the Nicobars, Andamans, and the most southern portions of the continent of Asia and the islands of the Malay Archipelago now are, that this fish fauna has its northward progress arrested by some cause at or near where the Himalayas now exist and mark the division between the fish-fauna of India and that of Turkestan. ”

Stewart's data for the comparison of the two faunas were based on the records of distribution of the various Indian species in Day's volumes in the “ Fauna of British India ” series and on the species described by Regan<sup>3</sup> and Lloyd<sup>4</sup> from Eastern Tibet. He found that

“ From the northern area seventeen species of fish are at present known, belonging to the families Siluridae and Cyprinidae. From the southern area thirty-six species of these two families are recorded in the *Fauna of British India*. These two groups have only two species in common (*Schizothorax esocinus* and *Diptychus maculatus*).<sup>5</sup> (These two species are also the only forms from the Trans-Himalayan Indus which have not hitherto been found in the Trans-Himalayan Brahmaputra. Thus there are no species common to the latter and to the rivers of the south face of the Himalayas). Thus of these two families there are fifteen species confined to the northern regions, thirty-four to the southern, and two are found in both. ”

It may, however, be noted that while Day's conclusions are based on a study of the forms occurring to the north and the south of the western portion of the Himalayas, Stewart's remarks relate to the forms found in the eastern portion of that great range. Both these authorities are, however, in complete agreement that there is no similarity between the

<sup>1</sup> Stewart, F. H.—Comparison of the fish fauna of the north and the south faces of the great Himalayan range. *Rec. Ind. Mus.*, III, pp. 121-123 (1909).

<sup>2</sup> Day, F.—*Scientific Results of the Second Yarkand Mission*. Ichthyology, pp. 1-25 (Calcutta : 1878).

<sup>3</sup> Regan, C. Tate.—Descriptions of five new Cyprinid fishes from Lhasa, Tibet. *Ann. Mag. Nat. Hist.*, (7) XV, p. 185 (1905); Descriptions of two new Cyprinid fishes from Tibet. *Ibid.* (7), XV, p. 300 (1905).

<sup>4</sup> Lloyd, R. E.—Report on the fish collected in Tibet by Capt. F. H. Stewart, I.M.S., *Rec. Ind. Mus.*, II, pp. 341-346 (1908).

<sup>5</sup> The known distributional records of *Schizothorax esocinus* Heckel and *Diptychus maculatus* Steind show that these species do not occur on the south face of the Himalayas and are typical members of the Central Asiatic fauna.

fish-fauna of the northern and the southern faces of the great Himalayan range. This conclusion appears to be based mainly on the distribution of the Schizothoracinae, and it is, therefore, of interest to examine the two faunas more closely.

#### FISH OF CENTRAL ASIA AND OF INDIA.

By "Central Asia" I mean the highlands bordered on the north by the Tien Shan Mountains and on the south by the north face of the Himalayas. To the west, where the Himalayan range does not extend, the Hindu Kush range forms the northern boundary while the southern and western boundaries are ill-defined. Towards the east of the headwaters of the Hwang Ho and the Yangtze Kiang form an undefined boundary. Within these limits are included the headwaters of the Jaxartes and the Oxus, the basins of the Hari Rud and the Helmund, the Trans-Himalayan portions of the Indus and the Brahmaputra, the Tarim Basin, the basin of Lake Balkash, the Mongolian Lake Basin and Tsaidam. The fauna of this vast territory, except near the fringes towards the east,<sup>1</sup> and the west,<sup>2</sup> is composed of the Schizothoracinae, of the catfishes of the genus *Glyptosternum* McClelland (Family: Sisoridae) and of the loaches of the genus *Nemachilus* van Hass. (Family: Cobitidae). Of these three types of fishes, the genus *Nemachilus* is the most widely distributed, as it is found not only throughout the Oriental Region, but its range extends to Africa as well. Though this genus is equally abundant in the northern and southern territories of the Himalayas, the species of the two regions are so different from one another that they can be readily distinguished.<sup>3</sup> The Trans-Himalayan species usually grow to a fairly large size; the body is greatly elongated and almost whip-like posteriorly. The skin is totally devoid of scales. The colour on the sides forms a mottled pattern. The species of the Indian region are usually small in size and possess short, stumpy bodies. Small scales, sometimes hidden in the skin, are usually present, while the body is invariably marked by a series of transverse bands. Several attempts have been made to subdivide the fishes of this genus, but from an intensive study of extensive material from the northern and the southern faces of the Himalayas I have not been able to discover any reliable characters for separating the groups recognised as genera by other workers. In spite of the great difference in the appearance of the

