# GASTRO-INTESTINAL TRACT OF POMADASYS JUBELINI (CUVIER, 1830) IN THE NEW CALABAR-BONNY RIVER, RIVERS STATE, NIGERIA

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**Abstract:** The mouth, teeth and intestinal tract of 20 out of 413 specimens of Pomadasys jubelini obtained from the New Calabar-Bonny River were examined macroscopically, microscopically and histologically; features of biological interest were captured photo-microscopically. The terminal mouth possessed by Pomadasys jubelini opens up to 20% of its total body length. The mouth has multiserial bands of setiform teeth; the pharyngeal teeth on the roof and floor surfaces of the mouth are modified into smooth pebble-like stones. The intestine of P. jubelini is short, about 50% of its body length and not coiled. Six to seven pyloric caeca were observed in all the species sampled. Histologically, the gastro-intestinal tract (oesophagus to the rectum) consists of the Serosa, Outer longitudinal muscle layer, Inner circular muscle layer, Submucosa, Muscularis mucosa and Mucosa.

**Key words:** Terminal mouth, gastro-intestinal tract, Pomadasys jubelini



## Introduction:

The functional morphology of the mouth and gastro-intestinal tract of different fish species, revealed the type of food and mode of feeding habits of the fish species. The diversity in feeding habits that a fish exhibit is particularly the result of evolution leading to structural adaptation for getting food from the diverse situations that constantly evolve in the environment (Dasgupta, 2000). Adaptation to the mode of feeding could be found in the mouth and jaws, teeth, the shape and size of gill rackers, stomach and intestine. The intestinal tract of fishes shows a remarkable diversity of morphology and functional characteristics. This is often related to their different feeding habits and to taxonomy as well as body shape, weight, size and sex (Diaz *et al*., 2008; Banan-Khojasteh *et al*., 2009). Specialised feeding structures are often peculiar feeding habits of some fishes for different dietary items.

The gastro-intestinal tract of fish has been studied from a few species such as rainbow trout *Oncorhynchus mykis*, white sturgeons *Asipenser transmontanus*, and *Tilapia nilotica* (Bana-Khojasteh *et al*., 2009; Domeneghini *et al*., 2002; Osman and Caceci, 1990). The knowledge of fish digestive tract is important to digestive physiology and improvement of nutrition protocols. Identification of digestive tract structure is also essential for understanding the histo-pathological mechanisms and nutritional functions (Banan-Khojasteh, 2012). *Pomadasys jubelini* has successfully adapted itself to the estuarine and marine environment which is reflected in its mode of feeding and the alimentary canal is also modified for maximum utilization of the food taken (Banan-Khojasteh, 2012).

This study investigated the oral cavity and the gastrointestinal tract of *Pomadasys jubelini* obtained from the New-Calabar Bonny River, Rivers State, Nigeria.

**Materials and methods:**

Twenty samples of *Pomadasys jubelini* that comprised of different sizes (length and weight) were collected from three different locations in the New Calabar-Bonny River, Rivers State Nigeria. Immediately after collection the samples were rinsed with water and wiped dry. The mouths and intestinal tracts were removed, the oesophagus, stomachs and intestines were gently slit open, their content rinsed off in gently flowing tap water, and thereafter fixed in 10% formaldehyde. Then the samples were dehydrated through a standard ethanol series to 100%, cleared in xylene and embedded in paraffin wax then sectioned with a rotatory microtome set at 5–6 µm, deparaffinized and stained with haemotoxylin and eosin. Prepared slides of the gastro-intestinal tract, were mounted and examined ith the Electronic Olympus microscope (model Bino Cxi IS4381) that had Samsung camera (model PL120) attached, to capture features of biological interest.

Pictures of the mouth, jaws and pharyngeal teeth were taken with a Samsung digital camera (Model PL 210).

