ISSN: 2347-5129
IJFAS 2014; 1(5): 108-112

www.fisheriesjournal.com
Received: 06-03-2014
Accepted: 08-04-2014

H Singh
Department Of Zoology, S. S. J. Campus Almora. Uttarakhand, (India).

I Bisht
Department Of Zoology, S. S. J. Campus Almora. Uttarakhand, (India).

Correspondence:
Hoshiyar Singh*
Department of Zoology, S. S. J. Campus Almora, Kumaun University Nainital, 263601, Uttarakhand, India.
Tel: +919012720377, +919548332745

Surface architecture of adhesive organ epidermis of *Schizothorax richardsonii*: adaptive modifications

H Singh, I Bisht

ABSTRACT
Adhesive apparatus is the modifications of the skin of the ventral surface. Fast water current is the single most important limiting factor deciding the occurrence and survival of fauna and flora unless equipped with special adaptive features to with-stand the vicissitudes of nature. In hill-stream fishes, the presence of adaptive modifications in their body organization is of prime importance for their progress against the fast water flow. Such adaptations are primarily manifested in the form of adhesive organ, integumentary specialization, usually situated on the ventral surface of the body between mouth and Pectoral fins and also on ventral fins.

Keywords: Hill-stream, surface architecture, modifications, skin.

1. Introduction
Lip may be associated with a specialized adhesive pad or modified as an oral sucker. The rapid flow of water would render the life impossible to the fishes, if they didn't possess special organs of adhesion or other appliances to counteract its influence. They overcome high velocity of water. In addition, the upper lip may be associated with a rostral cap, and the lower lip, in certain Hill-stream species, with an adhesive pad. The lips and associated structures, in different groups of fishes, are greatly modified in relation to the characteristic mode of feeding, food preference and the mode of life exhibited by the fish.
The adhesive organ is ventral in position. In the Cyprinids, it is located at the ventral head region, beneath the mouth opening. In the mountain stream catfish (Sisoridae), the major adhesive organ is located at the thoracic region [8, 16, 17, 18], while additional adhesive devices are present on the ventral surface of the paired Pectoral and Pelvic fins [6, 3]. The outer keratinized part of the adhesive organ epidermis provides structural support and protection (from damage) during adhesion. It appears that the callus part acts by creating vacuum first, while the tuberculated part of the adhesive organ epidermis assists in adhesion to the rocky substratum.

2. Materials and Methods:
Live adult specimen of *S. richardsonii* (Approximate length 7- 9 cm) was collected from the Kosi River at Hawalbagh district Almora. Water current was very fast having velocity 0.5 to 2.0 m/sec. [2]. To study the details of the morphological adaptations in some fishes, SEM was done. The following procedure was adopted for the preparation of specimen for SEM.
The specimen was maintained in laboratory at 25±2 ^{0}C. The fishes were cold anesthetized following [10], for SEM preparation of the lip. Section were cut of the lip with the help of sharp blades and rinsed in 70% ethanol and one change saline solution to remove debris and fixed in 3% Glutaraldehyde in 0.1M phosphate buffer at pH 7.4 overnight at 4^{0}C at the refrigerator. The tissues were washed 2-3 changes in phosphate buffer and dehydrated in an ascending series of ice cold Acetone (30%, 50%, 70%, 90% and 100% approximate 20-30min.) and the critical point dried, using a critical point dryer (BIO-RAD England) with liquid carbon dioxide as the transitional fluid. Tissues were glued to stubs, using a conductive silver preparation (Eltecks, Corporation, India). The samples were coated with gold using a sputter coater (JFC 1600), examined under (JEOL, JSM- 6610 LV) scanning electron microscope and the images were observed on the screen.

3. Results and Discussion:

The adhesive organ occurs at the ventral head region, just below the mouth opening (Fig. 1). It consists of a crescent callus part and below it; a strip of papillated posterior free labial plate is present at chin. Labial folds bearing semi-spherical tubercles (Fig. 2). The tubercles arise by outpouching of the epidermis of adhesive organ (Fig. 3). They vary in size considerably. The sucker is partially developed or in the form of labial strip. It bears continuous numerous pad like protrusions, which are flattened and densely packed, varying in size (Fig. 3) having spaces between them. Under high magnification, the tubercles appear to bear some pores, especially near the apical end. Each pad-shaped protrusion or papilla bear numerous pores or round vesicles (Fig. 4).

