World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

# Comparative study of chromatophores in fresh water fishes

Akanksha Singh and Newton Paul *

*Department of Zoology, Isabella Thoburn college, Lucknow.*

World Journal of Advanced Research and Reviews, 2025, 25(03), 708-711

Publication history: Received on 30 January 2025; revised on 06 March 2025; accepted on 08 March 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.25.3.0760

## Abstract

Fish play a vital role in biodiversity. Chromatophores are pigment-bearing cells found in vertebrates, including fish, that allow each species to change its body colour and pattern. Colour changes allow for dynamic camouflage and different means of communication. It is also an excellent example of plasticity, which is required for adaptation and survival in novel environments. Colour change can occur quickly in minutes or gradually over weeks due to various biological mechanisms. Chromatophores are composed of many pigment types that are present in the body and in the eyes in addition to the skin. Morphological colour change, especially seasonal colour variation, has piqued the curiosity of behavioral ecologists and evolutionary biologists. Melanophores, which absorb light, were discovered to be the most prevalent chromatophore. *Channa striata, Wallago attu*, and *Oreochromis niloticus* scales contain a great number of dendritic-shaped melanophores. Alongside melanophores, erythrophores are seen in *Wallago attu* and *Labeo rohita*. There are a lot of melanophores and xanthophores in *Danio rerio*.

**Keywords:** Fishes; Ecology; Phenotypic Plasticity; Chromophores; Melanophores; Xanthophore

## 1. Introduction

India has a great biodiversity, which is reflected in its fish diversity, with 3231 species of fish, 2443 of which are marine and 788 of which are freshwater. India is home to around 10% of the world's fish species [1]. Fish are one of the most important components of the aquatic ecosystem because they help to maintain ecological balance through balancing role in food chain. They also act as a gauge of the health of the water. It is a key source of nutrients and an important part of the human diet. Furthermore, it is crucial for maintaining national and rural incomes around the world. Biodiversity impacts the capacity of living systems to respond to changes in the environment and is vital for providing goods and services from ecosystems, such as nutrient cycling. The vertebrates with the greatest number of cells that produce colour are fish. Fish also have a wide range of physical traits, such as different pigment patterns. The striking beauty and diversity of colour patterns also appeal to biologists. Colour patterns are characteristics that emerge following the development of the embryo. The colour and colour patterns of fish have numerous ethological consequences since they serve as a mode of communication between members of the same species as well as other species. Colouration is utilized for more than just identifying species. Colouration is utilized not just to protect itself from predation but also to stay inconspicuous while catching prey [6,9].

Colour patterns employed for advertisement are notably widespread among highly visual, social teleosts, and many of the behavioral structures suggest that many of these patterns function as intraspecific signals to attract mates, demonstrate aggression, or communicate with young. Given the speed of reaction, the immediate colour changes seen in the study fish are characteristic of many social teleosts, where colour changes are thought to be completely controlled by the brain (sympathetic). The combinations of a fish's chromatophores mostly determine its colour pattern [6]. The distribution, density, size, and relative motility of different types of pigment cells will all have an impact on pattern display [4]. Fish colour changes fall into two categories: physiological colour changes, which are caused by the rapid

* Corresponding author: Newton Paul

motile reactions of chromatophores, and morphological colour changes, which are caused by changes to the morphology and density of chromatophores [12].

The degree of illumination has a considerable impact on fish behavior, notably diurnal activity, as well as many other aspects of their lives. Light has a significant influence on a fish's metabolism, maturation, behavior, and colouration. The numerous colour and patterns displayed by fish are mostly governed by genetic mechanisms [11]. Fish colouration typically results from a multitude of factors. Underlying biological tissues, body fluids, and even gastrointestinal debris are the sources of background colours. Specialized colour cells called chromatophores, or, less commonly, bioluminescent structures called photophores, produce the above hues [7]. Chromatophores provide structural or pigmentary colours [2]. The colours of fish are determined by the many types of chromatophores found on the fish's skin. There are six types of chromatophores, each distinguished by their colour viz. melanophores (black or brown), xanthophores (yellow or orange), erythrophores (red), and cyanophores (blue). Melanophores are loaded with melanin-laden granules called melanosomes, which give the cells their distinctive brown/black colour. Carotenoids in their xanthosomes, polyene pigments, or water-insoluble carotenoid vesicles are found in xanthophores. Iridophores and leucophores are examples of chromatophores that reflect light (Dixit, 2016) [5]. Many animals undergo physiological color changes in order to adapt to their surroundings and increase their chances of survival and reproduction.

