STUDY ON THE FISH DIVERSITY AND DISTRIBUTION OF CHROMATOPHORES IN SOME FISHES INHABITING MANAWAR TAWI, RAJOURI (J&K)

Abstract:

The present study on fish diversity from Manawar Tawi, Rajouri (J&K) was carried out for a period of three months, from September 2023 to November 2023. Fish are very important from a biodiversity point of view. Therefore, during the present survey, a total of six fish species belonging to five genera and two families were collected and identified in this region. Also, the distribution of different chromatophores was studied in the fish *Labeo boga.*

Keywords: Diversity, Manawar Tawi, freshwater, Chromatophores

Introduction:

India is rich in biodiversity, which is reflected in its fish diversity. There are 3231 species of fish, of which 2443 are marine fish and 788 are freshwater fish species. India is home to around 10% of the world's fish species (Gopi and Mishra, 2015; Jena *et al*., 2023). Fish are one of the most important components of aquatic ecosystems because they help maintain ecological balance. They are also indicators of aquatic health. For human beings, it is an essential source of nutrition and an important part of our diet. Moreover, it is critical to sustaining national and rural incomes throughout the world. Biodiversity affects the capacity of living systems to respond to changes in the environment and is essential for providing goods and services from ecosystems, nutrient cycling, and clean water (Rahbek and Colwell, 2011).

Further, fish show various morphological features, including different pigment patterns. The striking beauty and diversity of colour patterns attract biologists as well. Colour patterns are the traits that emerge during post-embryonic development. The cellular interactions involved in the formation of colour patterns serve as a signal in social behaviour, the ability to change their body colour i.e. camouflage, mimicry, and sexual behaviour **(Healey, 1999**; Fujii, 2000). Nature's aim in imparting versatile colours to fish is to facilitate their survival and act as a mode of communication **(Younis and Ajai, 2013).** Colouration is displayed in beautiful patterns that are made up of several pigments as well as many nanostructures that provide various colours in skin and appendages. The countless colours and patterns shown by fish are due to genetic mechanisms.

Chromatophores not only help in colour generation but also bring about a change in the colour of the surface coat. Within chromatophores, two types of colours are used: pigment colours and structural colours (Malek, 2008). Pigment colours generate colour by partial absorption and complementary partial reflection of incoming light, while structural colours use crystalline structures to generate colours by scattering. The colour of chromatophores depends on the light absorbance of pigments or phenomena of interference based on light-reflecting substances (Bagnara and Hadley, 1973; Fujii, 2000). The colour of fish skin is dependent on chromatophores such as melanophores (brown or black), xanthophore (yellow), erythrophore (red), cyanophore (blue), leucophore (white), and iridophore and guanophore (which contain guanine that reflect iridescent colour and metallic hues). Fish develop several chromatophores, which produce different colours. In fish, colour patterns arise as patches of chromatophores found in the hypodermis of the body and the epidermis of scales and fins.

The vast variety of colour in fish is an important part of the life of fish and the colouration and pattern mainly depend on the chromatophores present inside the body of the fish. Since there is less study done on the chromatophores of fish, it's now a topic of interest. In the Union Territory of Jammu and Kashmir, there is less study done on chromatophores in fish. A study on seasonal variations in chromatophore index in fish *Puntius sophore* from Jammu water bodies has been done by Kant *et al*. (2016) from the University of Jammu.

Keeping this in mind, the present research work has been designed to study the biodiversity of fish, as the fish in these areas are under threat due to anthropogenic activities such as overfishing and pollution. Hence another strongly recommended practical conservation action plan to prevent the loss of fish diversity and to elucidate the structure and arrangement of chromatophores in *Labeo boga* fish in the river Manawar Tawi located in Rajouri District (J&K). This study will help us learn about the different species and their habibat, as well as the importance of chromatophores in the life of fish and how the colouration of fish depends on a variety of factors.

Material and Methods:

Collection of Fish: To collect the fish, a cast net or throw net was used in the river Manawar Tawi, located in Rajouri district. It is a circular net with small weights distributed around its edges. The net is cast or thrown by hand in such a manner that it spreads out while it's in the air before it sinks into the water. After casting, the fisherman upturned the stones of the river in the area blanketed with nets, and fish got caught in peripheral pockets of the net. The

collected fish were placed in separate buckets containing water and brought to the laboratory for identification. We collected six species of fish, of which the fish named *Labeo boga* was also studied for chromatophores.

