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Gastric and intestinal morphohistology of *Epinephelus coioides* (Osteichthyes, Serranidae)

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Abstract: The morphohistology of gastric and intestinal wall of *Epinephelus coioides* was described. The gastric mucosa is folded and lined by simple columnar epithelium. Gastric pits open into simple tubular glands. Lamina propria – submucosa consists of connective tissue with numerous eosinophilic granule cells, and muscularis is bilayer. The intestine has many villi as finger like projections and its epithelium is simple columnar interspersed with goblet and rodlet cells. The tunica muscularis is composed of two muscle layers, thick inner circular and thin outer longitudinal. There were no muscularis mucosae in both of organs.

Key Words: Serranidae; fish; histology; digestive tract

Introduction

Characterization of the morphology and histology of the alimentary canal of fish is fundamental to understand their basic biological aspects, related to digestion and absorption of food. Besides the function of digestion and absorption, the stomach and intestine may play other functions e.g., assist breathing and in the osmoregulation, sufficient indication of the plasticity of these organs to change their structure and physiology (Silva *et al*., 2012).

The macroscopic and microscopic anatomy of the fish digestive tract shows remarkable differences among species. Although it shows a broad diversity in its morphology and function, but has some basic similarities in structure (Diaz *et al*., 2003; Domeneghini *et al*., 1999). The structure of the digestive system of teleosts varies with different factors including the nature of the food, the frequency of food intake, feeding habits, body size, shape and sex and taxonomy (Banan Khojasteh, 2012; Diaz *et al*., 2003; Domeneghini *et al*., 1999; Petrinec *et al*.,

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2005). The presence of mucosubstances in digestive tract of fish has been also documented in most teleosts (Kapoor *et al*., 1975; Leknes, 2010; Petrinec *et al*., 2005).

Morphological features, specifically those related to the capture and intake of prey, evolved to maximize feeding performance, and have been strongly correlated with diet (Ward-Campbell *et al*., 2005).

Groupers are species of the family Serranidae and subfamily Epinephelinae comprises of 161 species of marine fish divided into 15 genera and are one of the most commercially and ecologically important species worldwide. Characteristically strong, robust and stout, with large mouths, the Serranidae are among the most important carnivorous fish of coral reefs (Taylor, 2008).

Epinephelus coioides (Hamilton, 1822) is dominant species of Groupers in Persian Gulf and mainly is captured by the trap. In recent years more attention has been given to its culture in south East Asia, because of its economical importance. This fish is a target species for marine culture (Mohammadi *et al*., 2007).

As knowledge of fish's alimentary canal morphohistology is becoming increasingly important in fish digestive physiology, and identification of digestive tract structure is essential for understanding the related nutria-tional mechanisms (Banan Khojasteh, 2012) and with consideration that *E. coioides* is an important link in the trophic dynamics of tropical reef ecosystems, and also little is known about the morphological and histological characteristics of the stomach and intestine in *E. coioides*, the present study was undertaken.

Materials and methods

In this study, 10 adult male and female specimens of *E. coioides* (body weight 1000 – 1500 g; total length ranging from 20 to 40 cm) acquired from working fishermen's catches in Hengam Island (south of Qeshm Island, Hormuzgan province, Iran). The specimen's gastrointestinal tracts were dissected out and tissue samples of stomach (cardiac and fundic regions) and anterior and posterior intestine were immediately fixed in 10% neutral buffered formaldehyde. Then the samples were dehydrated through a standard ethanol series to 100%, cleared in xylene and embedded in paraffin wax. 5-6 µm serial sections were deparaffinized and stained with Mayer's haematoxylin and eosin for routine light microscopic study. The sections were examined under the Nikon light microscope and photographs taken with a Nikon photomicrographic attachment.

Results

The microscopic findings showed that the wall of stomach and intestine of *E. coioides*

consists of mucosa, lamina propria-submucosa, muscularis and serosa.