## Results

*Pomadasys jubelini* has a terminal mouth which is wide and protractile, with scales around it. The snout is pointed and elongated (Plate I). The mouth opens as wide as 20% of its total length (Plate II). It also has a tongue which arises as a fold from the floor of the buccal cavity. There are No teeth on the tongue. Multiserial bands of setiform teeth are found on the lower and upper jaws. The teeth of the upper jaw are premaxillary (teeth present in the front margin of the upper jaw) (Plate III) while the lower jaw has teeth arranged in a mandibular position (teeth present on the margin of the lower jaw) (Plate IV). Teeth are also present on the pharyngeal bones at the back of the mouth (in the throat) on the ventral and dorsal surfaces. The ventral surface is made up of a pair of pharyngeal teeth. These teeth are in the form of smooth pebbles (Plate V).

The gills are made up of four arches on each of the left and right sides (a total of 8). The gill arch is thick and cartilaginous and has thick, long, sparsely arranged spiky gill rakers (18 on Plate VI).

The gut of *P. jubelini* is made up of a large, long and distensible oesophagus which leads directly into the stomach. The stomach is large, thick–walled, flask-like and elongated with the anterior part larger than the posterior. The duodenum is slim and leads to the pyloric caeca. The pyloric caeca is the anterior part of the intestine (Plate IX) which gives rise to a number of finger-like, tubular outgrowths (6-7). The intestine is not distinguished into small and large, it is short, about 50% of the total length of the fish and it is not coiled. The rectum is much slimmer than the intestine and ends in the cloaca of the fish.

