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ARTICLE

Distal Intestinal Caecum of Farmed African Catfish (Clarias gariepinus Burchell, 1822): A Case Report.

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SUMMARY

The microanatomical characteristics of the distal intestinal caecum were investigated. The histology was typical of tubular organs containing tunica mucosa, submucosa, muscularis and adventitia. The lumen was lined by simple mucosal folds. The covering epithelium was of simple columnar cells containing goblet cells and intraepithelial lymphocytes. The lamina propria contained blood vessels, loose connective tissue and leukocytes. The muscularis mucosae of smooth muscle cells were observed. The submucosa contained loose connective tissue, smooth muscle cells, blood vessels and leukocytes. The tunica muscularis contained a myenteric plexus between the inner circular and outer longitudinal layers of smooth muscle cells. The mucin histochemistry revealed that the goblet cells present contained neutral and acid mucin but acid mucin predominated suggesting an organ with more need for protection against bacteria in the blind ended tube. When compared with the histology of the intestinal segments cranial and caudal to the diverticulum, the features of the caecum were very similar to the segment cranial to it necessitating the conclusion that the diverticulum is the distal intestinal caecum. The histology suggests an organ serving as complementary digestive structure to distal intestine in nutrient absorption without increasing the space occupied by the digestive tract.

KEYWORDS: DISTAL, INTESTINAL, CAECUM, FARMED, AFRICAN, CATFISH, CASE REPORT

INTRODUCTION

The African catfish being a popular aquaculture species is attracting research interest (Anetekhai *et al*., 2005; Gabriel *et al*., 2007). These studies have been directed towards factors that enhance the profitable production of this fish aimed at attracting more commercial interest from investors (Olagunju *et al.,* 2007; Kudi *et al*., 2008; Emokaro *et al*., 2010). The basic biology of this species from commercial farms in Nigeria is largely unknown, especially the modifications of its organs to adapt to restrained habitat of concrete ponds, but there is information on the early development of the organs (Osman *et al.,* 2008).

The need to describe the basic anatomy of this species for improvement in feed management in farms necessitated our research effort towards the system that is responsible for obtaining micronutrients from ingested feed- the digestive tract. The presence of a diverticulum of the distal intestine in only one of the thirty fish used for the study, necessitated further investigations on the diverticulum. This is important as the teleost intestines present a lot of interesting modifications like crypts of Lieberkuhn in Gididae (Jacobshagen, 1937; Bishop and Odense, 1966); ileorectal valve (Al-Hussaini, 1947; Ezeasor and Stokoe, 1981; Micale and Mughia, 2011); annulo-spiral fold in the rectum (Burnstock, 1959; Ezeasor and Stokoe, 1981); rectal caeca that is absorptive in nature (Agrawal and Singh, 1964); anal spincter (Daves ,1926). Hence, this paper presents our findings in the micromorphology of the distal intestinal caecum of the farmed African Catfish and segments of the tract cranial and caudal to the caecum. Though an isolated case, the knowledge obtained from this study will enhance our understanding of the species' possible evolutionary trend towards domestication and digestive biology as there is no report of such caecum in available literature.

MATERIALS AND METHODS

Thirty adult African catfish aged seven months, sourced from a commercial aquaculture in Eastern Nigeria were used for the study. They were quickly transported from the farm to the laboratory for dissection and processing. They weighed an average of 900g and measured a standard body length of 45cm on the average. The fish were killed by sharp blow to the head and the entire digestive tract was exposed through a mid-ventral incision and removed from the body. Only one the fish contained this diverticulum (plates1a, 1b), which was rapidly excised from the tract along with the segment cranial and caudal to the diverticulum. The samples were fixed in 10% buffered formalin, before subjecting to routine histological procedure of dehydration in graded ethanol series, clearing in xylene and embedding in paraffin wax. Sections 5µm in thickness were stained with haematoxylin and eosin (H&E), alcian blue (AB) at Ph 2.5, Periodic acid Schiff (PAS), and AB /PAS (Bancroft and Stevens, 1977). Photomicrographs were taken with Motican 2001 camera (Motican UK) attached to Olympus microscope.