Preservation: The collected fish were preserved in 10% formalin for identification. The fishes on the basis of their morphometric, meristic and diagnostic characters were identified.

Procedure for Analysis of Chromatophores: The scales of the fish were removed with the help of fine forceps and immediately transferred into the glass petri dishes, which contain 0.7% NaCl. Later on, the scales that were put into the slides were kept on the slide to study the chromatophore under the microscope. Photography: The chromatophores were observed under a compound microscope, and while observing the scales under the microscopes under 10X magnification, photographs were captured by a Nikon camera.

Observation and Discussion:

In the present investigation, a total of 6 fish species belonging to 5 genera, 5 species, and 2 families were collected and identified. The fish were identified as *Puntius conchonius, Gara gotyla, Tor putitora, Onocorhychus mykiss, Barillius vagra,* and *Labeo boga.* Out of which, *Onocorhychus mykiss* belonged to the family Salmonidae, while others belonged to the family Cyprinidae and order Cypriniformes (Table 1, Fig. 3,4,5,6,7,8, and 9). The family Cyprinidae was observed as the most abundant due to the fact that its members are fast-growing, pollution-tolerant, and most culturable. Similar results were found by Dass and Nath (1966 & 1971); Malhotra *et al.* (1975); Dutta and Malhotra (1984); Dutta and Kour (2005); Dutta *et al.* (2001, 2002 a & b; 2003 & 2006); Dutta *et al.* (2003); Dutta and Fayaz (2003); Kaur (2006); Bhakta and Bandyopadhaya (2008); Nagabhushan and Hosetti (2010); Patra *et al.* (2011); Shukla and Singh (2013); Baro *et al.* (2014).

However, the possibility of anthropogenic pressure and harsh winter conditions influencing the faunal elements could not be ruled out. In the winter season, fish tend to slow down and generally need less food to support themselves. From the study, it was concluded that the status of fish diversity shows a marked decline in fish diversity as well as richness as compared to the previous work done on the same river. This is a really alarming situation that needs immediate attention. We should safeguard the highly esteemed fish for future generations. It is not exactly possible to calculate the declining rate of fish diversity, but this report would serve as reference data for future evaluation.

Further, the distribution of the chromatophores was studied in *Labeo boga*, which was collected with other fish from the same sampling site (Manawar Tawi) in Rajouri district of J&K. The fish belong to the class Actinopterygii and the order Cypriniformes. The fish has cycloid scales. These scales are smooth-edged, thin, large, round or oval, and arranged in an overlapping pattern. The middle part of the scale, which develops initially in the cycloid scale, is called the focus. These scales help in the protection of themselves and form an interesting pattern on the fish body. After observing the scales under a microscope, the most abundant chromatophores were observed in *L. boga*. Chromatophores are large and stellate cells that derive from the neural crest (Kelsh *et al*., 1996; Helen *et al*., **2008).** It was also observed that different regions of the body have different quantities of chromatophores, i.e., the number of chromatophores varies within the body of fish. The difference in the number of chromatophores is due to the different genetic makeups of different species.

The maximum number of chromatophores were found in the body and anterior region of *L. boga*. Chromatophores were also observed in two different states, either in the dispersed phase or the concentrated phase. The dispersed chromatophores were observed as dendritic-shaped cells in different species. Concentrated chromatophores were seen in the dorsal region, and dispersed chromatophores were seen in the posterior region of *L. boga*. Later, it was concluded that concentrated chromatophores gave a light body colour to the fish body and dispersed chromatophores gave a dark body colour to the fish body. The pigment dispersion increases body pigmentation, and pigment aggregation decreases body pigmentation (Fuji and Oshima, 1994).

The reason behind the occurrence of two phases of chromatophores-concentrated and dispersed-is seasonal variation, while the other is fish adaptability to different backgrounds. Fish change their colour frequently, and this colour change occurs many times in a year as there are many changes in season during the year. This was reported by Kant *et al*. (2016) when they worked on seasonal variations in chromatophore index in fish, *Puntius sophore*, during monsoon season, as in monsoon, there are lots of rain and floods, and due to this, the chromatophores start concentrating in the scales of fish, and hence the density of chromatophores increases. Light intensity is also responsible for the changes in colour of the fish body.