**Plate I:** The mouth of *Pomadasys jubelini*



**Plate II:** The gape mouth of *Pomadasys jubelini*

ISSN 2229-5518

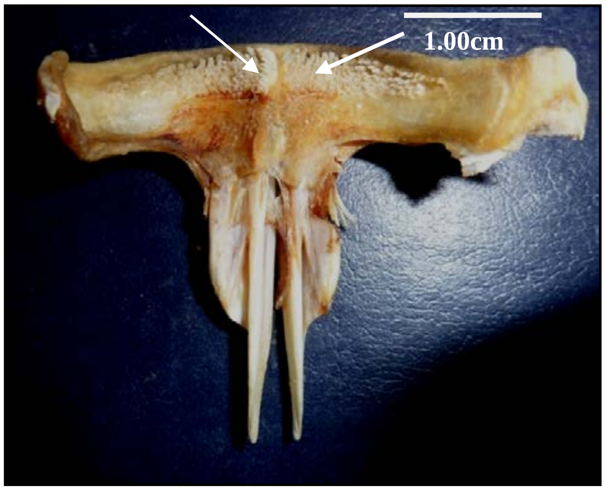


**Plate III:** The upper jaw of *P. jubelini* exhibiting premaxillary teeth (arrows).



**Plate IV:** The lower jaw of *P. jubelini* exhibiting mandibular teeth.
MT, Mandibular teeth

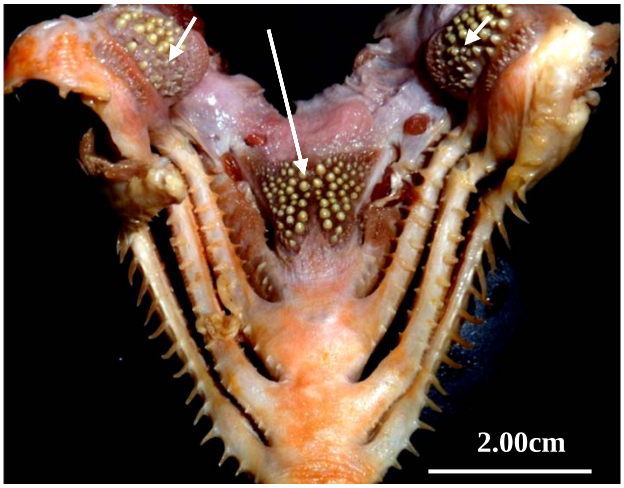


**Plate V:** The pharyngeal teeth (arrow) of *P. jubelini* as situated in the pharynx.

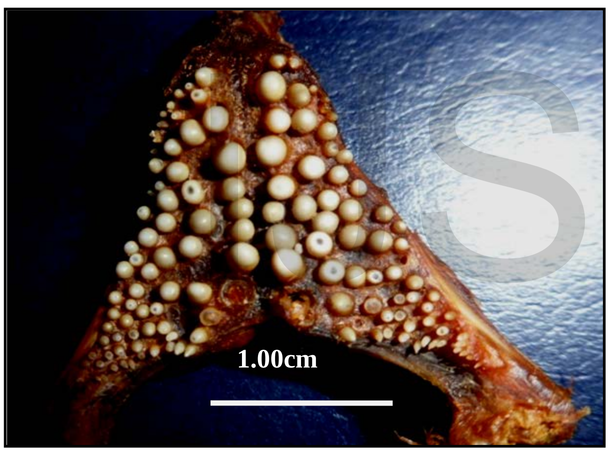


**Plate VI:** The lower pharyngeal band of teeth is triangular in shape

ISSN 2229-5518


**Plate VII:** The upper pharyngeal teeth of *P. jubelini*




**Plate VIII:** One gill arch of *Pomadasys jubelini*


**Plate IX:** The gastrointestinal tract of *Pomadasys jubelini*.
O, Oesophagus; S, Stomach; D, Duodenum; PC, Pyloric Caeca;
I, Intestine; R,Rectum; C, Cloaca

## Histology of the Gastro-intestinal tract of *Pomadasys jubelini*

The alimentary canal, from oesophagus to the rectum, consist of the following layers

Serosa: the outermost layer of which connective tissue are superimposed

a. Outer longitudinal muscle layer, a thin sheet of muscular bundle having longitudinal fibre.
b. Inner circular muscle layer: a thick layer of striated and smooth muscle fibre
c. Submucosa: This layer is made up of connective tissue embedded with blood vessels, ducts and fibers
d. Muscularis mucosa: A thin layer of fibre separating the submucosa from the mucosa
e. Mucosa: A membrane of variable thickness usually from folds of different lengths depending on the region to which it belongs



### The oesophagus

The outer longitudinal layer is represented by irregular bundles of fibre which permits distention while the inner circular muscle layer is of enormous thickness. These layers of tunica muscularis (longitudinal and circular muscle layers) account for the thickness of the oesophageal wall. The submucosa consists of compact connective tissue, blood vessels, fibres and gland ducts; this merges with the muscularis mucosa to extend as part of the large mucosal fold (Plate X). Lots of goblet cells and oesophageal pits containing blood vessels are present.

## Stomach

This is made up of four layers, the outer longitudinal muscle, inner circular muscle, the submucosa and mucosa. The circular muscle appears to be connected by lose connective tissues; it is wider and thicker than the longitudinal muscle layer. The submucosa is made up of loose connective tissue within which blood vessels occur. The mucosa is different from other parts of the GIT. It is thick due to presence of gastric glands which are round shaped. The mucosa is thrown into large longitudinal folds with many pits. The epithelium of the mucosa is made up of undifferentiated glandular and columnar cells. Goblet cells with uniform secretory cells and gastric ducts are also present (Plate XI).

## Pyloric caeca

The caeca have a thin layer of longitudinal muscle, a thick circular muscle layer, muscularis mucosa, the submucosa and mucosa which is filled with connective tissue. The epithelial lining is made up of columnar absorptive cells with goblet cells for mucus secretion. The mucosa is elaborated into numerous filiform folds with a basal columnar membrane which is closely packed and clearly visible (Plate XII).

## Intestine

The intestine is lined by a simple columnar epithelium consisting of absorptive cells and mucus-secreting cells; the serosa is thin, the inner circular muscle layer is wider than a less well developed longitudinal layer which is loosely packed by connective tissue (Plate XIII). The muscularis mucosa is not conspicuous. The mucosa is thrown into numerous elongated folds unlike those of the oesophagus and stomach which are made up of short, thick and few folds. The folds resemble villi.

