Original scientific article
Received: 2011-08-01

UDK 591.159:597.551.2(535)

SCALE DEFORMITIES IN ROHU *LABEO ROHITA* (OSTEICHTHYES: CYPRINIDAE)

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ABSTRACT

The present study describes the feature of scale deformities and disorientations in Rohu, Labeo rohita *originating from the Indian subcontinent and obtained from the frozen fish market in the Sultanate of Oman. Scales located at the caudal peduncle region of the fish body showed two types of abnormalities, slight and severe; within each type a number of cases were observed. Disoriented scales rotated dorsally or ventrally away from the normal scale position without any projection of the scales outwards from the body surface. Abnormal scales, both regenerated and ontogenetic, exhibit significantly larger focus diameter, higher number of radii and similar shape relative to normal scales. Several factors as causative agents of scale abnormality and disorientation were discussed and evaluated.*

Keywords: Scale deformity, *Labeo rohita*, Muscat, Oman

DEFORMITÀ DELLE SCAGLIE DI ROHU, *LABEO ROHITA,* (OSTEICHTHYES: CYPRINIDAE)

SINTESI

Il presente studio descrive le caratteristiche di deformità e disorientamento delle scaglie di Rohu, Labeo rohita*, originario dal subcontinente indiano ed ottenuto congelato dal mercato di pesce del Sultanato dell'Oman. Le scaglie poste nella regione del peduncolo caudale del corpo del pesce mostravano due tipi di anormalità, leggera e grave. Di ogni tipo sono stati osservati diversi casi. Le scaglie disorientate erano ruotate dorsalmente o ventralmente in confronto alla posizione normale, senza alcuna proiezione delle scaglie verso l'esterno dalla superficie corporea. Le scaglie anormali, sia rigenerate che ontogenetiche, esibivano diametri focali significativamente più grandi, un più alto numero di raggi e forme simili alle scaglie normali. Gli autori ipotizzano e valutano diversi fattori quali agenti causali di deformità e disorientamento delle scaglie.*

Parole chiave: Deformità delle scaglie, *Labeo rohita*, Muscat, Oman

INTRODUCTION

Labeo rohita (Hamilton) or Rohu is a cyprinid species, native inhabitant of rivers, streams, lakes and canals, of Bangladesh, India, Pakistan, Nepal and Myanmar.

Rohu is the most important among the three Indian major carp species used in carp polyculture systems. In India, it has been transplanted into almost all riverine systems including the freshwaters of Andaman, where we can now find a successfully established population (Ayyappan & Jena, 2001). In Oman, *L. rohita* is usually collected frozen from a supermarket where it is offered for sale. The anatomy and developmental patterns of fish scales and the relationship of scale morphology to genetic and environmental factors have already been reported (Blair, 1942; Yamanda, 1961; Fouda, 1979; Sire, 1986; Bereiter-Han & Zylberberg, 1993). Scale deformities in wavy band sole, *Zebrias japonica* were reported by Taki (1938); in red drum, *Sciaenops ocellatus* by Gunter (1941, 1945, 1948), in coitor croaker "*Sciaena coitor*" (= *Johnius coitor*) by Mookerjee (1948), Corrales *et al*. (2000) reported on scale disorientation in pinfish, *Lagodon rhomboids*, Jawad (2005a) reported Siamese scales in Nile tilapia, *Oreochromis niloticus*; Jawad (2005b) described them in *Barbus arabicus, Barbus exolatus, Labeo niloticus* (Cyprinidae), and *Lates niloticus* (Centropomidae). Jawad (2005c) and Jawad (2007) found scale deformities in different species of the Tripterygiidae family, and Jawad & Al-Jufaili (2007) recorded them in *Saurida tumbil*.

The present article reports the first record of scale deformity in *L. rohita*.