The polygonal epithelium cells are present in the base of protrusion on the adhesive pad of this fish, the free surface of the epithelium cells was differentiated into microridges, forming a characteristic patterns. The surface architecture of the epithelium cells is characterized by the presence of a series of micro-ridges separated by prominent irregular spaces. The microridges in general appear sinuous having rough surface, short with abrupt ends and irregular interwoven to form a web like patterns (Fig.5).

The aim of this study was to provide basic information on the morphological and ultrastructural organization of the adhesive organ in one Cyprinid species, *S. richardsonii*, which is highly adapted for living in the mountain torrents of Kumaun Himalaya region. Electron microscopy reveals that the adhesive organ is essentially an epidermal modification. In order to perform adhesive functions. Some aspect of the ultrastructure of the adhesive apparatus of several fishes has been studied before [1, 4, 5, 6, 9, 15, 17, 18]. In other species *Schizothorax plagiostomus*, *Crossocheilus latius latius* [17] adhesive organ consists of transverse band behind scrapping plate and provided with numerous tuberculated projections. The interspaces between the tubercles provide continuous flow of water for aeration. [17] *P. sulcatus* with highly specialized extremely modified adhesive structure and bottom dwelling habit, is one of the earliest occupiers of unique Hill-stream habitat where such modifications are of vital importance for successful survival. [13, 16] have been reported to serve as non-slipping frictional device. The adhesive disc is capable of generating formidable sticking force if applied against the substratum and pressed carefully to create a vacuum by draining the underlying water. The intensity of this force is directly proportional to the vacuum created [11]. The disc comes in contact with the substratum, first which not only anchor to the substratum but also act as mechano-sensory organ. In all the species of *Garra*, pre and post mouth opening components of the adhesive apparatus comprise four basic units (the fringed anterior labial fold, the posterior labial fold, the callous portion of the disc and the posterior free margin of disc) of integumentary specializations which improve on such modifications described so far in outer Hill-stream fishes (*Glyptothorax* and *Schizothorax*) which have only one unit (described as adhesive pad or adhesive apparatus) [20]. The most important question remains as to how adhesion is affected. [1, 6] were the view that friction alone is responsible for the adhesion process. [6, 7, 8] made an extensive survey of fishes with adhesive organs from North Eastern India torrents, depicted adhesive devices from an evolutionary point of view and correlated these as a response to life conditions in unique Hill-stream habitats. He specially studies adhesive apparatus of *Garra annandalis*, *Bhavania annandalei*, *Glyptothorax madraspatnum.* Adhesive organs have also been described in *Discognathus lamta* [12] *Glyptothorax telchitta* [1], *G. pectinopterus* [9, 21]. In this significant contribution on adhesive organs of Hill-stream teleosts, [13, 14] and [16] explained the adhesive mechanism in *Garra mullya* and *Pseudoecheneis sulcatus*. The callus part is drawn and a cavity is produced that is surrounded by the tuberculated borders. Adhesion results due to friction between tubercles and surface of substratum.

The surface architecture of the superficial layer of epithelium cells in the adhesive organ and associated structures is characterized by specialized structures, the microridges forming different patterns in different fishes. The term "microridges" is used in this study following [22, 23] and [24] and seems appropriate.

