



Study on the Fish Diversity and Distribution of Chromatophores in Some Fishes Inhabiting Manawar Tawi, Rajouri(J&K), India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study on fish diversity from Manawar Tawi, Rajouri (J&K) was carried out for the period of three months from September 2023 to November 2023. Fishes are very important from biodiversity point of view. Therefore, during the present survey, total 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*. This study emphasizes the importance of conducting regular surveys in order to analyse the impact of anthropogenic activities on the fish diversity and impact of pollution on the distribution of chromatophores.

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1. INTRODUCTION

India is rich in biodiversity which is reflected in its fish diversity, there are 3231 species of fishes of which 2443 are marine fishes and 788 are fresh water fish species. India is home to around 10% fish species of the world [1,2]. Fishes are one of the most important components of aquatic ecosystem as they help in maintaining the ecological balance, fishes are also the indicator of aquatic health. For human beings it is an essential source of nutrition and an important part of our diet. Moreover, it is critical in 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 [3].

Further, fishes show various morphological features including different pigment patterns. The striking beauty and diversity of colour patterns attract the biologists also. Colour patterns are the traits that emerge during post embryonic development. The cellular interactions involved in formation of colour patterns serve as a signal in social behaviour, ability of changing their body colour i.e. camouflage, mimicry and sexual behaviour [4,5]. The nature's aim in imparting versatile colours to fishes is to facilitate their survival and act as a mode of communication [6]. Colouration is displayed in beautiful patterns that are made up of several pigments as well as many nanostructures which provide various colours in skin and appendages. The countless colours and patterns shown by fishes are through genetic mechanism.

Chromatophores not only help in colour generation but also bring about the change in colour of surface coat. Within chromatophores, two types of colours are used- pigment colours and structural colours [7]. 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 [2,5]. 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 (contain guanine that reflect iridescent colour and metallic hues). Fishes develop several chromatophores which produce different colours. In fishes, colour patterns arise as patches of chromatophores found in hypodermis of body and epidermis of scales and fins.

The vast variety of colour in fishes is an important part of life of fish and the colouration and pattern mainly depends on the chromatophores present inside the body of fish. Since, there is less study done on chromatophores of fishes but now it's being a topic of interest. In the Union Territory of Jammu and Kashmir, there is less study done on chromatophores in fishes. A study in seasonal variations in chromatophore Index in fish *Puntius sophore* from Jammu water bodies has been done by Kant et al. [6] from University of Jammu.

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

2. MATERIALS AND METHODS

Collection of Fishes: To collect the fishes, cast net or throw net was used in the river which named Manawar Tawi located in Rajouri district (33.5707° N, 74.3384° E) (Figs. 1 & 2). It is a circular net having 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 river in the area blanketed with net and fishes got caught in peripheral pockets of the net. The collected fishes were placed in separate buckets containing water and were brought to the laboratory for identification. The colour spot, if any, maximum size and other characters (morphometric and meristic) of the fish sample

caught were measured [8]. The fishes were identified by using keys given by Day [9] and Talwar and Jhingran [10]. Out of collected six species of fishes, *Labeo boga* was further examined for the distribution of chromatophores.

Preservation: Collected fishes 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 fish were removed with the help of fine forceps and were immediately transferred into the glass petri dishes which contain 0.7% NaCl. Later on, the scales which were put into the slides were kept on the slide to study the chromatophore under the microscope.

3. OBSERVATION AND DISCUSSION

In the present investigation, total of six fish species belonging to 5 genera, 5 species and 2 families were collected and identified. The fishes were identified as *Puntius conchonius*, *Gara gotyla*, *Tor putitora*, *Onocorhynchus mykiss*, *Barillius vagra*, *Labeo boga*. Out of which *Onocorhynchus mykiss* belonged to family Salmonidae while others belong to family Cyprinidae and order Cypriniformes (Table 1, Figs. 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 [11,12]; Malhotra et al. [13]; Dutta and Malhotra [14]; Dutta and Kour [15]; Dutta et al. [16-21]; Dutta [22]; Dutta and Fayaz [22]; Kaur [23]; Bhakta and Bandyopadhyay [24]; Nagabhushan and Hosetti [25]; Patra et al. [26]; Shukla and Singh [27] and Baro et al. [3].

However, possibility of anthropogenic pressure and harsh winter conditions influencing the faunal elements could not be ruled out. As in 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 diversity of fishes shows a marked decline in fish diversity as well as richness as compared to the previous work done on the same river. This is really alarming situation which needs immediate attention that we should safeguard the fishes for future generation. It is not exactly possible to calculate declining rate in the fish diversity, but

this report would serve as a reference data for future evaluation.



Fig. 1. View of Manawar Tawi



Fig. 2. Fish catch using cast net

Further, distribution of the chromatophores was studied in fish named *Labeo boga* which was collected with other fishes from same sampling site (Manawar Tawi) in Rajouri district of J&K. The fish belong to class Actinopterygii and order Cypriniformes. The fish is having cycloid scales. These scales are smooth edged, thin, large, round or oval and arranged in overlapping pattern. The middle part of scale which develops initially in cycloid scale is called focus. These scales help in protection of themselves and form an interesting pattern on the fish body. After observing the scales under microscope, the most abundant chromatophores were observed in *L. boga*. Chromatophores are large and stellate cells that derive from the neural crest [28, 29]. It was also observed that different regions of body have different quantity of chromatophores i.e., the number of chromatophores varies within the body of fish. The difference in the number of chromatophores is due to different genetic makeup of different species.



