



Surface architecture of the oropharyngeal cavity and the digestive tract of *Mulloidichthys flavolineatus* from the red sea, Egypt: A scanning electron microscope study

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ABSTRACT

Surface architecture of the buccal cavity and the surface organization of the luminal mucosa of the oesophagus, stomach, and intestine of the carnivorous fish *M. flavolineatus* from the Red Sea were studied by using SEM. The results revealed that *M. flavolineatus* has four kinds of teeth; curved-blunt, wedge-shaped, flattened crowns, molariform and papilliform. Three types of taste buds (type I, II and III) were recorded in the oropharyngeal cavity. It was observed that taste buds and teeth are co-located in the pharyngeal region. Characteristic patterns of microridges of the surface cells in the oral cavity and oesophagus were observed. Mucous cells are distributed in the lining of the mouth cavity, oesophagus, stomach, and intestine. Characteristic patterns of mucosal folds throughout the alimentary canal, concerning oesophagus, stomach, and intestine were revealed. Numerous gastric pits, which represents the emergence of the gastric glands, were recorded in the anterior and middle regions of the stomach. Complex patterns of the folds and mucous cells were recorded in the intestinal mucosa. These results were discussed with other teleost fishes.

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1. Introduction

The mouth shapes and buccal cavities of fishes are a good clue to what a fish eats because they show great plasticity and structural adaptability for the exploitation of different food items (Baoom, 2012; El Bakary, 2012, 2014; Harabawy et al., 2008; Horn, 1998; Kapoor and Khanna, 1994; Kapoor et al., 1975). In teleosts, variations related to diet, feeding habit phylogeny, body shape and functional differentiation features in the gastrointestinal tract morphology were observed (Abaurrea et al., 1993; Anderson, 1986; Kapoor et al., 1975; Noaillac-Depeyre and Gas, 1974).

The study of the surface architecture of the oropharyngeal cavity, the form and distribution of taste buds, dentition and the surface organization of the mucosa of the oesophagus, stomach and intestine of a variety of fishes having different food habits and inhabiting a variety of habitats using scanning electron microscope has been reported (Abbate et al., 2006, 2012a,b; Anderson, 1986; Baoom, 2012; Bishop and Odense, 1966; Cataldi et al., 1987; Chakrabarti and Sinha, 1987; El Bakary, 2011, 2012; Ezeasor, 1982; Fishelson et al., 2004; Gamal et al., 2012; Grau et al., 1992; Guerrero et al.,

2015; Harabawy et al., 2008; Meyer-rochow, 1981; Osman and Caceci, 1991; Sinha and Chakrabarti, 1985; Sire and Allizard, 2001; Sire et al., 1998; Yashpal et al., 2006).

Yellow stripe goatfish (*Mulloidichthys flavolineatus*) is a marine water carnivorous fish that is commonly found in the Persian Gulf, the Red Sea and East Africa to the Hawaiian, Marquesan, and Ducie islands, north to the Ryukyu and Bonin Islands, south to Lord Howe and Rapa Islands. Occasionally schooling species inhabit shallow sandy areas of the lagoon and seaward reefs. Large adults are often found alone on sand slopes with other species following to feed on preys that are disturbed when the goatfish is feeding. Benthopelagic fishes feed on crustaceans, mollusks, worms, heart urchins and foraminiferans (Meyer-rochow, 1981).

The aim of the present work is to provide a better understanding of the structural and the functional relationship of the mouth cavity and the digestive tract, the study includes the surface organization of the mucosa of oesophagus, stomach and intestine of the carnivorous fish *Mulloidichthys flavolineatus* from the Red Sea.

2. Materials and methods

Specimens of *Mulloidichthys flavolineatus* were collected from the Red Sea at El-Ghardaqa (Hurghada) Egypt, and then transported directly to the laboratory and dissected out to get and preserve the

