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A Study on the Barbels of a Marine Catfish, *Arius thalassinus* (RÜPP.)

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A great variety of marine and fresh-water fishes possess externally situated appendages, the barbels. These are accessory feeding structures that carry sensory organs and thus seem to play an useful and important role in their daily activities. The number, length and position are extremely variable. The relevant histological findings on barbels are of MENG (1924), BAECKER (1926), SATÔ (1937a, b), DUCROS (1954), RAFFIN-PEYLOZ (1955), SATÔ and KAPOOR (1957), NAGAR and MATHUR (1958), SRIVASTAVA and SINHA (1961) and RAJBANSHI (1966). Contributions on gustatory sense in fishes by WUNDER (1927, 1936), EVANS (1940), HASLER (1957) and KONISHI and ZOTTERMAN (1963) are of special interest.

In India, the researches on barbels, so far, were confined to fresh-water fishes. From the viewpoint of propagation of knowledge, this study has been conducted on the barbels of a marine catfish, *Arius thalassinus* (RÜPP.) [[1]Order—Cypriniformes; Suborder—Siluroidei; Family—Ariidae]
[[2]Division III; Superorder—Ostariophysi; Order—Siluriformes; Family—Ardiiae].
The male *Arius* employs the mouth as an oral incubator for developing eggs.

The head of *Arius*, in Bouin's fixative, was kindly supplied by D. SUGANTHARAJ, Tuticorin. Sections (6-8μ) were stained with Delafield's haematoxylin in combination with eosin, and also with Mallory's stain.

Account of observations

Arius thalassinus possesses six barbels--one maxillary and two mandibular pairs (fig. 1).

The histological transections show that all the barbels have identical microscopic constituents. Each barbel has epidermis, dermis and a central skeletal axis of cartilage (fig. 2). The epidermis is not uniformly thick, has a stratified epithelium, and rests on a basement membrane. The cutaneous taste buds, each embodying sensory

1. LAGLER, K. F., BARDACH, J. E. and MILLER, R. R. 1962. Ichthyology. John Wiley and Sons, Inc., New York.

2. GREENWOOD, P. H., ROSEN, D. E., WEITZMAN, S. H. and MYERS, G. S. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms. Bull. Amer. Mus. Nat. Hist., cxxxi, 339-456.

and supporting cells, are profuse. The sense—organs flush with the surface and are situated on dermal papillose eminences of unequal height and width (figs. 3, 4). The small club cells are meagrely present. The mucous cells have not been observed in the sections examined. The dermis is made up of fibrous connective tissue. The blood vessels and nerves traverse the dermis. The branches of nerves pervade and reach upto the bases of the terminal buds. The central core of dermis is of a cartilaginous rod which stretches from base to the tip.

Discussion

Before the commencement of discussion, we should concede that this covers, besides the histology, in brief, the cognate aspects of barbels as well.

BAECKER (1926) classified two types of barbels: (a) tender and yielding barbels—each lacks the axial cartilaginous rod and the dermis has a network of blood vessels, (b) stiff barbels of motionless, and flexible kinds. The motionless barbel has a supporting axis of true bone. The flexible barbel has a cartilaginous axis. SATÔ (1937b) divided the barbels into two groups: (i) those which are devoid of cutaneous taste buds, (ii) those in which the taste buds are buried in the epidermis. He further differentiated latter type of barbels on the basis of their central axes: 1. absence of a rod of cartilage (carp type); 2. presence of a rod of cartilage (catfish type, goatfish type and loach type) and 3. presence of a rod of striated muscle (*Polymixia* type). RAFFIN-PEYLOZ (1955) demarcated three zones: peripheral, middle, and central which are equivalent to epidermis, dermis, and central axis respectively. SATÔ and KAPOOR (1957) stated that the carp and catfish types coincide with the "tender" and "flexible" barbels of BAECKER (1926) respectively. In accordance with these above classifications, the barbels of *Arius* are of a stiff, and flexible type (catfish type).

