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Morphology and ontogenetic development of the olfactory organ in *Colisa fasciatus* from freshwater habitats of Gaya, Bihar

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ABSTRACT

The present study investigates the morphological organization of the olfactory organ in *Colisa fasciatus* (barred gourami) collected from freshwater habitats of Gaya district, Bihar. Detailed anatomical dissection and microscopic examination revealed that the olfactory apparatus comprises an elliptical olfactory rosette with radially arranged lamellae lined by sensory epithelium. The number of lamellae ranged from 15 to 45 and exhibited a strong positive correlation with body length ($r = 0.93$, $p < 0.05$), indicating ontogenetic expansion of the sensory surface. A well-developed accessory olfactory sac and distinct vase-shaped olfactory bulbs connected to paired olfactory tracts were also observed. These findings suggest a highly specialized chemosensory system adapted to the ecological conditions of the species' habitat. The study provides baseline morphological data relevant to comparative anatomy, sensory ecology, and environmental assessment.

Key Words - *Colisa fasciatus*, olfactory organ, olfactory lamellae, chemoreception

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INTRODUCTION

The olfactory system in fishes is a primary sensory modality that plays a central role in survival and ecological interactions. It mediates essential behaviors such as food detection, predator avoidance, reproductive signaling, migration, and habitat selection. In aquatic environments, the diffusion and transport of dissolved chemical cues make olfaction particularly efficient compared to other sensory systems (Hara, 1994; Zeiske *et al.*, 1987).

Teleost fishes exhibit considerable diversity in olfactory structure, reflecting adaptations to different ecological niches. The olfactory organ typically consists of paired rosettes with lamellae that increase sensory surface area and enhance odor detection (Yamamoto, 1982). Variations in lamellar number, arrangement, and associated structures are often linked to environmental conditions such as water turbidity, flow dynamics, and habitat complexity.

Colisa fasciatus, a widely distributed freshwater teleost, inhabits ponds, marshes, and slow-moving streams that are often characterized by dense vegetation and reduced visibility. Under such conditions, reliance on chemical cues becomes critical (Datta Munshi & Hughes, 1992; Singh & Singh, 2014). Despite its ecological and economic importance, detailed morphological descriptions of its olfactory apparatus, particularly from eastern Indian populations, remain scarce.

The present investigation aims to provide a comprehensive morphological description of the olfactory organ in *C. fasciatus*, focusing on the structural organization of the olfactory rosette, lamellar arrangement, cranial associations, and neural connections. Additionally, the study evaluates the relationship between body size and lamellar number to understand developmental trends and functional implications.

MATERIALS & METHODS

Study Area and Sampling

Specimens of *C. fasciatus* were collected from five freshwater bodies in Gaya district, Bihar, including ponds, slow-flowing streams, and sections of the Phalgu River. These habitats represent typical environments inhabited by the species, characterized by variable turbidity, vegetation cover, and water flow.

Sampling was carried out between March and August 2023 to account for seasonal variability. Fish were captured using hand nets and baited traps to ensure minimal stress and representation of different size groups.

Specimen Collection and Morphometry

A total of 25 specimens ranging from 54 mm to 195 mm in total length were examined. Standard length and total length were measured using digital calipers with a precision of 0.01 mm. Specimens were grouped into size classes to analyze ontogenetic variation.

Preservation and Dissection

Ten specimens were examined fresh within four hours of capture to observe natural morphology, while fifteen were preserved in 10% buffered formalin for detailed anatomical study. The cranial region was dissected dorsally under a stereoscopic binocular microscope.

Care was taken to expose the olfactory chambers without damaging associated structures. The olfactory rosettes were carefully excised using fine forceps and transferred to saline solution for observation.

Microscopic Examination

The olfactory rosettes were examined under magnification to study their shape, lamellar arrangement, and surface features. Lamellae from both left and right rosettes were counted independently to ensure accuracy. Cranial bone associations and the orientation of olfactory tracts were documented using a digital imaging system.

Statistical Analysis

The relationship between body length and lamellar number was analyzed using linear regression. Pearson's correlation coefficient (r) was calculated to determine the strength of association. Statistical significance was considered at $p < 0.05$.

RESULTS

Morphology of the Olfactory Organ

The olfactory organs were paired and located in shallow depressions within the ethmoid region of the skull. Each olfactory chamber was bounded laterally by the ethmoid bone and protected dorsally by the frontal and nasal bones. The ventrolateral boundary was formed by the lachrymal bone. An accessory olfactory sac was consistently observed in all specimens and appeared to be structurally supported by the palatine bone.

