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# The Mouth and Gastrointestinal Tract of the African Lung Fish *Protopterus annectens* in River Niger at Agenebode, Nigeria

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***Abstract*—**The West African Lung fishes are fishes rich in protein and serve as an important source of food supply for man. The kind of food ingested by this group of fishes is dependent on the alimentary canal as well as the fish's digestive processes which provide suitable modifications for maximum utilization of food taken. A study of the alimentary canal of *P. annectens* will expose the best information on the anatomy and histology of the fish. Samples of *P. annectens* were dissected to reveal the liver, pancreas and entire gut wall. Digital pictures of the mouth, jaws and the Gastrointestinal Tract (GIT) were taken. The entire gut was identified, sectioned and micro graphed. *P. annectens* was observed to possess a terminal mouth that opens up to 10% of its total body length, an adaptive feature to enable the fish to swallow the whole of its pry. Its dentition is made up of incisors- scissor-like teeth which also help to firmly grip, seize and tear through the skin of prey before swallowing. A short, straight and longitudinal GIT was observed in *P. annectens* which is known to be common feature in lungfishes, though it is thought to be a primitive characteristic similar to the lamprey. The oesophagus is short and distensible similar to other predatory and carnivorous species. Food is temporarily stored in the stomach before it is passed down into the intestine. A pyloric aperture is seen at the end of the double folded pyloric valve which leads into an intestine that makes up 75% of the whole GIT. The intestine begins at the posterior end of the pyloric aperture and winds down in six coils through the whole length intestine and ends at the cloaca. From this study it is concluded that *P. annectens* possess a composite GIT with organs similar to other lung fishes; it is a detritor with carnivorous abilities

***Keywords*—**Gastrointestinal tract, incisors scissor-like teeth, intestine, mucus, *Protopterus annectens,* serosa.

## I. Introduction

THE West African Lung fish are an important source of food supply and adequate sources of protein for man. These fish species have adapted successfully to the River Niger which consist mainly of fresh water. This successful adaptation has made them versatile in their mode of feeding. The various forms of food and feed ingested are solely dependent on the alimentary canal and the processes of digestion which provides suitable modifications for maximum utilization of food taken. [2]. Research efforts are presently geared towards understanding the biology of numerous aquatic species in our water bodies; such studies will give an understanding of the food and feeding habits, nutrition and the ecology of different species. Studies have been carried out on the GIT of *Pomadasys jubelini*, and teleost [1] and [3].

The structures of the digestive tract of fish vary with different factors within species which include digestion, nutrient absorption and hormone secretion. Its structure also varies due to its food and feeding habits. It is short in carnivorous species, about 20% of its body length; with distinct portions of mouth cavity, esophagus, stomach and rectum [1], or the digestive tract is long; 20 times the body length [3]. The knowledge of fish digestive system is becoming increasingly important for the understanding of fish anatomy, fish physiology, fish digestive system and the improvement of nutrition protocols. This knowledge may help identify the differences in the anatomy and histology of internal organs of various species. The study and identification of the mouth and GIT of *P. annectens* in River Niger at Agenebode will reveal the best available knowledge on the mouth, morphology and histology of the fish.

## II. Materials and Methods

Ten specimens of the West African Lung fish, *Protopterus annectens* weighing 135g-600g were collected from the River Niger at Agenebode, Edo State, Nigeria. Samples were collected from catch landings at the water front. After collection, the samples were killed with a blow on the head and the ventral body wall was opened from the anal area. Further dissections were made to allow the exposure of the liver, pancreas and entire gut wall. Digital pictures of the mouth, jaws and the GIT were taken with a Samsung Digital Camera (Model PL 210). The entire gut was identified, removed and tissue samples were stored in 10% formaldehyde. The samples were then dehydrated through a standard ethanol series to 100%, cleared in xylene and embedded in paraffin wax. Then, 5-7$\mu m$ serial sections were deparaffinized and stained with Haemotoxylene and Eosin. The sections were examined under a Nikon light microscope and photographs were taken with a Nikon photo micrographic attachment.