<sup>1</sup>In my account of the "Fish of Afghanistan" (*Journ. Bombay Nat. Hist. Soc.*, XXXVI, pp. 688-706, 1933) I gave a short review of the types of fishes found in Waziristan, Baluchistan, Seistan, Chitral; the Pamirs and the Kashmir and in an addendum some further details are given on the information supplied by Prof. L. S. Berg. It will be seen how, with the exception of Chitral and the Pamirs, the Central Asiatic fauna becomes less marked as we move away from the central zone.

<sup>2</sup>In the lists of Chinese fishes given by Professor Tamezo Mori in his recent work entitled "Studies on the Geographical Distribution of Fresh water Fishes in Eastern Asia" (Chosen: 1936), we find that only one species of *Schizopygopsis* Steindachner is listed from Hoang-Ho, three species of *Schizothorax* Heckel, five species of *Oreinus* McClelland and two species of *Schizopygopsis* from the Yangtze Kiang and two species of *Schizothorax* and three species of *Oreinus* from Southern China. There is a considerable mixture of the Schizothoracine element with the typical Oriental forms in Szechuan, Yunnan and South China.

<sup>3</sup>Hora, S. L.—On Fishes belonging to the family Cobitidae from high altitudes in Central Asia. *Rec. Ind. Mus.*, XXIV, pp. 63-83 (1922).

northern and the southern forms there can be no doubt regarding the genetic affinity of the two types.

The Central Asiatic group of species can be divided ecologically into two categories,<sup>1</sup> (i) those that live in shallow, rapid-running waters and (ii) those that live in lakes. The lake-forms possess a secondarily developed large air-bladder in addition to the original structure enclosed in two bony capsules. The free air-bladder referred to above is, in my opinion, a secondary acquisition developed as an adaptation to life in deeper waters. The form of the free air-bladder is so varied that it is difficult to resist the conclusion that the production of a secondary free air-bladder in certain species of *Nemachilus* has independently occurred again and again in different lakes of Central Asia—the presence of intermediate forms in shallow, sluggish waters lends support to this hypothesis. On the southern face of the Himalayas there are no large lakes and even the small ones that exist are probably not of any great antiquity, since they do not possess any endemic faunas. The lakes of northern Burma,<sup>2</sup> however, are of considerable age, as their fish faunas are characterised by several aberrant and highly interesting indigenous forms. In this region we get certain species of *Nemachilus* which have developed a secondary air-bladder<sup>3</sup> but their general build is similar to that of the forms found in India. It may be concluded from the above that the *Nemachili* of the north and the south faces of the Himalayan range, though genetically identical, represent totally different races.

There are only two species of the genus *Glyptosternum*, *G. reticulatum* McClelland and *G. maculatum* (Regan). The latter is known from Eastern Tibet, while the former is widely distributed in the upper reaches of the Indus, the Kabul, the Amu-Darya and the Syr-Darya Rivers. There is reason to believe that the two species have been produced as a result of isolation and segregation of a once widely distributed ancestral stock. A great variety of Glyptosternoid fishes is found in Siam, Yunnan, Burma and the Brahmaputra drainage of India<sup>4</sup>. Recently I<sup>5</sup> have suggested the probable origin of the Glyptosternoid fishes from *Pseud-echeneis*-like ancestral forms, but whatever may be the origin of these interesting fishes there can be no doubt that the Trans-Himalayan *Glyptosternum* has its nearest allies in Siam, Yunnan, Burma and north-east India. Here again, though we find a close genetic similarity between the Himalayan and the Trans-Himalayan species, the diversity of form is so pronounced that the two faunas must be regarded as distinct.

