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COMPARATIVE STUDY OF OLFACTORY ORGANS OF *CHANNA PUNCTATA* (BLOCH) AND *HETEROPNEUSTESFOSSILIS* (BLOCH)

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ABSTRACT

The present study is an attempt to examine the histology with the help of light microscope (LM) of the olfactory epithelium and olfactory bulb of spotted snakehead *Channa punctata* and *Heteropneustes fossilis.* The olfactory organ of teleost consists of olfactory rosette, olfactory nerve, and olfactory bulb. In *C. punctata,* paired and oval shaped olfactory rosette present in the olfactory chamber on fish rostrum. Olfactory chamber opens externally via an anterior inlet and a posterior nostril outlet depending on presence of olfactory receptor neurons olfactory lamellae has two regions, sensory and non-sensory. A sensory region has olfactory receptor neurons. These neurons send their axons along olfactory nerve to olfactory bulb which work as relay centre. Olfactory bulb sends signal to telencephalon via olfactory tract. Olfactory bulb histologically shows four concentric layer, olfactory nerve layer, glomerular layer, mital cell layer, and granular cell layer. In *C. punctata,* olfactory lamellae run parallel to each other in antero-postero direction and olfactory rosette lack central raphe. *H. fossillis* has central raphe in olfactory rosette and olfactory lamellae runs outwardly from distinguish central raphe. Location of sensory region on olfactory epithelium also differ in *C. punctata and H. fossillis*. Sessile and pedunculated type of olfactory bulb present in *C. punctata and H. fossillis* respectively but histologically olfactory bulb of both teleost shows similar structure.

KEYWORDS: *Channa punctata, Heteropneustes fossilis*, Olfactory Rosette, Olfactory Bulb, Olfactory Epithelium.

INTRODUCTION

Snakehead, *Channa punctata* is highly esteemed as food. This fish is quite frequent in shallow and deep parts of rivers, tanks or pools with or without aquatic vegetation. The tenacity of the fish is very great and if taken out of water, it can survive for a long time. All the three species of *Channa* bear a pair of folded sac like outgrowth of pharynx called pharyngeal diverticulum to store air. These are lined by highly vascular respiratory epithelium and act as accessory respiratory organs. They can, therefore live for quite some time outside water, and hence grouped among live fishes. Snakeheads as they are commonly called as, are acclaimed all over the country for their flavour, medicinal and recuperative values (Chakraborty, 2006).

Another valuable fish is *Heteropneustes fossilis* which is also highly esteemed as food and occupies foremost place among live catfishes. The fish is locally called as "Singhee". *Heteropnuestes fossilis* is a tropical freshwater fish which attains an adult size of 18-30 cm. long and weighs about 40-80gm.

Various functions of the body including reproduction are controlled by endocrine system and nervous system. In both the systems, brain plays a vital role. Brain regulates the activities of pituitary gland through hypothalamus. Brain receives the stimuli through vision and olfaction. Impulses generated through these stimuli are then conveyed to the appropriate nuclei in the hypothalamus which in response secrete neuropeptides and neurohormones and regulate the secretion of pituitary. Olfactory system consists of olfactory rosette, olfactory tract, olfactory bulb, Olfactory bulb acts as the first relay station receiving primary olfactory nerve input in fish and other vertebrates (Farbman, 1994). Posteriorly it extends as olfactory tract. Each olfactory tract in turn has Lateral olfactory tract (LOT) and Medial olfactory tract (MOT) terminating on telencephalon. Signals arising from each of these tracts are transmitted to respective target areas in the telencephalon and diencephalon which are referred to as secondary olfactory areas.