Auerswald *et al*. (2008) and Miner *et al*. (2000) reported that fish colouration is different in different seasons due to background colouration and light intensity. The

chromogenic colour changes in freshwater fish, *channa gachua* and *Ophiocephalus gachua*, were reported by Dixit (2016) and showed that variation in environment plays an important role in pattern development and colouration of the body as well. Due to changes in background, not only body colour changes, but some changes also occur in eye colouration. Different types of chromatophores were observed in *Labeo boga* during the present study (Fig. 9 a, b, c). These were melanophores (black or brown), xanthophores (yellow or orange), erythrophores (red), and iridophores (reflective or iridescent).

In *Labeo boga*, melanophores were found in the head, body, and caudal region. The melanophores contain the pigment melanin, which gives the body a black or brown colour. The melanophores have melanin present in organelles called melanosomes. The pigment melanin is synthesized from the amino acid *L-tyrosine* (Fujii and Oshima, 1994).

The erythrophores were also observed. They are mainly red and orange carotenoids, termed erythrophores. Containing pteridine and carotenoids are sometimes found in the same cell, in which case the overall colour depends on the ratio of red pigment. In the head region, they found a dendritic shape in *L. boga* because granules are spread in cytoplasmic processes. **(Check Plagiarism)**

Xanthophores were also seen in the body and caudal regions of *L. boga*. They give a yellowish or orange colour to the body. These chromatophores generate pteridines from guanine triphosphate and possess supplemental biochemical pathways that accumulate yellow pigment.

The iridophores were also observed in *Labeo boga*. Iridophores are iridescent pigment cells, and they function by reflecting and scattering light from reflecting platelets. These platelets are arranged in stacks. The reason for the colouration is the deposition of crystals of purine, guanine, and hypoxanthine.

Hence, it was concluded from the study that chromatophores are responsible for the fascinating colouration and patterns of the fish, and they may be affected due to the adaptation of the fish and seasonal or environmental changes. Less work has been done on the chromatophores of fish, but it is quite evident that the study mainly aimed at the colour pattern of fish collected from the Manawar Tawi River in Rajouri District of Jammu and Kashmir.

References:

1. **Auerswald L, Freier U, Lopata A, Meyer B. (2008**). Physiological and morphological colour changes in Antartic krill, *Euphausia superba*: A field in the Lazarev Sea. *J. Exp Biol.* 211:3850-3858.
2. **Bagnara JT, Hadley ME. (1973).** Chromatophores and colour change; the comparative physiology of animal pigmentation. Englewood Cliffs, N.J.: Prentice-Hall, 8: 1-22 2/9.
3. **Baro DC, Sharma S, Baishya RA. (2014).** Status of ornamental fish diversity of Sonkosh River, Bodoland Territorial Council, Assam, India. *Science Vision*, 14(1): 28-33.
4. **Bhakta J, Bandyopadhyay P. (2008).** Fish Diversity in Freshwater Perennial Water Bodies in East Midnapore District of West Bengal, India. *International Journal of Environmental Research,* 2(3).
5. **Das SM, Nath S. (1971).** A revision of fishes from Jammu province, India. *Kashmir Sci*., 7: 1-12.
6. **Das, SM, Nath S. (1966)** The ichthyofauna of Jammu with their ecology. *Proc.* 53rd *Ind. Sci. Congr*., Part III: 374-375.
7. **Dixit A. (2016).** Studies on the chromogenic (morphological) colour change in the fresh water fish *Ophiocephalus gachua* (Ham.), *Indian J. Applied & Pure Bio*., 31(1): 57-63.
8. **Dutta SPS, Malhotra YR. (1984)** An up-to-date checklist and a key to the identification of Jammu fishes. *Jammu University Rev. (Sci.),* 2: 65-92.
9. **Dutta SPS, Bali, JPS, Kour H, Sharma ID. (2001).** Hydrobiology of river Basantar, an important tributary of the river Ravi. *J. Aquatic Biol*., 16(1-2): 41-44
10. **Dutta SPS. (2003).** Fish fauna of Poonch district, Jammu region. Jammu & Kashmir state. *Aquaculture*, 4(2): 241-246.
11. **Dutta SPS, Fayaz AF. (2003).** Ichthyofauna of Doda district of Jammu region (J&K state). *J Aquacult. Biol*., 18(2): 11-16
12. **Dutta SPS, Kour H. (2005)**. Fish fauna of Kathua District, Jammu Region. *In: Proc. Nat. Sem. "New Trends in Fishery Dev. in India*, Punjab University, Chandigarh. Feb. 16-18: 233-240

