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Short Communication

Microanatomy and histology of the alimentary tract of the air-breathing fish *Channa gachua* (Hamilton): SEM study

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Abstract

The microanatomy and histology of buccal cavity, oesophagus, stomach, pyloric caecae and intestine of the murrel *Channa gachua* (Ham.) have been described using light and electron microscopy. Dentition in the upper and lower jaws comprises villiform, pointed teeth and in the outer margins, a few inwardly directed teeth are located. Oesophagus shows large median and small lateral folds along its length. Stomach is differentiated into cardiac and pyloric regions, while the intestine is short and has luminal folds along its length

Key words: SEM, dentition, alimentary tract, fish.

1. Introduction

Fishes in general and bony fishes in particular are known to exhibit a great diversity in their food and feeding habits[1]. Consequent to this diversity, the cytology, histology and physiology of the gut of teleost fishes are known to vary[2–7]. In India, considerable attention has been paid to the culture of air-breathing fishes of the family Channidae[8]. Hitherto, scanning electron microscopic studies of the alimentary canal of Channid fishes were not attempted. Hence, this work elucidates the light and scanning electron microscopic studies on the microanatomy and histology of the digestive tract of the murrel *Channa gachua*. The work provides the basis to correlate the feeding habits and digestive system of the species.

2. Material and methods

Live individuals of *Channa gachua* were procured from the freshwater tank located in the premises of the Indian Telephone Industries, Bangalore, and transported to the laboratory. Fish were anaesthetized and dissected to expose the alimentary tract.

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2.1. *Light microscopy*

Different segments of the digestive tract were excised, washed in 0.9% saline solution and fixed immediately in Bouin's fluid. Tissues were then embedded in paraffin wax. The blocks thus made were sectioned at 10 μm thickness and the sections were stained using Haematoxylin-Eosin.

2.2. *Scanning electron microscopy (SEM)*

A longitudinal slit was made along the entire length of the alimentary tract and was washed with cold glutaraldehyde-cacodylate buffer. The different segments were fixed in 5% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.4) for 4 h and post-fixed in 1% osmium tetraoxide for 2 h. The post-fixed material was dehydrated thoroughly in ethyl alcohol and acetone. The dehydrated material was sputtercoated with gold using Polaran sputter coater and observed in Cambridge stereo scan 5150 scanning electron microscope.

3. Results and discussion

Figure 1 shows the ventral view of the digestive tract *in situ* of *Channa gachua*. The length of the gut is reduced considerably. The oesophagus leads to a well-defined stomach and the beginning of the intestine is marked by a pair of pyloric caecae. The nature of true stomach and the reduced intestine indicate the species to be carnivorous in their feeding habit[9].

3.1. *Dentition*

The upper and lower jaws of *C. gachua* bear teeth of varied shape and size arranged in several rows. The villiform and pointed teeth on the premaxilla are not only large but also directed inwards. Size of the teeth decreases towards the posterior end of the maxilla. The entire dentary has small villiform teeth on its surface. In addition, in the anterior region and along the outer margin, large inwardly directed teeth are present. This type of arrangement of teeth suggests their function in seizure and prevention of escape of prey.

Just behind and parallel to the upper jaw, vomers bear a small patch of large teeth anteriorly and a large patch of small teeth posteriorly. The posterior patch extends much beyond the angle of the upper jaw.

A pair of ovoid upper pharyngeal pads are found on the roof of the pharynx, near the entrance to the oesophagus. The teeth are distinctly arranged in two groups (Fig. 2), the larger in the anterior half and the smaller in the posterior half of the tooth pad. All the teeth appear recurved, especially the larger ones, each with a strong base and high conical cusp (Fig. 3). The lower pharyngeal bones together form a triangular structure and are situated on the floor of the pharynx, just opposite the upper pharyngeal tooth pads. Each lower pharyngeal bone shows several rows of straight teeth on its surface (Fig. 4). Of these, the teeth along the mesial region and posterior border are large with stumpy base while the rest of the teeth are smaller. The arrangement and direction of teeth on the pharyngeal pads suggest that they aid in preventing the escape of prey.