**Rectum**

The muscle layer of the rectum is much thicker than that of the oesophagus, stomach, pyloric caeca and intestine. The mucosa is considerably folded, they appear shorter and wider. Goblet cells are also present in this region though fewer than in the intestine (Plate XIV).

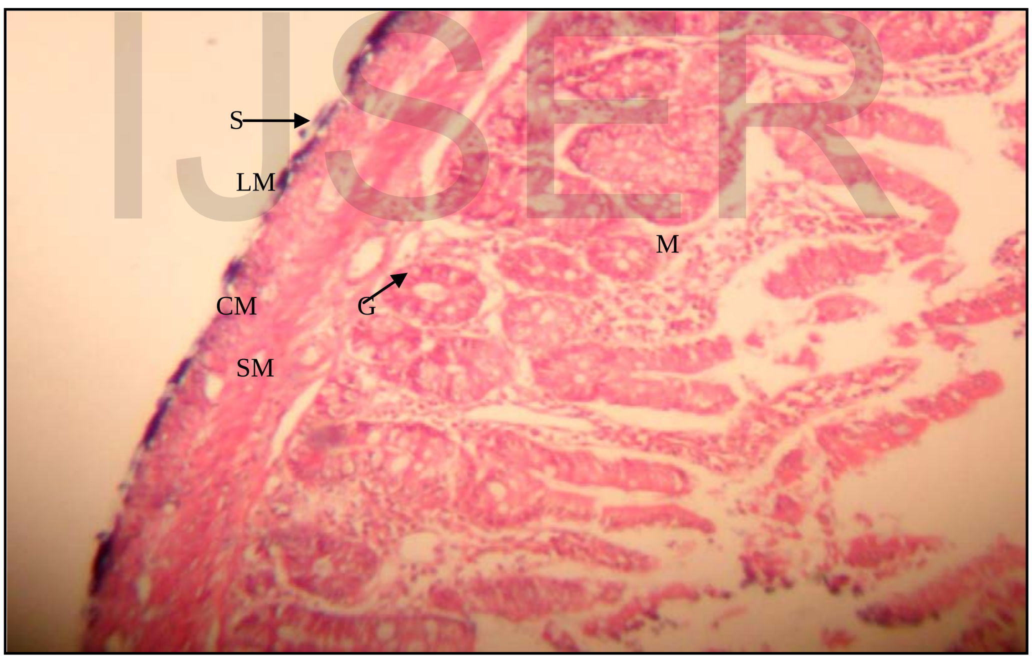


**Plate X:** Transverse Section of the Oesophagus of *Pomadasys jubelini*
S – Serosa, LM= Longitudinal muscle layer, CM – Circular muscle layer,
SM – Submucosa, M – Mucosa, G= Goblet cell, (Haemotoxylin and Eosin, ×40)

