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Ultrastructure of the scales of *Channa punctatus*: A fresh water fish

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ABSTRACT

In order to study scales of *Channa punctatus* live specimens were collected, after acclimatization the scales were collected from the fishes. The clean and air-dried scales were mounted on the metal stubs. After coating they were subjected to the scanning electron microscope study. Scales showed the presence of circuli, radii, chromatophores and denticles like structures called as lepidonts.

1) INTRODUCTION

Presence of the scale in a fish is one of the characteristic feature (except fishes of order siluriformes) and the types of scales in fishes can be placoid, cycloid, ganoid, cosmoid or ctenoid. Placoid scales are found in cartilaginous fishes and rest all are found in bony fishes. These are derived from the connective tissue of the dermis and form the exoskeleton. Scales of fish are used for classification, identification and growth studies of different fishes [1,2,3,4,5,6,7,8 and 9]

Some workers also suggested successful use of scales as pollution indicator when fish was exposed to pesticides [10]. [11] recommended that fish scales is most suitable system for the study of psychoactivity and toxicity of plant extracts on fish *Labeo rohita*. They also showed that fish scales chromatophores changed from reticulate to punctate, when exposed to 150-350 ppm doses.

Through electron microscopy [12] observed numerous minute processes called scalar denticles on the scales of *Tilapia mossambica*, which help to secure the position of the scale with reference to its surrounding dermal tissue.

According to [13] scales of Poecillid fish have a wide range of structural variation in the dentition (lepidonts) present on the crest of the circuli when viewed through electron microscopy. Lepidontal character such as shape, angle in relation to scale and type of attachment were described. He also suggested that lepidonts are useful in separating different taxa.

2) MATERIALS AND METHODS

SCANNING ELECTRON MICROSCOPY OF SCALES

The clean and air-dried scales were mounted on the metal stubs. These stubs are either made up of Aluminum or Brass. The scales are placed with dorsal surface upward and the ventral surface sticking to the double stick tape. Care was taken to avoid the trapping of air-bubbles under the tape. As scales are non-conductive specimens, these were coated with a thin layer (100 Å) of Gold in a Gold coating unit so as to overcome the problems of "charging" and "beam damage". An additional advantage of coating is an improvement in the

strength of the secondary electron signal from the specimen surface. Since high molecular weight materials yield stronger secondary electrons. The Gold coating was done in a sputter coating unit. The scale samples were viewed under vacuum in the JEOL JSM-6100 scanning electron microscope, at an accelerating voltage of 15/20 Kv at low probe current. The specimens were stored in a dessicator.

3) RESULTS AND DISCUSSION

GENERAL STRUCTURE OF THE SCALES

The structure of scales, its sculptural design and shape have been interestingly used as limiting character in fish taxonomy [14]. The scales of bony fishes are derived entirely from the dermal layer of the skin and overlap one another like the tiles. The overlapping (imbrications) of the scale is important in the sense that it imparts mechanical support. Each scale is shaped roughly like a human finger nail whose front end is inserted deep into the dermal layer, while the hinder end is free of exposed and bears the pigment cells or chromatophores on it. These chromatophores provide specific colour to the fish body. The muscles attached to the dermis tend to exert a somewhat unequal pull and therefore, depresses the scale area, particularly their front margins. In this way, the growing scale is forced to lie obliquely and at later stages its hinder end appears through the skin covered by thin epidermal and dermal membranes.

In the teleostean group which constitutes major percentage of the fishes, scales are quite thin, flexible and transparent structures and are commonly termed as leptoid scales. These may either be cycloid or ctenoid; the former is simpler of the two and is characteristic of more primitive teleost fishes with soft ray fins. These scales have lost all traces of cosmine and ganoine layers and have only fibrous layer or fibrous plate. Both cycloid and ctenoid scales are very similar to each other. They are either circular or long-ovoid in shape. They have a

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soft anterior and a hard posterior end. Structurally they differ from each other in having ctenii or spines on the posterior end which provide rough appearance to the scale. The exact function of the ctenoid scales is not known but they improve the hydrodynamic efficiency of swimming. They also bear scalar denticles called lepidonts on their dorsal surface [15]

A typical cycloid scale (a characteristic feature of most of the carp is circular or oval in shape. These scales have a soft anterior part and hard posterior part. The dorsal surface of the scales is rough as it bears the lines of growth, whereas the ventral surface that touches skin in shining. The cycloid scale has concentric rings around the focus and these rings/lines of growth as sclerites. Only the anterior and lateral sides of scale have these circuli. These are the marks of periodical growth of fish. Any sudden changes in fish's environment is recorded on the scales in the form of alteration in the circuli shape, pattern or altered elemental deposition [16 and 17] thus making these hard structures a testimony to life history of the fish. These revealing marks may be annual marks, winter marks or the larval marks.