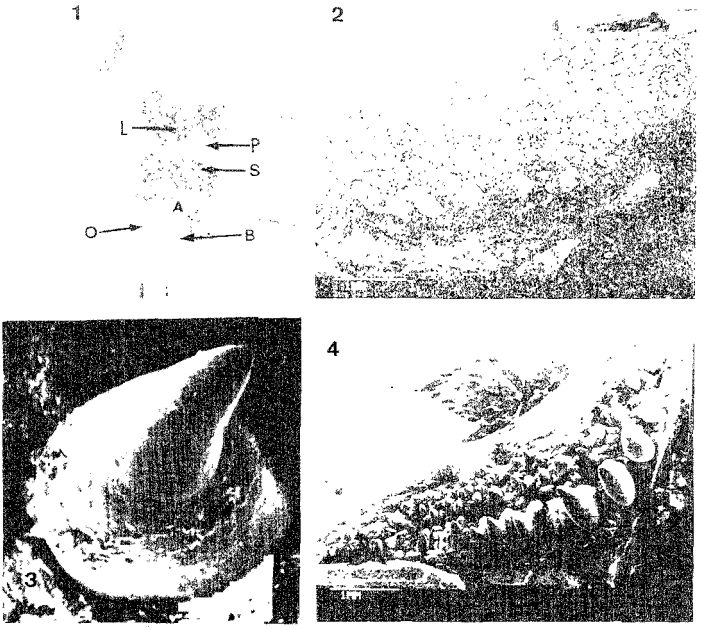


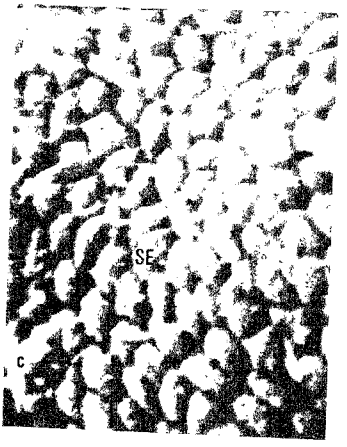
FIG. 1. Ventral view of the digestive tract *in situ* of *Channa gachua*. L: Liver, P: Pyloric caecum, S: Stomach, O: Ovary, A: Air bladder and B: Urinary bladder. FIG. 2. Entire view of the right pharyngeal tooth pad showing the distribution of teeth. FIG. 3. A single large tooth magnified from the above (460 μm). FIG. 4. Entire view of left pharyngeal tooth pad showing the arrangement of teeth.

3.2. *Oesophagus*

Oesophagus is a short, highly muscular tube. Histological features of the oesophagus as revealed through light microscopy conform to the details reported by Islam[9]. Further, under scanning electron microscope, the oesophagus shows longitudinal luminal folds of the mucosa. Large median folds and comparatively smaller lateral folds run along the length of the oesophagus (Fig. 5a). The luminal surface of the median longitudinal fold shows a number of secondary folds (Fig. 5b). These folds are lined by squamous epithelial cells (Fig. 5c), the boundaries of which show numerous modified microvilli ridges (Fig. 5d).


M
L
5a
1MM


b


SE
c


MV

←FIG. 5a. Scanning electron micrograph of oesophagus showing larger median and smaller lateral folds. M: Median fold, L: Lateral fold; b. Luminal surface of median fold of oesophagus showing secondary folds (1350 μm); c. Secondary folds of the above further magnified to show squamous epithelial cells (750 μm). SE: Surface epithelium; d. Squamous epithelial cells of the above showing modified microvilli ridges (100 μm). MV: Microvilli

3.3. *Stomach*

Stomach is demarcated into anterior cardiac and posterior pyloric portions. SEM Studies reveal that cardiac stomach contains large longitudinal primary folds or rugae (Fig. 6a). Each of these has secondary folds (Fig. 6b) and is lined by columnar epithelial cells (Fig. 6c). Histologically, the stomach wall shows four tunics. From the inner side, they are tunica mucosa, tunica submucosa, tunica muscularis and tunica serosa (Fig. 6d). Tunica mucosa shows a number of short and tall temporary outgrowths called rugae, each lined by columnar