## III. Results

The mouth of *Protopterus annectens* is terminal and has no scales (Fig. 1). The mouth opens up to 10% of the total body length (Fig. 2). The jaws reveal scissors-like incisors teeth. There are a set of premaxillary teeth (teeth on the upper lip) on the upper jaw and a set of mandibular teeth on the lower jaw (Figs. 3-5). Four gills are present on the left and right side of

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the fish. The gills have thick and cartilaginous gill arches, with much reduced gill rakers (16) and numerous gill filaments (24 on Fig. 6).


Fig. 1 Mouth of *P. annectens*


Fig. 2 The gape mouth of *P. annectens*


Fig. 3 The gape mouth of *P. annectens* showing the inscisors teeth


Fig. 4 The upper jaw of *Protpterus annectens* (arrow indication premaxillary teeth)


Fig. 5 The lower jaw of *Protopterus annectens* (teeth are inscisors scissors-like and fused together)

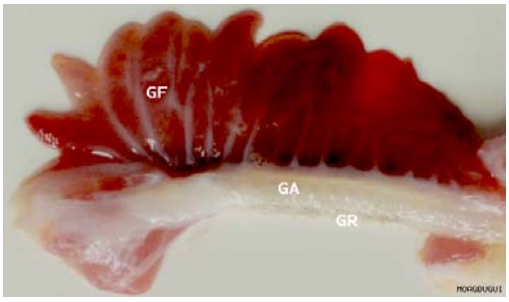


Fig. 6 One gill of *Protopterus annectens* (GA: Gill arch; GR: Gill rakers; GF: Gill filament)

The GIT of *Protopterus annectens* is a longitudinal organized organ whose components include the oesophagus, stomach, pyloric aperture, intestine and cloaca that were well enveloped by the peritoneal serosa (Fig. 7). The oesophagus is short and distensible, a typical characteristic in predatory and carnivorous species. The oesophagus leads into a short, flat, tubular, somewhat straight stomach which pours into a tubular pyloric aperture. The pyloric aperture is without outgrowths or projections. The pyloric aperture leads to the intestine which is longitudinal and made up of seven folds. The intestine is not distinguished into small and large; it is a continuous longitudinal spiraling tube from the anterior part to the posterior end. This spiraling effect progresses to the rectum and then ends at the cloaca. The inner intestine surface is very dark. The mucosal ridges are tenuous and disorganized. The lumen of the whole gut is filled with mucus and dark mesenteries.

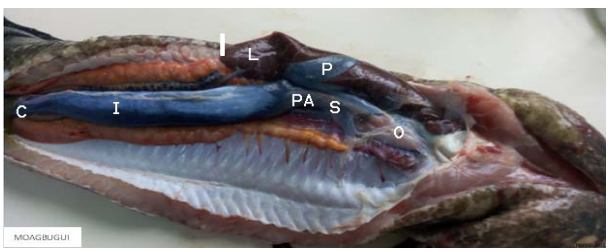


Fig. 7 The Composite GIT of *P. annectens* (in situ) C: Cloaca; I: Intestine; L: Lungs; PA: Pyloric caecum; P: Pancreas; S: Stomach; O: Oesophagus

The intestine is a single, thick longitudinal tube which ends with a cloaca. The intestine is much larger at the anterior part

than at the caudal end. The intestine had several spiral folds forming six coils all through the length of the intestine. The liver and pancreas are located on the right side of the stomach. The pancreas runs caudally and dorsally and is tightly fitted to overlap a shallow area on the liver (Fig. 8). Plate IX shows the tightly fitted shallow area of the liver occupied by the pancreas. The two organs maintain a close relationship with the caudal end of the liver overlapping the cranial part of the pancreas. Both organs are attached to each other and to other organs of the GIT by sheaths of connective tissue and by serosa and blood vessels.


Fig. 8 The detached GIT of *P. annectens*. O: Oesophagus; S: stomach; I: intestine; C: Cloaca; P: Pancreas; L: liver.