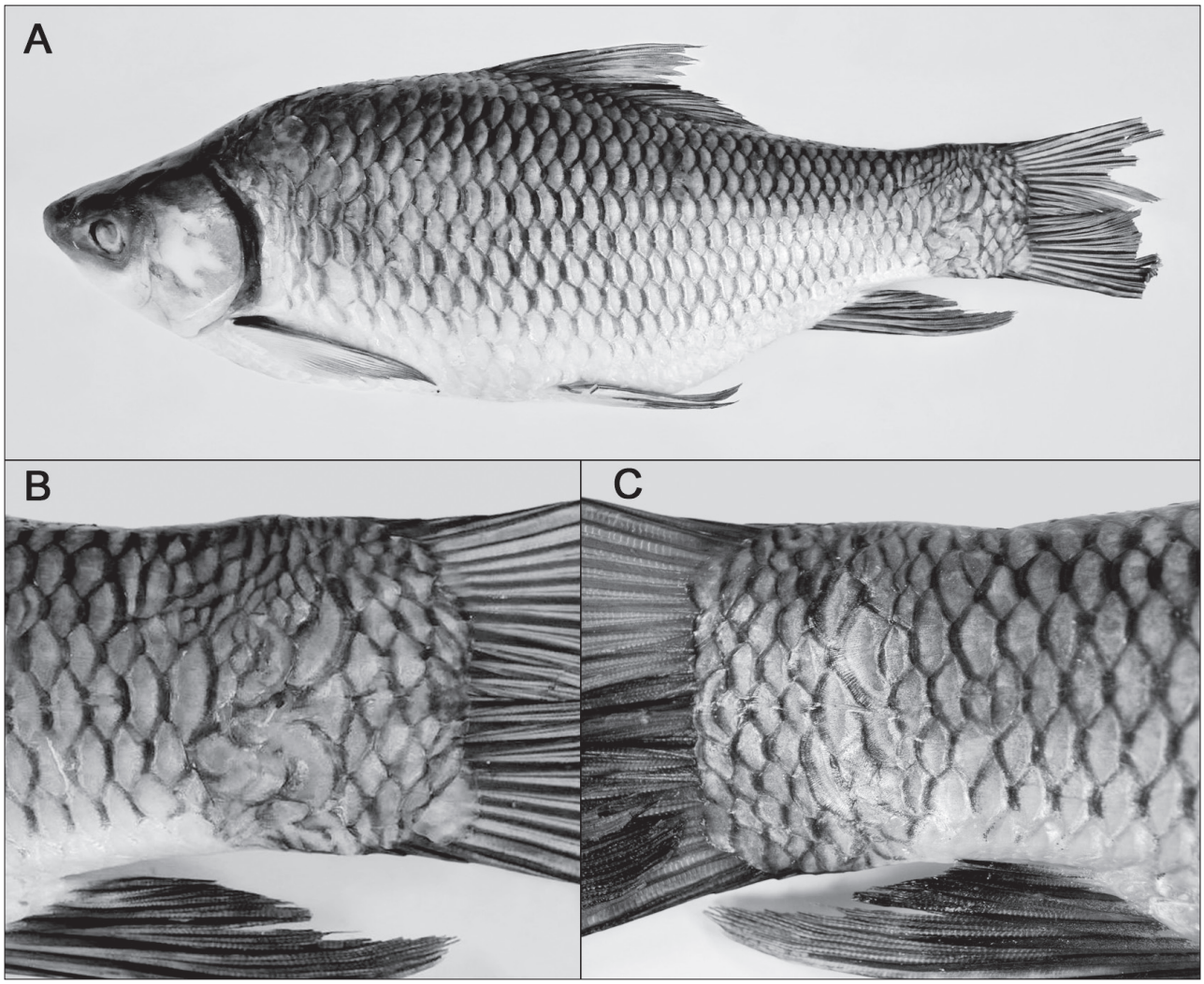

Fig. 1: *Labeo rohita* ***specimen showing abnormal scales on the caudal peduncle area. A: general view; B: left side; C: right side.***
Sl. 1: Primerek vrste *Labeo rohita* ***z nepravilnimi luskami v predelu med predrepno in repno plavutjo. A: generalni pogled; B: leva stran; C: desna stran.***