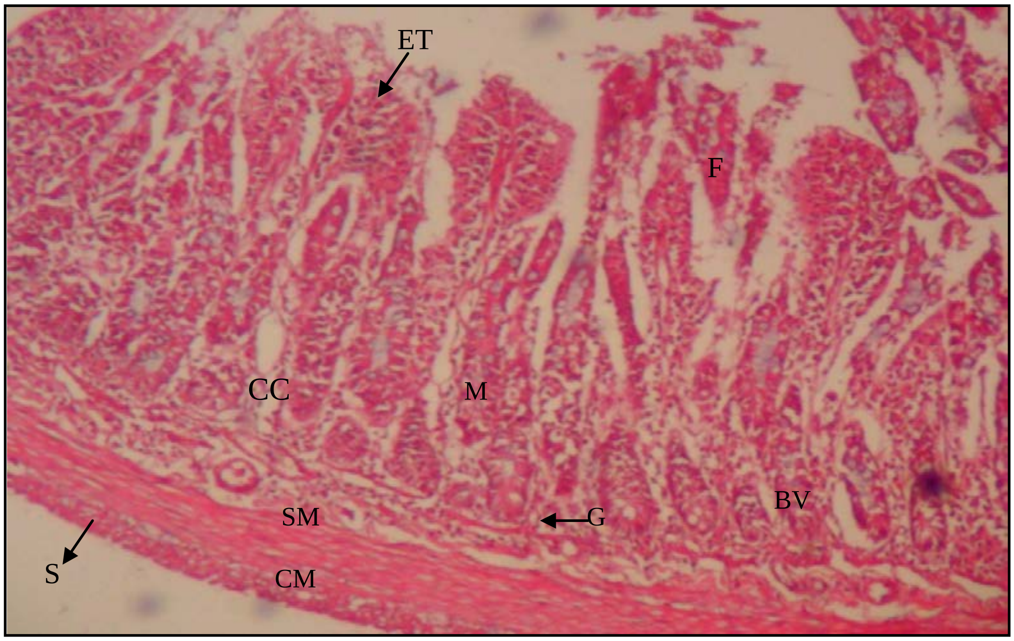


**Plate XI:** Transverse Section of the Stomach of *Pomadasys jubelini*
S – Serosa, CM – Circular muscle, SM – Submucosa, G – Goblet cells,
M – Mucosa, BV= Blood cell, F= Fold, ET= Epithelial tissues,
(Haemotoxylin and Eosin, ×40)

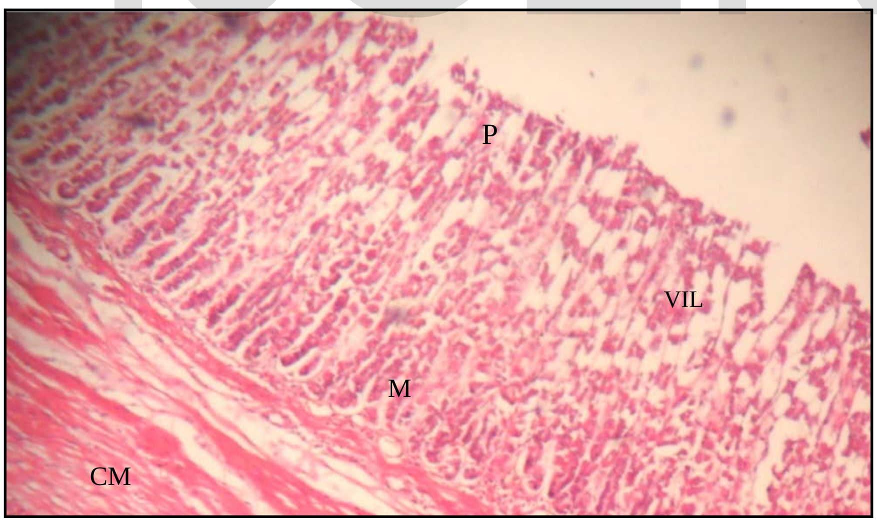


**Plate XII:** Transverse Section of a Pyloric caecum of *Pomadasys jubelini*
CM – circular muscle, M – mucosa, VIL – Villi, P – Pits,
(Haemotoxylin and Eosin ×40)