Fig. 9 The GIT of *P. annectens* showing the pyloric aperture, arrows revealing the shallow area occupied by the pancreas

*A. Histology of the GIT of P. annectens*

1. The Oesophagus

The oesophagus revealed no internal protrusions, no compact connective tissue, a few blood vessels, fibers and gland ducts; these merges with the muscularis mucosa to extend as part of the mucosal fold which is primarily large. Discrete boundaries between segments were not observed. The oesophagus was filled with mucus (Fig. 10).

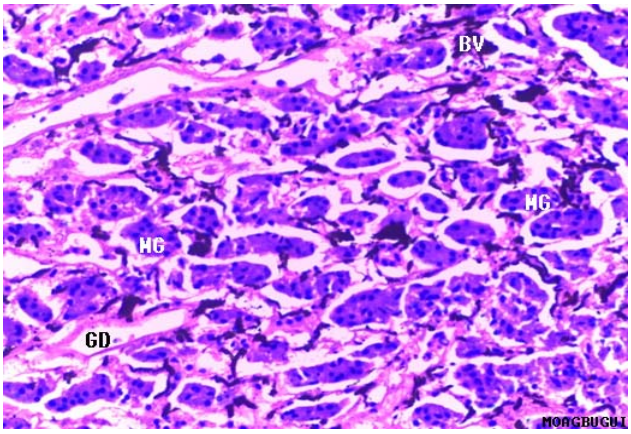


Fig. 10 The Oesophagus of *P. annectens* (x500) MG: Mucus Gland; GD: Gland duct; BV: Blood vessels

2. Stomach

The stomach lacks regional specializations though the internal surface shows few, but large longitudinal folds and pits. Goblet cells with uniform secretory cells and gastric ducts are also present (Fig. 11).

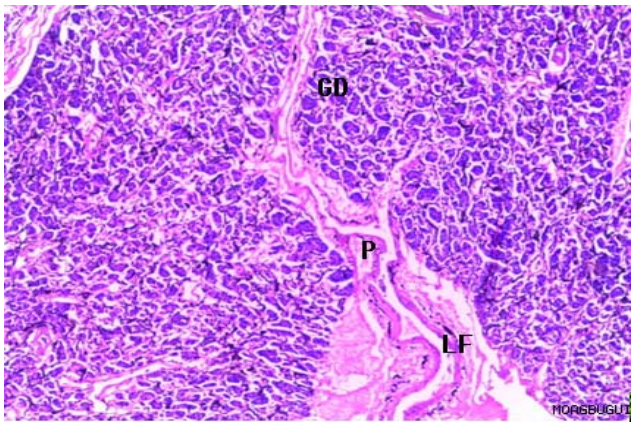


Fig. 11 The Stomach of *P. annectens* (x500) GD: Gastric ducts; P: Pits; LF: longitudinal fold

3. Pyloric Caecum

Columnar absorptive cells and goblet cells meant for mucus secretion are components of the epithelial of the pyloric caecum, the basal columnar membrane are from the mucosa and are closeley packed. The pyloric aperture was guarded by a valve that consists of two thick lateral leaflets and a void (Fig. 12).

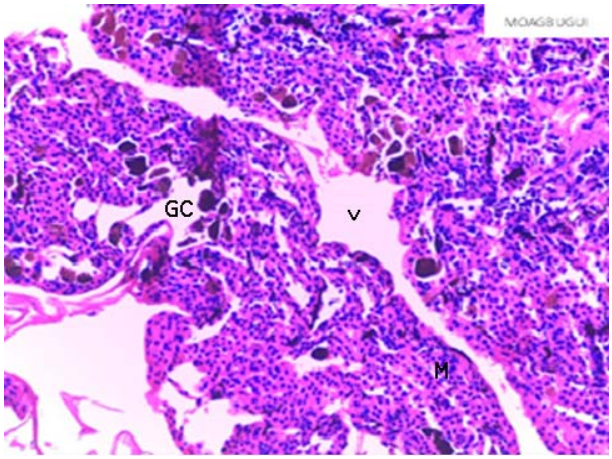


Fig. 12 The Pyloric Caecum of *P. annectens* (x100) GC: Goblet Cells; V: Valve; M: Mucosa

4. The Intestine

The intestine consists of very few and large chambers. This large chamber continues downward forming six coils and attached to the lower wall with the aid of serosa. The coils are cone shaped and piled one over another. The large spaces between the turns are also very conspicuous, as in Fig. 13.