The Schizothoracinae are small-scaled Barbels with their nearest allies in the so-called large-scaled or moderate-scaled Barbels of the

<sup>1</sup> Hora, S. L.—Report on Fishes of the Yale North India Expedition. Part I: Cobitidae. *Mem. Conn. Acad.*, X, pp. 299-305 (1936).

<sup>2</sup> Annandale, N.—Fish and Fisheries of the Inle Lake. *Rec. Ind. Mus.*, XIV, pp. 33-64 (1918); Prasad, B. and Mukerji, D. D. *Rec. Ind. Mus.*, XXXI, pp. 161-223 (1929).

<sup>3</sup> Hora, S. L.—The Value of Field Observations in the Study of Organic Evolution. *Journ. Bombay Nat. Hist. Soc.*, XXXIV, pp. 377, 378, 382 (1930).

<sup>4</sup> The distribution of the Glyptosternoid fishes is as follows: *Oreoglanis* Smith in Siam; *Glaridoglanis* Norman in Yunnan; *Euchiloglanis* Regan in Tonkin, China, Burma and the Brahmaputra drainage of India; *Exostoma* Blyth (used in its broadly accepted sense) in Burma and *Glyptosternum* McClelland in Kashmir, Turkestan and Tibet.

<sup>5</sup> Hora, S. L.—On a New Genus of Chinese Catfishes allied to *Pseudocheneis* Blyth. (In press.)

Oriental and the Aethiopian regions. Both kinds of Barbels occur in diverse types of habitats—from strong currents to muddy pools—and have consequently become differentiated into a variety of closely related genera, which are often very difficult to distinguish from one another. The Schizothoracinae are distinguished from the Cyprininae by the possession of minute scales but in some cases the scales are entirely absent. A membranous sac or slit anterior to the anal fin, which is laterally bounded by a row of vertically placed scales, like eave-tiles, and which are continued along the base of the anal fin, is also characteristic of the Schizothoracinae. On the southern face of the Himalayas, this subfamily is represented by the genus *Oreinus* McClelland which is spread from Afghanistan along the whole Himalayan and contiguous ranges of hills to south-eastern China. So far as is known, these fishes appear to be strictly residents of rivers in the hilly regions, neither descending far into the plains nor occurring in the level plateaux on the summits of the mountains. Their mouth is armed with a special adhesive device which enables them to resist the rapid currents of the torrential streams. Though *Oreinus* is a well recognised morphological genus, there is every reason to believe that it represents only specialised members of the genus *Schizothorax* Heckel.<sup>1</sup> The two genera interbreed very freely and in several large collections intermediate forms between *Schizothorax* and *Oreinus* are not uncommon. Several Himalayan rivers have Trans-Himalayan sources and it is along these channels that *Oreinus*, a representative of the Schizothoracinae, has probably come down during floods, etc., to the Himalayan rivers. No other genus of this subfamily is found in the small torrential streams of the Himalayas. Tchang<sup>2</sup> has recently described two species of *Barbus* Cuvier from Yunnan, *B. regani* and *B. normani* in which the scales are minute and their general build is very much like the Schizothoracinae, except that they do not possess the tiled rows of scales in front of and at the sides of the anal fin. It thus seems likely that such species of *Barbus* were the progenitors of the Schizothoracinae. In the case of the Schizothoracinae, therefore, we have specially modified Oriental Barbels, but the differences between the two types of Barbels are sufficiently well marked for distinguishing the fish faunas of the northern and the southern faces of the Himalayas.

The great variety of other Catfishes and Carps that characterise the aquatic fauna of the southern face of the Himalayas is not at all represented on the northern face of the range.