Stomach- The gastric mucosa was folded and lined by simple columnar epithelial cells with an oval nucleus situated in the basal part of the cell (Fig. 1 and 2). No goblet cells were observed between columnar cells. Simple gastric tubular glands opened into pits (crypts) (Fig. 2). The muscularis mucosae was not observed. The lamina propria was typical loose connective tissue, but the submucosa was relatively dense one. Numerous eosinophilic granule (acidophilic or mast) cells were observed in lamina propria-submucosa that had irregular shape, eccentric nuclei and eosinophilic granules (Fig. 3). The muscularis of the stomach was composed of two layers of smooth muscle. A serosa (simple squamous epithelium in association with a loose connective tissue) surrounded the stomach.

Intestine- The mucosa of intestine had many branched villi (Fig. 4). The epithelium consisted of tall and cylindrical columnar cells (called also enterocytes that were interspersed with goblet and rodlet cells (Fig. 5 and 6). The epithelial surface showed a prominent brush border (Fig.6). The goblet cells were distributed throughout the intestinal epithelium but tended to be more numerous in the posterior part of the organ (Fig. 5 and 6). There were no muscularis mucosae and mucosal tubular glands. Lamina propria-submucosa extended into the mucosal folds. The muscularis consisted of smooth muscles arranged in a thick circular inner layer and a thin longitudinal outer layer (Fig. 7). Between these two muscular layers there were many nerve plexus. A serosa was located at the external part of the muscular layer (Fig. 7). No stratum compactum was seen in stomach and intestine.

Discussion

The general structural peculiarities of the gastric and intestinal wall of *E. coioides* is nearly similar to that in other bony fishes (Arellano *et al*., 2001; Banan Khojasteh *et al*., 2009; Canan *et al*., 2012; Carrasson *et al*., 2006; Cinar and Senol, 2006; El Hag *et al*., 2012; Marchetti *et al*., 2006; Park and Kim, 2001; Silva *et al*., 2012). The stomach and intestine are composed of four layers: mucosa, (lamina propria) submucosa, muscularis and serosa, classically described for vertebrates (Diaz *et al*., 2003).

The results of present study showed that well developed folds are present in gastric mucosa that may suggest adaptation to increase the internal surface and perform exclusively function of chemical digestion (Silva *et al*., 2012). The mucosal folds may allow delay in the food passage through the stomach into smaller portions, permitting an efficient mixing of the food bolus with digestive fluids (Osman and Caceci, 1990).

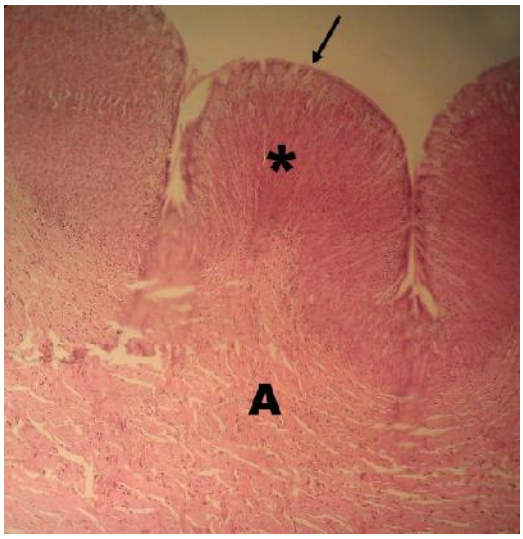

Fig.1. Section of stomach: epithelium (arrow), mucosa with simple tubular glands (star) and submucosa (A). × 40.

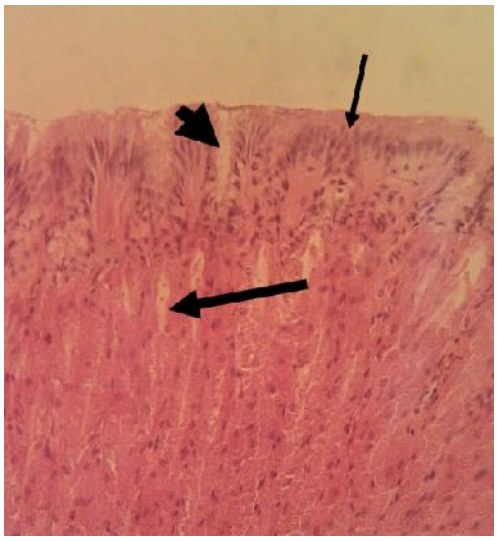

Fig. 2. Mucosa of stomach: simple columnar epithelium (small arrow), gastric pit (arrowhead) and simple tubular glands (large arrow). × 400.

