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Scale surface structure of *Mugil cephalus* (Teleostei; Mugilidae) using Scanning Electron Microscopy (SEM)

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ABSTRACT: As fish scale contain numerous microstructures that could be helpful for fish identification such as, ctenii, position of focus, circuli, annuli and radii. Therefore, in the present study, a traditional approach was made for studying in detail the structures of scales from a mullet species, *Mugil cephalus* (family Mugilidae). Samples were purchased from market of joint road, Quetta, Balochistan. During the study period extends from August 2014 to December 2014, total length of all collected specimens was ranged from 12.5-17.5 cm, respectively. From each fish, scales were taken from the three different body regions *i.e*., HS (head scales), CS (caudal scales) and TRS (transverse row scales) in order to analyzed the variation in the microstructures on the scales. The scales have been subjected to scanning electron microscope (SEM) for the study of microstructures of scales in detail. Thus, from the result of the present study, it had been proved that in addition to external morphological characters of fish, some microstructures of scale could be helpful in systematic classification of any fish species.

Keywords: *Mugil cephalus*, scale surface structure, scanning electron microscopy (SEM).

INTRODUCTION

Fishes of the family "Mugilidae" hare known by the name of "grey mullets" or more simply by "mullets". A mugilid, *Mugil cephalus* is known as "Flathead mullet" that is widely distributed throughout the world (Nelson, 2006; Froese and Pauly, 2011).

Fish scales are dermal outgrowths and very useful in fish taxonomy (Kaur and Dua, 2004), separate various groups of fishes, understand the feeding habits of fishes (Lekuona *et al.*,1998; Campos *et al.*, 2002). Tzeng *et al.*(1994) reported that fish scale as useful tool to understand the life history of a fish such as, age composition, growth rate, at first maturity. Scales have been used phylogenetic relationships, systematic classification sexual dimorphism by some workers including Kobayashi (1953), Dulce-Amor, *et al.* (2010), Esmaeli *et al.*(2012) and Zubia *et al.* (2015). Agassiz (1833-34) was the first who use the fish scales for taxonomy and divided fishes into four groups: Placoidei, Ganoidei, Ctenoidei and Cycloidei. Recently, Vernerey and Barthelat (2010) had separated fish scales into four classes on the basis of their morphology i.e., Placoid scales (a seen in rays and sharks), Ganoid scales (seen in sturgeon and gar fishes), Cosmoid scales (seen in fossil fishes and lungfish) and Leptoid scales (most the bony fishes).Different scale microstructures i.e., circuli, radii, ctenii have been used for taxonomy (Kaur and Dua, 2004; Batts, 1964). Variations have also been observed in the types of scales among different species i.e., *Myxus capensis*, *M. elongates* and *Aldrichettaforsteri* contained both ctenoid and cycloid scales; *Mugil cephalus* ctenoid scales; *Neomyxus chaptalii* and *Crenimugil crenilabus* have only cycloid scales (Roberts, 1993). Due to the importance of scale morphology in taxonomy and fisheries sciences, a number of scientists have studied variations in scales of fishes including Coburn and Gaglione (1992), Patterson *et al.* (2002), Ikoma *et al*. (2003) and Jawad (2005). "Scanning Electron Microscopy (SEM)" has been to the scale structure of fish. Johal *et al*. (2006), Reza *et al.* (2009), Brraich and Jangu (2012), Yang *et al.* (2013), Alkaladi *et al*. (2013), Esmaeili *et al.* (2014) and Johal*et al*. (2014). Therefore, present study was conducted to study in detail the structures of scale surface of *Mugil cephalus* in order to observe their significance in its taxonomy.

MATERIAL AND METHODS

To study the scale surface microstructures of *Mugil cephalus*, total 120 samples were taken (24 samples per Month), these samples were collected during the following months due to ease of collection and availability of fish samples. Fresh samples were collected during five months from August 2014 to December 2014 from fish market of joint road, Quetta city of Balochistan, Pakistan. Fish samples were immediately transferred to the laboratory of Zoology department of Sardar Bahadur Khan Women University, Quetta. Total length of each individual fish sample was measured from the tip of the snout to the tip of the caudal fin in cm. From each fish sample, 10scales were removed carefully with forceps from the three selected body regions i.e., head, transverse and caudal regions as labelled in the figure of *Mugil cephalus* for SEM. Scales were washed with warm water that was about 60 degree centigrade for 3 to 4 hours and gently rubbed with fine brush to remove mucous and soft tissues from scale surface following the procedure as outlined in Esmaeili *et al.* (2012). During this process the scales were removed, washed and cleaned using KOH 5% solution for about 10 minutes then dried on filter paper, kept between two micro slides for 2 days to avoid curling of the scales. Scales were dried and aluminium stubs were used to mount scales. This mount was used for SEM analysis for taking several images of the scales.