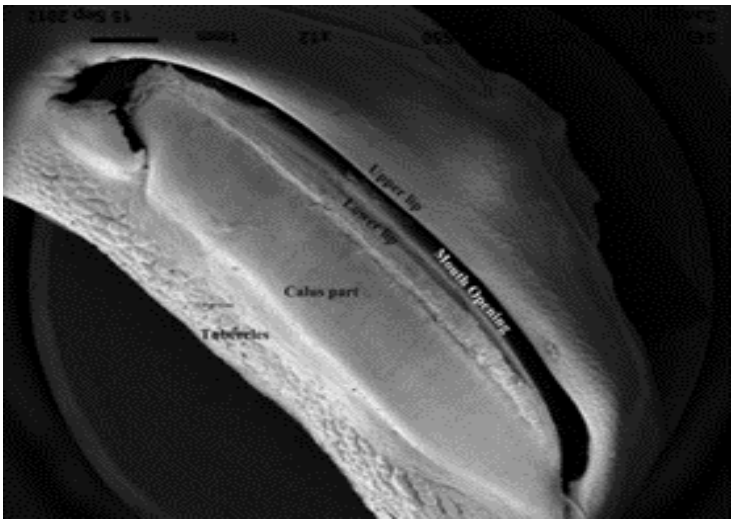

Fig 1: Surface electron microphotograph (SEMPH) of the ventral side of lip epidermis of *S. richardsonii* showing well developed tubercles on adhesive pad of posterior lip (Scale bar- 01 m).

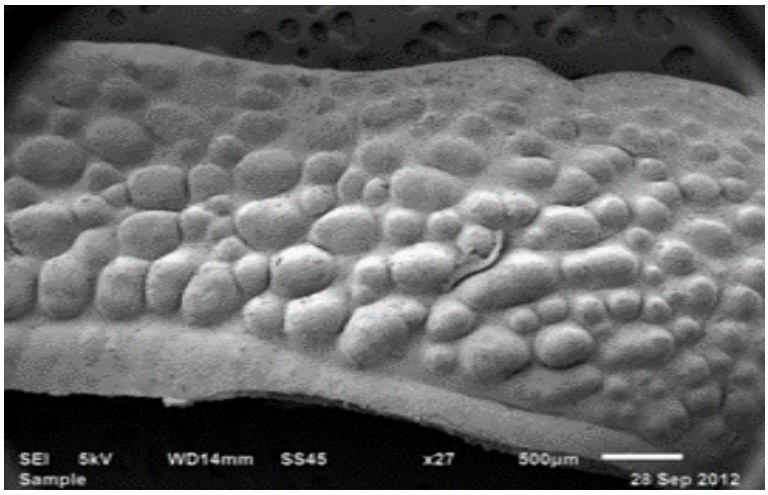

Fig 2: Surface electron microphotograph (SEMPH) of the *S. richardsonii* showing numerous pad like- protrusions or tubercles (Marked by arrows) (Scale bar- 500µm).

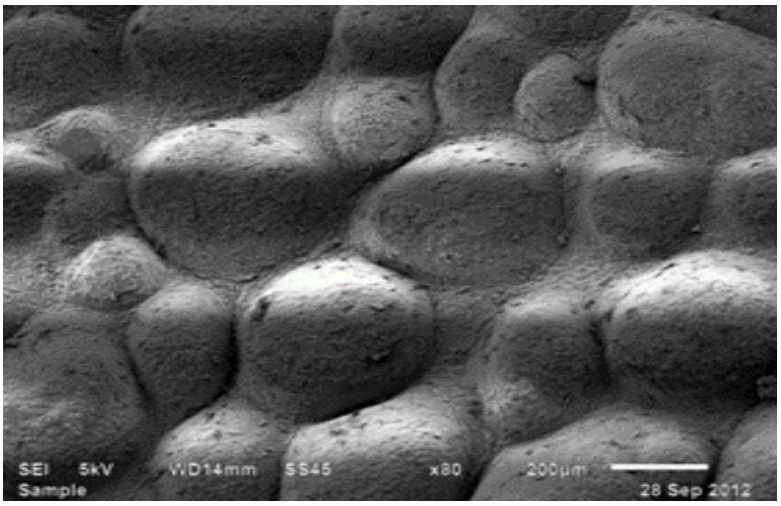

Fig 3: Surface electron microphotograph (SEMPH) of the *S. richardsonii* showing tubercles, which are flattened and densely packed, varying in size (Scale bar- 200µm).