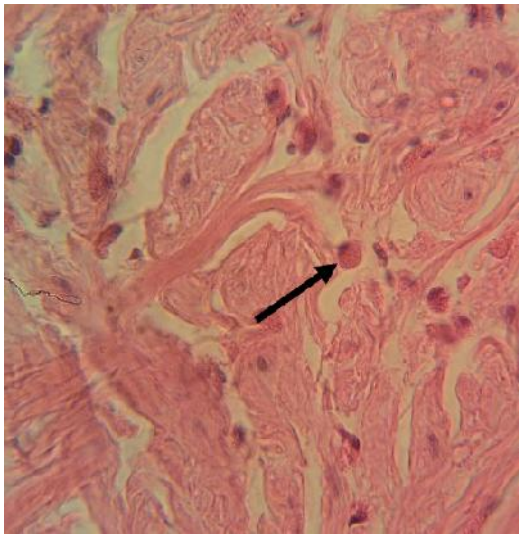

Fig. 3. Submucosa of stomach containing eosinophilic granule cells (arrow). × 400.

Fig. 4. Transverse section of the intestine: villi (large arrow), thick inner muscle layer (star) and serosa (small arrow). × 400.

Fig. 5. A villus of intestine: many goblet cells (arrow) in posterior intestine, and lamina propria (L). × 100.

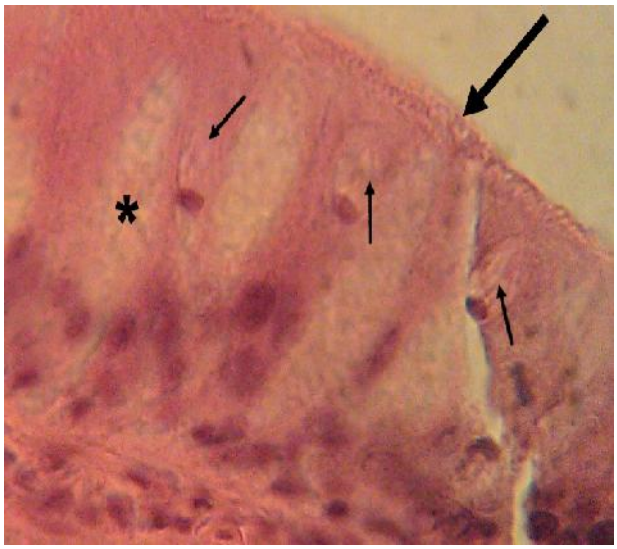

Fig. 6. Epithelium of intestine: brush border (large arrow), rodlet cells (small arrows) and goblet cell (star). × 400.

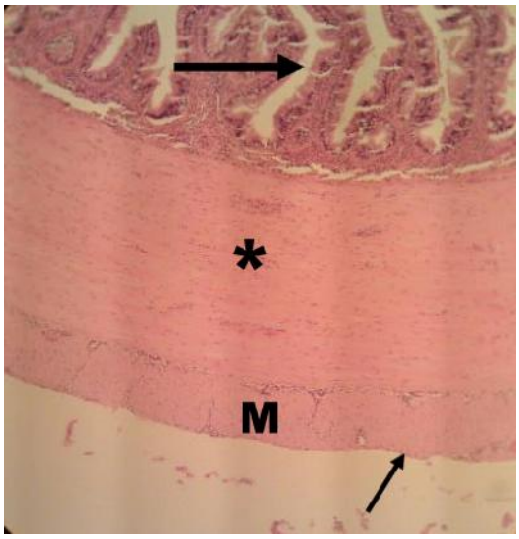

Fig. 7. Transverse section of intestine: villus (large arrow), thick inner circular muscle layer (star), thin outer muscle layer (M) and serosa (small arrow). × 40.