Olfactory Bulbs and Neural Connections

The olfactory bulbs were prominent and exhibited a characteristic vase-shaped morphology, consisting of a narrow anterior neck and a broader posterior region. From each bulb, an olfactory tract extended posteriorly along the cranial floor and connected to the anteroventral region of the telencephalon. The tracts were symmetrically arranged and formed an average angle of 23° ± 1.8° relative to the longitudinal axis of the body.

Structure of the Olfactory Rosette

The olfactory rosette was elliptical in shape and composed of multiple lamellae arranged radially around a central raphe. Each lamella was crescent-shaped and lined with sensory epithelium. The arrangement ensured maximum exposure of the sensory surface to incoming water currents.

Variation in Lamellar Number

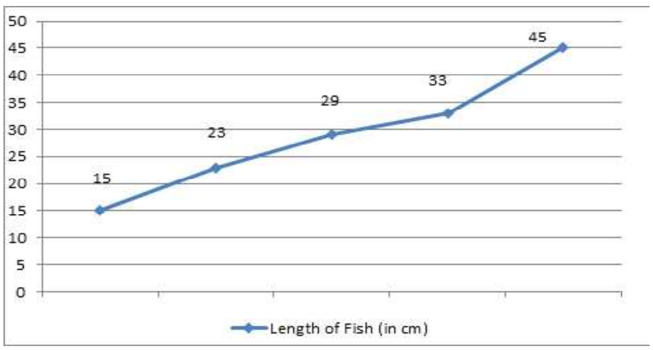
The number of lamellae varied considerably across specimens, ranging from 15 in smaller individuals to 45 in larger individuals. Both left and right rosettes showed comparable counts, indicating bilateral symmetry.

Relationship Between Body Length and Lamellae

A strong positive correlation was observed between total body length and the number of olfactory lamellae ($r = 0.93$, $p = 0.019$). Regression analysis indicated that lamellar number increased at a rate of approximately 0.18 lamellae per millimeter of body length, suggesting progressive expansion of sensory capacity during growth.

Table 1- Relationship Between Body Length and Number of Olfactory Lamellae in *Colisa fasciatus*

Sl. No.	Total length (mm)	Standard length (mm)	No. of olfactory lamellae		Total No. of lamellae in both rosettes
			Left rosette	Right rosette	
1	54	45	7	8	15
2	110	95	11	12	23
3	140	120	15	14	29
4	190	150	17	16	33
5	195	180	23	22	45



Graph 1- Graph illustrates how the number of olfactory lamellae increases in tandem with the fish's length

DISCUSSION

The olfactory organ of *C. fasciatus* exhibits structural features typical of teleost fishes, including an elliptical rosette and radially arranged lamellae. Such an arrangement is known to increase the effective sensory surface area, thereby enhancing the detection and discrimination of odorant molecules (Yamamoto, 1982; Bhute & Baile, 2007).

The observed increase in lamellar number with body size reflects ontogenetic development of the olfactory system. As fish grow, their ecological requirements become more complex, necessitating improved sensory capabilities. Similar correlations between body size and lamellar number have been reported in other freshwater species (Ali & Anjum, 2010; Sarkar & De, 2011).

The consistent presence of an accessory olfactory sac suggests a functional role in regulating water flow across the sensory epithelium. Efficient water circulation is essential for continuous exposure of receptor cells to chemical stimuli, particularly in stagnant or slow-moving waters (Reutter & Kapoor, 1990; Zeiske *et al.,* 1987).

The well-developed olfactory bulbs and clearly defined tracts indicate efficient neural processing and transmission of olfactory signals. This structural organization is consistent with findings in other teleosts and suggests evolutionary conservation of olfactory pathways.

The habitat of *C. fasciatus* characterized by turbidity and dense vegetation limits visual perception, thereby increasing reliance on chemoreception. The morphological adaptations observed in this study support the hypothesis that enhanced olfactory development is associated with such environmental conditions (Hara, 1994; Datta Munshi & Hughes, 1992).

CONCLUSION

The present study demonstrates that the olfactory organ of *Colisa fasciatus* is structurally well-developed and adapted for efficient chemoreception. The increase in lamellar number with body size highlights ontogenetic enhancement of sensory capacity. The presence of an accessory olfactory sac and well-defined neural pathways further support the functional significance of the olfactory system in this species. These findings provide valuable baseline data for comparative morphological studies and contribute to a better understanding of sensory adaptations in freshwater fishes.

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