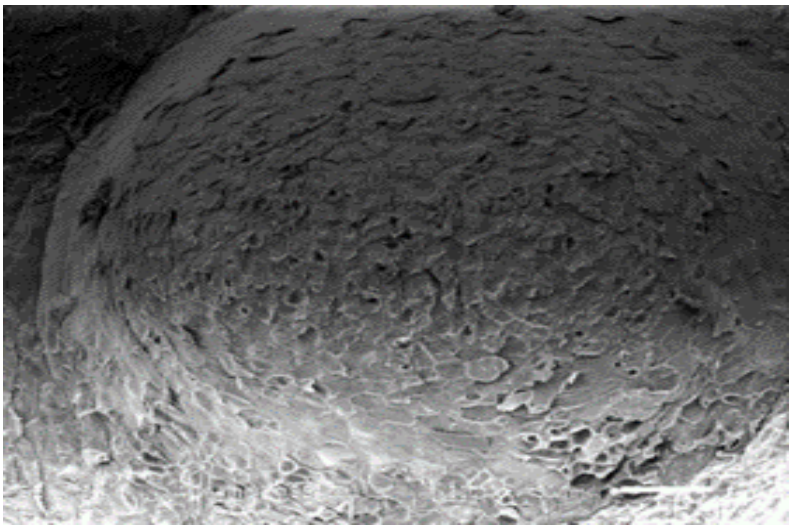

Fig.4 Surface electron microphotograph (SEMPH) of the *S. richardsonii* showing the tubercles appear to bear some pores (Scale bar- 50 µm).

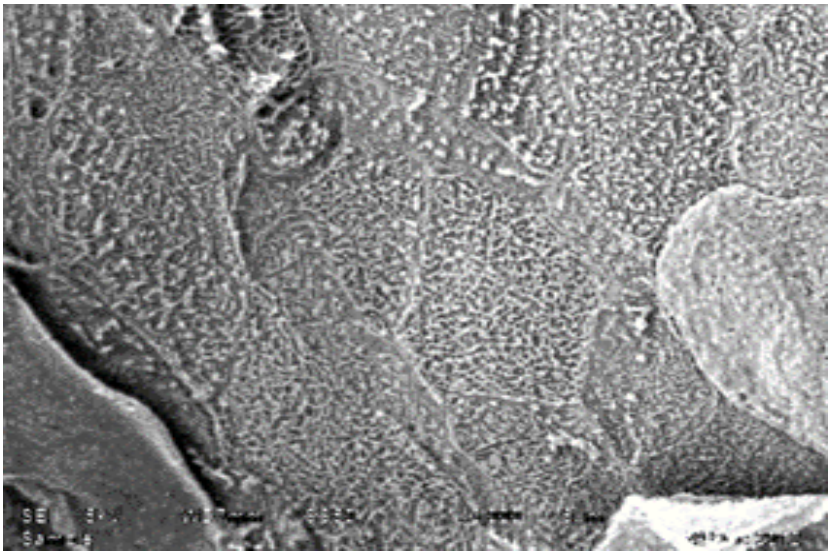

Fig 5: Surface electron microphotograph (SEMPH) of the *S. richardsonii* showing the microridges having rough surface, short with abrupt ends and irregular interwoven to form web like patterns (Marked by arrows) (Scale bar- 5 µm).

4. Conclusion

Many Himalayan fishes have developed a unique morphological specialization in the form of an adhesive organ to maintain their station in the strong water currents. The adhesive organ is characteristically large and arched structure that appears like a shallow plate divided into a central region and a relatively wide peripheral region. Adhesion results due to friction between tubercles and surface of substratum.

5. Acknowledgement

We are grateful to all the people who helped in different part of this work, especially the Department of College of Veterinary and Animal Sciences, G. B. Pant University of Agriculture and Technology, Pant Nagar (U.K.), for providing necessary instruments for this research work. Thanks are also due to Mr. M. P. Singh, for his technical support.