#### PHYSICAL FACTORS AND THE CHARACTERISTIC FEATURES OF THE TWO FAUNAS.

In an account of the 'Ecology, Bionomics and Evolution of the Torrential Fauna'<sup>3</sup> it was shown that the physical factors of an environment play a great part in the association of the fauna of a particular

<sup>1</sup> Hora, S. L.—The Fish of Chitral. *Rec. Ind. Mus.*, XXXVI, pp. 307-310 (1934).

<sup>2</sup> Tchang, T. L.—Two New Species of *Barbus* from Yunnan. *Bull. Fañ Mem. Inst. Biology*, (Zool.), VI, pp. 60-63 (1935).

<sup>3</sup> Hora, S. L.—Ecology, Bionomics and Evolution of the Torrential Fauna, with special reference to the organs of attachment. *Phil. Trans. Roy. Soc. London*, (B), CCXVIII, pp. 171-282 (1930).

habitat. Having shown that the fish faunas of the northern and the southern faces of the Himalayan range are almost totally different, though genetically closely related, we may enquire into the factors governing the habitats of the two faunas.

Stewart (*op. cit.*) gave the following four principal physical characteristics of the Central Asiatic region :—(i) its great elevation (usually over 10,000 ft.); (ii) its very low rainfall; (iii) sparse vegetation and (iv) the rapidity of flow of streams. From the point of view of the conditions that govern fish life, the first three factors are of little significance. For instance, the Schizothoracinae are not confined only to high altitudes but are also known from low elevations (for example Seistan, where *Schizothorax* and *Schizocypris* Regan occur, is situated in a deep depression less than 2,000 feet above sea level). It is also immaterial for fish life whether the water in a particular stream is derived from rainfall, glaciers or from springs, as fishes become gradually acclimatised to changes in temperature. Most of the hill-stream fishes feed on insect larvae or aquatic vegetation (mostly slimy algae adhering to rocks and stones), and it is no consequence whether the terrestrial vegetation of the area is sparse or thick. The nature of the river bed and the swiftness of the current are, however, important factors.

It is a general characteristic of the highlands of Central Asia that the rivers run with some rapidity in broad beds of boulders and often expand into marshes and lakelets. Further there are lakes of considerable magnitude dotted all over this area. For an understanding of the correlation between the type of habitat and the corresponding fauna reference may be made to my account of the fish of Chitral cited above. On the southern face of the Himalayas the streams are small and precipitous and there are no large lakes. The nature of the streams is so torrential that very few species of fish are found above an altitude of about 4,000 ft.; the greatly diversified fish-fauna of this region is mainly restricted to valleys. On the southern face of the Himalayas, therefore, fishes require mechanical devices to enable them to withstand the rapidity of the currents, such forms are *Garra* Hamilton, *Glyptothorax* Blyth, *Pseudecheneis* Blyth, etc., which do not grow to a large size, while some, like *Balitora* Gray, are greatly flattened. In the large rivers and lakes of the highlands of Central Asia the conditions of life are presumably not so rigorous and in consequence the rivers are stated by every observer to be teeming with fish life. The fish grow to a fairly large size and are trout-like in appearance, with the exception of *Glyptosternum* which is flattened and is found clinging to rocks, etc.

The most striking feature of the fishes of Central Asia, however, is the degenerate nature of their scales,<sup>1</sup> culminating in their total absence in some forms. As in the Salmonidae, the smallness of the scales in the Schizothoracinae is probably due to the necessity for a supple integument whether in fast-swimming fishes or in those that live in smooth, rapid-running waters, for it must be remembered that whether a fish moves through water swiftly or the water glides over it with great rapidity the physical factors involved are the same in both

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<sup>1</sup> Annandale, N. and Hora, S. L.—The Fish of Seistan. *Rec. Ind. Mus.*, XVIII, p. 154 (1920).

