AGPE THE ROYAL GONDWANA RESEARCH JOURNAL
OF HISTORY, SCIENCE, ECONOMIC, POLITICAL AND SOCIAL SCIENCE
ISSN (E): 2583-1348 | A Peer reviewed | An Open Access & Indexed
Volume 06 | Issue 04 | April 2025 | *www.agpegondwanajournal.co.in* | Page No. 06-13

HISTOLOGICAL STUDY OF OLFACTORY ORGAN IN TELEOST

Dr.Suresh Masram[1], Dr.Prakash Ghodeswar [2], Dr.Ujjwala Rahate [3], Achal Kamdi [4], Pranali Khedekar [5]& Harsha Kapgate [6]

Dept. of Zoology, An Autonomous Department of RTM Nagpur University, Nagpur, Maharashtra, India

~~~~~~

Abstract:

The olfactory organ, as a primary chemoreceptor in fish, plays a crucial role in locating food, finding mates, avoiding predators, and help in reproduction. This organ helps fish detect chemical signal in the water, guiding essential behaviorfor survival and reproduction. The histoarchitecture of the olfactory organ in teleost is a fascinating subject that underscores the importance of olfaction in aquatic environments. In addition to giving knowledge about fish behaviour and ecology, an understanding of these structures demonstrates the evolutionary adaptations that enable teleosts to flourish in a variety of environments.

Keywords: olfactory organ, chemoreceptor, teleost.

Introduction:

The olfactory system in fish is a remarkable sensory organ as it fundamentally serves as a chemoreceptor for gathering information about the surrounding aquatic ecosystem. In most teleost, behavioural patterns such as foraging, alarm response, predator evasion, social interaction, reproductive activity, and homing-migration rely on this sense. (Gayaso*et al.*, 2012).

Nowadays, teleosts are the most significant fish. There are at least 20,000 extant species that emerged during the Mesozoic epoch. Fossils of teleosts are thought to have existed in the late million years. They descended from clade Holostei bowfins, which resembled fish. Throughout the Mesozoic and Cainozoic periods, they experienced diversification. 96 percent of fish species are

CORRESPONDING AUTHOR:	REVIEW ARTICLE
Dr. Prakash Ghodeswar Dept. of Zoology, An Autonomous Department of RTM Nagpur University, Nagpur, Maharashtra, India E-mail: prakash18ghodeswar@gmail.com	
~~~~~~

teleosts. According to evolutionary order, jawed fish (Gnathostomata), bony fish (Osteichthyes), and ray-finned fish (Actinopterygii) are vertebrates.They must have advantages over earlier fish to explain their success. Compared to early bony fishes, teleost is generally faster and more supple. Their skeleton has changed to become lighter throughout time. Because teleost bones are made of structural scaffolding, they are powerful without gaining weight. The jaw muscles are different in teleost, and their jaws may move (Tetsuto, 2024).They can now project their jaws outside of their mouths because to these modifications. This adaption enhances their capacity to seize swiftly moving prey. The sense organs of teleosts are quite advanced. The colour vision of almost all daylight fish is at least as good as that of an average human. Acute sensations of taste and smell are also attributed to chemoreceptors, are present in many fish (Holzman, 2008).

The fish olfactory organ is essentially a chemoreceptor and is vital for both locating food and identifying the presence of odoriferous compounds in the aquatic ecology, research on this organ is extremely important. The two main chemosensory mechanisms in fish that allow the creature to survive in an aquatic environment are gustation and smell. Olfaction plays a key role in mediating chemical signals and influences a variety of teleost behaviours (Hara and Zielinski, 1989). Chemicals dissolved in the water enter the olfactory chamber of fish through the nostrils and penetrate the olfactory cells on the surface of the lamellae (Fishelson, 1995). The olfactory nerve innervates the olfactory organ, which produces olfactory sensation by stimulation of its sensory receptor cells. As a result, the olfactory organ is a fish organ the receptor neurons are directly exposed to an aquatic ecosystem and are therefore susceptible to toxins found in the water. Fish have a distinctly localized, highly developed olfactory system that is coated with the epithelium that is extremely important to biology and is essential for inducing behaviour *(*Hara, 1971).Fish depend heavily on their sense of smell for a variety of activities in their lives, such as feeding, sex and species recognition, predator avoidance, sexual behaviour and migration (Kleerekoper, 1967).