MATERIAL AND METHODS

Ten specimens of *L. rohita* ranging from 356 to 375 mm standard length were collected in May 2010 from the frozen fish market in Muscat City, Sultanate of Oman. The origin of the specimens was traced back to several localities in India. All of the specimens showed to bear deformed scales on their caudal peduncle area (Figs. 1a-c). The angle of growth of each scale was recorded relative to the normal scales in adjacent areas outside of the abnormal patch. Degrees of deviation from normal were used to set the direction of the abnormal scales. Such degrees were grouped into 30 degree increments (*i.e.*, 0º = reversed, free edge toward the head of the fish and180º = normal, free edge toward the tail of the fish).

The surface area of each abnormal scale patch was expressed as the percentage of the body surface on a single side of a fish where scale abnormality is shown. Scale abnormality areas were measured on all rohu fish specimens, obtained from the frozen fish market which exhibited scale abnormality (n = 10) (Corrales *et al*. (2000)). These areas were measured by tracing the outline of the fish (exclusive of the head and fins) and each abnormal scale patch onto a tracing paper, one side at a time. Areas of abnormal scale regions were estimated using graph paper.

Normal and abnormal scales (37 scales per fish) were cleaned in 1% KOH solution and stained with alizarine red S stain to reveal the scale surface ornamentation. Four variables were measured for each scale: anterior-posterior length (major axis), dorso-ventral length (minor axis), diameter of the focus in the centre of the scale, number of radial lines (radii) radiating from near focus, and the ratio of major to minor axes was calculated as a measure of scale shape.

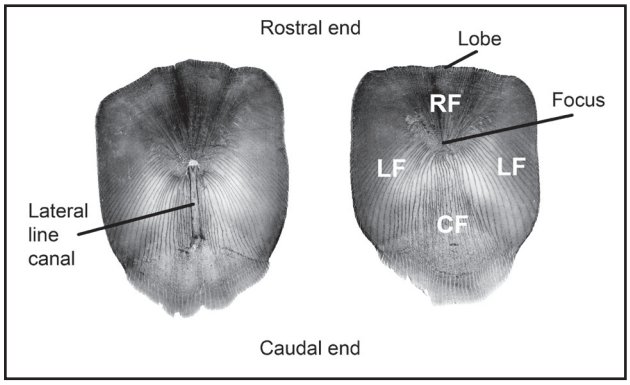

Fig. 2: Principal scale fields of *L. rohita*. ***Left: Lateral line scale. Right: RF - rostral field; LF - lateral field; CF - caudal field.***
Sl. 2: Glavni deli lusk pri vrsti *L. rohita*. ***Levo: lateralna linija luske. Desno: R - rostralni predel; LF - lateralni predel; CF - kavdalni predel.***

RESULTS

Four fields were recognized in the scale of *L. rohita*: rostral, two lateral and caudal. Scale dimensions, total scale width and anterior radius from the focus to the anterior edge of the scale were chosen to give a measure of scale size (Fig. 2).

Description of scale deformities

In body scales, two categories of scale deformity were observed: slight and severe. In the first category, two cases were common and are shown in Figure 3. Other uncommon slight deformities were also recorded (Fig. 4). For lateral line scales four slight deformities were obtained and are shown in Figures 5a-d. As to the severe cases, there are five cases observed and recorded from patches of different fish specimens (Fig. 6). Three cases were observed in body scale (Figs. 6a-c) and two cases were observed in lateral line scale (Figs. 6d-e). Of the body scale, one scale with no focus area but an external fold containing only circulii instead lies on the rostral end of the scale. The second extreme example is a scale with an irregular shape and severely deformed sides. The third severely damaged scale is an elongated scale, narrow and short with no focus but a pocket structure with circulii instead covers the rostral end and runs on the sides.

Deformities include irregularities in scale shape, and irregularities and displacement of the lateral line canal and twin scales.