In *E. coioides* like other teleosts, the gastric mucosa is lined with a simple columnar epithelium and the mucosal epithelium invaginates to form gastric pits at the bottom of which gastric glands open (Desantis *et al*., 2009; Diaz *et al*., 2008). Electron microscopic studies have shown that short microvilli and small quantities of neutral mucosubstances exist in gastric epithelial cells that could indicate the absorptive function (Arellano *et al*., 2001). Like the *E. coioides*, the presence of gastric tubular glands has been reported from other species. Secretion of neutral glycoconjugates containing sugar residues in these glands may serve to protect the stomach epithelium from autodigestion caused by HCL and enzymes produced in gastric glands (Ferraris *et al*., 1987; Arellano *et al*., 2001). The presence of mucosa secreting mucus should have the task of facilitating the food passage through the organ; adjust the pH, as well as protecting from the microorganisms (Silva *et al*., 2012; Ringo *et al*., 2007; Osman and Caceci, 1990).

The findings of this study revealed that many eosinophilic granule cells present in lamina propria-submucosa. These cells mediate immune responses (Osman and Caceci, 1990). It has been verified an increase in the number of the other immune cells such as macrophages in fish inhabiting polluted water (Agius and Roberts, 2003). The stratum compactum was not observed in stomach of *E. coioides*, but has been found in other fish such as mud loach *Misgurnus mizolepis* (Park and Kim, 2001).

The tunica muscularis of stomach of *E. coioides* is consisted of two smooth muscle layers that are similar with *Dentex dentex* (a demersal carnivorous sparid) and *Solea senegalensis* (a flatfish) (Carrasson *et al*., 2006; Arellano *et al*., 2001).

The histological features of intestine in *E. coioides* are similar to other piscivorous fish, although few variations are distinguishable. The well developed villi in intestinal mucosa also described by other investigators (Manjakasy *et al*., 2009; Xiong *et al*., 2011). These fingerlike projections are directly involved in absorption processes (Silva *et al*., 2012). The intestinal length together with the villi increase the number of enterocytes, cells that have the function of final digestion, absorption of nutrients, proteins and lipids (proximal intestine), as well as water, electrolytes and protein macromolecules (distal intestine) (Takashima and Hibiya, 1995). Goblet cells are common components of the post gastric mucosa in fish and considered as a dominant mucous cell type in intestine of fishes (Banan Khojasteh, 2012; Diaz *et al*., 2003). The increased number of these cells toward the posterior part of intestine observed in present study, has also reported in other species like rice field eel (Dai *et al*., 2007) and rainbow trout (Banan Khojasteh *et al*., 2009) that may

imply the need for increased mucosal protection and lubrication for fecal expulsion. Banan Khojasteh *et al*. (2009) reported mucus granules with different sizes and densities in goblet cells of rainbow trout's intestine.

The rodlet cells observed in the intestinal mucosa of *E. coioides* have been found in a large number of species. It has been suggested that rodlet cells may be involved in water or electrolytes transport, or have functions similar to those of mucous cells e.g., pH control, lubrication, antibiotic effects and reaction to the presence of ectoparasites on epithelial surfaces and that an antibiotic substance secreted by these cells helps dampen the parasitic infections. They may play a role in host defense mechanism in fish (Banan Khojasteh, 2012). In this study muscularis mucosae and mucosal tubular glands were not seen in intestine, but in pike's intestine there are muscularis mucosae. The codfishes have deep glands in their intestine (Banan Khojasteh *et al*., 2009).

In conclusion, the results of this investigation suggested many similarities between gastric and intestinal structure of *E. coioides* with other bony fishes. But more studies should be done on other histological and morphological aspects of alimentary tract of this important commercial species, including digestive mucosubstances histochemistry and electron microscopic studies.

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