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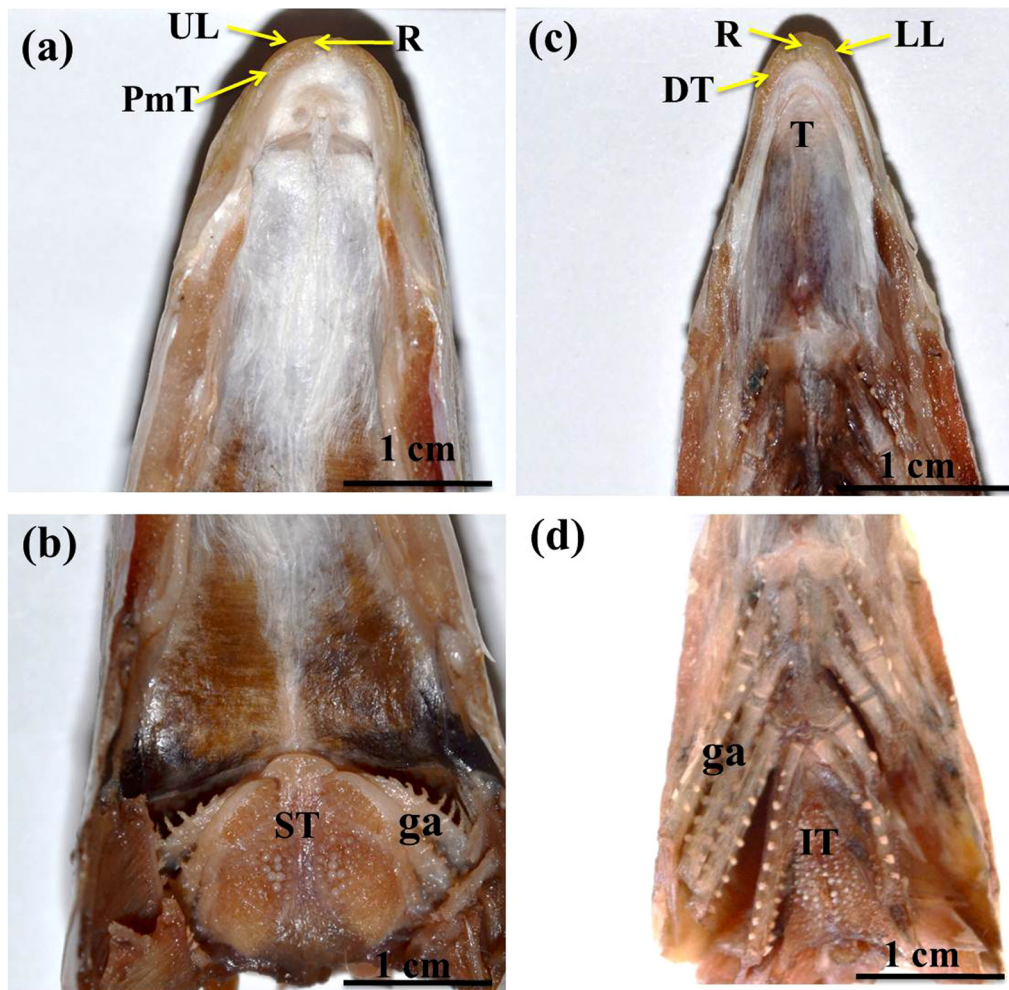


Fig. 1. Photographs showing the morphology of the roof (a & b) and the floor (c & d) of the mouth cavity of *M. flavolineatus*. UL: upper lip, PmT: premaxillary teeth, ST: superior pharyngeal teeth, LL: lower lip, DT: dentary teeth, R: ridge-like structure, T: tongue, IT: inferior pharyngeal teeth, ga: gill arch.

different parts of the lining tissue of the buccal cavity (1 cm length). The dissected buccal cavity of the fish was photographed with a digital camera. For studying the lining epithelium of the digestive tract, small parts (2 cm length) from the anterior, middle and posterior regions of each of oesophagus, stomach and intestine were obtained. Each part was opened, cleaned carefully from its food content. A brush which was pre-immersed in 1% hydrochloric acid was used to dissolve and remove the mucous from the epithelium. Then, the tissues were fixed in 2.5–5% glutaraldehyde buffered with $\text{NaH}_2\text{PO}_4 + \text{NaH}_2\text{PO}_4$ (0.1–0.2 M) (Ph = 7.2–7.3) (Cataldi et al., 1987) and washed in cacodylate buffer for one hour and post-fixed in a buffered solution of 1% osmium tetroxide (OSO_4) at 37 °C for two hours, dehydration in ethyl alcohol with complete dehydration in amyl acetate pure for two days and dried in carbon dioxide (CO_2) and sputter-coated with gold. The tissues were examined by a JEOL Scanning Electron Microscope (JSM-5400LV) in the Electron Microscope Center of Assiut University, Assiut, Egypt.

3. Results

3.1. Morphology of the mouth cavity

In *M. flavolineatus*, the oral cavity opens anteriorly through a narrow transverse mouth opening, which is bordered by the upper and lower lips. The lining of the mouth cavity of this species is divided into two regions, the dorsal roof and the ventral floor (Fig. 1).

The roof of the mouth cavity of *M. flavolineatus* (Fig. 1a & b) comprised anteroposteriorly: (a) an upper jaw with premaxillary teeth, (b) an elongated ridge-like structure occurred between the premaxillaries. The upper lip is fleshy and partly covers the teeth on the upper jaw (Fig. 1a). Oval superior pharyngeal teeth are observed (Fig. 1b).

The floor of the mouth cavity of the aforementioned species (Fig. 1c & d) also, comprised anteroposteriorly: (a) a lower jaw with dentary teeth, (b) an elongated ridge-like structure occurred between the dentaries and (c) tongue. The lower lip is fleshy and partly covers the teeth on the lower jaw (Fig. 1c). Triangular inferior pharyngeal teeth are observed (Fig. 1d).

3.2. Scanning electron microscope observations

3.2.1. Upper and lower lips

Scanning electron micrographs showed that the upper lip of *M. flavolineatus* had mucous cell openings and scattered residue of mucous spheres (Fig. 2a).

The lower lip consists of a mosaic pavement of irregular epithelial cells of varied dimensions, taste buds of type III are observed among epithelial cells (Fig. 2b). The free surface of each epithelial cell is characterized by the presence of a series of microridges and mucous cell openings are observed (Fig. 2c).

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