

# ULTRASTRUCTURE OF THE SCALE OF HILLSTREAM FISH, *SCHISTURA MONTANUS* (MCCLELLAND) AND ITS PHYLOGENIC SIGNIFICANCE

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## KEY WORDS

*Schistura*  
Circuli  
Radii  
SEM

Received on :  
29.05.2010

Accepted on :  
22.08.2010

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## ABSTRACT

Adult specimens of *Schistura montanus* (McClelland) (syn. *Nemacheilus kangrae* Menon) were collected from Kamal river (78°05' 36.4" E: 30°58' 19.8" N; altitude 1375 MSL) of Uttarkashi district of Uttarakhand state, India. In the scale of *S. montanus* (McClelland), the focus region is neither similar to Indian major carps nor to minnows. The shape and structure of circuli of the scale of *S. montanus* (McClelland) is similar to the circuli of the scale of *Cobitis linea* (Heckel) to some extent. It is opined that the generalized structure of the scale of *S. montanus* (McClelland) is more closer to the cobitid scale of *Cobitis linea* (Heckel), hence, this scale should also be referred as Cobitid scale because the circuli of the scales of both the fishes show great similarity.

## INTRODUCTION

India supports 10% of world's fish diversity (Jayaram, 1999), hence, the correct identification of fishes especially of those genera having large number of fish species is a big concern for fish taxonomists, fish conservationists and fish biologists. Conventionally, the fishes are identified on the basis of morphological characters. Some time, the morphological characters overlap or may be ambiguous, hence, there is an urgent need to explore the alternate characters, which can substantiate the morphological characters and give more credence to the identification procedures.

In the Indian hillstreams, the members of the fish family Balitoridae and the subfamily Nemacheilinae, specially Genus *Schistura* McClelland which includes the loaches poses the problem of exact identification of its members upto the species level. Jayaram (1999) and Talwar and Jhingran (1991), employed number of colour bands and spots on the body parts and fins as major identifying character in addition to the other morphological characters which are either overlapping or ambiguous (Jayaram, 1999). To solve this problem, Jayaram (1999) gave dichotomous keys of this genus belonging to different geographical areas and drainage systems clearly indicating the acute problem for the identification of the fish species of the genus *Schistura* McClelland. It must be pointed out here that members of the genus *Schistura* McClelland may not have substantial economic importance, but they are

very important in maintaining the ecological balance of the hillstreams and act as natural scavengers as they scrap the algal matter scum and mucous present on the stones for their food. Moreover, because of their unique colouration and surface scraping habit, almost all the species of the genus *Schistura* McClelland are considered to be excellent aquarium fishes (Biswas *et al.*, 2007).

The general morphology and ultrastructure of fish scale has been employed for classification and phylogeny (Chu, 1935; Lagler, 1947; Kobayasi, 1953), age determination and growth studies (Tandon and Johal, 1996 and Johal *et al.*, 1996), species identification (Johal and Dhiman, 2007) and as pollution indicator (Johal and Dua, 1994 and Johal and Sawhney, 1997). The authors are of the view that the lepidological study can be made use for the identification of various fish species of the genus *Schistura* McClelland inhabiting the hillstreams of the lower and middle Himalayan regions of India. A similar successful attempt has already been made in this regard for the identification of the fish species of the genus *Puntius* Hamilton inhabiting the waters of Western Ghats (Johal and Dhiman, 2007).