MATERIALS AND METHODS

Fishes were collected from natural habitat all around the Nagpur City; they were acclimatized in small ponds. Fishes were treated as per the guidelines of Institutional Animal Ethics Committee (IAEC), Post Graduate Teaching Department of Zoology, RTM Nagpur University, Nagpur (Registration no.- 478/01/a/CPCSEA). Matured fishes

were selected with body weight ranging from 500 to 700 gm. in case of *C. punctata* and 100 to 125 gm. in case of *H. fossilis*. The fishes were anesthetized and olfactory organ, were dissected out and immediately fixed in Bouin's fixative, embedded in paraffin wax and cut at 8 to 10 µm in transverse planes. Sections were stained by HE double staining technique and Niss'l staining method (Kluver and Barrera, 1953).

RESULTS

In *C. punctata,* a paired olfactory rosette situated in olfactory chamber (Figure 1a). Olfactory rosette comprises of several olfactory lamellae running in rostro-caudal direction. Olfactory epithelium of olfactory lamellae have sensory region with olfactory receptor neurons (ORNs) and non-sensory region without ORNs. In *C. punctata,* sensory region present at the proximal and basal part of olfactory lamellae and non-sensory region lies at middle and distal part of olfactory lamellae (Figure 1c). ORNs are elongated cells and have dendrite towards the outer side (Figure 1d, 1e). Towards inner side, ORNs send the axon. These axons collectively form olfactory nerve which which runs posteriorly and meets with olfactory bulb (Figure 1a, 1b). *C. punctata* has long olfactory nerve (Figure 1a, 1b). Snakehead *C. punctata* have sessile type of olfactory bulb as it is attached with telencephalon (Figure 1a, 1b). Axons of ORNs form outer olfactory nerve layer (ONL) (Figure 1f). Inner to ONL, glomerular layer (GL) with synapses of axons of ORNs and mitral cells present (Figure 1f).GL towards inner side has mitral cell layer (MCL) and central granular cell layer (GCL) (Figure 1f).

In *H. fossilis,* a paired elongated olfactory rosette lies in olfactory chamber (Figure 2a). Olfactory lamellae radiated outwardly from central raphe which is absent in *C. punctata.* In *H. fossilis,* sensory region lies at middle portion as ORNs present in this region (Figure 2b, 2c). ORNs sends their axons towards olfactory bulb. Olfactory bulb in *H. fossilis* is of pedunculated type as it remains in proximity of olfactory rosette. Axons of ORNs form ONL which is outermost layer followed by GL, MCL and central GCL as in *C. punctata* (Figure 2d). From olfactory bulb fibers arises and form long olfactory tract which run towards the telencephalon (Figure 2a).