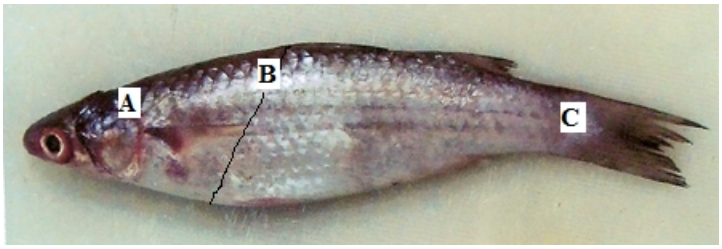

Fig. 1. Showing the body regions for scale collection. (A = head scales; B = Transverse scales; C = Caudal scales).

RESULTS AND DISCUSSION

The scale of mugilid fish is divided into anterior, posterior and lateral field like other teleost fishes. Anterior field is inserted in the fish skin and the posterior field is exposed from the body. Small structures present on scale surface are known as lepidonts. Many fish species are differ in size and shape of lepidonts, which is helpful to classify some taxa at the specie level and also function on control organs (Jawad and AL-Jufaili, 2007; Delamater and Courtenay, 1974).Some fishes contain teeth like structures on their scales, which are known as ctenii. On posterior field of *Mugil cephalus*, small ctenii are present. As species of the family Mugilidae contain two types of ctenoid scales such as, crenate and basic ctenoid scales, but according to the investigation of Zubia *et al*. (2015), *Mugil cephalus* contain only basic ctenoiid scales which have the separate ctenii from the body of the scale. On the basis of the arrangement of ctenii on posterior margin of the scale, ctenoid scales can also be divided into three types. i. Transforming ii. Peripheral and iii.Whole ctenoid scale. Out of three types, *Mugil cephlus* of our present study contain has only 'whole ctenoid type scales'. Conversely, on the anterior field of the scale, radii are present. There are three types of radii have been studied on scales of mugilid fishes *i.e*., i. Primary radii, ii. Secondary radii and iii. Tertiary radii. Esmaeili *et al.* (2014) observed these three types of radii on the scales of *Liza abu*, while primary radii were absent in *Liza klungzingri*. However *L. salines* have only tertiary type of radii. Presence of higher numbers of radii shows the good feeding condition of the fish (Alkaladi *et al.*, 2013). It has been noticed that the scale of mugilid fish species vary in terms of shape, size, scale type, circuli shape, focus as well as shape and size of ctenii. Which may be due to fish habitat and the structure determined by SEM can be used in fish identification.

A. Head scale (HS)

The photographs of head scales of *Mugil cephalus* obtained from the SEM revealed that both radii and ctenii are found less in number as compare to scales obtained from the caudal and transverse regions. While the central region or focus is quit prominent and it is in a bilobed shaped. The mucous pores are visible near ctenii and the posterior margin of the scale. Lepidonts and microstructures are also visible in SEM photographs (Plate I A-D).

B. Caudal scale (CS)

The caudal scale of *M. cephalus* has fine and large number of ctenii on its posterior margin. Focus is near to the ctenii and single tube like in shape. Only primary type of ctenii is present on the anterior margin of the scale. Mucous pores are less in numbers as shown in Plate I E-H, respectively.

