

Comparative study on Scale Morphology of two cyprinid fish *Cyprinus carpio* and *Catla catla*

Anju Rani^{*1}, Deepak Rai², and Kanika Pahwa³

¹Department of Zoology, Starex University, Gurugram, India

²Department of Zoology, Kurukshetra University, Kurukshetra, India

³K J Somaiya College of Science and Commerce, Mumbai, India

Received 11 April 2026 | Revised 08 May 2026 | Accepted 06 June 2026 | Available Online 03 July 2026

*Corresponding Author: Anju Rani | Email Address: thaakran2101gmail.com

Citation: Anju Rani, Deepak Rai, and Kanika Pahwa (2026). Comparative study on Scale Morphology of two cyprinid fish *Cyprinus carpio* and *Catla catla*. *Life Science Review*. DOI: <https://doi.org/10.51470/LSR.2026.10.02.13>

Abstract

Fish scales display various characteristics features like position of focus, number of radii, appearance of circuli which could be helpful in identification of fishes. The present study comparatively investigated the scale morphology of two commercially important cyprinid fishes, *Cyprinus carpio* and *Catla catla*. A total of 40 specimens of *C. carpio* and 30 specimens of *C. catla* (15–30 cm total length) were collected from fish markets of Gazipur (Delhi) and Yamunanagar (Haryana), India. Scales were sampled from four body regions, namely the predorsal region, basal region, below the dorsal fin, and lateral line region. After cleaning with 1% KOH, scales were examined under a stereomicroscope to document variations in shape, position of the focus, arrangement of circuli, distribution of radii and margin morphology. Both species possessed cycloid scales; however, distinct interspecific differences were observed in scale shape, focus position, radii distribution, and anterior and posterior margin characteristics across different body regions. *Cyprinus carpio* predominantly exhibited cordate scales with centrally positioned focus and smooth anterior margins, whereas *Catla catla* displayed round-squarish or ovoid scales with an anteriorly positioned focus and characteristic wavy anterior margins. The lateral line scales of both species contained a well-developed longitudinal canal but differed in overall morphology. These findings demonstrate that scale micro-morphological characters are reliable diagnostic features for distinguishing closely related cyprinid species and can complement conventional taxonomic approaches. The study highlights the significance of comparative scale morphology in fish systematics, biodiversity assessment and fisheries research.

Keywords: morphological, scale, *cyprinus carpio*, *Catla catla*, variation.

INTRODUCTION

Cypriniformes is well known diverse group of freshwater fishes and serves as an important model organism in different taxonomic studies [12 and 13] *C. carpio* and *C. catla* belonging to order cypriniformes and family cyprinidae is native to Europe but have been introduced and widely found everywhere except for the poles and Northern Asia.

Scale surface morphology and its meticulous hidden details has always been a keen interest of the ichthyologist. The utilization of the scale in the field of taxonomy has been tracked back since Agassiz (1883-1884); who classify the fishes into different groups according to the structure of the scale i.e. Placodei, Ganoidi, Ctenoidei, and Cycloidei. The morphology of the scale is considered as an appropriate tool in the fish identification [11][6][4][14].

Detailed structure of the scales proved to be important in paleontological analysis and in sexual dimorphism [7]. It could also provide a complete knowledge of life history, growth rates, age, maturity level and average life span of fishes [8] [15]. In addition to this, fish scale is used to test for pollutants such as heavy metals in the water and hence called the bioindicators [17][1]. Due to the utmost importance of scale morphology in the field of taxonomy and fishery sciences, the present study is a traditional approach to inspect the various morphological and microstructural characteristic features of the scale of telost fish *Cyprinus carpio* and *Catla catla*.

MATERIALS AND METHODS

To examine the scale surface morphology, a total 40 specimens of *C. carpio* and 30 of *C. catla* of total length ranging from 15-30 cm were collected from fish market of Gazipur, Delhi and Yamunanagar, Haryana. (25° 35' 2.5512" N 83.577019). Specimens were collected in the ice box and were immediately transferred to the laboratory. All fish specimens were cleaned and measured for total length (TL), standard length (SL), head length (HL) and body weight (BW) nearest to 0.01mm and 0.01gms. Approximately 5-7 scales were gently removed from the left side of the body from the four different regions i.e., pre-dorsal (PDR), basal region (BR), below the dorsal fin (BDF), and lateral line region (LR) with the help of fine forceps. Immediately scales were dipped in 1% KOH solution for 2-3min and the adhering soft tissue and mucus were cleaned with the help of fine brush, thereafter scales were washed in the distilled water in triplicates. Then the scales were air dried and kept in different labeled envelopes for further analysis. For digital image analysis scale from each body region were mounted between the two glass slides to avoid curling of scale. Thereafter, digital image was taken by using SMZ Stereo microscope to reveal various characteristics features.