## MATERIALS AND METHODS

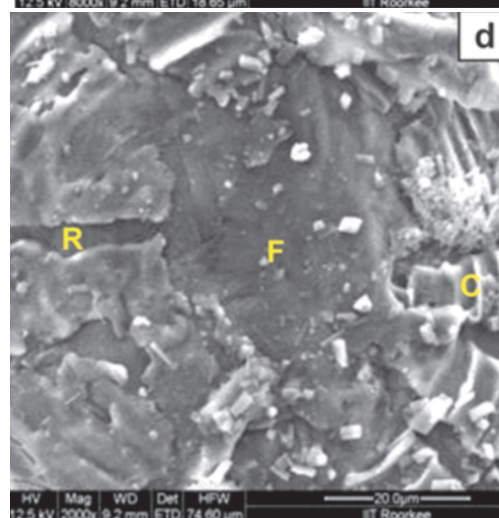
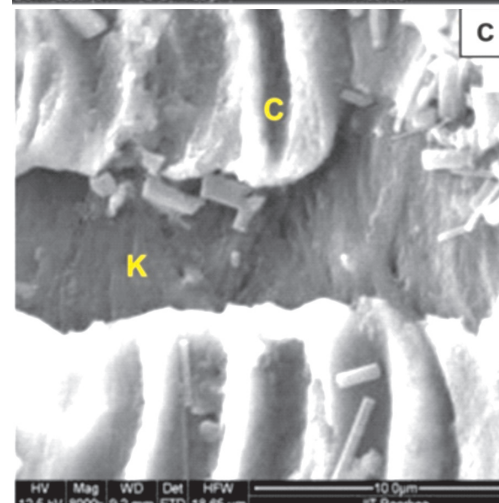
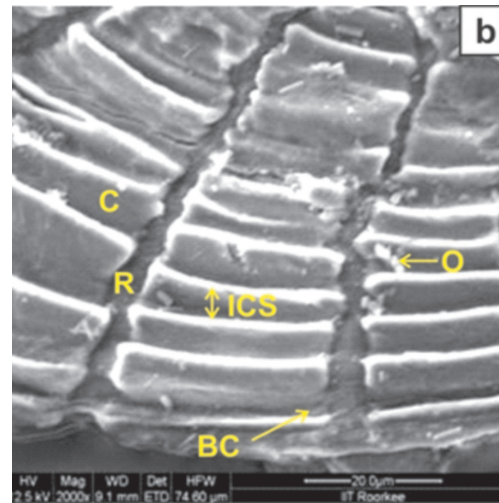
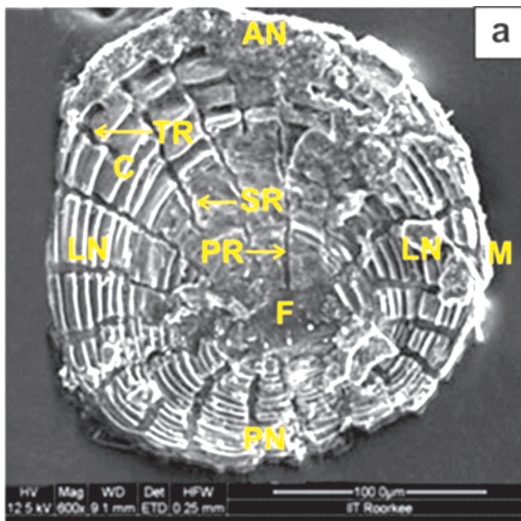
Adult specimens of *Schistura montanus* (McClelland) (syn. *Nemacheilus kangrae* Menon) were collected from Kamal river (78°05' 36.4" E: 30°58' 19.8" N; altitude 1375m MSL) of

Uttarkashi district of Uttarakhand state using scoop and plankton nets. The embedded scales were gently removed with the help of sharp blade and fine forceps from the posterior side of the body between the dorsal fin and lateral line. Scales were cleaned manually using the fine brush and rinsed in triple distilled water, dehydrated in the ascending series of ethanol alcohol and finally dried on Whatman No. 20 filter paper. The cleaned scales were mounted on metallic stub with double 36 stick tape, coated with 100 Å thick layer of gold in gold coating unit. The gold coating of the scale overcomes the problem of charging, beam damage and the damage of the scales specimen. The gold coated scales were viewed under vacuum in SEM/EDAX Quanta 200 FEG scanning electron microscope (FEI) at an accelerating voltage of 20 KV at the low probe current.