The barbels of siluroid fishes present a histological diversity in the zone of epidermis. SATÔ (1937a) described the occurrence of taste buds and club cells in the barbels of a Japanese marine catfish, *Plotosus anguillaris*, a feature akin to that of barbels of *Arius thalassinus*. SATÔ (1937b) observed taste buds, mucous cells and club cells in the barbels of *Liobagrus reini*. SATÔ and KAPOOR (1957) mentioned similar features in the barbels of *Callichrous bimaculatus* and *Heteropneustes fossilis*. NAGAR and MATHUR (1958) mentioned a thin cuticular investment on the epidermis the presence of taste buds, and the absence of mucous cells and club cells in the barbels of *Bagarius bagarius*; while SRIVASTAVA and SINHA (1961) recorded copious mucous cells, clavate cells and taste buds, in that of *Clarias batrachus*. AGARWAL and RAJBANSHI (1965) stated that taste buds, mucous cells and club cells are lacking in the barbels of *Mystus vittatus*, and thus they are tactile and not gustatory in function.

Recently, disputable observations have been made by RAJBANSHI (1966) on the barbels of *Wallago attu* and *Clarias batrachus*. He describes that the barbels of *Wallago attu* have a thin covering of cuticle, taste buds and mucous cells. He records

that a few patches of cells are found scattered along the periphery and these are tactile organs and they outnumber the taste buds in *Wallago attu*. The barbels of *Clarias batrachus* are similar to those of *Wallago attu*, but the most notable point is that in *Clarias* the tactile organs are completely absent, while they are well developed in the case of *Wallago attu*. In both fishes, the club cells described by earlier workers (BHATTI, 1952; SATÔ, 1937a,b; SATÔ and KAPOOR, 1957) are not seen. It may be stated here that the above workers mentioned by RAJBANSHI (1966) did not study the barbels of *Wallago attu* and of *Clarias batrachus*. The work on the barbels of *Clarias batrachus* by SRIVASTAVA and SINHA (1961), who have stated the presence of taste buds, mucous cells and clavate cells, also escaped his notice.

According to RAJBANSHI (1966), the presence of tactile organs (receptors for taste, touch, and pressure) in *Wallago attu* and their absence in *Clarias batrachus* acquires special significance in view of the fact that *Wallago attu* is a mid-feeder whereas *Clarias batrachus* is a bottom-feeder. He further mentions that at this stage it is rather premature to pinpoint the cause of disappearance of the tactile organs in *Clarias* and their retention in *Wallago* with reference to their feeding habits. As far as we can gather from the accessible literature, there is no record of such tactile receptors in the barbels of fishes as mentioned by RAJBANSHI (1966) and, hence, this needs verification and a convincing photomicrograph.

WRIGHT (1884) stated that end-buds are to be found in profusion in *Amiurus*, for tactile sensibility is at its highest development. They reach their greatest size, and are most closely crowded together on the barblets, which are solely for the purpose of increasing the functional range of the end-buds, and are little else than modified projections of skin stiffened by a cartilaginous axis attached to the underlying bone, and bearing on each papilla an end-bud. HERRICK (1902) remarked that in all cases where terminal buds are found on barblets, gustatory nerves belonging to the communis system are distributed to them. These barblets likewise receive a very rich innervation of tactile or general cutaneous nerves, so that they merit the popular designation "feelers." Both sets of end-organs undoubtedly cooperate in the discrimination of food, and the animal has the power of very accurate localisation of the stimulus. Whether the gustatory stimulus alone can be localised apart from its tactile accompaniment can not at present be stated (HERRICK, 1902).

Debateable observations have also been mentioned by BHATIA (1950) who found flask-shaped tangoreceptors and spherical chemoreceptors performing taste and olfactory functions respectively in the barbels of a hill-stream catfish, *Glyptothorax telchitta*. She stated that maxillary barbels perform an adhesive function. The epidermal cells are highly vacuolated, and these vacuoles add to the turgidity of the barbels to perform an adhesive function. The distinction of receptors on the basis of their shapes has been criticised by BHATTI (1952) and others.

HERRICK (1902) and PARKER (1922), employing behavioral techniques, confirmed that the taste buds are chemosensory organs. HOAGLAND (1933) was the pioneer to

record nerve discharges from gustatory fibres in the facial nerve which innervate the barbels of the catfish. He showed that receptors in the lips and barbels of *Ameiurus nebulosus* are very sensitive to mechanical stimuli such as touch and water movement. According to MOORE (1950), there is the possibility that taste buds have a dual function. He called them as organs of chemical sense. In general it may stated that, wherever they occur, taste buds have a gustatory function, with some reservation in view of a possible multiple function for these structures. There may even be a possibility that in some species these structures possess the single function of taste, whereas in others they may have taken on tactile, thermal, or common chemical sense-functions. BHATTI (1952) stated that gustatory receptors are present in abundance in all the barbels and it may safely be presumed that barbels serve entirely as gustatory receptor organs in *Rita rita*. Unlike our observations and of many others, he described the additional basal cells besides the usual gustatory and sustentacular cells organising a taste bud. AL-HUSSAINI and KHOLY (1953) remarked that the barbs of *Clarias lazera* are gustatory and tactile. The taste buds are more concentrated on these barbs. This also negates the observations on tactile sense of *Clarias* by RAJBANSHI (1966).