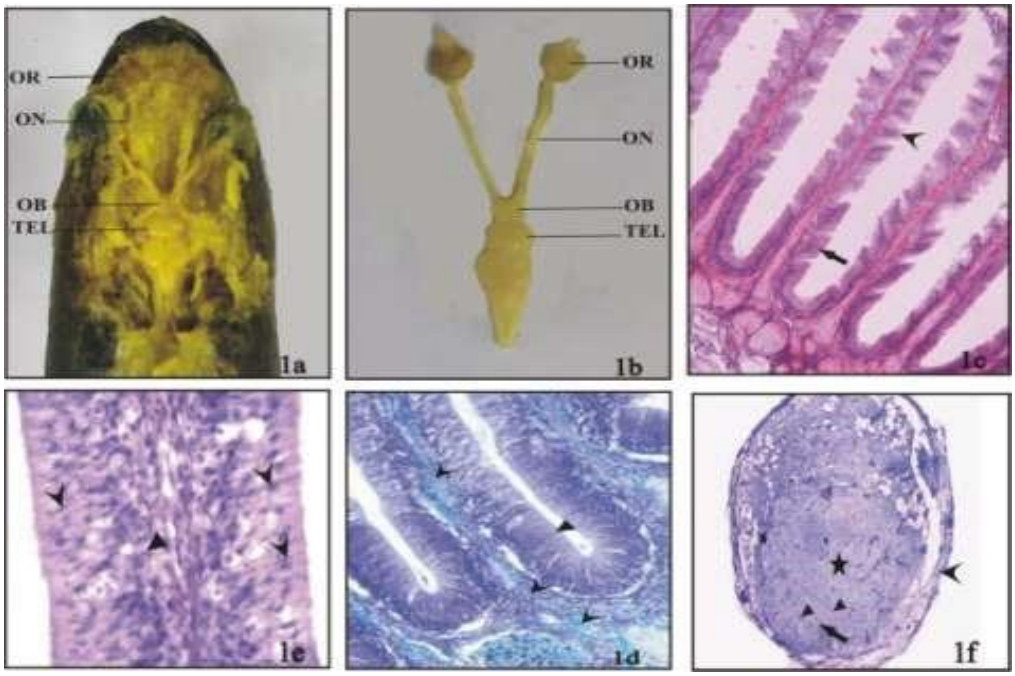

Fig. 1. Olfactory organs of *C. punctata.*

1a: Dissecting head of *C. punctata* showing olfactory rosette (OR), olfactory nerve (ON), olfactory bulb (OB) and telencephalon (TEL). **1b**: ex-situ olfactory rosette (OR), olfactory nerve (ON), olfactory bulb (OB) and telencephalon (TEL) of *C. punctata*. **1c**: Olfactory epithelium of *C. punctata* showing sensory epithelium (Arrow), non- sensory epithelium (Arrow head), HE staining, 40 X. **1d**: Olfactory epithelium of *C. punctata* showing ORNs (Triangle), which sends their axons (Arrow head) to olfactory bulb, KB staining, 40 X. **1e**: Olfactory epithelium of *C. punctata* showing ORNs (Arrow head), and basal cells (Triangle), HE staining, 40 X. **1f**: Olfactory bulb of *C. punctata* showing olfactory nerve layer (Arrow head), glomerular layer (Arrow), mitral cell layer (Triangle) and granular cell layer (Star), KB staining, 40 X.