Fig. 3. *Puntius conchoni*



Fig. 4 *Gara gotyla gotyla*



Fig. 5 *Tor putitora*



Fig. 6 *Oncorhynchus mykiss* (Rainbow trout)



Fig. 7. *Barilius vagra*



Fig. 8 *Labeo boga*

Maximum number of chromatophores were found in body and anterior region of *L. boga*. Chromatophores were also observed in two different states-either in dispersed phase or concentrated phase. The dispersed chromatophores were observed as dendritic shaped cells in different species. The concentrated chromatophores were seen in dorsal region and dispersed chromatophores were seen in the posterior region of *L. boga*. Later it was concluded that concentrated chromatophores gave light body colour to the fish body and dispersed chromatophores gave dark body colour to the fish body. The pigment dispersion increases body pigmentation and pigment aggregation decreases the body pigmentation [30].

The reason behind occurrence of two phases of chromatophores- concentrated and dispersed is due to seasonal variation and other is fish adaptability to different backgrounds. Fishes change their colour frequently and this colour change occurs many times in a year as there are many changes in season during year. This was reported by Kant et al. [8] when they worked on

seasonal variations in chromatophore index in fish, *Puntius sophore* during monsoon season as in monsoon, there occurs lots of rain and floods and due to this the chromatophores starts concentrating in scales of fishes and hence the density of chromatophores increases. Light intensity is also responsible for the changes in colour of fish body.

Auerswald et al. [1] and Miner et al. [31] reported that fish coloration is different in different seasons due to background coloration and light intensity. The chromogenic colour changes in freshwater fish, *channa gachua*, *Ophiocephalus gachua* was reported by Dixit [32] and showed that variation in environment plays an important role in pattern development and coloration of body also. Due to change in background, not only body colour changes but some change occurs in the eye coloration also. Different types of chromatophores were observed in *Labeo boga* during the present study (Figs. 9a, 9b, 9c). These were melanophores (black or brown), xanthophores (yellow orange) erythrophores (red) and iridophores (reflective or iridescent).

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

S.No.	Family	Scientific Name
1	Cyprinidae	<i>Puntius conchonius</i>
2	Cyprinidae	<i>Gara gotyla gotyla</i>
3	Cyprinidae	<i>Tor putitora</i>
4	Salmonidae	<i>Oncorhynchus mykiss</i> (Rainbow trout)
5	Cyprinidae	<i>Barilius vagra</i>
6	Cyprinidae	<i>Labeo boga</i>

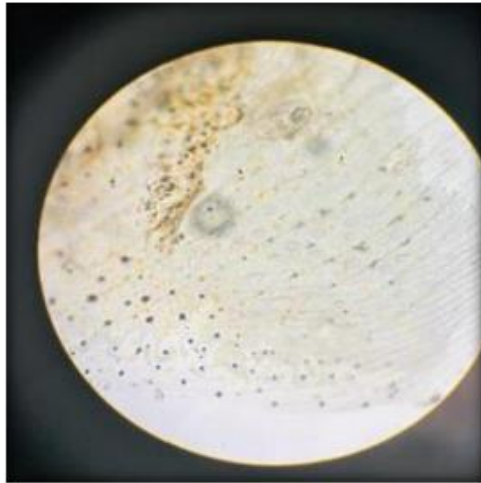


Fig.9 (a)



Fig. 9 (b)

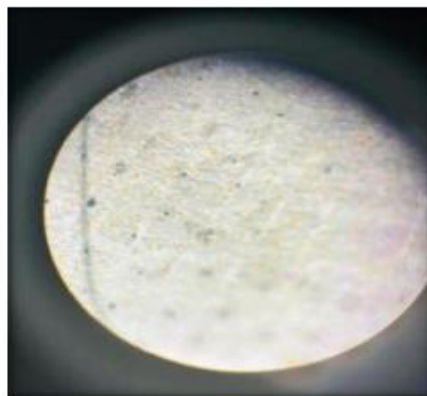


Fig. 9(c)

Fig. 9 Chromatophores observed in the different region of *Labeo boga* (a) head region , (b) body region, (c) caudal region

In *Labeo boga* melanophores were found in head, body, and caudal region. The melanophores contain pigment melanin which gives black or brown colour to body. The melanophores have melanin present in organelle called melanosomes. The pigment

melanin is synthesized from amino acid, *L-Tyrosine* [30].

The erythrophores were also observed. They are mainly red orange carotenoids are 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 colour pigment [33]. In head region they found in dendritic shape in *L. boga* because granules are spread in cytoplasmic processes [34].

Xanthophores were also seen in body and caudal regions of *L. boga*. They give yellowish or orange colour to the body. These chromatophores generate pteridines from guanine triphosphate and possess supplemental biochemical pathways that accumulate yellow pigment [35].

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

Hence, it was concluded from the study that chromatophores are responsible for the fascinating coloration and patterns of the fishes and it may get affected due to adaptation of fishes and the seasonal changes or environmental changes. Less work has been done on the chromatophores of fishes but it is quite evident that the study mainly aimed at the colour pattern of fishes collected from River named Manawar Tawi in Rajouri District of Jammu and Kashmir [36].

4. CONCLUSION

Manawar Tawi is good source of fish species. During the present study the fishes belong to the family Cyprinidae dominated the river. However, fish fauna is at risk due to several anthropogenic activities as these act as major cause of habitat alteration and fish stock depletion. The observation thus can be utilized by decision makers for conservation and management of river ecosystem in a scientific manner. Such ongoing survey and research are useful for monitoring and distribution of fishes in different water bodies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image

generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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