## 2. Material and methods

The purpose of the study was to observe morphology of chromatophores among freshwater fishes. During the study, five freshwater fish species from different genera and families were collected and identified in Lucknow region to investigate different types of chromatophores. Different region of freshwater fish was marked for the observation like head, trunk and tail from where skin was removed with the help of forceps and needle. Photographs were taken with the help of a compound microscope and camera.

## 3. Results and Discussion

Chromatophores are specialized pigment-containing cells in fish that are responsible for their coloration. These cells help fish with camouflage, communication, thermoregulation, and protection from predators. Chromatophores play a crucial role in the survival and behavior of fish. Two types of chromatophores viz. melanophores and erythrophores were found in *Labeo rohita*. The head region contains melanophores and erythrophores. The trunk region has less underlying melanophores and erythrophores whereas tail (caudal) region has a higher abundance and more uniform distribution of erythrophores and melanophore. Both melanophores and erythrophores are dendritic in shape (Plate 1 Fig 2-4).

In *Channa striata*, melanophores are the most prevalent. There are a lot of melanophores in the head region. Although they are less dispersed than in the head, melanophores are plentiful in the trunk region but they are confined at a particular point. In the tail (caudal) region, melanophores are gathered in clusters and are incredibly rare (Plate 1, Fig 6-8).

In *Danio rerio*, chromatophores melanophores and xanthophores are large and scattered sparsely. Zebrafish are brilliantly coloured because of xanthophores. Both xanthophores and melanophores were found in the head region. In trunk region chromatophores were not clearly seen both melanophores and xanthophores are overlapped with each other. Only melanophores were detected in aggregate in the tail (caudal) region (Plate 1, Fig 10-12).

Carnivorous *Wallago attu* has large and prominent melanophores and erythrophores. Melanophores and erythrophores were both observed in the head region, but they overlapped. Erythrophores are branched in shape. Melanophores are few in the trunk area. The tail (caudal) region is home to a moderate number of melanophores (Plate 1, Fig 14-16).

The most prevalent kind of chromatophores in tilapia (*Oreochromis nilotica*) were melanophores. Melanophores are responsible for the dark color of tilapia. Although they were concentrated in a few areas, melanophores were common throughout the head region. The trunk region had the lowest and most erratic distribution of melanophores. Melanophores were more common in the caudal region than the trunk region and are observed in aggregate form (Plate 1, Fig 18-20) [3].

Among all species, *Channa striata* has the largest concentration of melanophores (Fig 6-8). The number and shape of chromatophores differ between species and within the same species (head, middle, and tail), due to the variation in ecological habitat such as temperature, light, etc. In the head region chromatophores are predominately found due to its ecological factors like penetration of the light. Erythrophores, which are typically dendritic in shape, were seen in *Labeo rohita* with melanophores and are responsible for the red hue of the skin. While *Wallago attu* contains erythrophores. *Danio rerio* has both melanophores and xanthophores. Xanthophores are responsible for bright variant colour in *Danio*. The scales of *Oreochromis niloticus, Channa striata, Wallago attu*, and *Labeo rohita* contain many melanophores. *Oreochromis niloticus* scales contain fewer chromatophores and are moderately scattered in pigment granules [7,10].