The olfactory organ in teleost fish is a vital structure for detecting and processing chemical signals in aquatic environments. Unlike terrestrial animals, fish rely heavily on their olfactory senses to navigate, find food, avoid predators, and communicate with conspecifics. The olfactory system is highly specialized, allowing fish to detect waterborne odorants such as amino acids, bile salts, and pheromones, which are key to a range of behaviours including foraging, mating, and territoriality (Doving, 2007).

Clarias gariepinus, commonly known as the African sharp tooth catfish, is a resilient and widely distributed freshwater fish found primarily in African and some Asian waters. This species is noted for its adaptability to various environments, including rivers, lakes, swamps, and hypoxic (low-oxygen) conditions, supported by its auxiliary breathing organ that allows it to respire air. Its significance extends to both ecological and economic domains due to its role in aquaculture and its function in regulating pest populations in aquatic ecosystems. Morphologically, *Clarias gariepinus* is characterized by an elongated, scaleless body and advanced sensory systems, particularly its olfactory organ, which is essential for detecting chemical cues crucial for feeding, mating, and orientation (Doving, 2007; Zeiske*et al*., 1992).

Review of Literature:

The composition of the olfactory organ varies by species in terms of location, quantity, and detailed structure (Yamamoto, 1982). Typically, this organ features a rosette-like formation with one to several lamellae developed on the floor of the olfactory cavity (Hara, 1975). The olfactory epithelium contains three primary types of cells: olfactory sensory neurons (OSNs), which detect odorants; supporting cells, which provide structural and metabolic support; and basal cells, which function as stem cells for epithelial regeneration. The arrangement and types of these cells, as well as their ultrastructural features, vary across species, indicating that different teleost's have evolved unique olfactory adaptations to suit their environmental needs **(**Zeiske*et al*., 1979; Kim and Park, 2021).

Studies have shown significant diversity in the number, shape and arrangement of olfactory lamellae and variations in sensory epithelium and non-sensory epithelium distributes and receptor cells across the different species in teleost. The olfactory system folding epithelium enhances surface area, sensitivity and effectiveness of the olfactory organ (Zeiske*et al.* 1976). The Sensor system in teleost is categorized into mechano- and chemo-reception based on differences in their innervation pathways, signalling transduction cascades, and the type of olfactory organ, which is critical for fish impacted by olfaction, swimming behaviour, water volume, substrate composition, and water clarity in their habitats (Ferrando *et al*., 2017). Occasionally, the olfactory organ has been considered a prototype for morphological adaptations corresponding to fish lifestyles (Kim *et al*., 2016).

The olfactory epithelium is a representation of the olfactory receptor organ, is located on the floor of the nasal chamber. Numerous studies have been conducted on its morphology and histology.(Zeiske*et al*. 1987; Hara and Zielinski 1989; Hara *et al*. 1993). The olfactory epithelium is divided into sensory and non-sensory regions, with the sensory epithelium showing diverse distribution patterns, including continuous, regularly separated, irregularly interspaced, and scattered in islets (Hara *et al*. 1993.) The brain controls the endocrine and nervous systems, regulating functions like reproduction. It influences the pituitary gland through the hypothalamus, which processes visual and smell stimuli to release hormones. In fish and other vertebrates, the olfactory system relays smell signals, with the olfactory bulb receiving them first (Farbman*et al.*, 1994).

Teleost frequently have two types of Olfactory Receptor Cells (ORC) with either cilia or microvilli on their apical surface were observe as well as third type of ORC also found known as crypt ORC which have been described by the variety of fishes and considered as same feature in the bony fish by (Thommesen 1983, Farbman 2000, Hansen and Finger 2000). Fish detect smells through receptor cells in the olfactory epithelium, which are surrounded by nerve fibers. The olfactory system plays a key role in communication, migration, feeding, defense, and reproduction, with its structure changing during puberty (Hansen *et al*., 2000).

SEM was used to analyze the olfactory rosette in Heteropneustesfossilis (Bloch), and the results showed an oval structure with several lamellae aligned along a median raphe. Each olfactory lamella's lateral side was divided into sensory and non-sensory epithelium based on cellular properties and distribution. The ciliated non-sensory epithelium is heavily coated with cilia, which mask the presence of other cell types, whereas the sensory epithelium is made up of receptor and supporting cells. (Datta *et al*., 1998).