**RESULTS**

In Figs. 1a to 1d the generalized scale description of *S. montanus* (McClelland) is given. It is roughly oval (Fig. 1a) with imbricate margin. The scale is slightly more broad than its length and the length and breadth ratio is 1.00; 0.90. The focus region lies in the posterior part of the scale and occupies 13-15% in the length of the scale and 19-21% in the breadth of the scale. There are no remnants of organized or disorganized circuli in the focus region (Figs 1a, 1b). The circuli are few in number (Fig. 1a) but very distinct. Their number varies between 13-15 (Fig.1a) in the fully grown scale of the adult specimen of *S.montanus* (McClelland) having the total fish length of 6.00-8.00 cm. The intercircular space is maximum in the anterior region, minimum in the posterior region and intermediate in the lateral regions (Figs. 1a, 1b and 1d). In the developing scale the different forms of radii can be observed (Fig. 1a).

The radii cut the circuli at right angle resulting in the formation of radial canal (Fig. 1c). In the radial canal several pores are present which facilitate the movements of nutrients and excretory products. In the radial canal there may be present broken parts of circuli and debris present in the surrounding



Figures 1a to 1d: Scanning electron micrographs of the scales of *Schistura montanus* (Mc Clelland). A = entire scale; b = Enlarge view of the lateral region; c = Details of the radii forming radial canal and circuli; d = Details of the focus region showing the appearance of radii and beginning of circuli

**Abbreviations:** AN- Anterior region; BC- Base of circulus/circuli; F- Focus; ICS- Intercircular space; K- Radial canal; LN- Lateral region; M- Margin of scale; PN- Posterior region; O- Osteoclast; PR- Primary radii; SR- Secondary radii; TR- Tertiary radii.

water. Radii provide flexibility to the scale. Each circulus has broad base (Fig. 1b). The intercirculus space shows great variation (Figs 1a, 1b and 1c). Few circuli above the focus region in the anterior part of the scale are poorly formed, whereas, distinct circuli formation begins from the outer margin of the focus in the posterior region of the scale (Fig. 1d). In between the circuli, there are present osteoclasts (Fig. 1b), formed as a result of the chipping of circulus when radii are formed. They are of various shapes and sizes and are being absorbed after some time.

The scales of all these group of fishes have very distinct anterior, posterior and lateral regions, which are poorly demarcated in the scale of *S. montanus* (McClelland). In the scale of *S. montanus* (McClelland) the focus region is neither similar to Indian major carps nor to minnows. The shape and structure of circuli of the scale of *S. montanus* (McClelland) is similar to the circuli of the scale of *Cobitis linea* (Heckel) to some extent.

It is interesting to observe that in four species of the genus *Schistura* McClelland namely, *S. kessleri kessleri* (Günther), *S. kessleri lepidocaulis* Mirza and Nalabant, *S. lindbergi* (Banarescu and Mirza) and *S. punjabensis* (Hora) the scales are absent on the body whereas in other species of this genus the scales are conspicuous in certain areas on the fish's body and may be absent on certain areas. It can be assumed that phylogenetically, the loaches occupy a position in between the orders Cypriniformes, Perciformes and Siluriformes.

It may be further added here that the scale of *S. montanus* (McClelland) show regenerative characters, not primitive characters phylogenetically, which may also be related to the adaptations of this fish to the fast moving waters of the hillstreams.

## DISCUSSION

Tandon and Johal (1996) studied the number of radii present on the scale indicate the rate of growth of the scale and also reported primary, secondary and tertiary on the scales of major carps.

The scale of *S. montanus* (McClelland) is entirely different from the cycloid scale of major carps, minor carps (Johal et al., 1996) and minnows and perches (Hollander, 1986) in several aspects. Johal et al., (1996) and Hollander, (1986) have stated that the cycloid or ctenoid scales have very distinct and large number of circuli. In Indian major carps, there is present distinct larval mark, whereas it is absent in minnows (Tandon and Johal, 1993). Scales having distinct larval mark have indistinct circuli inside the larval mark, whereas in minnows the distinct circuli make their appearance exactly from the focus which is very sharp and distinct (Tandon and Johal, 1993). The cobitid scale (Johal et al., 2006) of *Cobitis linea* (Heckel), a closely related hillstream fish has distinct four regions similar to those of cycloid and ctenoid scales, position of focus is similar to that of minor carp. If the pattern of the distribution of scales on the body of the fishes belonging to the genus *Schistura* McClelland is carefully observed (Talwar