There are six shapes of scales in the deformed scale patch, namely triangular, elongated, squarish, truncate,

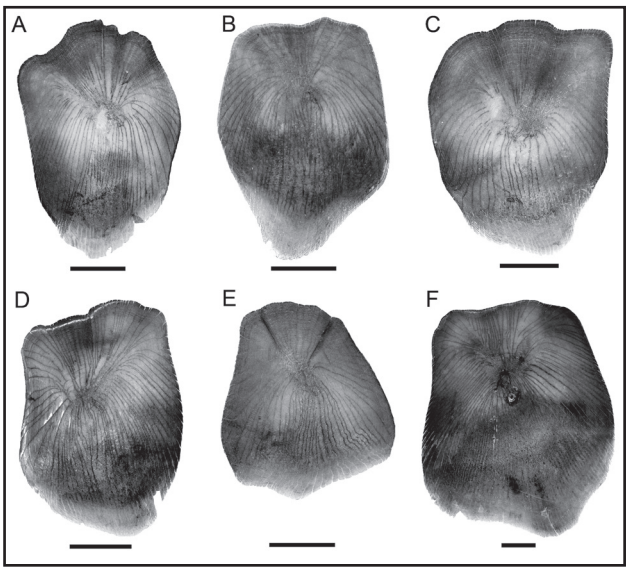

Fig. 3: Common slight body scale deformities in *L. rohita*.
Sl. 3: Običajne manjše deformacije lusk na telesu vrste *L. rohita*.

pyriform and oblong. The most common shape for the body and lateral line scales was the pyriform shape (Fig. 7).

Orientation of scales in the abnormal scale patches

In each patch of the abnormal scales there were a number of disoriented scales. The disoriented scales felt rough to the touch compared to the neighbouring scales. The direction of growth of the disoriented scales deviated from 120°-220°, they were flat and never projecting up from the surface of the fish. Moreover, the patches of the abnormal scales were never observed to involve any ulceration or other overt damage to the epidermal layers.

The patches of scales were represented as a continuous patch over and under the lateral line. The size of the patches ranges between 4.3-8.1 % of the body surface.

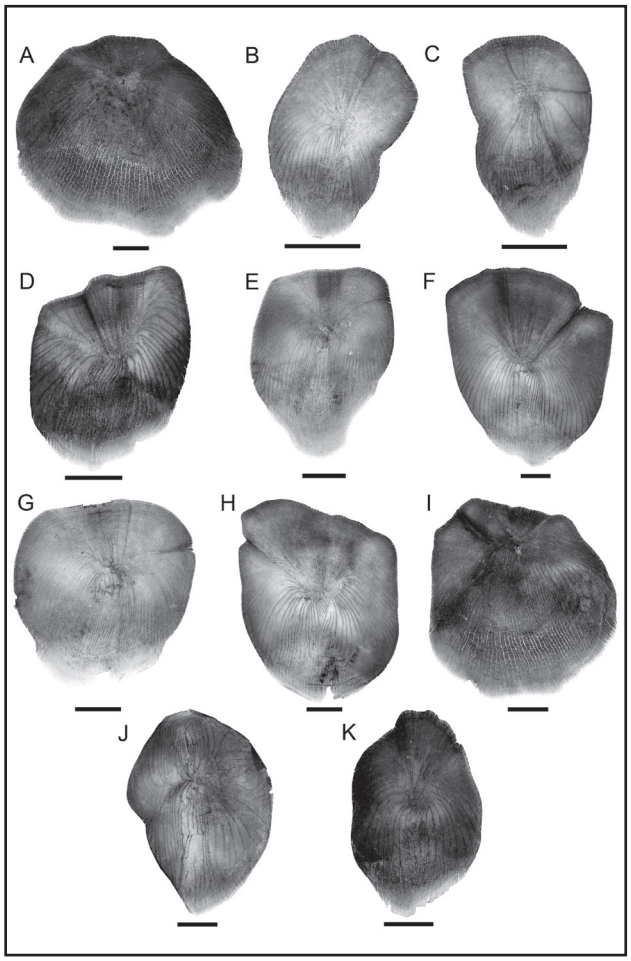

Fig. 4: Uncommon slight body scale deformities in *L. rohita*.
Sl. 4: Neobičajne manjše deformacije lusk na telesu vrste *L. rohita*.