13. **Dutta SPS, Gupta SC, Rathore V, Sharma A. (2006).** Fish fauna of some tributaries of river Ravi, District Kathua, J&K state. *In: Trends in Biodiversity and Aquaculture.* Wanganeo A, Langer RK. Daya Publishing House, Delhi-110035: 443-452.
14. **Dutta SPS, Kour H, Zutshi N. (2003).** Ichthyofauna of river Tawi and its tributaries. *J. Aqua. Biol.,* 18(2): 61-68
15. **Dutta SPS, Kour H, Gupta SC, Bali JPS. (2002b).** Fish and fisheries of river Chenab, Jammu Province(J&K). Coldwater fish genetic resources and their conservation. *NATCON Pub*., 7: 181-187
16. **Dutta SPS, Gupta SC, Salaria S. (2002a).** Ichthyofaunistic survey of Rajouri District (J&K State). *Aquacult*., 3(2): 201-205.
17. **Fujii R. (2000).** The Regulation of Motile Activity in Fish Chromatophores. *Pigment Cell Research*, 13(5): 300-3-19.
18. **Fujii R, Oshima N, (1994).** Factors influencing motile activities of fish chromatophores. *Advances in Comparative and Environmental Physiology*, 20:1-54.
19. **Gopi KC, Mishra SS, (2015).** Diversity of marine fish of India. Marine faunal diversity in India. Academic Press, 171-193.
20. **Sköld HN, Aspengren S, Cheney KL, Wallin M. (2016).** Fish chromatophores—from molecular motors to animal behaviour. *In: Kwang Jeon, International review of cell and molecular biology*, Chennai: Academic press, 321: 171-220.
21. **Helen NS, Amundsen T, Svensson PA, Mayer I, Bjelvenmark J, Forsgren E. (2008).** Hormonal regulation of female nuptial coloration in a fish. *Hormones and Behavior*, 54(4): 549-556.
22. **Jena S, Kalaiselvam M, Jayalakshmi S, Jena G. (2023).** Biodiversity of the ray fish along the southeast coast of India with their conservation status: A Comprehensive Overview. *Eur. Chem. Bull*., 12(4): 1580-1591.
23. **Kant KR, Gupta K, Langer S. (2016).** Seasonal variation in chromatophore index in fish Puntius sophore from Jammu water bodies, Jammu and Kashmir. *International Journal of Fisheries and Aquatic Studies*, 4(4): 425-430.
24. **Kaur S. (2006).** Studies on the impact of tourism on stream Banganga and the indwelling micro and macro-organisms. *Ph.D. Thesis*, University of Jammu, J&K.
25. **Kelsh RN, Brand M, Jiang YJ, Heisenberg CP, Lin S, Haffter P, Odenthal J, Mullins MC, van Eeden FJ, Furutani-Seiki M, Granato M, Hammerschmidt M,**

Kane DA, Warga RM, Beuchle D, Vogelsang L, Nu¨sslein-Volhard C. (1996). Zebrafish pigmentation mutations and the processes of neural crest development. *Development*, 123(1): 369-389.

26. **Malek TB. (2008).** The Genetic Basis of Male Nuptual Color in the Threespine Stickleback, *Gasterosteus aculeatus*. Seattle: Proquest.
27. **Malhotra YR, Jyoti MK, Dutta SPS. (1975).** An aid to the identification of fishes found in Jammu Division of J&K State. *J. Univ. Review*, 5(8): 50-66.
28. **Miner BG, Morgan SG, Hoffman JR. (2000).** Postlarval chromatophores as an adaptation to ultraviolet radiations. *J. Exp. Mar. Biol. Ecol.,* 249: 235-248.
29. **Nagabhushan CM, Hosetti BB. (2010).** Diversity of ichthyo - fauna in relation to physico-chemical characters of Tungabhadra Reservoir, Hospet. *Wetlands, Biodiversity and Climate change*, 1-9.
30. **Patra AK, Sengupta, S, Datta T. (2011).** Physico-chemical properties and ichthyofauna diversity in Karala River, A Tributary of Teesta River at Jalpaiguri District of West Bengal, India.
31. **Rahbek C, Colwell RK. (2011).** Biodiversity: species loss revisited. Nature573,288-289.
32. **Shukla P, Singh A. (2013).** Distribution and diversity of fresh water fishes in Aami river, Gorakhpur, India. *Advances of Biological Research*, 7(2): 26-31.
33. **Varghese T, Ebeneezar S, Sreekanth GB, Mishal P. (2014).** Into the Pigmentation of Fish: A Physiological Perspective. *International Journal of Science and Research*, 3:12.