RESULTS

The diverticulum with a length of 1.5cm, weight of 0.25g, and diameter of 0.35cm was observed on the distal segment of the intestine. On transverse section it presented a lumen filled with long mucosal folds almost reaching the centre of the lumen (Plate 2). The histology showed that the basic arrangement was similar to vertebrate tubular organs: an epithelial covering of simple columnar cells containing goblet cells and intraepithelial lymphocytes (plate 4). The lamina propria that formed the core of the mucosal folds contained collagen fibres, smooth muscle cells, leukocytes and blood vessels (Plate 3). Muscularis mucosae of smooth muscle cells were observed (Plates 4, 5). The submucosa contained loose connective tissue, smooth muscle cells, blood vessels and leukocytes (plate 5). The tunica muscularis contained smooth muscle fibres arranged in an inner circular and outer longitudinal orientation (Plate 6). Myenteric plexus was seen between the two muscle layers of the tunica muscularis (plate 6). The covering tunica adventitia was composed of vascularised thick loose connective tissue..The segment cranial to the diverticulum presented similar histology but the mucosal folds were shorter and wider (Plate 7) and connective tissue fibres of the lamina propria were less dense. The segment caudal to the diverticulum had histology of similar features with the diverticulum but the mucosal folds were larger and the shortest in height of the three segments (plate 8). The simple columnar epithelium contained more goblet cells than the other two preceding segments. The patent lumen was widest. The submucosa was large. The tunica muscularis was relatively thin in diameter. On subjecting the sections to mucin histochemical stains, the goblet cells of the diverticulum was PAS positive (Plate 9), weak AB positive (Plate 10) and acid dominance after combined AB and PAS procedure (Plate 11). The distal intestine goblet cell was PAS positive (Plate 12).

The result summary of the mucin histochemistry of the goblet cells is presented in table I.

DISCUSSION

The histology of the diverticulum or caecum presented simple columnar absorptive epithelium covering the mucosal fold suggesting an organ involved in food digestion. This microanatomy of finger-like or leaf shaped villi with apical branching increases surface area for absorption and digestion. It is similar to the histology of distal intestinal segment cranial to the caecum, just as the pyloric caeca and proximal intestine are structurally similar and have the same function in digestion (Cataldi*, et al.,* 1987). Hence, this diverticulum can be referred to as distal intestinal caecum. The absence of intestino-rectal valve in this digestive tract does not suggest that a defined rectum is not present because from available literature in teleost without the intestino-rectal valve, the rectal segment is characterized by a reduction in height of the mucosal folds and an increase in number of goblet cells as was observed in the segment caudal to this diverticulum (Moshin, 1962; Reifel and Travill, 1979).

The intestino-rectal valve when present prevents the reflux of the posterior intestine content (Reifel and Travill, 1979; Jaroszewska *et al*., 2008). The increased number of goblet cells seen especially towards the rectum is associated with lubrication of the tract against mechanical harm by fecal materials and protection against bacteria. This finding has also been reported in literature (Falk-Petersen and Hansen, 2001; Cinar and Senol, 2006; Khojasteh *et al*., 2009; Trevino *et al*., 2011).

The intraepithelial lymphocytes seen have been reported in most teleosts and is associated with local defense mechanism (Park *et al*., 2003; Khojasteh *et al*., 2009).

Muscular arrangement of inner circular and outer longitudinal smooth muscles, seen in the tunica muscularis has been reported also in teleost (Albrecht *et al*., 2001; Delashoub *et al*., 2010) and the thickness is related to nature of feed as carnivorous teleost lacking a stratum compactum usually possesses thick tunica muscularis. This fish being an omnivore contains a moderately sized muscularis externa. The myenteric plexus observed in this study, has been reported in the digestive tract of other teleosts (Reifel and Travill, 1979; El-Bakary and El-Gammal, 2010).

The presence of both acid and neutral mucins seen in the intestinal goblet cells has been reported in literature (Riberiro *et al*., 1999; Albrecht *et al*., 2001) but the acid mucin predominated in the distal intestinal caecum. The predominating acid mucin is associated with biofilm formation to protect against parasitic or other pathogens (Neuhaus *et al*., 2007). This adaptive feature becomes necessary due to the structure of the tube being a blind sac, thus allowing feed content to stay longer in this caecum with possible accumulation of pathogens from feed ingredients. Intestinal neutral mucosubstances participate in enzymatic food digestion and absorption (Kozaric *et al*., 2008, Ribeiro *et al.,* 1999).

In conclusion, histology of the distal intestinal caecum may suggest an organ acting like the pyloric caeca which strengthens the intestinal function in a limited space of the abdominal cavity without increasing intestinal length. (Bisbal and Bengtson, 1995; Baglole *et al.,* 1997).