cases. A remarkable feature of the Schizothoracinae is the anal sheath of scales. Besides these enlarged scales, there are usually somewhat larger scales in the scapular region, at the bases of the dorsal and ventral fins and along the lateral line. As the fish moves through the water, these are precisely the regions where, owing to protection afforded by the conical head, fins, and the stream-lined body of the fish, the tearing-away action of the current is least felt. In consequence, these scales do not undergo degeneration to the same extent as on the parts of the body more exposed to the currents. It seems logical, therefore, to assume that the whole of the fish-fauna of the highlands of Central Asia has been modelled to suit the peculiar conditions of the rivers of that region. *Schizothorax*, the perfectly scaled member of the Schizothoracinae, is found in lakes and in large rivers with backwaters,<sup>1</sup> while other genera of the subfamily with scales in varying degree of reduction live in swift waters of varying rapidity.

Along the southern face of the Himalayan range, on the other hand, though the streams are more torrential, we have forms with larger scales. In fact, the *Barbus tor* group, constituting the renowned 'Mahseers' of India, is well represented in the Himalayas and even in *Garra*, which possesses a true vacuum sucker, the body is provided with moderately large scales. The same is true of such mountain genera as *Balitora*, *Psilorhynchus* McClelland, *Crossochilus* van Hass., etc. Even the Siluroids, which live on the exposed surfaces of rocks, such as *Sisor* Hamilton, *Glyptothorax*, *Laguvia* Hora, *Erethistes* Müll. & Trosch., etc., have developed wart-like, hard projections on the skin. This may seem contradictory to what has been stated above regarding the reduction of scales in Central Asiatic fishes, but in reality it is not so. In dealing with the physics of the mechanism of attachment in hill-stream animals it was shown<sup>2</sup> that though at certain velocities the resistance of a body subjected to a current is greatly reduced by the rounding-off of its contours, at other velocities, in some bodies, such as spheres and cylinders, the resistance is actually reduced by the roughening of the surface. Those who have visited the Trans-Himalayan and the Cis-Himalayan areas of the great range will bear out very fully that the nature of the flow of water currents in the two areas differs very considerably. It is these differences in the nature of the currents that account for the different types of fish-fauna of the two regions.

#### ORIGIN OF THE TWO FAUNAS.

According to Day (*vide supra*, p. 241) at some very early age the Himalayas acted as a barrier between the northern and the southern forms and the resulting isolation kept the two faunas very distinct. This is true so far as it goes and certainly at the present day the Himalayan range is an effective barrier that does not permit the northern and the southern fish-faunas to intermingle. It has been shown above that

<sup>1</sup> Hora, S. L. and Mukerji, D. D.—Pisces in *Visser's Karakorum*, I, pp. 427, 428 (Leiden: 1935).

<sup>2</sup> Hora, S. L.—Ecology, Bionomics and Evolution of the Torrential Fauna, with special reference to the organs of attachment. *Phil. Trans. Roy. Soc. London (B)*, CCXVIII, pp. 254-256 (1930).

the Central Asiatic *Glyptosternum* and *Schizothorax* have their close allies in Yunnan and the adjoining territories of south-eastern Asia. It seems reasonable, therefore, to infer that the fish-fauna of Central Asia was derived from an eastern stock, as I<sup>1</sup> have suggested in regard to the origin of the fish-fauna of India as a whole. The close genetic similarity between the two faunas is undoubtedly due to their common origin, and the dissimilarity between them is probably due to their differentiation in different geological ages, long isolation and the resulting segregation. Attention may here be directed to Regan's<sup>2</sup> hypothesis "that as a rule the first step in the origin of a new species is the formation of a community with a new and restricted environment, or with new habits; in other words, that some form of isolation, either localization or habitual segregation, is the condition of the development of a new species." What is true of the species is also applicable to faunas as a whole. The fish-fauna of Central Asia, at any rate, affords a remarkable instance in support of this hypothesis.

To compare the origin of the Trans-Himalayan and the Cis-Himalayan fish-faunas it seems worth while to give a very brief account of the geological history of the Himalaya, but unfortunately our knowledge of Trans-Himalayan geology is very meagre indeed.