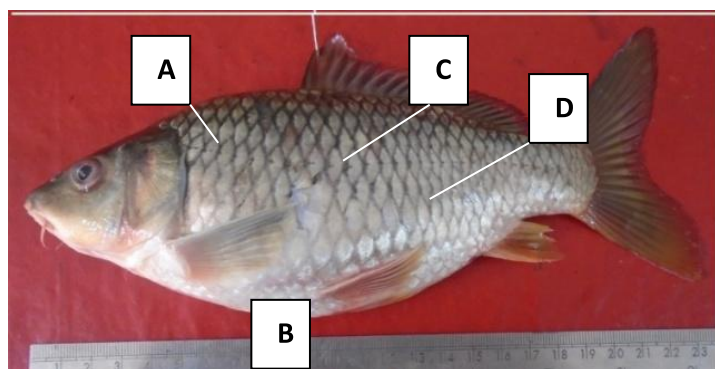


Fig. 1. Showing four different body region of scale collection of *Cyprinus carpio* (A- pre-dorsal, B- above the pelvic fin, C- below the dorsal region and D- lateral line region)

RESULTS

Body of *Cyprinus carpio* and *Catla catla* covered with cycloid scale which is usually divided into three fields i.e. anterior, posterior, and lateral fields. Anterior field was embedded in the skin and overlapped by the posterior field of the successive scale. Ventral surface of the scale appeared shiny whereas the dorsal surface was rough and convex. Scale from each body region displayed various surface ornamentation viz. focus, radii, circuli and annuli. Focus of the scale was large and positioned either anteriorly or centrally. Surrounding the focus present various circular lines called circuli. Circuli were observed to be non-distinct and overcrowded in anterior and lateral fields but quite apart in posterior field. Anterior, posterior and lateral fields were covered by the deep grooves called radii. Radii were categorized into three types i.e., primary radii originating from the focus and reaching the margin of the scale whereas, some radii fail to develop completely, known as 'secondary radii' and 'tertiary radii' originating between midway.

Anterior, and lateral margins of the scale were smooth and rounded whereas, posterior margin had round, triangular and tongue like appearance. Scales displayed inter-specific variations in its shape and surface morphology with in different.

Pre-dorsal scale (RgA)- The scale of pre-dorsal region of *C. carpio* was cordate in shape whereas, it was round- squarish in *C. catla*. Focus was large and centrally positioned in *C. carpio* and it was positioned anteriorly in *C. catla*. Radii were present only on anterior and posterior field with a greater number of primary radii than secondary radii. The shape of anterior and posterior margins was smooth and rounded in *C. carpio* but wavy anterior margin was observed in scale of *C. catla*. Circuli were non distinct in appearance in both species.

Basal scale (RgB)- The shape of the basal region scale was reverse ovoid in *C. carpio* but it was ovoid in *C. catla*. Focus was large and anteriorly positioned. Radii were more numerous and distributed more towards the anterior field than posterior field in both the species. Anterior margin was smooth and rounded with a short prominent projection in *C. carpio*. Posterior margin in both the species was smooth and tongue like.

Below the dorsal region scale (RgC)- Scale from region C was cordate shape. Focus was positioned centrally in *C. carpio* but it was towards the anterior field in *C. catla*. Radii were distributed more towards the anterior field with more numbers of primary radii than the secondary and tertiary radii. Anterior margin was smooth and rounded in *C. carpio* but it was wavy in *C. catla*. Posterior margins were smooth and rounded in both the species.

Lateral line scale (RgD)- The lateral line scales were similar to scales of other body regions except for the presence of a straight, longitudinal canal traversing which cover about two-thirds of the length of the scale, with its anterior end reaching focus. Shape of lateral line was observed as cordate in *C. carpio* and round- squarish in *C. Catla*. Focus was near about towards the center in both the species. Anterior margin was smooth and rounded in *C. carpio* whereas it was wavy in *C. catla* and posterior margins in both the species were smooth and rounded.