Table I .Mucin Histochemical reaction of the segments

	Distal Caecum (DC)	Distal intestine (DI)	Rectum (R)
PAS	++	+	+
AB(Ph 2.5)	+	++	+
AB/PAS	AB	P	AB

KEY: AB, Alcian blue; PAS, Periodic Acid Schiff; AB/PAS, combined Alcian blue with PAS procedure after diastase treatment; DI, distal intestine; DC,Distal intestinal caecum; R, Rectum; weak (+); medium (++); AB, AB dominance; P, equal coloration.

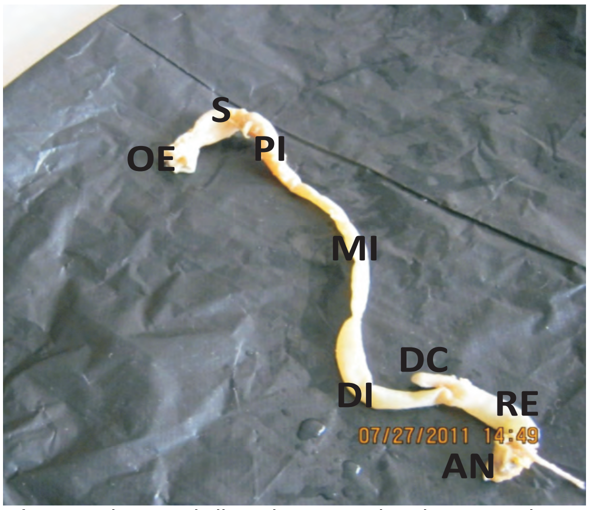

Plate1a.Dissected digestive tract showing oesophagus (OE),stomach (S),proximal intestine (PI), middle intestine(MI),distal intestine(DI), Distal intestinal caecum (DC),rectum (RE),anus(AN).

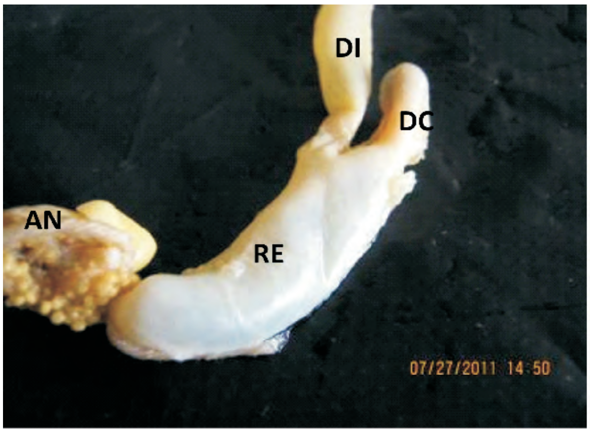

Plate 1b .Dissected caudal part of the digestive tract showing distal intestine(DI), Distal intestinal caecum (DC),rectum (RE),anus(AN).

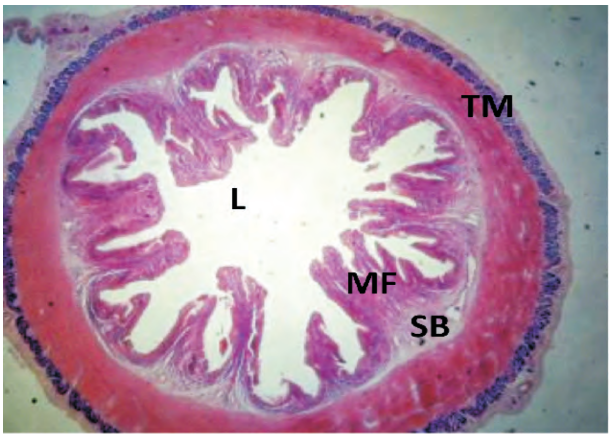

Plate 2. Transverse section of the distal intestinal caecum showing simple mucosal folds (MF). Note the lumen (L), submucosa (SB) and tunica muscularis (TM). H& E. x40