6. References

1. Bhatia B. Adaptive modification in a Hill-stream cat fish *Glyptothorax telchitta* (Hamilton). Pro Natn Inst Sci India 1950; 16:271-285.
2. Bhatt SD, Pathak JK. Streams of Great Mountain are Physiography and Physiochemistry. In Ecology of the mountain waters. Ashish publ House New Delhi 1991; 43-58.
3. Das D, Nag TC. Adhesion by paired Pectoral and Pelvic fin in a mountain stream catfish, *Pseudocheneis sulcatus* (Teleostei: Sisoridae). A scanning electron microscope study. Env Boil Of fishes 2004; 71:1-5.
4. Das D, Nag TC. Structure of adhesion organ of the mountain-stream catfish, *Pseudocheneis sulcatus* (Teleostei: Sisoridae). Acta Zool 2005; 86:231-237.
5. Das D, Nag TC. Fine structure of the organ attachment of the teleost *Garra gotyla gotyla* (Ham.). Zoology 2006; 86:231-237.
6. Hora SL. Structural modifications in the fish of mountain torrents. Rec Indian Mus 1922; 24:31-61.
7. Hora SL. Observations on the fauna of certain torrential streams in the Khasi-hills. Rec Ind Mus 1923; 25:579-598.
8. Hora SL. Ecology bionomics and evolution of torrential fauna with special reference to the organs of attachment. Phi Trans Roy Soc London 1930; 218:171-282.
9. Lal MB, Bhatnagar AN, Uniyal JD. Adaptive modification of a Hill-stream fish, *Glyptothorax pectinopterus* (Mc Celland). Proc Natn Acad Sci India (B) 1966; 36:109-116.
10. Mittal AK, Whitear MA. A note on cold anaesthesia of pokiolotherms. J Fish Biol 1978; 13:519-520.
11. Nagar KC, Sharma MS, Tripathi AK, Sansi RK. Electron Microscopic study of Adhesive organ of *Garra lamta* (Ham.). International Research Journal of Biological Sciences 2012; 1(6):43-48.
12. Rauther M. Der saugmund von discognathus. Zool J Abt 1928; 3:45-78.
13. Saxena SC. Adhesive apparatus of a hill-stream Cyprinid fish *Garra mullya* (Sykes). Proc Natn Acad Sci India 1959; 25:205-214.
14. Saxena SC. Adhesive apparatus of an Indian Hill-stream sisorid fish *Pseudoecheneis sulcatus*. Copeia 1961; 1961:471-473.
15. Saxena SC. Adaptive modifications of certain Indian Hill-stream fishes. A thesis submitted to the University of Delhi, 1963.
16. Saxena SC, Chandy M. Adhesive apparatus in certain Indian Hill-stream fishes. J Zool Lond 1966; 148:315-340.
17. Singh N, Agarwal NK. Organs of adhesion in four Hill-stream fishes; a comparative morphologica study. In: Advances in Limnology, (Eds. Singh HR.) in press 1990.
18. Singh N, Agarwal NK. SEM surface structure of the adhesive organ of the Hill- stream fish *Glyptothorax pectinopterus* (Teleostei: Sisoridae) from the Garhwal hills. Funct Dev Morphol 1991; 1:11-13.
19. Singh N, Agarwal NK. The SEM surface structure of the adhesive organ of *Pseudecheneis sulcatus* Mc Clelland (Teleostei: sisoridae) from Garhwal Himalayan hill-streams. Acta Ichthyological at Piscatcrria 1991; 2:29-35.
20. Singh N, Agarwal NK, Singh HR. SEM investigations on ssssthe adhesive apparatus of *Garra gotyla gotyla* (Family- Cyprinidae) from Garhwal Himalaya. In: Advances in fish biology and Fisheries (Eds: HR Singh).

Hindustan Publishing Corporation Delhi 1994; 1:281-291.
21. Sinha AK, Singh I, Singh BR. The morphology of the adhesive organ of the sisorid fish *Glyptothorax pectinopterus*. Japan J Ichthyol 1990; 36:427-43.
22. Suzuki N. Fine structure of epidermis of the mudskipper, *Periophthalmus modestus* (Gobiidae). Japan J Ichthyol 1992; 38:379-396.
23. Whitear M. Causative aspects of microridges on the surface of fish epithelia. J Submicrosc Cytol Pathol 1990; 22:211-220.
24. Whitear M, Moate R. Cellular diversity in the epidermis of *Raja clavata* (Chondrichthyes). J Zool Lond 1998; 246:275-285.