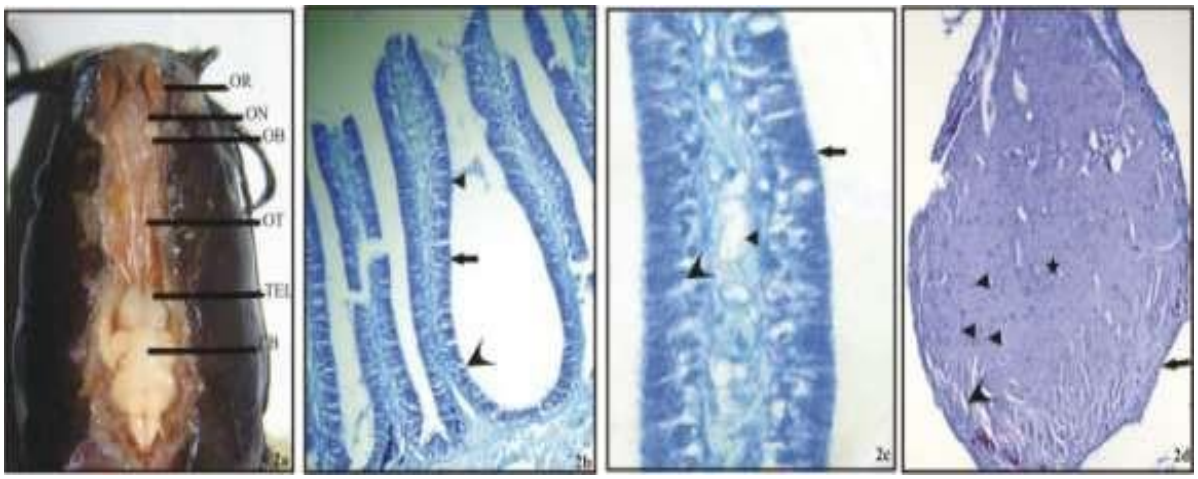

Fig. 2.Olfactory organs of *H. fossilis.*

2a: Dissecting head of *H. fossilis* showing olfactory rosette (OR), olfactory nerve (ON), olfactory bulb (OB) and cerebellum (CB). **2b**: Olfactory epithelium of *H. fossilis* showing sensory region at middle part (Arrow), non-sensory region at distal part (Arrow head), HE staining. 10X, **2c**: Olfactory epithelium of *H. fossilis* showing ORNs (Arrow), Basal cell (Arrow head) and axonal fibers (Triangle), KB staining, 40 X. **2d**: Olfactory bulb of *H. fossilis* showing olfactory nerve layer (Arrow), glomerular layer (Arrow head), Mitral cells of MCL (Triangle) and granular cells of GCL (Star), KB staining, 40 X.

DISCUSSION

Sensory region is at the proximal end and basal regions of lamellae in *C. punctata* as in *N. notopterus* (Baile et al., 2008) while in *L. rohita*, sensory region occupies middle of the lamellae and non-sensory region is at the proximal and distal regions on either side of sensory region of lamellae (Bhute et al., 2007) . Similar arrangement of sensory region over olfactory epithelium found in *H. fossilis*.

In *C. punctata*, olfactory bulb is attached to the telencephalon and is sessile. Lamellae run parallel to central raphe and are arranged in rostro-caudal direction. Sessile olfactory bulb is reported in *Salmon* (Evans et al., 1998), *Carassius, Ictalurus and Gnthonemusi* (Nieuwenhuys, 1998). Olfactory bulb is pedunculated in *H. fossilis.* It is in the proximity of the olfactory rosette and caudally connected to the telencephalon by long olfactory nerve. Such type of olfactory bulb is found in *Salmo, Anguilla and Gasterosteus* (Nieuwenhuys, 1998), *Labeo rohita* (Bhute et al., 2007), *Notopterus notopterus* (Baile et al., 2008). Interestingly olfactory bulb is altogether absent in moray, *Muraena undulate* (Kapoor and Ojha, 1972).

As in other teleosts, olfactory bulb comprises of four concentric layers; Olfactory nerve layer (ONL), Glomerular layer (GL), Mitral cell layer (MCL) and Granular cell layer (GCL) from superficial to the deep in *C. punctata* and *H. fossilis.* ONL axons march inward and synapse with the dendrite of mitral cell in glomerular layer (GL) (Ichikawa, 1976; Kosaka and Hama, 1982; Oka, 1983). In *Oncorhynchus*, the glomerular layer appears to contain nine discrete terminal fields, each of which receives convergent input from all rosettes in the olfactory epithelium (Riddle and Oakaley, 1992). Inner to the GL, mitral cell layer (MCL) containing comparatively larger mitral cells is present. Distal dendrites of mitral cells synapse with fibers of olfactory nerve while proximal dendritic shaft make contact with granule cell dendrites (Ichikawa, 1976; Oka, 1983). Axons of mitral cells originate in the basal part of the soma, become myelinated after some distance (Kosaka and Hama, 1982) and projected in the medial and lateral olfactory tract (Fujita et al., 1988). There are some slight, but significant morphological differences between medially and laterally located mitral cells (Fujita et al., 1984) that might be correlated with different physiological properties (Satou et al., 1983). Centralmost area is occupied by granular cell forming granular cell layer (GCL). Same and identical arrangement of different cell layers as described above is found both in *C. punctata* and *H. fossilis.*

CONCLUSION

Snakehead, *C. punctata* has rostro-caudally running olfactory lamellae while olfactory lamellae radiating outward from central raphe. Olfactory bulb is sessile and pedunculated in *C. punctata* and *H. fossilis* respectively. Sensory region is at base of olfactory lamellae in *C. punctata*. In *H. fossilis,* sensory region occupies central part of olfactory lamellae. *C. punctata* has long olfactory nerve. Catfish, *H. fossilis* has short olfactory nerve and long olfactory tract.

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