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STRUCTURE OF THE RESPIRATORY ORGANS OF A HILL-STREAM LOACH *NOEMACHEILUS RUPICOLA* (MCCLELLAND), COBITIDAE

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Abstract: Morphological and histological structure of the respiratory organs with special reference to mouth, gill-openings, paired and unpaired fins , gills have been studied in detail. Four pairs of gills are not much developed. However, the region of the gill-head is provided with many taste buds forming a layer which are chemical detectors for food and water. Mucous gland cells also have formed a well developed middle layer, and the inner layer has formed by well developed abductor muscles. Primary lamellae are pointed at their tips, provided with two rows of moderately developed secondary lamellae in which thicker water blood diffusion barrier (2.25 μm) in comparison to other denizen, *Garra lamta* (1.75μm) are present.

Key Words: *Noemacheilus*, respiratory organs, histology, hill stream fish.

INTRODUCTION

Fishes inhabit a variety of aquatic environments. If marine fishes are kept apart, some live in normoxic and lentic water of the ponds and lakes, lotic water of rivers, some inhabit hypoxic water of the hill-streams, which are characterized by rocky, zig-zag water beds, high current of water, and plenty of oxygen. Hence the fishes which inhabit such aquatic bodies, undergo a variety of morphological adaptations to live in, and to withstand swift water current (Rooj, 1984). Hora (1982) made some preliminary observations on the structural modifications in some Indian hill-stream fishes with special reference to respiratory system also. However, litle information is available regarding the respiratory apparatus (Robotham, 1978; Sharma *et al.*, 1982; Ojha *et al.*, 1982; Rooj and Ojha, 1985). Recently some studies have been conducted on the respiratory apparatus of some hill-stream fishes with the help of modern instruments and appliances (Rooj, 1984; Ojha and Singh, 1986; Ojha, 1987; Ojha and Singh, 1992).

In the present work the morphological and histological structure of the respiratory organs of a hill-stream loach, *Noemacheilus rupicola* (McClelland) has been studied.

MATERIALS AND METHODS

Live specimens of *N. rupicola*, were collected from Jonha Fall (near Ranchi) with the help of local tribals. Morphological details were studied in living conditions and operculum was removed from one side after anesthetizing with MS-222, dissolved in water, and all pieces were fixed in Bouin's fixative, dehydrated inside laboratory with graded ethanol, embedded in molten paraffin wax and horizontal sections (7μm) were obtained with the microtome and stained with haematoxylin, counterstained with eosin. The microphotographs were obtained from different parts of the gill to show histological structures, after mounting in DPX.

RESULTS

Mouth (also the incurrent aperture for water) is situated as a small, simple and more or less crescentic aperture on the antero-ventral side of the snout, margin of which forms lip like boundary and a ring like sucker. Pectoral fins are transverse in position and small fan like structures.

All the fins are very thin and are highly vascularized. The gill openings or opercular apertures (the excurrent apertures for water) are laterally placed and are reduced in size. Water is seen to be retained for a longer period in side opercular chamber. The branchiostegal rays and membranes are greatly reduced. Gills (4 pairs), are small and slender structures, gill filaments are small, not compactly arranged and are borne over epi-and cerato-branchial parts of the gill arch.

On histological examination, the outer surface of the gill arch is seen to be evenly provided with outer epithelial layer (E) middle taste bud (T) layer, and mucous gland (M) layers and inner striped muscle (M) layers, (abductor muscles) which together constitute a well developed gill head (Fig. 1). At some places short gill rakers (R) originate as elevations from the gill arch epithelium (Fig. 2).

The inner surface of the gill arch develops two rows of primary lamellae (PL) which are short, pointed towards tips, and are provided with two rows of oppositely arranged. secondary lamellae (SL) and a central filamentar axis (A) (Fig. 3 and 4). lamellar spaces are more or less uniform (Fig. 5). Each secondary lamella consists of an outer layer of squamous epithelium (EP) a middle layer of basement membrane and inner core of blood channels (BC) separated by series of pillar cells (PC). Chloride cells could not be observed.

Water blood diffusion barrier have been measured to vary from 2.20-2.25 μm.

Fig. 1. Horizontal section (H.S.) of the gill of *N. rupicola* (x100) showing epithelial layer (E) Taste bud layer (T) Mucous gland land layer (M) and striped muscle fibre layer (S).