Table 1: Fish diversity in Manawar Tawi, Rajouri (J&K)

Sl. No.	Family	Scientific name
1	Cyprinidae	*Puntius conchonius*
2	Cyprinidae	*Gara gotyla gotyla*
3	Cyprinidae	*Tor putitora*
4	Salmonidae	*Oncorchyncus mykiss* (Rainbow trout)
5	Cyprinidae	*Barilius vagra*
6	Cyprinidae	*Labeo boga*

Fig. 1: View of Manawar Tawi

Fig. 2: Fish catch using cast net

Fig. 3: *Puntius conchonius*

Fig. 4: *Gara gotyla gotyla*

Fig. 5: *Tor putitora*

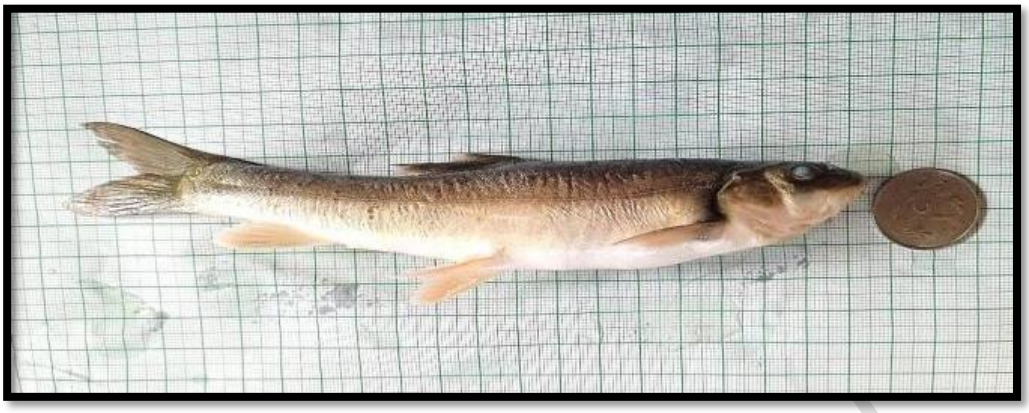

Fig. 6: ***Oncorchyncus mykiss (Rainbow trout)***

Fig. 7: ***Barilius vagra***

Fig. 8: ***Labeo boga***

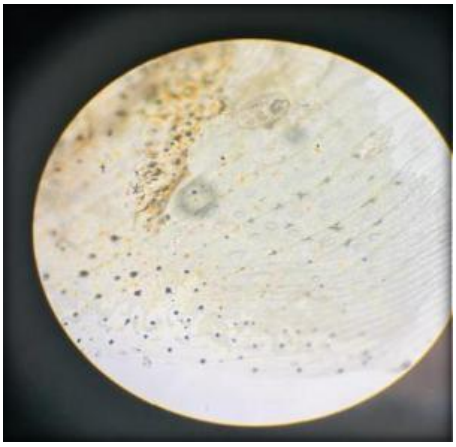

Fig. 9 (a)

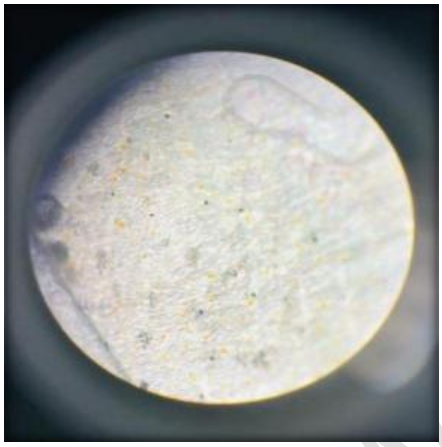

Fig. 9 (b)

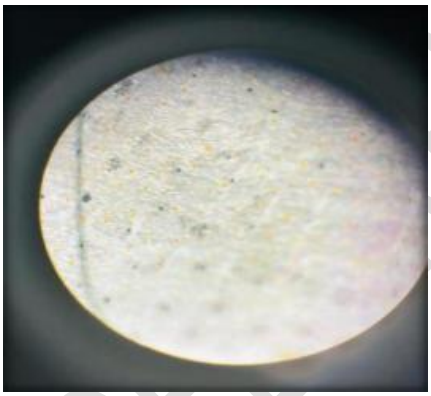

Fig. 9(c)

Fig. 9: Chromatophores observed in the different region of *Labeo boga*

(a) head region

(b) body region

(c) caudal region