FISH FAUNA OF KEDAR VALLEY, CHAMOLI—GARHWAL

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Introduction

No attempt seems to have been made so far to explore the fish fauna of Kedar Valley, inspite of the richness of water resources and zoogeographical significance. Kedar valley is in Chamoli-Garhwal and is situated in North latitude 30°-47' and East longitude 79°-8'. The main river of this valley is Mandakini with a number of tributaries. River Mandakini originates at an altitude of 3583 metres at the southeastern base of Kedarnath peak, north latitude 30°-47' and east longitude 79°-8'. The fishes were collected both from the river and its tributaries.

Systematic list of fishes

Total number of species recorded were 18, as given below.

Family Cyprinidae

1. *Barilius bendelisis* Hamilton
2. *Crossocheilus latius* (Hamilton)
3. *Garra gotyla gotyla* (Gray)
4. *Labeo dero* (Hamilton)
5. *Schizothorax richardsonii* (Gray)
6. *Schizothoraichthys progastus* (McClelland)
7. *Tor chilinoides* (McClelland)
8. *T. putitora* (Hamilton)
9. *T. tor* (Hamilton)

Family Cobitidae

10. *Botia dayi* Hora
11. *Noemacheilus beavani* (Gunther)
12. *N. montanus* (McClelland)
13. *N. rupicola* (McClelland)

Family Sisoridae

14. *Glyptothorax brevipinnis alaknandi* Tilak
15. *G. cavia* (Hamilton)
16. *G. garhwali* Tilak
17. *G. pectinopterus* (McClelland)
18. *Pseudecheneis sulcatus* (McClelland)

Some Physico-chemical Features of River Mandakini

Water of sampling ranged between 3.3 m to 7.44 m deep in different months, deepest in July-August and shallowest in winter. Water temperature ranged between 6° to 20°C, maximum in summer months and minimum in the winter. Powers (1929), Hora (1930), Ricker (1934) and Burton and Odum (1945) considered temperature to be an important factor governing the distribution of fishes. Lindsey (1956) considered temperature to be a factor imposing a barrier on downstream spread of fishes. Temperature differences of even 2.5°C have been found to effectively limit distribution of fish in the rivers of Uttar Pradesh (Raj and Hussain 1955). During the present study it has been observed that temperature governs the migration of fishes (*Tor putitora, T. tor* and *Labeo dero*) upstream from March onwards in these hill-streams. These fishes migrate upstream for spawning. After monsoon season the winter conditions begin to prevail, the water temperature starts decreasing and these fishes descend downstream from their spawning grounds. The low winter temperature also affects the feeding intensity of fishes. Atmospheric temperature ranged between 1.2° to 36.4°C, maximum in summer months and minimum in January. A corresponding correlation has been observed in water temperatures. Water velocity ranged between 1.5 to 4.580 m|sec., maximum in July-August and minimum in winter. In the hill-streams of this valley, due to fast current, there is no opportunity for rooted vegetation to grow. The only type of vegetation that exists in hill-streams are algae and diatoms covering the stones and rocks. Hora (1922, 1923, 1927 and 1930), Rajan (1963) and Grover and Baloni (1977) observed that hill-streams are poor in planktons as compared to the streams and rivers in plains. It was observed that there is usually relative rarity of fish in rapid waters and the species occur are those which have developed adaptations, such as streamlining or dorso-ventral flattening of body and hold-fast organs to counteract the influence of fast current. These hill-streams are well-oxygenated and water temperature is low as a result of rapid flow of water and support only cold-water hill-stream fishes. Turbidity ranged between 0.4 to 1158.4 ppm, maximum in August and minimum in January. In the present study, it has been observed that increased turbidity during monsoon months causes less production of plankton. A negative relationship was noticed also between the turbidity and dissolved oxygen. Hill-streams become more muddy and turbid during rainy season. The increased turbidity affects the feeding of the fishes. In most of the fishes, the stomachs were found to be empty and devoid of any food item. pH ranged between 6.6 to 8.1, maximum in April and minimum in January and May. Ellis et al (1946) considered that 6.0 to 8.6 pH is favourable for the existence of fish. Dissolved oxygen ranged between 8.0 to 30.4 ppm, maximum in winter months and minimum in monsoon months. Hora (1923, 1930), Powers (1929), Burton and Odum (1945), Rajan (1963) and Grover and Baloni (1977) found hill-streams to be richer in oxygen contents than the streams in the plains. The present study agrees with the observations of these authors. The oxygen contents fall during monsoon months due to high turbidity. This suggests that the oxidation of the organic material producing the turbidity may have been responsible for low oxygen contents. A large amount of oxygen is consumed in the process of oxidation of decaying organic matter. Such matter is brought down into the streams by the rain water from the surrounding hills. Free carbon dioxide ranged between 0.2 to 1.8 ppm, maximum in April-May and minimum in winter months. The quantity of carbon dioxide is so low in the hill streams under study here that it has an almost negligible effect on the fishes.