KONISHI and ZOTTERMAN (1961) found that barbels are much less sensitive to chemical than to mechanical stimulation. TATEDA (1964) studied electrophysiologically the taste responses from isolated barbel of the catfish, *Parasilurus asotus*.

EDWARDS (1930) discussed the origin of taste buds. OLMSTED (1920) and MAY (1925) pointed out that the presence of the gustatory nerve is the causative factor in the differentiation and transformation of epithelial cells into taste buds.

SATÔ (1941) stated that fishes which detect food by taste buds situated in the body surface, especially in the barbels, have large facial lobes. The same is held by EVANS (1952), and MILLER and EVANS (1965).

The club cells in the epidermis of the barbel of *Arius* are few and small. PFEIFFER (1963) mentioned that barbel epidermis of the carp and some catfish contains no club cells or only a few very small ones, while the body epidermis of these species is abundantly supplied with these cells. Fright reaction occurred to body skin, but did not occur to barbel skin. KAPOOR (1965, 1966a, b) has discussed on these cells in the skin of fishes.

Taking the dermis into consideration, it may be stated that in *Arius*-barbel, it has the same structure as described by most of the earlier workers. Quite a different observation has been reported by BHATIA (1950) who described that the cartilaginous axis in the barbel of *Glyptothorax telchitta* is ensheathed by an inner circular and several bundles of longitudinal layers of muscles which in turn are surrounded by a circular layer of muscles.

The central axis of cartilage in *Arius*-barbel authenticates the above-mentioned classifications of barbels on axes-basis.

Summary

The barbels of a marine catfish, *Arius thalassinus* (RÜPP.) have been studied. Each barbel is composed of epidermis, dermis and a central rod of cartilage. The epidermis has a stratified epithelium. It contains abundant cutaneous taste buds and a few, small club cells. The mucous cells are not seen. The dermis incloses blood vessels and nerves. The axial, supporting, skeletal rod is cartilaginous in nature. The barbels are of stiff, and flexible type. The various histological constituents have been explicitly discussed.

Acknowledgements

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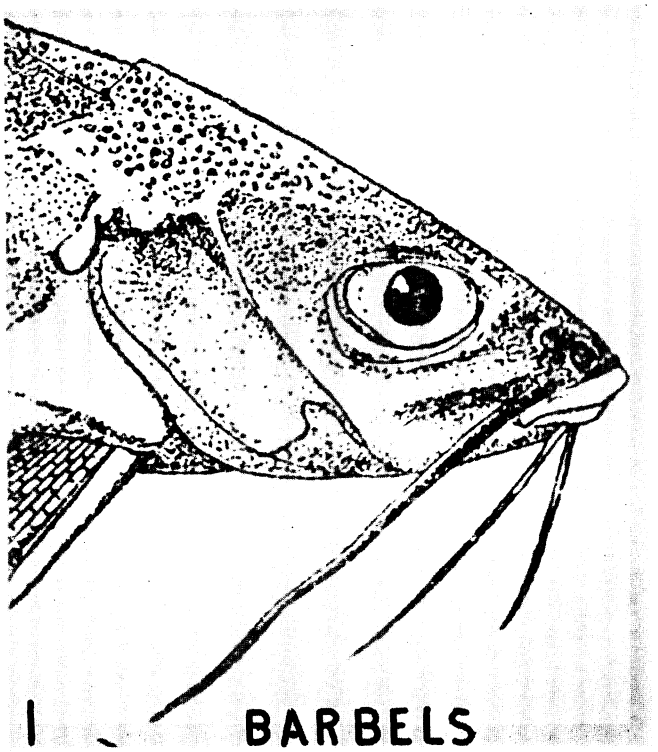
Explanation for illustrations and lettering

Fig. 1. The head of *Arius thalassinus* showing barbels.
Fig. 2. A part of the cross-section of the barbel.
Fig. 3. A part of the cross-section of the barbel showing profusion of cutaneous taste buds.
Fig. 4. A magnified view of cutaneous taste buds.