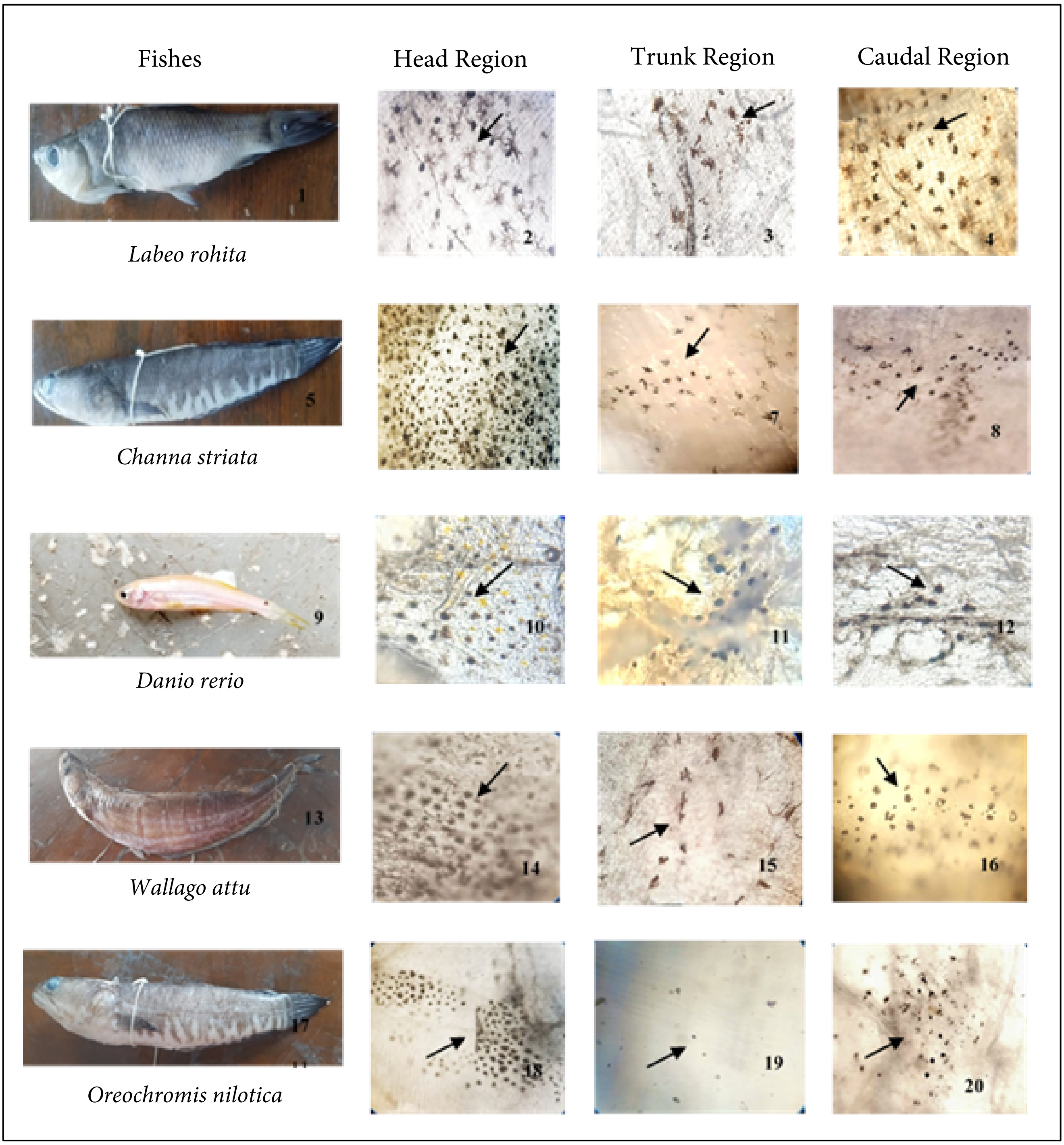


Fig 2-4 Erythrophores and Melanophores *in Labeo rohita*; Fig 6-8 Melanophores in *Channa striata*; Fig 10-12 Melanophores and Xanthophores in *Danio rerio*; Fig 14-16 Melanophores and Erythrophores in *Wallago attu*; Fig 18-20 Melanophores in *Oreochromis niloticus*.