"There is no evidence to show that the Himalaya, as a great mountain range, are older than the latter part of the Eocene period".<sup>3</sup> Before that the Himalayan area formed the northern coast of Gondwanaland and a number of rivers flowed northward into the Tethys Sea of that period. The orogenic movement, which was strongly pronounced during the Oligocene, probably began in late Cretaceous times and continued throughout the Eocene and Middle Tertiary periods. There is considerable evidence to show that it was still active during the Pliocene and the later periods. The ossiferous beds of Ngari Khorsum and of the Karewas of Kashmir, however, indicate that during the Pleistocene period the Himalayas had already acquired the general features of their present-day form. The nature of the Siwalik deposits shows that the main drainage lines on the south face of the Himalayas date as far back as the Pliocene epoch and that "the rivers which brought down the sands and boulders from the mountains to build up the Siwaliks of the Duns and the Hundes were the direct ancestors of our modern Sutlej and Ganges."

From the generalised nature of the Trans-Himalayan fish-fauna it may be surmised that the eastern portion of the Tibetan plateau was the first area to be lifted and raised above the neighbouring Chinese territory. The drainage of this new land joined the then existing drainage of southern China and thus channels were established for the Chinese forms to colonise new lands. As the crustal movements gradually lifted the Tibetan region, better adapted hill-stream forms

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<sup>1</sup> Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the Probable Land Connections between India and the Adjacent Countries. *Curr. Sci.*, V, pp. 351-356 (1937).

<sup>2</sup> Regan, C. Tate.—Mendelism and Evolution. *Nature*, CXIII, p. 569 (1924).

<sup>3</sup> For geographical and geological facts about the history of the Himalayas I am indebted to Burrard and Hayden's "A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet" revised by Burrard and Heron (Delhi: 1933).

were able to invade the higher reaches of these streams. The association of the fish-fauna shows that these rivers had fairly broad valleys with deep beds of boulder and rapid-running currents. It has then to be presumed that at a certain period a localised disturbance caused this region to be lifted up so as to isolate the fauna of this area from the ancestral stock. The geographical distribution of the Schizothoracinae shows that the waters of Central Asia may have flowed at first towards the east, then towards the west and north before the present drainage pattern was established.

“On the basis of his geomorphological studies, Dr. de Terra has reconstructed the Tertiary drainage pattern of the western part of the Tibetan plateau. A number of rivers ran from west to east, one of them occupying the present valley of the Upper Indus. It is difficult to resist the conclusion that a similar pattern extended farther north, the Tarim basin draining into the Hwang-ho.”<sup>1</sup> According to Burrard, Hayden and Heron<sup>2</sup>, the evidence furnished by the feeders of the Trans-Himalayan Brahmaputra shows that the Tsangpo formerly flowed through Tibet from east to west, and that of the great rivers of the world, “the Brahmaputra furnishes the only instance of drainage flowing in a diametrically opposite direction to what it formerly did, though still occupying the same bed.”

The Schizothoracinae are at present found in at least twelve major river systems and numerous closed basins adjoining the plateau of Central Asia. *Glyptosternum* is also found in the eastward and westward flowing rivers. Mukerji and I<sup>3</sup> found the same species of *Nemachilus* in the headwaters of the Indus and the Karakash rivers. These facts concerning the geographical distribution of Central Asiatic fishes can only be explained reasonably on the assumption that after the establishment of the typical highland fish fauna local upheavals repeatedly led to changes in the drainage pattern of this region and thus made possible the wide dispersal of these forms.

So in the origin and distribution of the fish-fauna of Central Asia, the first step was the colonisation of the newly produced lands of Eastern Tibet, probably during the post-Eocene period, by the fauna of southern China, particularly of Yunnan. The second step was the lifting of this region, which resulted in the isolation of the fauna of the upper reaches by the reversal of the drainage system, and finally through localised orogenic movements in the region of the Tibetan trough the drainage pattern was made to oscillate from time to time resulting in the wide dispersal of the Central Asiatic forms within the limits of the trough defined above.