Morphological Adaptations to Hill-streams

Fishes tend to specialise on specific habitat types (Zaret and Rand, 1971; Mendelson, 1975 and Gorman and Karr, 1978). Hora (1936a) has studied in detail the relationship of fishes to the substratum in torrential hill-streams. Nature of the substratum is an important ecological factor in the distribution of fishes. In the hill-streams of this valley the bed is rocky with big boulders, stones and pebbles. This type of substratum helps the fishes and aquatic insets in hiding and adhering to the rocks and stones. The fishes like *Noemacheilus beavani, N. montanus, N. rupicola* and *Botia dayi* are admirably adapted for creeping into holes and crevices beneath the stones. The rapidity with which they seek such shelters is extraordinary. Fishes like *Pseudecheneis sulcatus, Glyptothorax cavia, G. pectinopterus, G. garhwali* and *G. brevipinnis alaknandi* are admirably specialised for adhering to rocks and stones by means of adhesive thoracic apparatus.

Garra gotyla gotyla, Crossocheilus latius, Schizothorax richardsonii and *Tor chilinoides* are found where the bottom is rocky. All the above mentioned fishes can survive only on a stony bottom which is well suited for their various life processes. The stony bottom is invariably associated with fast current. The stones and boulders provide good protection from fury of the current of water and from the predators.

Hora (1922, 1930 and 1936b) stated that in most of the hill-stream fishes the lower lobe of caudal fin is longer and better developed than the upper. A powerful stroke of such fin result in the forward movement of the fish and tend to rotate the anterior end of the fish upwards, when darting from rock to rock in shallow rapid running waters. But in free-swimming lake-species, the upper lobe is longer and better developed than the lower. This modification enables these fishes to go to the bottom more easily and to keep the head directed towards the bottom. Gray (1933) is of the opinion that the caudal fin of the fish is not mainly responsible for the forward movement of the fish which is executed primarily by the alternate muscular contractions of the body, producing a forward thrust. He stated that "until a very accurate method is devised for measuring the currents produced various types of tail fin, it is dangerous to speculate on the effect produced by variations in the shape of the caudal fin." Therefore, it is difficult to put full reliance on the idea presented by Hora on the the role of enlargement of either of the lobes of the caudal fin. The actual impact of the tail fin in affecting various types of movements in a hill-stream fish is at present not well understood and further bio-physical efforts are needed for a clear understanding of this mechanism. The balancing of the body is the main function of the paired fins which are quite powerful in the fishes of the torrential streams.

In *Schizothorax richardsonii*, the papillated hard plate at the chin has no adhesive function (Tilak, unpublished). This fish adheres to the rocks and stones with the help of underside of the lower lip and paired fins.