There is sufficient proof that the shape and arrangement of circuli are species-specific. According to [18] circuli arise whenever bone-forming material occurs in a quantity that is greater than the required need of the growing edges. These ridges may also probably help in anchoring the scale of the skin. The radii are the grooves radiating from the focus to the margin of the scale. These structures are formed due to the less available space in the anterior part of the scale, thus circuli exhibit invariable folding on the mid-central region of the scale. The number of radii are less on the later side. Maximum on the anterior and may be completed absent on posterior of the scale [19, 20 and 21].

SCALE STRUCTURE OF *CHANNA PUNCTATUS*

The type of scale in *Channa punctatus* is semi oval in shape. Structurally we can divide the scale into three distinct regions i.e., the anterior, a pair of lateral and a single caudal or lunula or posterior (Fig.1). Both anterior and lateral sides of scale bear ring like structure called circuli (Fig. 1). These are very well spaced on the later sides and got bifurcated when these enter into the anterior region (Fig.2a). Therefore, the anterior region of the scale has maximum number of circuli while the posterior region of scale has thick circuli that are formed by fusion of 2-4 circuli present in the lateral region. The intercircular distance ranges from 5-10 μm , and 50-70 μm in the anterior, lateral and caudal regions respectively.

Anteriorly these circuli are interrupted by radii (Fig. 2b) which originate from central portion of the scale i.e., focus. When seen under the SEM the anterior circuli showed rows of minutes hook like structures know as teeth or scalar denticle lepidonts (Fig.2b and 3 a and b).

In the older part of the scale each circulus of the anterior region carry a row of such denticles (Fig. 2b). These sharply pointed lepidonts are set in deep sockets, curved inward with their pointed ends towards the focus of the scale. Fully developed lepidonts measures 1-5 μm in length and has a base of 0.05-1.5 μm . Its shape and size vary depending upon the stage of development (Fig. 3a and 3b).