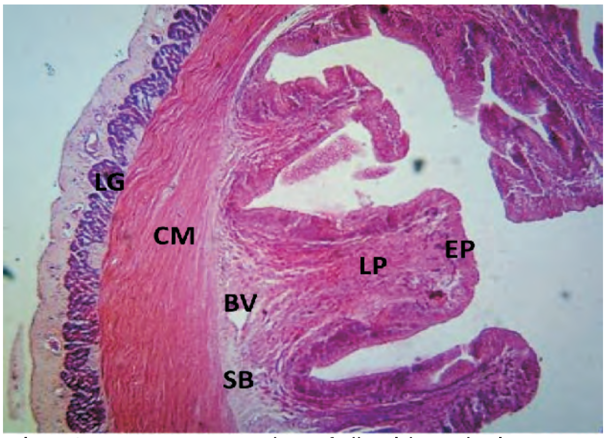

Plate 3. Transverse section of distal intestinal caecum showing simple columnar epithelium (EP), underlying lamina propria LP, Note the submucosa (SB) containing blood vessel (BV). Observe inner circular (CM), and outer longitudinal (LG) smooth muscle layers. H & E x100

Plate 4. section of distal intestinal caecum showing simple columnar epithelium (EP) containing goblet cells and intraepithelial lymphocytes. Note the muscularis mucosae (MM) and submucosae (SB). H & E x400

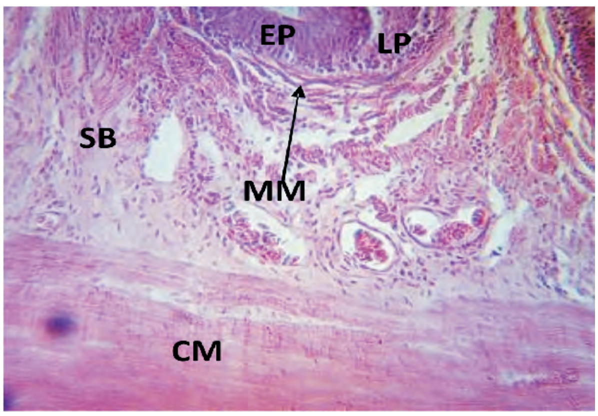

Plate 5. section of distal intestinal caecum showing epithelium (EP), muscularis mucosae (MM) separating the lamina propria (LP) from the submucosa (SB). Note the circularly oriented smooth muscle layer of the tunica muscularis CM. H&E. x400

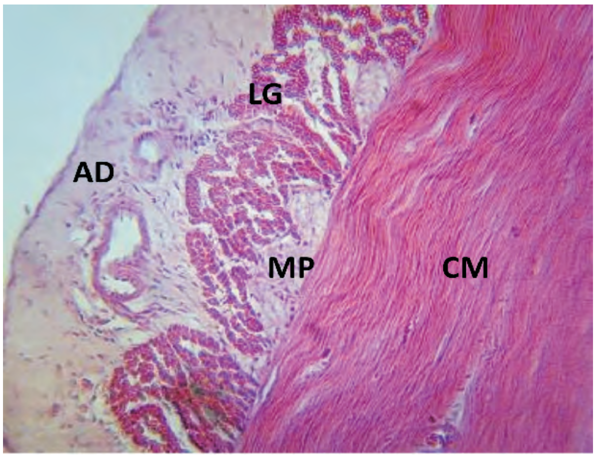

Plate 6. section of distal intestinal caecum showing Myenteric plexus (MP) between the inner circular (CM) and outer longitudinal (LG) smooth muscles of the tunical muscularis. Note the tunica adventitia (AD) containing blood vessels and loose connective tissue. H&E. x400

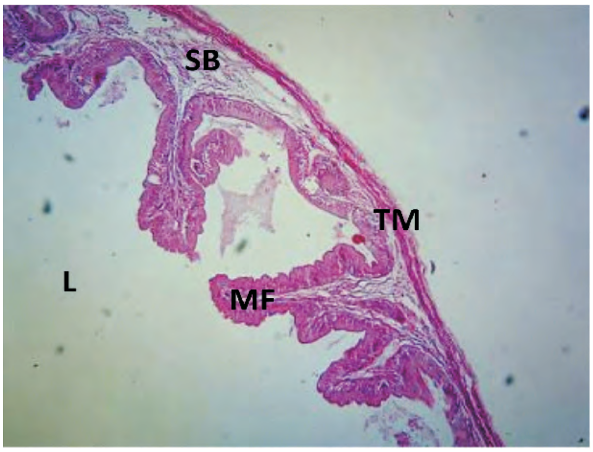

Plate 7. Transverse section of the distal intestine cranial to the caecum showing simple mucosal folds (MF). Lumen (L), submucosa (SB) and tunica muscularis (TM). H&E. x100

Plate 8. Transverse section of the rectum (caudal to the caecum) showing simple mucosal folds (MF). Lumen (L), submucosa (SB), and tunica muscularis (TM). H.&E. x100