Furthermore, histological studies have shown that olfactory organs in some teleost's undergo significant developmental changes over the course of their lives. For example, in species like the spotted snakehead (*Channa punctatus*), the olfactory epithelium exhibits notable changes in its structural organization as the fish matures, reflecting shifts in the fish's environmental interactions and sensory needs (Mandal *et al*., 2005).The exact anatomy of the olfactory organs in teleost fish has been thoroughly shown by advanced microscopic techniques as light microscopy, transmission electron microscopy (TEM), and scanning electron microscopy (SEM).In a study on the olfactory epithelium of the Korean eel goby (*Odontamblyopuslacepedii*), electron microscopy revealed distinct microvilli and cilia on the surface of the OSNs, which play crucial roles in capturing and transducing chemical signals (Kim *et al*., 2018).

An anatomical and histological study of the olfactory organ in the freshwater fish Heteroneuptus*fossilis* revealed that the paired olfactory chambers are located antero-dorsally on the snout, with an anterior tubular and a simple oval posterior nasal opening. The olfactory lamellae contain supporting cells, primary and secondary olfactory receptor neurons, basal cells, and goblet cells. Synapses form between primary and secondary neurons, and basal cells can develop into olfactory receptor or supporting cells, while goblet cells are mostly located at the edge of the epithelium (Goel *et al.*, 1978).

The scientist observed that histology of the olfactory epithelium and bulb in *Heteropneustesfossilis and Channa punctata*. He seen that *C. punctata*, the olfactory rosette lacks a central raphe, and *Heteropneustes. fossilis* has one. Both species exhibit similar olfactory bulb structures, with distinct sensory regions and olfactory lamellae patterns, though *C. punctata* has a sessile bulb and *H. fossilis* a pedunculated bulb (Chakrabarty, 2006). The common carp (*Cyprinus carpio*) fifty species were studied to examine their olfactory organs, lateral line canal, and neuromasts. The olfactory organ is oval-shaped, containing 28 lamellae, while the lateral line consists of six cephalic canals and a trunk canal with 35 scales extending to the caudal peduncle. Neuromasts are of two types: external neuromasts around the eyes and jaws, and pit organs, both featuring sensory and supporting cells by (Sawad,2006).This study examines the histology of the olfactory epithelium and bulb in *Channa punctata* and *Heteropneustesfossilis*. In *C. punctata*, the olfactory rosette lacks a central raphe, while*Heteropneustesfossilis* has one. Both species exhibit similar olfactory bulb structures, with distinct sensory regions and olfactory lamellae patterns, though *C. punctata* has a sessile bulb and *Heteropneustesfossilis* a pedunculated bulb (Prakash *et al*., 2018).

In India, *Catlacatla, Cirrhinusmrigala, and Labeorohita* are important food fish, with reproduction influenced by seasons. This study used SEM and TEM to examine the olfactory organ of male*Labeorohita*, revealing its structure and cell types. It provides the first detailed analysis of its olfactory system, opening research into sensory processing and reproduction (Bhute, 2007).

The olfactory sense is crucial in the lives of vertebrate species. In fish, amphibians, reptiles, and the majority of mammals, essential behavioural responses, particularly those linked to feeding and mating, heavily rely on the proper operation of the olfactory system. (Allison, 1953). Teleost olfactory receptors have 4-6 cilia arranged in a circular formation at the tips of their dendrites, with pointed basal feet located at the center of the ring of cilia. In some fish types, another variant of the receptor is present, lacking cilia but extending from the epithelial surface with several longitudinally aligned fibre bundles. (Banniste, 1965). Using a variety of fixation and staining techniques, the secondary folding of the olfactory organ in juvenile and adult sea trout examined the growth of the olfactory rosette in parr, smolt, and adult sea trout. Initial, cuneiform, filiform, and fungiform laminae are the four types of secondary lamina that are formed by folding primary laminae in the rosette. The folding resulting from ecological adaptations was explored, and this secondary folding seems to exist between a blood capillary and the sensory epithelium (Bertmar 1972).

Light microscopy and transmission electron microscopy have been used to investigate the olfactory organ of *Channa punctata* (Bloch). The olfactory bulb, olfactory nerve, and olfactory rosette make up *C. punctata* olfactory system. An anterior inlet and a posterior nostril output connect the olfactory chamber to the outside world. There are sensitive and non-sensory regions inside the olfactory epithelium. (Ghodeswar*et.al*, 2020).