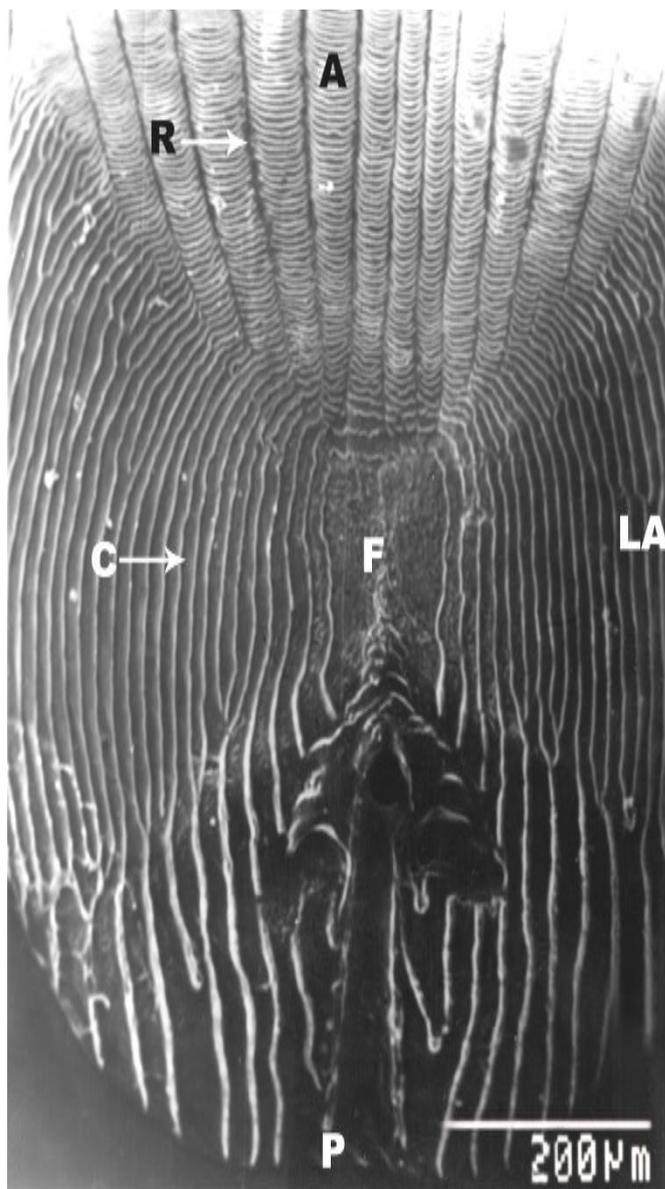


Fig. 1: Scanning electron micrograph of normal cycloid scale of *Channa punctatus* A: Anterior, C: Circulus, F: Focus, LA: Lateral, P: Posterior, R: Radius.

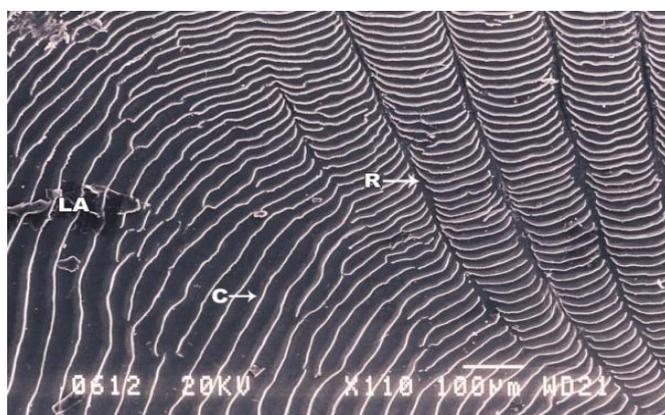


Fig No (2a)

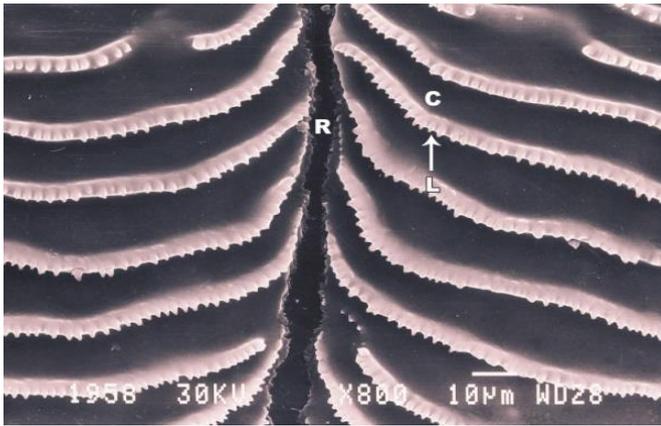


Fig No (2b)

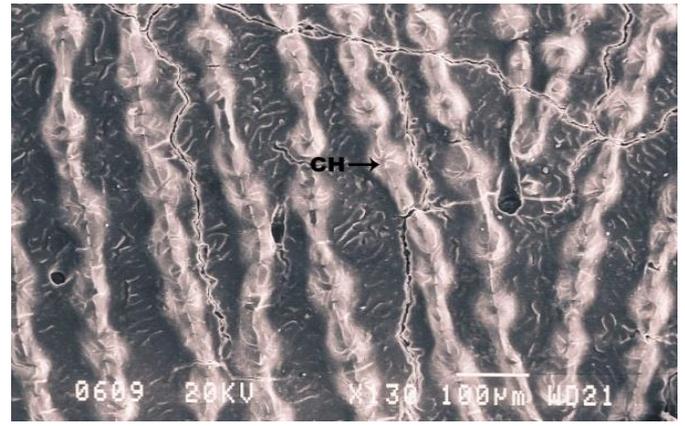


Fig No (4a)

Fig. 2: Scanning electron micrograph of anterior region of scale showing (a) bifurcating circuli (C) of the lateral side when entering anterior region. (b) Scanning electron micrograph of anterior region of scale showing a single radius and circuli bearing teeth like structures lepidonts (L) C : Circulus, L : Lepidont