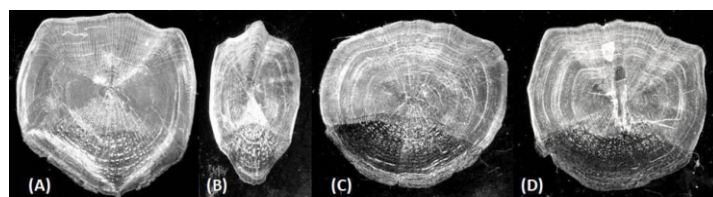


Fig.2. Showing digital image of scale from different body regions of *Cyprinus carpio* (A) pre-dorsal region (B) basal region (C) below the dorsal region (D) lateral line region

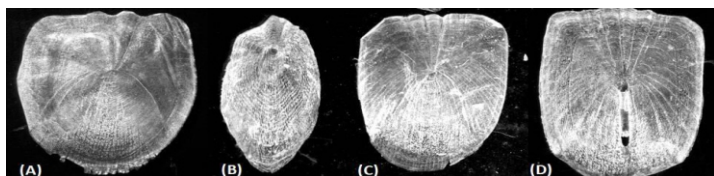


Fig.3. Showing digital image of scale from different body regions of *Catla catla* (A) pre-dorsal region (B) basal region (C) below the dorsal region (D) lateral line region

DISCUSSION

Scale is an important tool in the field of fish biology as it possesses extensive hidden information in its structure that help the ichthyologists to fetch valuable particulars of its bearer. Since ages, shape and its surface ornamentation viz., circuli, radii, cteni, lateral line canals, crenae, lepidonts, position, shape and size of focus have always fascinated the fish biologists. The results of the present investigation revealed inter-specific variation in the shape and other surface features of the scale from different body regions of the fish species.

During the present study, the shape and other surface morphological features of scale i.e. position of the focus, number of radii, appearance of circuli, shape of anterior and posterior margins of *C. carpio* and *C. catla* were described. The scale of *C. carpio* and *C. catla* was cycloid with rough dorsal and shiny ventral surface. Scale bears distinctiveness in architectural details on its surface such as focus, circuli and radii. Focus is considered to be feature of the scale that formed first during ontogenesis and it remains constant throughout the life of fish hence, can be useful for species identification [3]. In the present study focus was clear, prominent and positioned towards the anterior end or at the center of the scale. However, focus was circular and larger in size. The findings of the current study were in contrast to the work reported by [7] wherein different shapes of focus viz., rectangular, oblong and semi-circular were recorded in lizardfish *Saurida tumbil*.

Circuli, formed by the deposition of calcium salts in the dermal layer, are useful indicators of growth patterns, with their spacing reflecting periods of rapid or slow growth [10]. In both species examined, circuli were closely packed and indistinct in the anterior and lateral fields but more widely spaced in the posterior field. Similar variations in the thickness, spacing, and arrangement of circuli have been reported in previous studies [10], suggesting that these characteristics are influenced by both species' identity and growth dynamics.

Radii, which extend from the focus towards the margins of the scale, were predominantly distributed in the anterior field. A greater number of primary radii than secondary and tertiary radii was observed in both species. Previous studies have suggested that a higher number of radii may be associated with favourable feeding conditions [16] and may also contribute to increased flexibility of the scale [2]. In addition, distinct differences in margin morphology were observed between the two species. The anterior margin was smooth and rounded in *C. carpio*, whereas it was characteristically wavy in *C. catla*.

The posterior margin was either smooth and rounded or smooth and tongue-shaped depending on the body region examined. These findings highlight the value of comparative scale morphology as a simple, cost-effective and non-destructive approach that can complement conventional taxonomic methods and contribute to fish identification, biodiversity assessment and fisheries research.

CONCLUSION

The present study showed that the scales of *Cyprinus carpio* and *Catla catla* possess distinct morphological features, including differences in scale shape, focus position, radii, circuli, and margin characteristics. These variations can serve as reliable taxonomic characters for distinguishing the two species. The findings suggest that scale morphology is a simple, economical and non-destructive tool that can support fish identification and contribute to studies on taxonomy, biodiversity, and fisheries management. Future studies combining scale morphology with advanced imaging and molecular techniques will further improve species identification and systematic research.

ACKNOWLEDGEMENTS

The authors are highly grateful to the Department of the Kurukshetra University, Kurukshetra, India, for providing the necessary laboratory facility for the accomplishment of the present study. The authors are also thankful to the local fishermen for providing suitable help during the sampling.