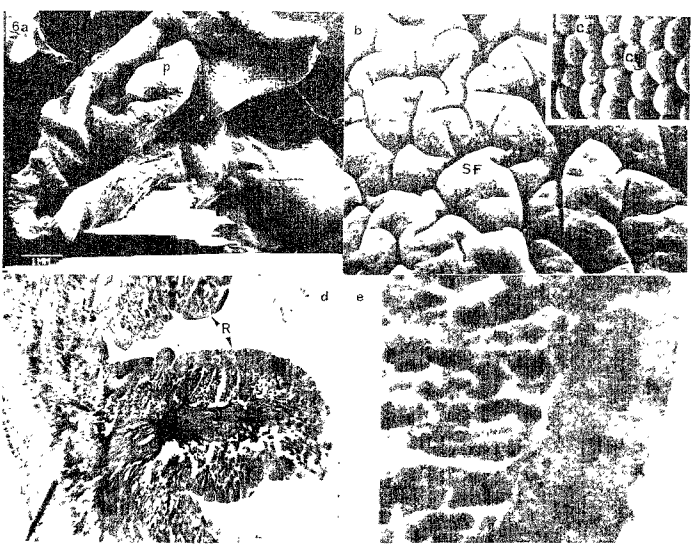


FIG. 6a. Scanning electron micrograph of cardiac stomach with luminal surface showing large primary folds. P: Primary fold; b. Secondary folds on the primary folds of the above (3300 μm). SF: Secondary fold; c. Inset shows the columnar epithelial cells on the secondary folds (3100 μm). CE: Columnar epithelium; d. Cross-section of cardiac stomach showing gastric epithelium and gastric glands (× 60). R: Rugae, G: Gastric gland; e. Enlarged view of gastric glands (× 60). G: Gastric gland.

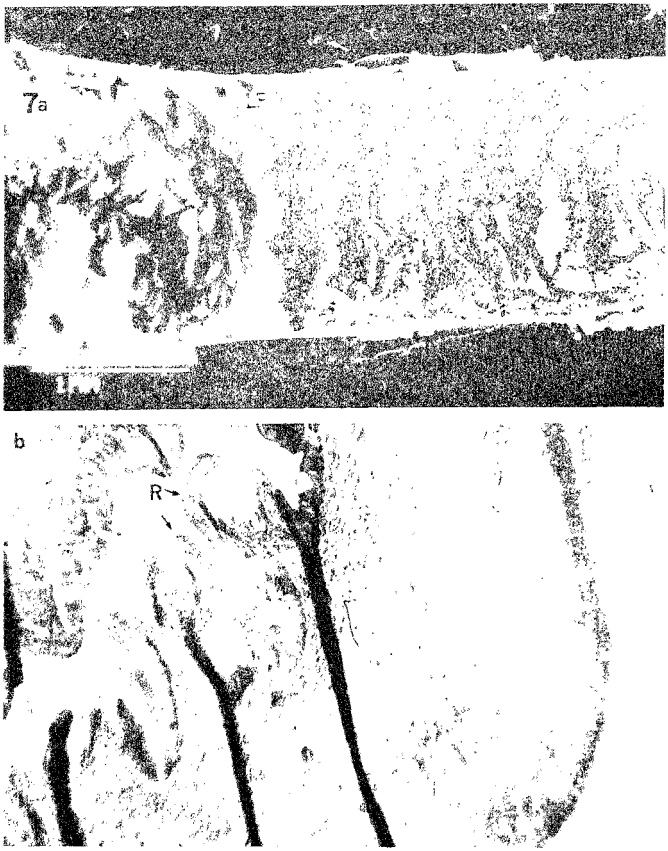


FIG. 7a Scanning electron micrograph of pyloric stomach with luminal surface showing numerous primary folds. LF: Luminal fold; b. Cross-section of pyloric stomach showing magnified rugae (× 130). R: Rugae.

epithelial cells. The tubular gastric glands lie between the gastric epithelium and tunica propria and they open into gastric pits (Fig. 6e). Tunica muscularis consists of inner thicker circular muscle layer and outer comparatively thin longitudinal muscle layer. This

observation is different from that reported for the same species by Islam[9], but is similar to those observed in the sea bass, *Centropristes striatus*[10], the sea robin, *Prionotus carolinus*[11] and the canine catfish, *Plotosus canius*[6]. Tunica muscularis is covered externally by a thin layer, tunica serosa. While demarcation of the stomach into cardiac and pyloric regions in *C. gachua* has not been reported earlier by Islam[9], the SEM studies on the pyloric stomach clearly show a different type of longitudinal folds from that of cardiac stomach (compare Figs 6a and 7a). Longitudinal folds of pyloric stomach are small in size and large in number (Fig. 7a). Histologically, the tunica mucosa of pyloric stomach shows fairly elongated, often branched folds, each lined by columnar epithelial cells and without gastric glands (Fig. 7b).

3.4. *Pyloric caecae*

Channa gachua bears a pair of pyloric caecae. Of the two, the left one is longer (2.4 cm) than the right one (1.7 cm). SEM Studies reveal that pyloric caecum also contains luminal folds (Fig. 8a). These folds on enlargement appear as in Fig. 8b and a portion of this is