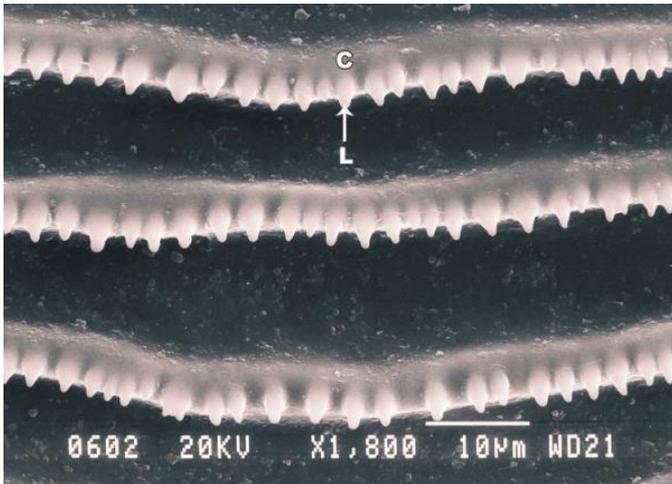


Fig No (3a)

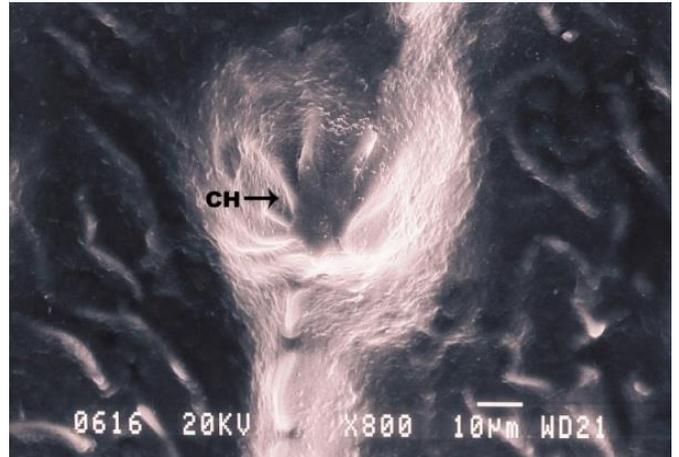


Fig No (4b)

Fig. 4b: Scanning electron micrograph of control scale showing chromatophores (Ch), (a) the beads like structures present on the posterior field or lunula of the scale (b) Scanning electron micrograph showing single enlarged chromatophores (Ch). Ch:Chromatophores

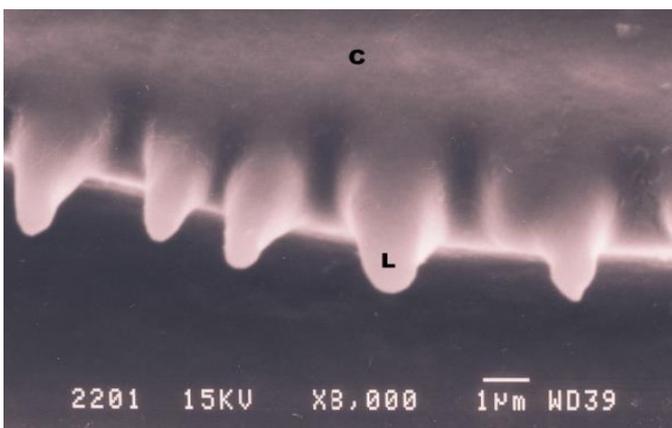


Fig No (3b)

Fig. 3: Scanning electron micrograph of scale showing (a) rows of circuli (C) bearing lepidonts (L) at different developmental stage showing single row of lepidonts (L) present on circulus (C) pointing towards focus C: Circulus, L: Lepidont

With the increase in the scale size there is an addition of circuli on the margin and the lepidonts in older circuli are either shed off or reabsorbed. Hence, the lepidonts in older circuli are either shed off or reabsorbed. Hence, the lepidonts are present on the anterior most regions only.

The lateral and posterior regions of the scale are sharply demarcated by the appearance of chromatophores (Figs. 4a and b). These chromatophores (Figs.4a and 4b). These chromatophores provide colour to the body.

The structure of scale of *Channa punctatus* differs from the scale structure of India major carps [22] in the following respects:

- Circuli present are not in circular fashion
- The bifurcation of the lateral circuli when these enter into anterior portion
- Presence of distinct circuli on the posterior part of the scale

4) CONCLUSION

SEM structure of the scales of *Channa punctatus* are composed of circuli and radii anteriorly and chromatophores posteriorly. In the older part of the scale each circulus of the anterior region carry a row of pointed structures called as denticles.

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