Scale morphology

Abnormal scales, both regenerated and ontogenetic, were significantly smaller in both major and minor axes than normal scales (t-test, $p < 0.05$). The difference in the ratio of major to minor axes was not significant (t-test, $p > 0.05$), making them similar in shape. The number of radii observed in abnormal scales, both regenerated and ontogenetic, was significantly higher than in normal scales (t-test, $p < 0.05$; Tab. 1).

Tab. 1: Morphology of the normal and abnormal scales from *L. rohita* ***obtained from frozen fish market at Muscat, Oman. Scales from abnormal scale patches were subdivided based on focus diameter into ontogenetic or regenerated type. All values as mean values in mm (No. = 10 fish).***

Tab. 1: Morfologija normalnih in abnormalnih lusk primerkov *L. rohita*, ***pridobljenih na tržnici z zmrznjenimi ribami v kraju Muscat, Oman. Abnormalne luske so razdeljene na ontogenetski in regeneriran tip, glede na premer fokusa. Podane vrednosti so povprečne vrednosti v mm (No. = 10 rib).***

Scale measurements	Normal scales	Abnormal Scales	
		Regenerated scales	Ontogenetic scales
No. Scales	240	120	250
Focus diameter (mm)	2.5	3.5	3.1
Scale length (mm)	21.8	13.8	13.1
Scale width (mm)	16.6	11.1	10.7
Length/width ratio	1.3	1.2	1.2
Number of radii	6.8	9.2	9.1

Focus diameter was used as an index to classify scales into two types: ontogenetic and regenerated. The results showed that normal scales have smaller focus size than abnormal scales, both ontogenetic and regenerated.

DISCUSSION

The results obtained raise an important question of the nature of the etiologic factor or factors which trigger the development of abnormalities in scale morphology and disorientation. Corrales *et al*. (2000) suggested that there are four possible general groups of agents that were involved in the production of the scale anomalies in general: genetic, infectious, physical and chemical. Pathological studies on skin ulcerations in a variety of fish species have shown that these can be caused by injuries from fishing gear (Mellergaard & Bagge, 1998), bacterial and fungal infections (Noga *et al*., 1988; Hilger *et al*., 1991), a combination of infections and injury (Ludemann, 1993) and chemical agents (Minchew & Yarbrough, 1977; Fournie *et al*., 1996).

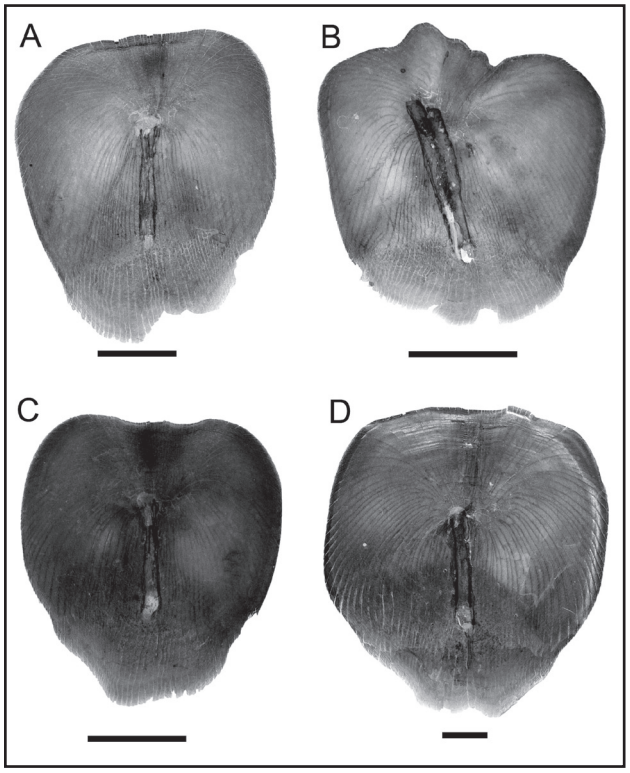

***Fig. 5: Slight scale deformities of the lateral line scale of** L. rohita.*
***Sl. 5: Manjše deformacije lusk lateralnega predela pri vrsti** L. rohita.*