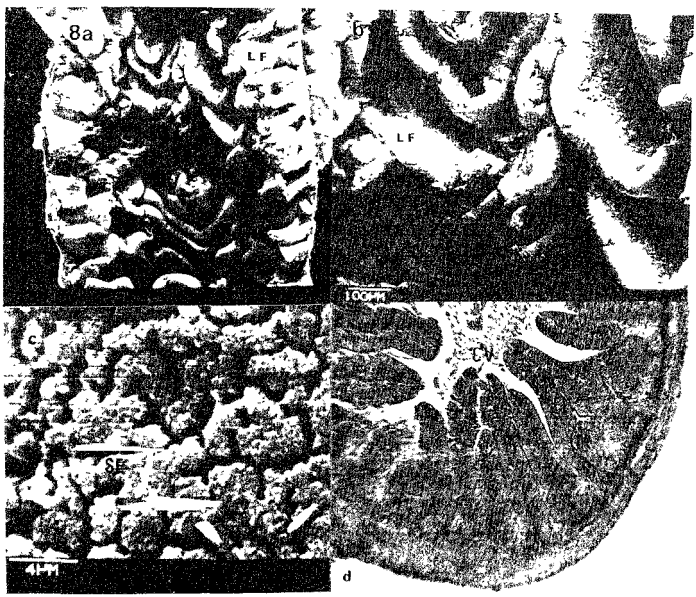
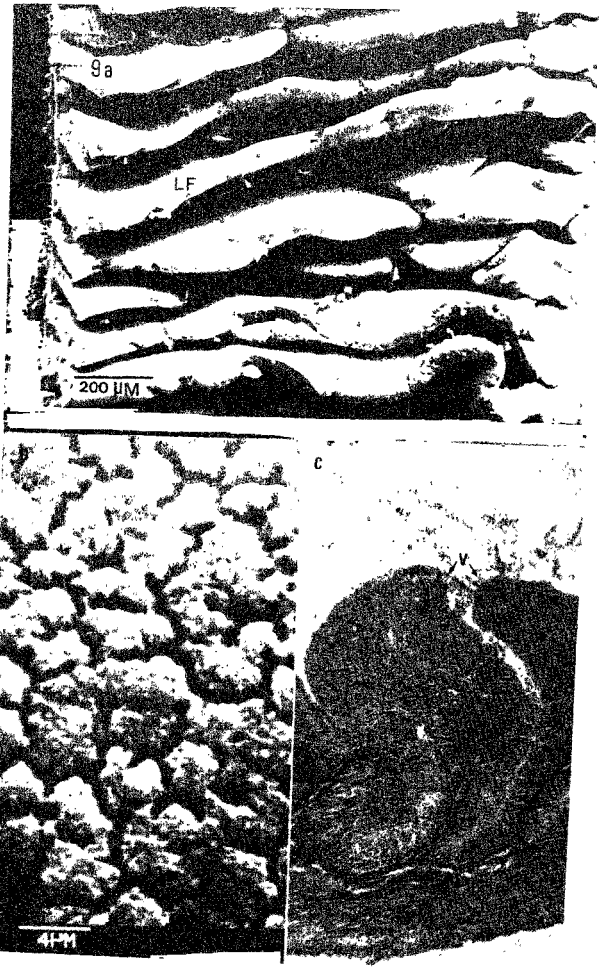


FIG. 8a. Scanning electron micrograph of pyloric caecae showing luminal folds. LF: Luminal fold; b. Enlarged luminal folds of pyloric caecum; c. Luminal folds further enlarged to show caecal villi. SE: Surface epithelium; d. Cross-section of pyloric caecum showing long caecal villi (× 100). CV: Caecal villi.


9a
LF
200 µM
c
V
4µM

← FIG. 9a. Scanning electron micrograph of the intestine showing luminal folds. LF. Luminal fold, b. Higher magnification of the above folds showing the presence of intestinal villi; c Cross-section of the intestine (a portion) showing intestinal villi (× 90). V. Villi, TM: Tunica muscularis.

further magnified to show the numerous 'caecal villi' (Fig. 8c) as designated by Rahimullah[12]. Histologically, the pyloric caecae resemble the intestine with their villi reaching almost the centre of the lumen (Fig. 8d). The caecal villi of *C. gachua* are not anastomosed and there is no reticulate appearance. No glands are observed in pyloric caecae indicating that the pyloric caecae carry out only an absorptive function.

3.5. *Intestine*

The intestine shows two descending limbs and an ascending limb. From SEM observation, it is evident that the modification of mucosal layer is mostly uniform all along the length of intestine except at the rectal region. The intestine shows a number of longitudinal folds running parallel to each other (Fig. 9a). A magnified view of luminal fold shows a number of villi (Fig. 9b). Histologically, the intestinal wall comprises four tunics similar to that observed in stomach. Tunica mucosa is thrown into finger-shaped outgrowths called villi. Each villus is lined by simple columnar epithelium. Tunica muscularis is heavily thickened in the intestine (Fig. 9c).

It could be concluded that the dentition and digestive tract of *C. gachua* exhibit a clear adaptive nature to receive food of animal origin.

Acknowledgement

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