Electron microscopy can be used to observe the olfactory system in Indian big carps. In India, *Catlacatla, Labeorohita, and Cirrhinusmrigala* are important nutritional fish. Scanning and transmission electron microscopy have been used to study the structure of the olfactory organ in male *Labeorohita*. This structure originates from the median raphe and consists of an olfactory bulb with 47–52 lamellae in adults, a short nerve, and olfactory epithelium. The lamellae contained ciliated non-sensory cells and microvillar sensory cells, as demonstrated by scanning electron microscopy (Bhute, 2007).

An analysis of the olfactory epithelium's morphology, morphometry, and neuroanatomy in *Notopterusnotopterus* revealed a multilamellar structure with 70–76 lamellae extending from a median raphe. There were sensory and non-sensory areas on each lamella. In contrast to the non-sensory region, which included ciliated non-sensory cells, basal cells, and mucous cells, the sensory region included ciliated, microvillous, and crypt receptor cells, supporting cells, and basal cells (Patle*et al*.,2014).

An investigation into the morphology and surface ultrastructure of the olfactory rosette in Indian Major Carp, *Labeorohita*, was conducted utilizing a Scanning Electron Microscope (SEM). The olfactory rosettes are oval in shape, positioned at the dorsal aspect of the head, and reside in pairs within the olfactory chambers. On the lamellar surface, ciliated patches are primarily made up of type-1 ciliated cells with long cilia. The non-ciliated or indifferent epithelium features microridged epithelial cells interspersed with prominent openings of mucous glands (Kumari, 2020).

Histological structures of the olfactory organs (epithelium and bulb) of two freshwater fish species, *Channa punctata* (spotted snakehead) and *Heteropneustesfossilis* (catfish), using light microscopy. The fishes were collected from natural habitats and acclimatized. Mature fishes of *C. punctata* (500-700g) and *H. fossilis* (100-125g) were used. The olfactory organs were dissected, fixed in Bouin's fixative, embedded in paraffin, and cut into transverse sections (8-10 µm thick). These sections were stained using HE double staining and Nissl staining techniques for histological examination. *C. punctata* has a paired, oval-shaped olfactory rosette with sensory and non-sensory regions (P. Ghodeswar*et al*., 2018)

Conclusion:

The olfactory organ in fish as a primary chemoreceptor and sensory organs. In olfactory chemoreceptor is locating main function of the food help in reproduction and etc. The olfactory organ in fish helps them detect chemical signals in the water, playing a crucial role in behaviour related to survival and reproduction. By sensing these chemical cues, fish can locate food, avoid predators, and find mates. This ability is essential for their overall fitness and successful reproduction.

References:

1. Bhute, Y.V. and Baile, V.V (2007). Organization of the olfactory system of the Indian Major Carp *Labeorohita* (Ham): A scanning and Transmission Electron Microscopy study. *Journal of Evolutionary Biochemistry and physiology* 43:342-349.
2. Chakrabarti, P. (2006). Histological and histochemical studies on the olfactory rosette of *Mugil parsia*(Hamilton). *Folia morphologica*, 64:41-46.
3. Farbman, A.L (1994). Developmental biology of olfactory sensory neurons. *Seminars in Cell Biology*, 5:3-10.
4. Fishelson, L (1995). Comparative morphology and cytology of the olfactory organs in moray eels with remarks on their foraging behaviour. *Anatomical Record. A*, 243: 403-412.
5. Gayoso J.A., Castro A., Anadon R., Manso M.J (2012).Cryptcells of the zebrafish *Danio rerio* mainly project to the dorsomedial glomerular field of the olfactory bulb – *Chemical Senses* 37: 357-369.
6. Goel H. R (1978). Functional Anatomy of the Olfactory Organ in the Fresh Water Teleost, *HeteropneustesFossilis. Okajimas Folia Anatomica Japonica.*, 55:289-300.
7. Hansen A., Finger T.E., (2000). Phyletic distribution of crypt types olfactory receptor neurons in fishes. *Brain, Behavior and Evolution* 55:100–110.
8. Hara T.J (1993). Chemoreception. pp 191–218. *In*: Evans D.H. (ed.) The physiology of fishes. *Chemical Rubber Company Press, Inc*, *Boca Raton*, FL.