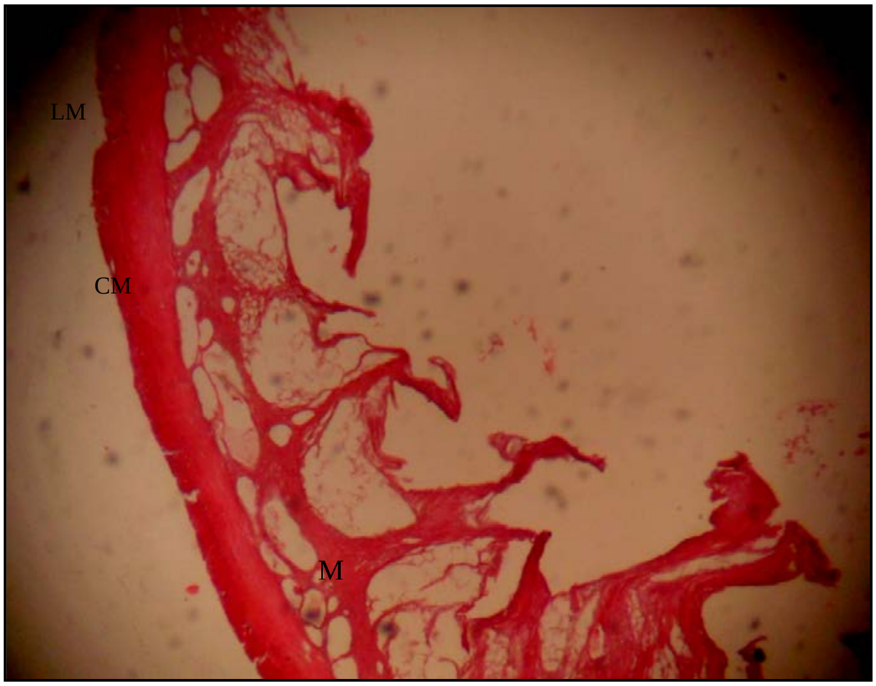


**Plate XIII:** Transverse Section of the Intestine of *Pomadasys jubelini*
LM – Longitudinal muscle, CM – Circular muscle,
M – Mucosa, (Haemotoxylin and Eosin, ×40).

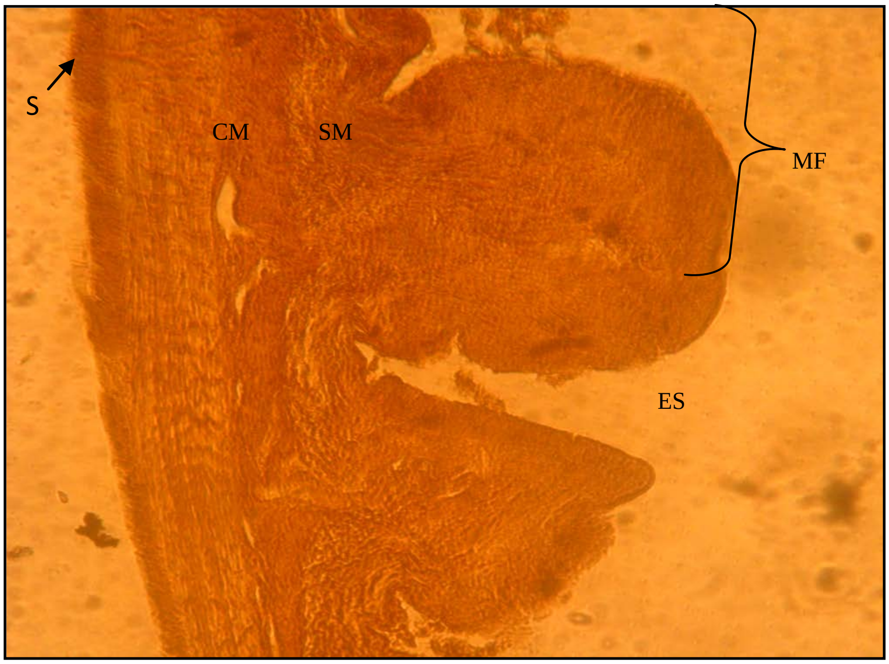


**Plate XIV:** Transverse Section of the Rectum of *Pomadasys jubelini*
S, Serosa: CM, Circular muscle: SM, Submucosa;
MF, Mucosal fold; ES, Epithelial sheath;
(Haemotoxylin and Eosin, ×40).



**Discussion:**

The terminal mouth possessed by *P. jubelini* which opened up to 20% of its total body length allows the fish to seize its prey easily. The presence of the multiserial bands of setiform teeth enables the fish to grip its prey firmly in the mouth for suffocation, before swallowing. The pharyngeal teeth on the roof and floor surfaces of the mouth which are modified into pebble-like stones are adapted for crushing bone, shells and crustaceans before swallowing. The thick, long, cartilaginous, sparsely arranged and spiky gill rakers confirm that *P. jubelini* is carnivorous (Pandey and Shukla, 2005).