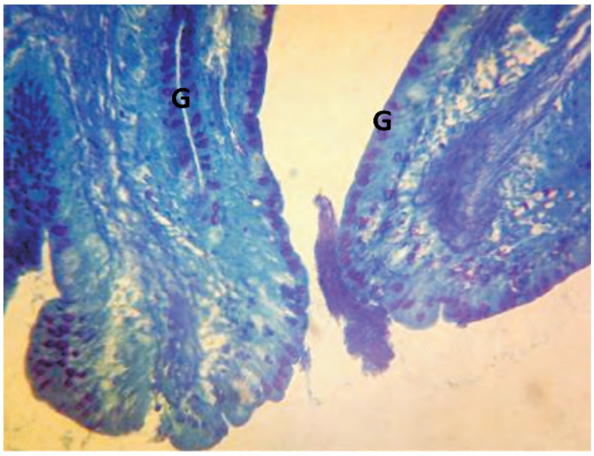

Plate 9. Section of distal intestinal caecum showing PAS positive goblet cells (G). PAS X400

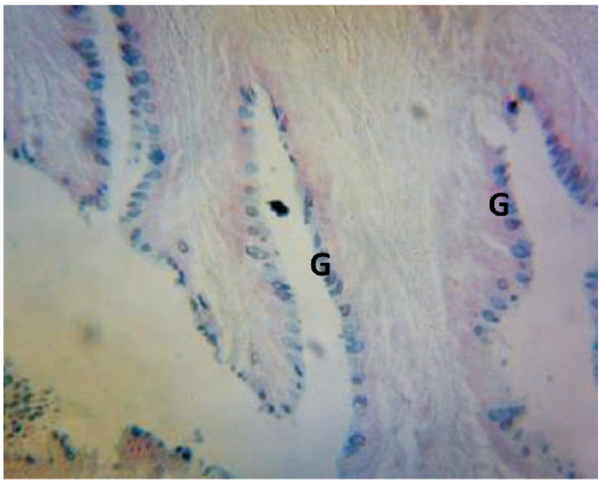

Plate .10. Section of distal intestinal caecum showing weak AB positive goblet cells (G). AB X400

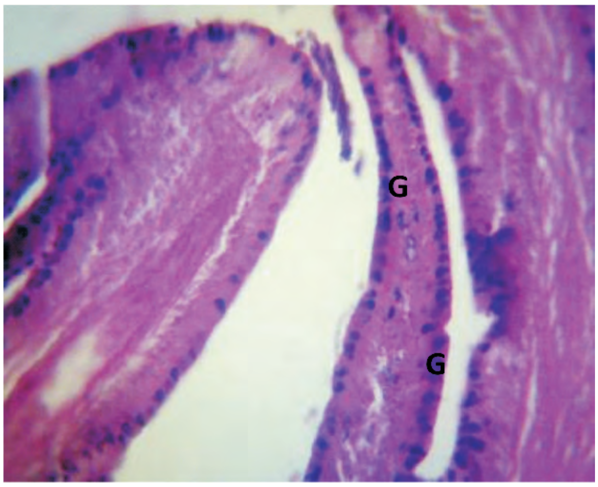

Plate 11. Section of distal intestinal caecum showing acid mucin dominance in the positive goblet cells (G).AB/PAS X400

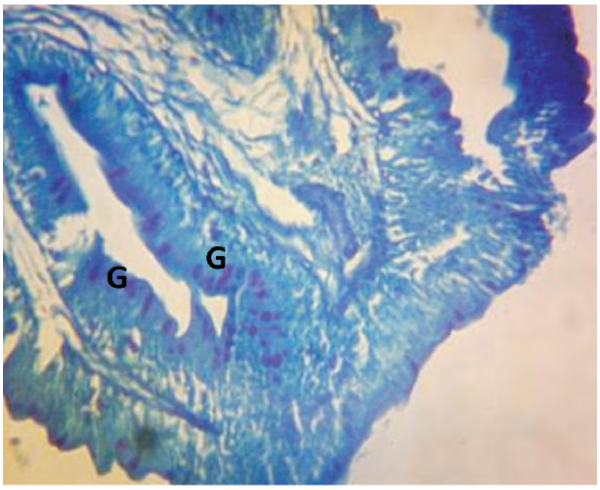

Plate .12. Section of distal intestine showing PAS positive goblet cells (G). PAS X400

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