REFERENCES

1. Dua, A., and M.S., Johal, 1994, "Use of fish scale as indicator of pesticide pollution (Abstract). Proc. National Symposium on Aquaculture For 2000 A.D., Madurai Kamraj University, Madurai, India
2. Esmaeili, H.R. and Gholami, Z. (2007): Investigations on the surface ultrastructure of scale of Genio tooth-carp, *Aphanius ginaonis* (Holly, 1929) (Actinopterygii: Cyprinodontidae) using scanning electron microscope. *Iranian Journal of Biology*, 20: 307–314.
3. Esmaeili, H.R. and Gholami, Z. (2009). Scale structure of *Alburnoides punctatus* (Actinopterygii: Cyprinidae) using scanning electron microscope (SEM). *Ferdowsi University International Journal of Biological Sciences*, 1(1): 19-27.
4. Harabawy, A.S.A., Mekawy, I.A.A. and Mahmoud, U.M. (2007). A comparative study on scale characteristics and their functional morphology of four Goatfishes (Family Mullidae) from the Red Sea. *Journal of Egyptian Society of Biotechnology and Environmental Society*, 9: 123-163.
5. Helfman, G.S., Collette, B.B., Facey, D.E. and Bowen, B.W. (2009). *The diversity of fishes: Biology Evolution and Ecology* (p. 720). John Wiley & Sons, Ltd.
6. Jawad, L.A. (2005). Comparative morphology of scales of four teleost fishes from Sudan and Yemen. *Journal of Natural History*, 39(28): 2643–2660.
7. Jawad, L.A. and Al-Jufaili, S.M. (2007). Scale morphology of greater lizardfish *Saurida tumbil* (Bloch, 1795) (Pisces: Synodontidae). *Journal of Fish Biology*, 70: 1185–1212.

8. Johal, M. S. and K. K. Tandon 1992. Age and growth of the carp *Catla catla* (Hamilton 1922) from north India. *Fisheries Research*, 14: 83-90
9. Johal, M.S., Novak, J. and Oliva, O. (1984). Notes on the growth of the common carp *Cyprinus carpio* in Northern India and middle Europe. *Vestník Československé Společnosti zoologické*, 48: 24-38.
10. Kaur, N. and Dua, A. (2004). Species specificity as evidenced by scanning electron microscopy of fish scales. *Current Science*, 87(5): 692-696.
11. Lippitsch, E. (1993). A phyletic study on *lacustrine haplochromine* fishes (Perciformes, Cichlidae) of East Africa, based on scale and squamation characters. *Journal of fish Biology*, 42: 903-946.
12. Mayden, R.L, Chen, W.J, Bart, H.L, Doosey, M.H and Simons A.M. (2009). Reconstructing the phylogenetic relationships of the earth's most diverse clade of freshwater fishes-order Cypriniformes (Actinopterygii: Ostariophysi): A case study using multiple nuclear loci and the mitochondrial genome. *Molecular Phylogenetics and Evolution*, 51: 500-514.
13. Mayden, R.L., Tang, K.L., Conway, K.W., Freyhof, J., Chamberlain, S., Haskins, M., Schneider, L., Sudkamp, M., Wood, R.M., Agnew, M., Bufalino, A., Sulaiman, Z., Miya, M., Saitoh, K and He, S. (2007). Phylogenetic relationships of *Danio* within the order cypriniformes: A framework for comparative and evolutionary studies of a model species. *Journal of Experimental Zoology*, 308B (5): 642-654.
14. Mekkiawy I.A.A.; Wassif E.T. and Basmidi A.A.M., (2011): Scale characteristics of three *Lutjanus* species (Family: Lutjanidae) from the Red Sea. Egypt. J. Fisher. Aqu. Sci., 6: 506-522.
15. Seshappa, G (1999). Recent studies on age determination of Indian fishes using scales, otoliths and other hard parts. *Indian J. Fisheries*, 46(1): 1-11
16. Tandon, K. K. and Johal, M. S., 1996. Age and Growth in Indian Freshwater Fishes. New Delhi, Narendra Publishing House. 232p. Van Oosten,
17. Tandon, K.K., and Johal, M.S., 1993, "Mineral composition of different regions of the scale of an endangered fish – *Tor putitora* (Hamilton) using energydispersive X-ray microanalysis technique," *Curr. Sci.*, 65, pp. 72-573.