The absence or reduction in the size of barbels is an important modification in hill-stream fishes to offer least resistence to the fast flowing water. An exception to this is the species of *Glyptothorax* and *Pseudecheneis sulcatus* which have well-developed barbels with thick membranous base, which are, nonetheless, very well adapted to the hill-stream environment. Their movement, however, is restricted to only darting about from one stone to the other, and, in doing so, they do not encounter the main force of the running water. Moreover, these fishes remain attached to stones and big rocks pressing their body and head, along with the barbels, in such a way that the anterior end of the head projects very little above the stone and the fast flowing water passes smoothly over the head without finding an obstruction. The broad bases of the barbels in the species of *Glyptothorax* and *Pseudecheneis sulcatus* provide an advantage in increasing the expanse of ventral surface of the body which applies closely to the rocks for adherance. The broad basal part of the barbel is membranous and forms a cup-shapped excavation which, when applied to the surface of stones, can help in creating a vacuum, facilitating the adherance of the fish to the rocks. The mechanism of the creation of the vacuum by the bases of the barbels in these fishes is probably on the same lines as in the adhesive thoracic apparatus or the sucker of *Garra*.

Pseudecheneis sulcatus is more evolved than *Glyptothorax* as is evidenced by the findings of Tilak (1976) on the early developmental stages of its adhesive thoracic apparatus. The profusely papillated lips and the areas surrounding the mouth as well as the greatly expanded paired fins of the *P. sulcatus* are developed according to the requirements of a torrential stream. The adults of *P. sulcatus* are found in the main and strong current of water while the young stages, in which these characters have not yet been strongly developed, restrict themselves to the quieter and slower sections of the stream. In *P. sulcatus*, besides the adhesive thoracic apparatus, both the pectoral and pelvic fins act as organs of adhesion. The pelvic fins play an important role in adaptation to the torrential life in comparision to the pectorals. The pelvic fins are large and rectangular and reach the base of the anal. They are covered by thick skin and the individual rays are not externally visible. The skin on the ventral surface of the first two rays is thrown into ridges and grooves. The first ray is broad and highly modified. The modifications in the morphology of the head region, particularly the lips, the fins and their girdles, adhesive thoracic apparatus etc., indicate that the fish is highly adapted to life in torrential streams.

Rapid currents and nature of available food bring a change also in the position of mouth and structure of jaws. The mouth is considerably behind the tip of the snout as an adaptation to help the fish in rasping off food from the rocks and stones.

Owing to the use of the ventral-surface for the purpose of adhesion, the gill-openings are generally restricted to the sides to facilitate easy respiration when the fish is feeding and clinging to the rock by closely applying the ventral surface. As the water in the hill-streams is well oxygenated and the temperature low, the fish can retain water in the gill chambers for fairly longer time. According to Ege and Krogh (1915), "the quantity of oxygen absorbed by the fish is greatly reduced when the temperature of the water in which it is placed is lowered." The low temperature of the hill-stream water is thus a distinct advantage to the fish.

The eyes are much reduced in the species of *Noemacheilus, Glyptothorax* and *Pseudecheneis sulcatus* because these fishes lead a partly hidden life under or beneath the rocks and stones. That these fishes do not feed by sight is evidenced from the position of their eyes on the dorsal surface of the head.

The reduction or absence of scales on the ventral surface is necessitated by the fact that a plain and smooth surface is necessary for adhesion to a rocky substratum. It has been demonstarted by Hora (1930) that reduction in the extra structures on the body of a fish is an adaptation to an environment of torrential streams.

The paired fins are horizontally placed and their outer rays are greatly flattened. This change is brought about for two reasons: first, to allow the ventral surface to be firmly applied to rocks and second, to enable the fins to act as organs of adhesion.

The small size of the hill-stream fishes is advantageous to reduce the resistance of the current. It is well known that food has a considerable effect, not only on the size of the organism, but also on the size of its progeny. In hill-streams, the food has to be collected by elaborate devices. The majority of fauna are smaller in size and feed on algae, diatoms, insects (their larvae and nymphs) and slime covering rocks and stones.

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