Genetic factors have been shown to result in several types of diseases and gross fish anomalies including a variety of vertebral deformities (Schultz, 1963; Tave *et al*., 1982; Jawad & Öktener, 2006; Jawad & Hosie, 2007; Al-Mamry *et al*., 2010; Jawad *et al*. 2010), albinism (Rothbard & Wohlfarth, 1993; Jawad *et al*., 2007) and melanoma (Schartl *et al*., 1982). At this point, it is impossible to comment on the genetic factor as an agent causing the scale deformity in *L. rohita* for two reasons: firstly, the specimens are an imported commodity in Oman, and secondly, as far as the authors are concerned, there are no studies available on the effect of the genetic factor in developing fish anomalies in India.

Infections with bacteria, protozoan, virus and fungus have been shown to produce necrosis, granuloma, hyperplasia and hypertrophy in the epidermis and dermis of fish (Noga, 1996). Abnormal growth of scales can occur if any of these phenomena takes action. Freshwater fish species in India and in particular *L. rohita* have been known to be exposed to bacterial infection (Lio-Po & Lim, 2000), but no records about the bacterial action in producing scale anomalies have been documented.

In several fish species, physical injuries obtained during the growth of the scales have shown not to play the main role in producing scale anomalies and disorientation, but are considered a co-factor in producing such changes (Corrales *et al*., 2000).

The localization of the abnormal scale patches to the caudal peduncle suggests that either the scales in this area of the body are genetically more susceptible to development of abnormality or that this region is more likely to be exposed to the etiologic factor of anomalies. Rodger (1991) noted that UV exposure had been shown to cause skin damage in localised fish body surface in several fish species, creating a syndrome resembling 'sun burn' in mammals. However, according to the mentioned authors, no data on the effect of UV light exposure in producing scale anomalies in fish is available from the Indian subcontinent.

There are slight differences in salinity and temperature regimes of the regions where the fish specimens were originally collected. However, these differences are typically small in comparison with the seasonal fluctuations, occurring within any of the areas (Acharya *et al*., 2005).

The last group of potential etiologic factors is the organic and inorganic chemicals found in the water column and sediments where *L. rohita* specimens used to live in their original environment. There is a possibility for the chemical agents to be collected via contact with the skin or gills and /or by ingestion. Among these chemical agents there is tributyltin substance that is used as biocides and enters in the content of most herbicides, causes hyperplasia of the dermal layers of the skin in Atlantic salmon, resulting in protruding scales (Bruno & Elis, 1988). The use of this chemical as herbi-

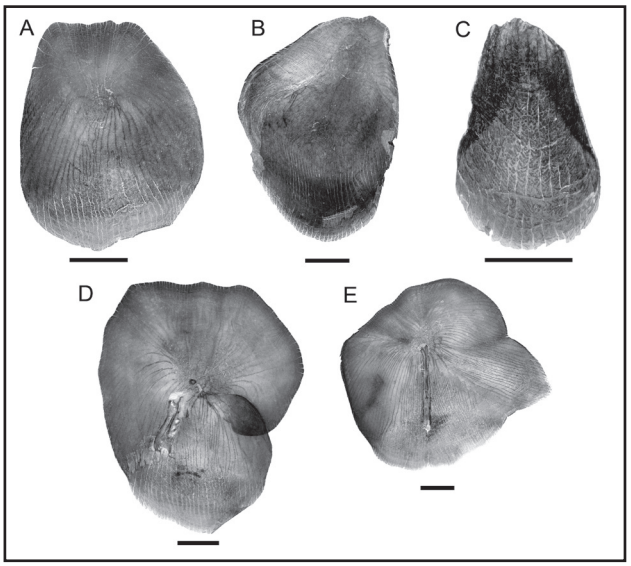

***Fig. 6: Severe body and lateral line scale deformities of** L. rohita.*
***Sl. 6: Večje deformacije lusk na telesu in lateralnem predelu pri vrsti** L. rohita.*