9. Hara, T. J (1971). Chemoreception. In: Fish physiology, Vol.-5. (Hoar, W. S. and D. J. Randall, Ed.). *Academic Press, New York*: 79-120.
10. Hara, T. J. and B. Zielinski (1989). Structural and functional development of the olfactory organ in teleosts. *Transactions of the American Microscopical Society* 118: 183-194.
11. Holzman R.., Day S. W.., Mehata R. S.., Wainwright P. C (2008*)*.Jaw protrusion enhances forces exerted on prey by suction feeding fishes.*Journal of Royal Society Interface* 10:1445–1457.
12. Kleerekoper H. (1967). Some aspects of olfaction in fishes, with special reference to orientation. *American zoologist* 7: 385-395.
13. Prakash L. G, Nilesh D. G, Prashant P. I, Suresh C. M and Lalit P. D (2018). Comparative study of olfactory organ of *Channa punctata* and *HeteropneustesfossiliInternational Research Journal of Natural and Applied Sciences* 2349-4077.
14. Sawad A. A, S. A. Hussein S. A and Azal N. A (2006). Morphological and histological study form some sensory orhan in common carp (*Cyprinus carpio* L.) *marina mesopotamica*22: 197-207.
15. Tetsuto M., (2024). Fossil record of fishes and major evolutionary transitions. *Module in Life Sciences.*
16. Thommesen G (1983). Morphology, distribution, and specificity of olfactory receptor cells in salmonid fishes. *Acta Physiologica Scandinavica* 117: 241–249.
17. Zeiske E., Kux J., Melinkat R (1976). Development of the olfactory organ of oviparous and viviparous cyprinodonts (Teleostei). *Zeitschrift für ZoologischeSystematik und Evolutionsforschung* 14: 34–40.
18. Allison, A. C. (1953). The morphology of the olfactory system in the verterbrates. Biol. Rev., 28: 195-244.
19. Bannister, L. H. (1965). The fine structure of the olfactory surface of teleostean fishes. Quart. J. Micr. Sci., 106: 333-342.
20. Datta N.C. and Bandopadhyay, S. (1997). Ultrastructure of cell types of the olfactory epithelium in a catfish, *Heteropnesteus* (Bloch). J. Bisci., vol.22. No.2, PP233-245.
21. Ghodeswar P., Gorghate N., Masram S. (2020). Light and Transmission Electron Microscopic Study of Olfactory Organ of Spotted Snakehead, Channa punctata (Bloch). Advances in Zoology and Botany, 8(6), 483 - 490.
22. Kim H.T., Park J.Y. (2016). The anatomy and histoarchitecture of the olfactory organ in Korean flat-headed Goby Lucigobius guttatus (Pisces; Gobiidae) – Appl. Microsc. 46: 51-57.
23. Kumari K. (2008). Morphology and of the olfactory rosette of a teleostean fish: *Catlacatla* (Ham) Our Nature, pp. 30-37.
24. Patle P.J., Baile V.V. (2014). "Morphology, morphometry and neuroanatomy of the olfactory Epithelium and the olfactory bulb of a feather back fish, *Notopterusnotopterus*". International Journal of Life Sciences, Vol.2, No.1, 1-12.
25. Yamamoto M. (1982). Comparative morphology of the peripheral olfactory organ in teleosts – In: Chemoreception in fishes (Ed.) T.J. Hara, Elsevier, Amsterdam: 39-59.

26. Døving, K. B. (2007). The functional organization of the fish olfactory system. *Progress in neurobiology*, *82*(2), 80-86.
27. Ferrando, S., Gallus, L., Amaroli, A., Gambardella, C., Waryani, B., Di Blasi, D., &Vacchi, M. (2017). Gross anatomy and histology of the olfactory rosette of the shark Heptranchiasperlo. *Zoology*, *122*, 27-37.
28. Ghodeswar, P., Gorghate, N., &Masram, S. (2020). Light and Transmission Electron Microscopic Study of Olfactory Organ of Spotted Snakehead, Channa Punctata (Bloch). *Advances in Zoology and Botany*, *8*, 483-490.
29. Kim, H. T. (2024). Anatomy and Histology of the Olfactory Organ of Asian Swamp Eel Monopterus albus. *Korean Journal of Ichthyology*, *36*(1), 40-47.
30. Zeiske, E., Breucker, H., &Melinkat, R. (1979). Gross morphology and fine structure of the olfactory organ of rainbow fish (Atheriniformes, Melanotaeniidae). *Acta Zoologica*, *60*(3), 173-186.

■ ■ ■