The length of the gut (short) was observed to be related to the feeding habit of *P. jubelini*. The long and distensible oesophagus is characteristic of carnivorous and predatory fish species. The flask-shaped stomach is swollen at the anterior part (intestinal bulb) is meant for storage and reduced at the posterior part (Ugwumba and Ugwumba, 2007). The digestive tract is modified to accommodate the feeding habit of *P. jubelini* (Ugwumba and Ugwumba, 2007). Other fish species possessing a flask-shaped stomach are the *Tor tor, Catla catla* and the *Labeo rohita* (Pandey and Shukla, 2005). Generally, the thick-wall of the flask-shaped stomach aids in masticating food. Pyloric caeca were observed in all the specimens studied and were between 6 to 7 outgrowths. The number and shape of caeca might be peculiar to this species and it is used as one of the structures for its identification. Srivastava (1988) stated that intestinal caeca serve as accessory food reservoirs and may also play an important role of secreting enzymes for food digestion and absorption. The number of pyloric caeca varies from species to species. For example, only a single caecum is found in *Polypterus* while up to a hundred are found in mackerel (Pandey and Shukla, 2005). The intestine of *P. jubelini* is short and nearly straight, it is about 50% of its body length, which is known to be common to carnivores (Lagler *et al*., 1978). The rectum is much slimmer, though histologically, a continuation of the intestine ends with the cloaca.

The presence of numerous oesophageal folds and muscle layers (longitudinal and circular) observed in *P. jubelini* allows for the expansion of the oesophagus hence the swallowing of large substances is made possible (Clarke and Witcomb, 1979).

The goblet cells /mucus secretory pits observed along the entire length of the gut secrete mucus and perform different functions in different regions of the gut. It takes the place of the salivary gland in the buccal cavity and oesophagus (Andrew, 1959), The mucus aids digestive activities in the first part of the intestine and lubricates faecal material in the rectum (Banan-Khojasteh *et a*l. 2009) as well as give protection to the intestinal epithelium against mechanical damage. The presence of numerous goblet cells is typical of carnivorous species (Domeneghini *et al*., 2002; Dai *et al*., 2007; Banan-Khojasteh *et a*l., 2009)

The large mucosal folds in the stomachs of *P. jubelini* are associated carnivorous species (Osman and Caceci, 1991). These large folds allow fishes to accommodate a large quantity of food items as a result of its ability to distend. The undifferentiated columnar epithelia cells and mucosal folds also provide large surface area for storage in the stomach (Osman and Caceci, 1991).

The presence of the epithelial lining which is made up of columnar cells and goblet cells for mucous secretion in the pyloric caeca is an indication that the pyloric caeca is not only used for storage but it is also used for absorption. The filiform folds with basal columnar membrane are slender, elongated and closely packed. In the intestine, the villi provide a large surface area for absorption (Clarke and Witcomb, 1979). The hind (rectum) region of the gut revealed sparse, stunted and spaced folds with the presence of villi. This situation reveals that digestion and probably absorption takes place within the whole length of the gut (Clarke and Witcomb, 1979; Banan Khojasteh *et a*l., 2009).

The dense region of blood vessels and connective tissues in the sub mucosa is prominent and varies in thickness from one region of the gut to another.

The muscular layers of the gastro-intestinal tract of *P. jubelini* vary in thickness from one region to another. The outer longitudinal muscle and inner longitudinal muscle layer make up the muscular layers (tunica muscularis). The prominence of these muscle layers indicates the thickness of the gut of carnivorous fishes. Banan Khojasteh *et a*l. (2009) stated that the muscles of the gut are striated and thick and the circular muscle is more prominent than the longitudinal muscle.

## C**onclusion:**

The length of the gut is related to the feeding habit of *P. jubelini*. The intestine is short and not coiled and allows for faster digestion of meaty substances.

The striated muscularis in the oesophagus with smooth muscle in the stomach, pyloric caeca, intestine and rectum consist of inner circular muscle layer and an outer longitudinal layer. The circular muscle is more prominent.

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