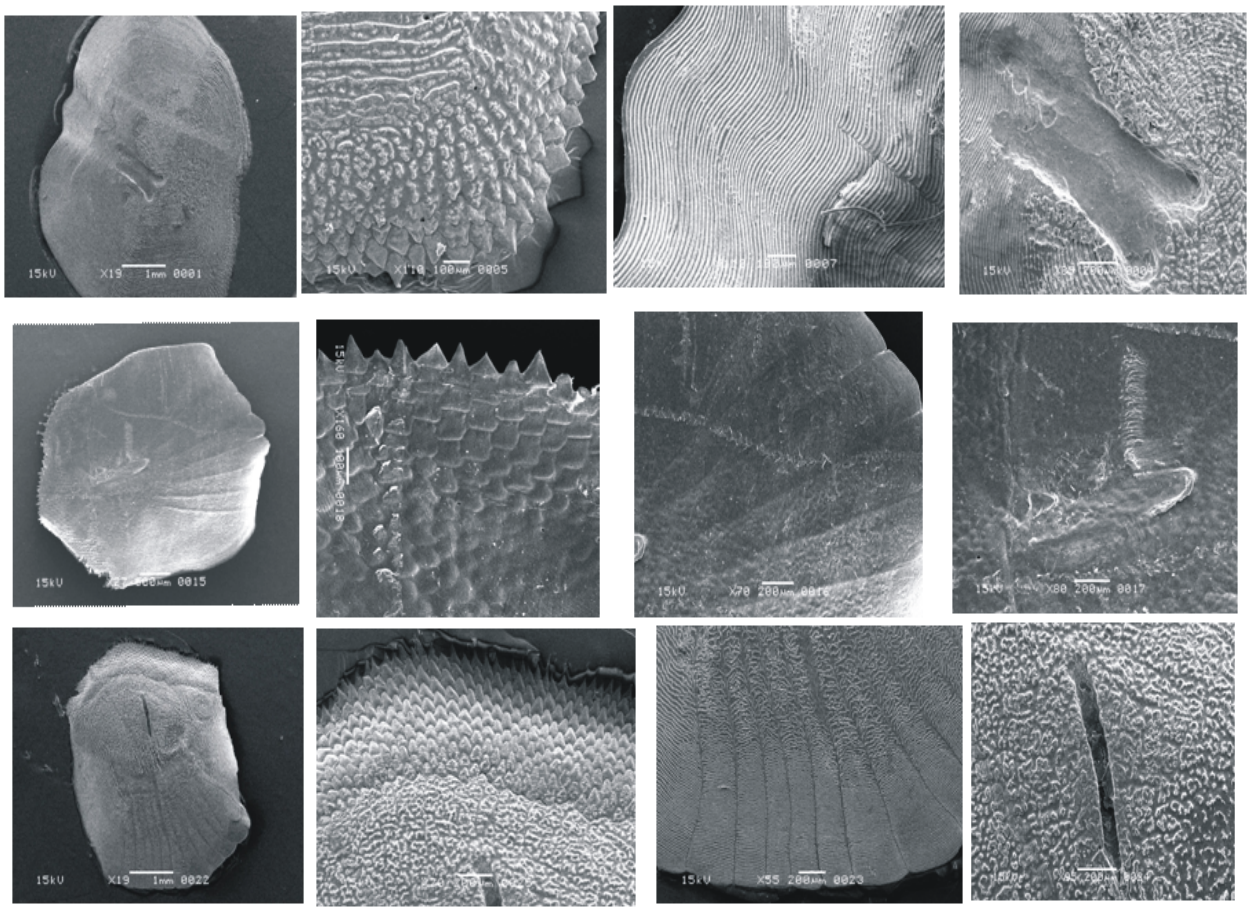

PLATE 1. Shows the different SEM photographs of the scales obtained from the three body regions i.e., head, caudal and transverse regions (scales obtained in transverse series from the origin of dorsal fin to the origin of pelvic fin)of *Mugil cephalus*. Figures A-D showed SEM photographs of Head scale (HS), (E-H) showed SEM photographs caudal scale (CS), and (I-L) showed SEM photographs of transverse series scale (TRS). (B, F and J) showed shapes, position arrangement of ctenii on the posterior margin of scales; (C, G and K) showed the arrangement of radii at the anterior margin of scale, while (D, H and L) showed the shape and position of focus on scale.

C. Transverse row scale (TRS)

The SEM photograph of transfer row scale shows a very distinct lateral canal near focus. The number of ctenii and radii were more in numbers and well explained in photographs. Only primary type of radii are found on TRS, while ctenii are finely pointed. Mucous pores are visible around focus and in between of ctenii of the scales as shown in Plate I I-L, respectively.

CONCLUSION

Thus, from the study of scale structure of fishes, it was concluded that the *M. cephalus* of our present study can easily identified on the basis of position of the focus, which is more centrally located as compare to the other mullet species and confirmed the importance of scale study in Taxonomy. Hence, our present study has also confirmed the worth of fish scales use in taxonomy.

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