and Jhingran, 1991), it can be inferred that this genus occupies the position between true carps and perches belonging to the orders Cypriniformes and Perciformes respectively having well developed cycloid and ctenoid scales, and the members of the order Siluriformes where scales are completely lacking. It is opined that the generalized structure of the scale of *S. montanus* (McClelland) is closer to the cobitid scale of *Cobitis linea* (Heckel) (Johal et al., 2006) hence, this scale should also be referred as Cobitid scale because the circuli of the scale of both the fishes show great similarity.

## ACKNOWLEDGEMENTS

We thank Director, Indian Institute of Technology, Roorkee, Uttarkhand for providing the SEM facility.

## REFERENCES

- Biswas, K. P., Das, J. N., Sarkar, U. K. and Lakra, W. S. 2007.** Ornamental Fishes of North-East India: An Atlas, National Bureau of 160Fish Genetic Resources, Lucknow, Uttar Pradesh. p. 111.
- Chu, Y. T. 1935.** Comparative studies on the scales and on the pharyngeal and their teeth in Chinese cyprinides, with particular reference to taxonomic and evolution. *Biol. Bull. St. John's Univ.* **2**: 1-221.
- Hollander, H. R. 1986.** Microanalysis of scale of Poeciliid fishes. *Copeia*. **1**: 86 - 91.
- Jayaram, K. C. 1999.** *The Freshwater Fishes of the Indian Region*, Narendra Publishing House, Delhi. p. 551 + pls. 154XVIII.
- Johal, M. S., Tandon, K. K. and Kaur, S. 1996.** Scale structure, age and growth of *Labeo calbasu* (Hamilton) from North India. *Acta. Hydrobiol.* **38**: 53-63.
- Johal, M. S. and Dhiman, M. 2007.** Ultrastructure of fish scales as a tool in fish identification up to species level of genus *Puntius* Hamilton-Buchanan. *Pb. Univ. Res. J. (Sci.)*. **57**: 73-81.
- Johal, M. S. and Dua, A. 1994.** SEM study of the scales of freshwater snakehead, *Channa punctatus* (Bloch) upon exposure to endosulfan. *Bull. Environ. Contam. Toxicol.* **52**: 718-721.
- Johal, M. S. and Sawhney, A. K. 1997.** Lepidontal alteration of the circuli on the scales of freshwater snakehead, *Channa punctatus* (Bloch) upon exposure to endosulfan. *Curr. Sci.* **72**: 367-369.
- Johal, M. S., Esmaili, H. R. and Sharma, M. L. 2006.** Scale structure of a cobitid fish *Cobitis linea* (Heckel, 1949) using different modes of SEM. *Curr. Sci.* **91**: 1464 -1466.
- Kobayasi, H. 1953.** Comparative studies of the scales in Japanese freshwater fishes with special reference to phylogeny and evolution-IV. Particularly lepidology of freshwater fishes. *Jpn. J. Ichthyol.* **2**: 83-91.
- Lagler, K. F. 1947.** Lepidological studies 1. Scale characters of the families of great *Loha*. *Trans. Am. Microsc. Soc.* **66**: 149 -171.
- Talwar, P. K. and Jhingran, A. G. 1991.** Inland Fishes of India and Adjacent Countries, Vols. I and II, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, p. 1158.
- Tandon, K. K. and Johal, M. S. 1993.** Mineral composition of different regions of the scale of an endangered fish, *Tor putitora* using energy dispersive X-ray microanalytic technique. *Curr. Sci.* **64**: 524-525.
- Tandon, K. K. and Johal, M. S. 1996.** Age and Growth in Indian Freshwater Fishes, Narendra Publishing House, Delhi, p.174.

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