AC—Axial rod of cartilage; BM—Basement membrane; BV—Blood vessel; CC—Club cell; D—Dermis; EP—Epidermis; NF—Bundle of nerve fibres; TB—Cutaneous taste bud.

* Not consulted in original.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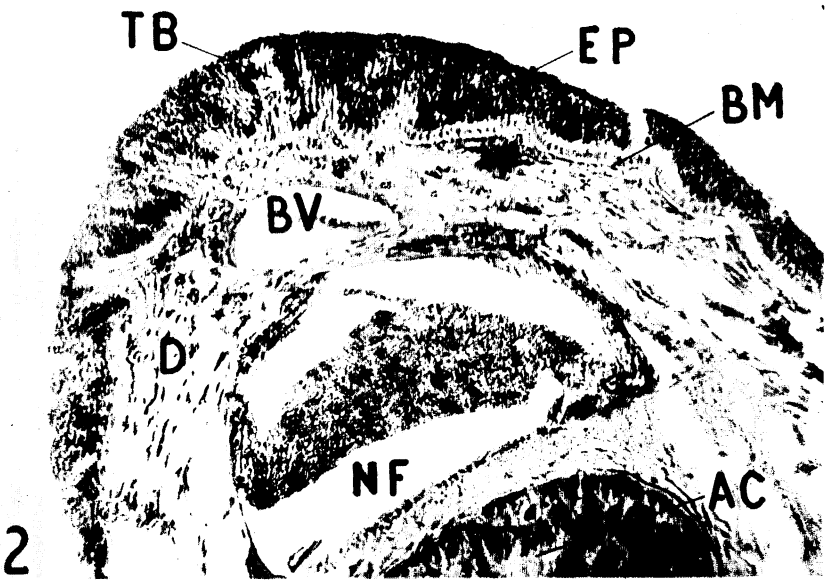
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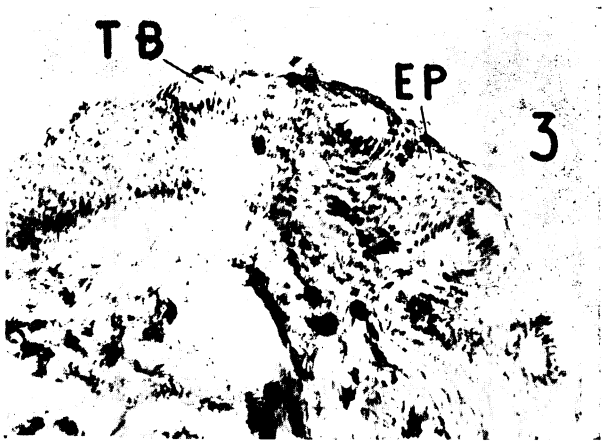
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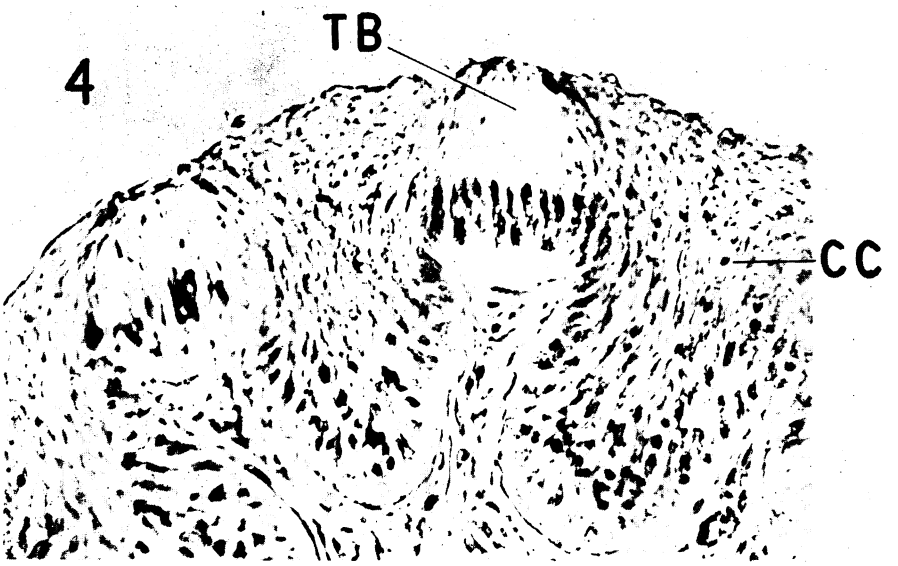
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