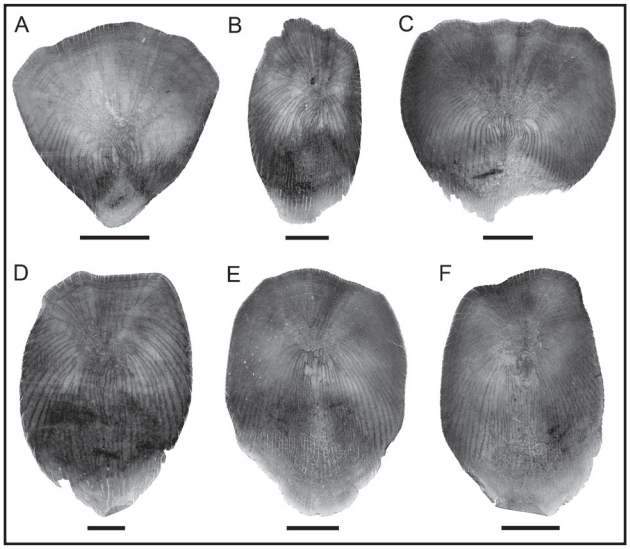

Fig. 7: Shape of scales of *L. rohita*.
Sl. 7: Oblika lusk pri vrsti *L. rohita*.

cide component was reported to have effect on *L. rohita* (Sijatha *et al*., 1996; Das & Mukherjee, 2000; Saravanan & Sundaramoorthy, 2010). Heavy metals and organic pollution of water and sediments seem to be the main reason behind the vertebral anomalies in fishes (Bengtsson, 1974; Benoit & Holcombe, 1978; Bengtsson *et al*., 1988; Middaugh *et al*., 1990). Fournie *et al* (1996) reported that skin lesions (mainly fin erosion, ulcerations and papillomas) were more evident in areas with chemically contaminated sediments. Moreover, it has been found that demersal fish are more likely to be affected than pelagic fish. In the case of *L. rohita*, heavy metals were reported to be present in its original environment (Rauf *et al*., 2009; Zutshi *et al*., 2010) in addition to the fact that it is a fish species with demersal feeding habits (FAO, 2010).

Since the present observations were not conducted in the area where the fish specimens had been obtained, it is not possible at this stage to determine the correlations between severity of scale abnormalities and locations of potentially toxic sediments. The generally higher contaminant levels reported to be present in the original environment of the species in question correspond to the trend which would be predicted if chemical agents were an important component in the development of the scale abnormality. However, a direct proof of such an etiology, including identification of the specific agents responsible, would require experimental exposure of *L. rohita* to a variety of contaminants and/or sediment types found in the original area of the species studied. This is a call for the environmentalists in the Indian subcontinent to conduct further research on this important issue in the future to unveil the relationship between pollutants and the scale deformity discussed in the present work.

DEFORMACIJE LUSK PRI VRSTI *LABEO ROHITA* (OSTEICHTHYES: CYPRINIDAE)

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POVZETEK

Pričujoča študija opisuje deformacije in dezorientacijo lusk pri vrsti rohu, Labeo rohita*, ki izvira z Indijske podceline. Obravnavani primerki so bili pridobljeni na tržnici z zmrznjenimi ribami v Sultanatu Oman. Na luskah v predelu med predrepno in repno plavutjo sta bili opaženi dve vrsti nepravilnosti, manjše in večje; zabeleženo je bilo več primerov obeh vrst nepravilnosti. Dezorientirane luske, zasukane dorzalno ali ventralno od normalne pozicije lusk, ne štrlijo stran od površine telesa. Abnormalne luske, tako regenerirane kot ontogenetske, imajo opazno večji premer fokusa, večje število radijev in normalnim luskam podobno obliko. V članku so obravnavani in ocenjeni tudi različni faktorji, ki bi lahko delovali kot povzročitelji nepravilnosti in dezorientacije lusk.*

Ključne besede: deformacija lusk, *Labeo rohita*, Muscat, Oman

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