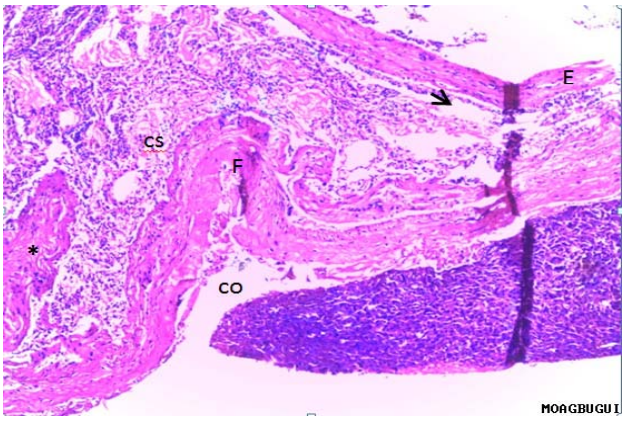


Fig. 13 The Intestine of *P. annectens*. (x100) *: Reticular tissue; E: Epithelial sheath; Co: Coil; F: folds; Arrow: First Coil leading to ridges, an Indication of overlapping of coils

## IV. Discussion

The mouth of *P. annectens* is terminal and has the ability to open up to 10% of its total body length; this ability is to sufficiently allow the fish to capture its prey. The incisors-scissor-like teeth also capacitates the fish to firmly grip, seize and tear through the flesh of prey before swallowing. The cartilaginous gill arch, and fleshy numerous leaf-like and overlapping filaments is an indication that the fish is a detritor. The gill rakers are few, sparsely arranged and very short, again an indication that the fish particularly takes in small sized food substances.

The GIT of *Protopterus annectens* is made up of different organs and structures, thus making the GIT a composite. It is packed together by connective tissues and wrapped by the serosa.

A short, straight and longitudinal GIT was observed in *P. annectens* which was similar to the findings of [7], which is known to be a common feature in lungfishes [9], [10], though it is thought to be a primitive characteristic similar to the lamprey [8].

The oesophagus is typically short but distensible again, a character typical of predatory and carnivorous species [1]. The stomach was full of large quantity of mucus and longitudinal ridges, gastric pits and glands were not present in the stomach. Reference [6] suggested that the longitudinal ridges could be the reason for the contraction of the musculature wall. The stomach is primarily to store food and slow down the passage of food into the intestine. A double folded pyloric valve is noted to end the pyloric aperture. This double folded aperture is said to be similar to that of *Neoceratodus forsteri* [7], [10]. The intestine makes up about 75% of the whole GIT. The spiral valve in the intestine was noted to have begun at the posterior end of the pyloric aperture, winds down in six coils progressively through the whole length of the intestine and ends at the cloaca. A different observation was made by [10], where the spiraling coils in the intestine of the Australian lung fish *N. forsteri* begins behind the glottis. On genera notes, the spiraling feature of the intestine appears to be similar in all lungfishes, varying differences might be seen in the length of the intestine and the number of coils, again it is said that the higher the number of coils, the greater the more time needed for digestion. The spiraling feature of the intestine is said to be primitive and also observed in Sturgeons and in some Elasmobranchs. The spiraling feature aids food transit, facilitates digestion and absorption [4], [5]. Again, this might help absorb most of the bottom dwelling and detritus particles taken by this fish species. The reticular tissue forms part of the intestine mucosa and submucosa. The presence of connective tissue appears to hold all the components of the GIT together. The spaces and guts observed may be a reserve for holding fluid or other substances for absorption. The intestinal mucosa of *P. annectens* show oblique ridges, these are seen mainly at the first and second chambers and then end abruptly, similar findings were made by [7].

## V. Conclusion

The results obtained from this study show the anatomical organizations and histology of the GIT of *P. annectens*. The GIT is a composite of organs that is purely of detritus origin and similar to other lungfishes with an ability to be carnivorous.

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