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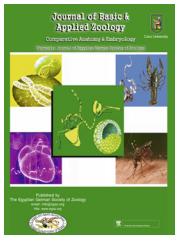

Morphological, anatomical and histological studies on the olfactory organs and eyes of teleost fish: *Anguilla anguilla* in relation to its feeding habits

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Abstract The morphology, anatomy and histology of the olfactory organ of *Anguilla anguilla* have been described. It was found that each olfactory chamber opens externally by an anterior inlet and posterior outlet nostrils. The olfactory rosette situated in each chamber is oval and the number of its olfactory lamellae in the olfactory rosette increases with the increase of body length. The olfactory epithelium of the lamellae is composed of receptor, supporting, basal and goblet cells.

The average olfactory surface area is about 590.9% of the retinal area. Thus *A. anguilla* is a macrosmatic species "nose-fish" in which olfaction plays an important role in its feeding habit. It is noticed that, the photoreceptor cell layer in *A. anguilla* (bottom feeder) is made up only of rod cells.

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Introduction

The feeding habits of fishes are reflected on the structure and size of sense organs, particularly the eyes and olfactory organs. For many animal groups vision is the most important, while information about the chemical nature of the external environment is more essential in others. For fishes, where life is entirely restricted to the aqueous environment, chemoreception plays a major and sometimes decisive role in many of its behaviour such as feeding, defence, spawning, schooling, orientation and migration (Hara, 1975). Nevertheless, according to Popova (1967) predaceous fish may be divided into two groups on the basis of their method of finding and procuring food; being diurnal and nocturnal predators. In the former group vision plays the main role in capturing prey, whereas nocturnal fishes apply the senses of smell, touch and lateral line organs. Burne (1909) and Teichmann (1954) had earlier classified the olfactory rosettes of fishes into three specific morphological types. Fishes having greater number of olfactory lamellae show behavioural responses to olfactory stimulation, nose fish (macrosmatic). But, fishes having lesser number of lamellae, show lesser response to olfaction and greater to sight, eye fish (microsmatic). The intermediate between macrosmatic and microsmatic, mediosmatic ones, eye-nose fishes. The literatures on the structure of the olfactory organs in many teleostean fishes have recently been reviewed extensively by (El-Attar and El-Agamy, 1989; El-attar, 1990; El-Agamy and El-attar, 1990, 1991; El-Attar et al., 1999, 2006, 2010; Kumari, 2008; Zeiske et al., 2009 and Charkrabari and Gosh, 2010).

The visual system in teleostean fishes has attracted the attention of many authors such as (El-Attar et al., 1999; Donatti and Fanta, 2002, 2007; Asli et al., 2012 and Begum et al., 2013).

The present work aimed to find out a correlation between the olfactory organ and retina on one side and the feeding habits on the other side in the teleost fish *A. anguilla*.

Materials and methods

Adult 26 live specimens of *A. anguilla* (Family: Anguillidae) were collected from Bahr Mouas, a branch of the River Nile in Sharkia province. The standard length of specimens was ranged from 34.2 to 54.4 cm.

For the morphological and morphometric studies, the fish specimens were immediately sacrificed. The fish head then was fixed in 10% formalin in order to be dissected from their cranial roof. However, for histological studies, the olfactory organs were fixed in Bouin's solution and eyes in Carnoy's fluid. Transverse and vertical serial sections of 6 μm thick, were stained with Harris haematoxylin and Toluidine blue.

Morphometric studies

For morphometric studies, each of the following parameters was measured in cm (SL = standard length).

Area of retina

The area of retina (SR) was calculated by using the equation: $SR = 2\pi r^2$ where (π) is constant and (r) is the average of the two radii of the eye.

Olfactory area

The olfactory rosettes of both sides were dissected out carefully, and the number of lamellae in each rosette is counted. Then after, the left and right rosette were stained for 10 min with neutral red the olfactory lamellae were separated from the mother rosette, mounted in glycerine and were drawn by camera lucida to illustrate their measurements. The average olfactory surface area of all lamellae in each fish was calculated for one rosette, and compared with the area of retina according to the methods described by Teichmann (1954).

The obtained data were recorded in tables, analysed and curves were made to reveal the relationship between these parameters.

Results

The olfactory organs

In *A. anguilla* the olfactory organs are represented by a pair of olfactory chambers situated dorso-anteriorly between the eyes and snout. Each olfactory chamber opens externally by two nostrils; an anterior inlet and a posterior outlet and is occupied by an olfactory rosette, formed of numerous lamellae (Fig. 1).

Dissection of the head from the dorsal side shows the anatomical relationship between the brain and the olfactory rosette. The olfactory lobes are closely situated to the cerebrum so the olfactory nerves are long and thick. Each nerve is formed of bundles of olfactory fibres arising from the ventral surface of the corresponding rosette (Fig. 2).

It has been found that the olfactory rosette is oval in shape and occupies most of the olfactory chamber cavity. Thus, it belongs to type II of Bateson (1889) or column II of Burne

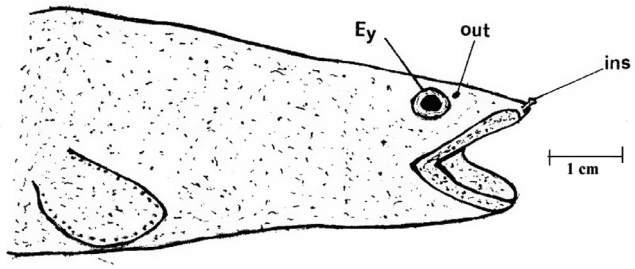

Figure 1 Camera, lucida drawing of dorsal view of the head of *A. anguilla*, showing Ey, eye; out, outlet nostril; ins, inlet nostril.

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