As indicated above, the fish of the southern face of the Himalayas are highly specialised and appear to have spread over this region from the east at a somewhat later date, possibly in the late Miocene or Pliocene periods. Of the hill-stream fishes of this region we have fossil records of *Bagarius* Bleeker, a widely distributed genus of the somewhat larger

<sup>1</sup> Hutchinson, G. E.—Yale North India Expedition. *Nature*, CXXXIV, p. 87 (1934).

<sup>2</sup> Burrard, S. G. and Hayden, H. H.—*A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*. 2nd Edition, revised by Burrard, S. G. and Heron, A. M. (Delhi: 1933).

<sup>3</sup> Hora, S. L. and Mukerji, D. D.—Pisces in *Visser's Karakorum I*, pp. 427-428 (1935).



rivers of India, Burma and the Malay Archipelago, from the Siwalik formations of Nahan and the Tertiary formations of Padang in Sumatra. All students of Oriental fishes are familiar with the great similarity between the south Himalayan fish fauna and that of Burma, Siam, the Malay Peninsula and the Archipelago and Indo-China. In another place I<sup>1</sup> discussed the probable origin of the fish fauna of India and showed that it was derived from the eastern countries. For the probable mode of dispersal of fishes from east to west reference may be made to Gregory<sup>2</sup> and Gregory and Gregory<sup>3</sup> who have attempted to demonstrate that in south-eastern Asia the western rivers beheaded the rivers on the east; thus effecting the transference of eastern fauna towards the west. As the total Himalayan uplift was accomplished in three or more stages, every wave of orogenic movement may have affected the drainage pattern of that period, but, as evidenced by the distribution of freshwater fishes, it seems that every time the western rivers captured the waters of the eastern rivers. Changes in the drainage of the southern face of the Himalayas may also have resulted from localised disturbances. At any rate, it seems certain that when the South Chinese fauna began to spread along the southern face of the Himalayas, even the parental stock in China had probably already undergone considerable changes due to the torrential nature of the streams on the newly produced precipitous hill-sides.

It is thus seen that though the fauna of the northern and the southern faces of the Himalayas is derived from the same source, the Central Asiatic fauna, comprising comparatively less specialised forms, was probably differentiated at an earlier date when the parental stock was of a generalised nature; while that of the southern face of the Himalayas, comprising highly specialised forms, was produced at a later date when the original stock had already become fairly well adapted for life in torrential streams.

#### SUMMARY.

Attention is directed to the conclusions reached by Day and Stewart as a result of the comparison of the fauna on the northern and southern faces of the Himalayan range. From a critical examination of the fish of Central Asia and of India evidence is adduced in support of the earlier conclusions that the two fish faunas are very distinct from each other. The physical factors governing fish life in Central Asia and on the southern face of the Himalayas are discussed and it is shown that the fish of the two regions are adapted to suit the nature of their respective streams. The characteristic features of the two fish faunas are examined and their close correlation to environmental factors is indicated. The probable origin of the two faunas is described and it is shown that though the

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<sup>1</sup> Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the Probable Land Connections between India and the Adjacent Countries. *Curr. Sci.*, V, pp. 351-356 (1937).

<sup>2</sup> Gregory, J. W.—The Evolution of the River System of South-Eastern Asia. *Scottish Geog. Mag.*, XLI, pp. 129-141 (1925).

<sup>3</sup> Gregory, J. W. and Gregory C. J.—The Alps of Chinese Tibet and their Geographical Relations. *Geog. Journ.*, LXI, pp. 153-179 (1923).

Central Asiatic and the Indian faunas are derived from the same source in south-eastern Asia, especially Yunnan, the former probably became differentiated at an earlier age when the parental stock was of a generalised nature, whereas the fauna of the southern face of the Himalayas was derived from a younger and more vigorous stock which had already become specialised in south-eastern Asia for life in torrential streams.