**Figure 1** Freshwater Fishes showing different chromatophores on their different region of body

## 4. Conclusion

A study of the chromatophores in the freshwater fish collected from Lucknow region. The most abundant chromatophores were melanophores. *Channa striata*, *Wallago attu*, and *Tilapia* scales have a great number of melanophores. Erythrophores, in addition to melanophores, were reported in *Labeo rohita* and *Wallago attu*. Melanophores and xanthophores were found in *Danio rerio* which are responsible for its dazzling colour. Finding shows the most abundant chromatophores are melanophores, erythrophores and xanthophores in studied fresh water fishes. The study of chromatophores in freshwater fishes holds promise for advancements in aquaculture, environmental sciences, medicine, and biotechnology. With new tools like genetic sequencing and bioinformatics, future research will provide deeper insights into fish pigmentation and its applications in various fields. Chromatophore reactions to pollutants (heavy metals, pH changes, toxins) can be used for biomonitoring. Chromatophores respond to temperature and light changes can help predict how freshwater fish will adapt to climate change. Chromatophores interact with bioluminescent proteins, which could be useful in medical imaging and sensor technologies. Chromatophores are similar to human melanocytes, studying them can provide insights into melanoma (skin cancer) and cell regeneration.

## Compliance with ethical standards

### *Acknowledgments*

The author is thankful to the In-charge, Prof. (Mrs.) Chitra Singh, Department of Zoology and Principal Prof. (Mrs.) Panzy Singh of Isabella Thoburn College, Lucknow all the necessary laboratory facilities and support

### *Disclosure of conflict of interest*

The authors have no any conflict of interest for publishing this article.

## References

[1] Auerswald L, Freier U, Lopata A, Meyer B. Physiological and morphological colour change in Antarctic krill, Euphausia superba: a field study in the Lazarev Sea. J Exp Biol. 2008 Dec;211(Pt 24):3850-8. doi: 10.1242/jeb.024232. PMID: 19043057.

[2] Baro, D. C., S. Sharma, and R. A. Baishya. Status of ornamental fish diversity of Sonkosh River, Bodoland Territorial Council, Assam, India. Sci Vis; 2014; 14 (1): 28-33.

[3] Bathe P. N. and Jadhav P. A. Study of Chromatophores of Freshwater Fishes from Amravati Local Market. International Journal of Innovative Science and Research Technology 2020: 5 (9); 1469-1472

[4] Burton D. The physiology of flatfish chromatophores. Microscopy Research and Technique; 2002; 58: 481–487. doi:10.1002/(ISSN)1097-0029

[5] Dixit A. Studies on the chromogenic (morphological) colour change in the fresh water fish Ophiocephalus gachua (Ham.), Indian J. Applied and Pure Bio. 2016;31(1): 57-63.

[6] Fujii R. "6 Chromatophores and Pigments." Fish physiology. Vol. 3. Academic Press, 1969, pp.307-353.

[7] Fujii R. The regulation of motile activity in fish chromatophores. Pigment Cell Res. 2000 Oct;13(5):300-19. doi: 10.1034/j.1600-0749.2000.130502.x. PMID: 11041206.

[8] Fujii, R. "The Physiology of Fishes, Coloration and Chromatophores, ed." Evans, DH (CRC, Boca Raton, FL) (1993): 535-562.

[9] Healey E.G. The skin pattern of young plaice and its rapid modification in response to graded changes in background tint and pattern. J. Fish Biol., 2005, vol.55, pp.937- 971.

[10] Kaur S.; Raina S. and Jangral S. Study on the Fish Diversity and Distribution of Chromatophores in Some Fishes Inhabiting Manawar Tawi, Rajouri(JandK), India. Asian Journal of Research in Zoology; 2024; 7(3):82-90; DOI:10.9734/ajriz/2024/v7i3160

[11] Luo M, Lu G, Yin H, Wang L, Atuganile M, Dong Z. Fish pigmentation and coloration: Molecular mechanisms and aquaculture perspectives. Rev Aquacult. 2021;1–18. https://doi.org/10.1111/raq.12583

[12] Sugimoto, M. Morphological color changes in fish: regulation of pigment cell density and morphology. Microsc. Res. Tech. ; 2002; 58, 496–503.