Fig. 2. Enlarged Fig. 1, (x450)

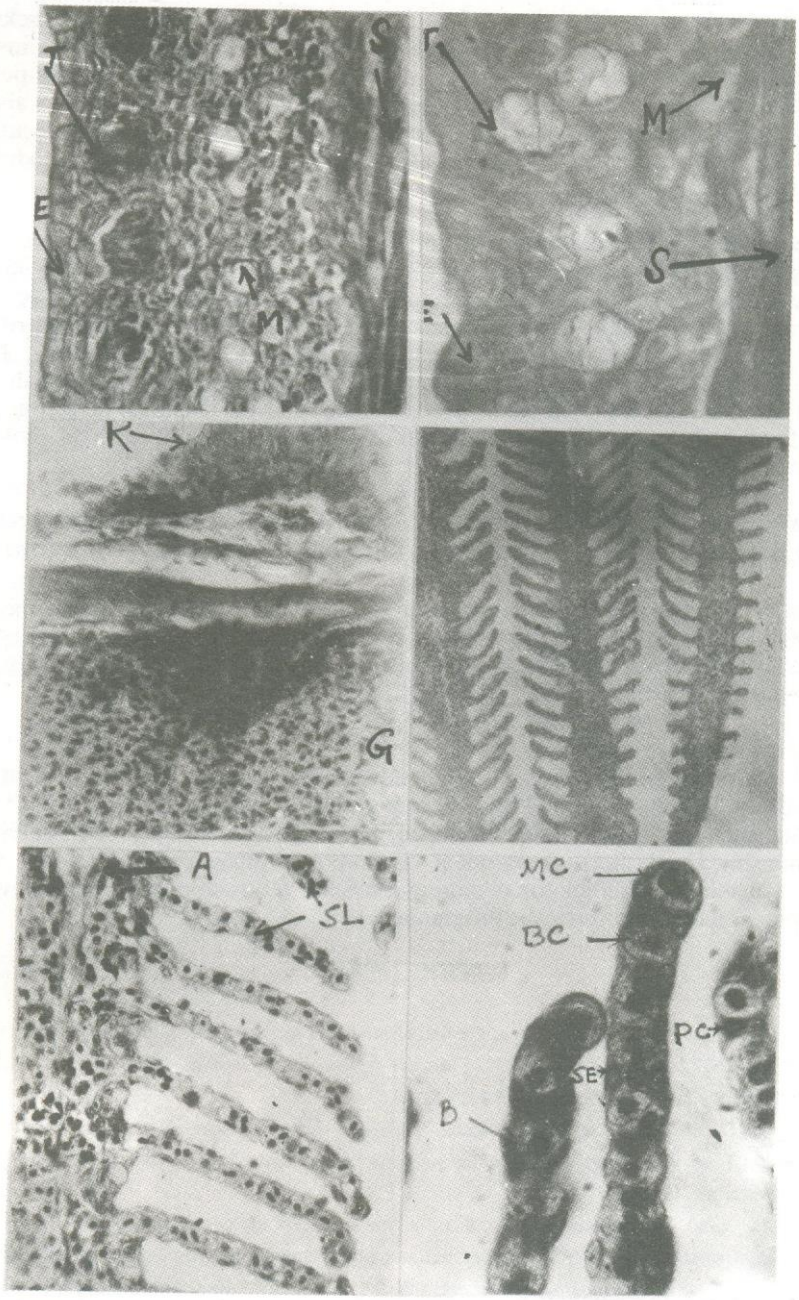
Fig. 3. H. S. of the part of the gill (x100) of *N. rupicola* showing gill arch (G) and gill raker (R).

Fig. 4. H. S. of the part of gill (x100) of *N. rupicola* showing primary lamellae (tip-region).

Fig. 5. Part of Fig. 4 (x450) showing secondary lamellae (SL) and filametar axis (A).

Fig. 6. Enlarged Fig. 4 (x1000), showing S.L. containing squamous epithelium (SE) Basement membrane (B) Pillar cell (PC) Blood channel (BC) and Marginal channel (MC).

RESPIRATORY ORGANS OF A HILL–STREAM FISH



DISCUSSION

With the employment of under surface for the purpose of adhesion to rocks and stones of the hill-streams, the gill openings are restricted to the sides. The inspired water is therefore retained for a longer period inside opercular chamber for the purpose of better gas exchange. Probability of the use of the fins of hill-stream fishes, also for respiration, was observed earlier (Hora, 1992). High vascularization, thin membrane like structures with capillary circulation, and their constant remaining in undulating condition in water, supports also the earlier observations.

Gills are not much developed, as intestine in loaches also acts as accessory respiratory organ (Moitra and Singh, 1987). Highly developed gill-head with taste buds, mucous glands, with small and stumpy gill rakers, and abductor muscles show resemblance with a catfish, *Chaca chaca* (Ojha *et al.*, 1989). Such type of well developed abductor muscles are also seen in *Macrognathus aculeatum* (Ojha, 1975), stumpy gill-rakers are indicative of the carnivorous feeding habit of the fish, well developed taste bud system signifies its greater capacity of the chemical detection of the nature of food, and surrounding water. Presence of large number of mucous glands are of great value in various purposes.

Structures like tertiary lamellae (Munsji, 1960, Hughes and Mittal, 1980) and inter filamentar fusions (Rooj, 1984; Singh *et al.*, 1992) have not observed in this fish.

The water blood diffusion barrier in *Garra lamta* (1.75μm) a denizen of the same environment, signifies the lesser adaptability of *N. rupicola* for respiration, specially by gills (Rooj, 1984). Striped muscle layers constitute abductor muscles of the gills, was observed earlier (Ojha and Munshi, 1976).

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