Bulgarian Journal of Veterinary Medicine (2013), **16**, No 2, 88–95

MORPHOLOGICAL AND HISTOCHEMICAL OBSERVATIONS ON THE OESOGASTER OF THE DOMESTICATED AFRICAN CATFISH (*CLARIAS GARIEPINUS* BURCHELL*,* 1822)

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Summary

Ikpegbu, E., D. N. Ezeasor, U. C. Nlebedum & O. Nnadozie, 2013. Morphological and histochemical observations on the oesogaster of the domesticated African catfish (*Clarias gariepinus* Burchell*,* 1822). *Bulg. J. Vet. Med.*, **16**, No 2, 88–95.

The morphology of the intermediate region between the adult caudal oesophagus and cardiac stomach usually referred to as oesogaster was investigated in the farmed African catfish. This study was carried out to fill the dearth of information from available literature, especially the anatomic features that relates to the adaptation of this species to restriction in concrete tanks. The oesogaster was characterised by covering of PAS positive stratified mucous epithelium and gastric gland within the lamina propria. It contained a combination of the epithelia seen in both oesophagus and stomach. The gastric mucosa had the presence of oxyntopeptic cells in the lamina propria but these cells were absent in the region with oesophageal-like epithelium. The tunica muscularis in this transition region contained skeletal muscle fibres. The serosa was of simple squamous cells. The presence of the oesogaster in a stomach possessing fish suggests that the fish is adapting to fast deglutition in an intensive rearing environment necessitating the need for extension of esophageal mucosubstances which will help lubricate the feed further in the stomach, increase surface area for gastric digestion and possibly add extra carbohydrate to the fish diet, and buffer the effect of acid from the oxyntopeptic cells of the gastric gland.

Key words: African catfish, histochemistry, histology, neutral mucin, oesogaster

INTRODUCTION

The teleost gastrointestinal tract presents a morphology which shows specific variation that correlates with feeding habit, diet, body shape and also environmental conditions – ecomorphology (Noaillac-Depeyere & Gas, 1974; Kapoor *et al*, 1975; Zihler, 1982; Anderson, 1986; Winemiller *et al.,* 1995). The features reflect functional morphological differentiation for adaptation.

The oesogaster is anatomically used to describe a dilated region between the oesophagus and intestine especially in stomachless fish (Becker *et al.,* 2010) like the grass carp *Ctenopharyngodon idelle*. In the racer goby *Neogobius gymnotrachelus,* a secretory oesogaster has been described as a transition region where the secretory oesophagus merges into the intestine (Jaroszewska *et al.,* 2008). This secretory oesogaster in this species is believed to be an evidence of the loss of the functional stomach. In the rainbow trout, *Salmo gairdneri,* Ezeasor (1984) described the distal third of the oesophagus as oesogaster since it presented the gastric-type glands in the lamina propria. This specialisation was related to increasing the surface area for gastric digestive activity.

The African catfish *Clarias gariepinus* an omnivorous freshwater fish, is a popular delicacy relished in Nigeria. It is a prominent culture species because of its resistance to diseases and stress, and fast growth rate (Olojo *et al.,* 2005). Despite the increasing interest and population of African catfish aquaculture, there is dearth of information on the basic anatomical characterisation of those from commercially intensively farmed fish in concrete tanks. This paper provides information on the histological features of the intermediate region between the caudal oesophagus and cardiac stomach in this species. The result will provide important baseline information about morphological features that will help in understanding the physiological adaptation of this fish to intensive farming.

MATERIALS AND METHODS

Fifteen adult African catfish sourced from a commercial aquaculture in eastern Nigeria were used for the study. They weighed on average 900 g and measured a standard body length of 475 cm. The fish were euthanised with chloroform. The body cavity was cut open through the mid ventral surface and the alimentary tract dissected out. The specimen under study, the region between the caudal oesophagus and cardiac stomach (Fig. 1), in this species was excised and immediately fixed in 10% neutral buffered formalin.

The tissue was passed through graded ethanol, cleared in xylene, impregnated and embedded in paraffin wax. Sections 5 µm thick were obtained with Leitz microtome model 1512. They were stained with haematoxylin and eosin (H&E), for light microscopy. Mucins were demon-

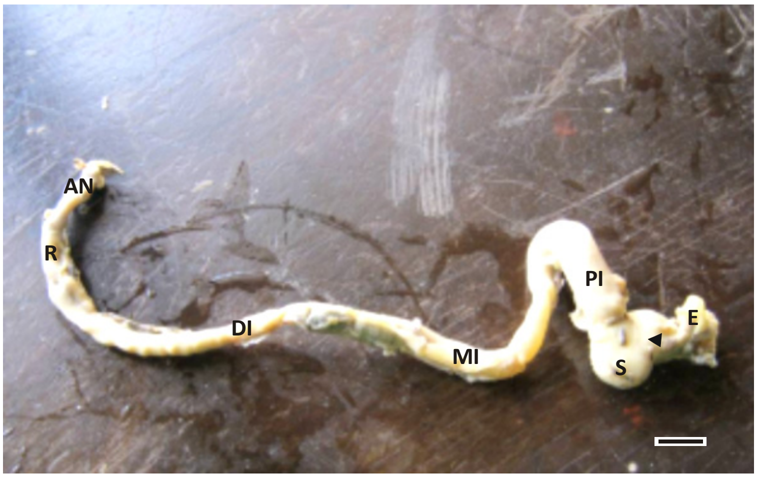

Fig. 1. Dissected section of adult digestive tract showing oesophagus (E), oesogaster (arrowhead), stomach (S), proximal intestine (PI), middle intestine (MI), distal intestine (DI), rectum (R) and anus (AN). Scale bar = 2 cm.

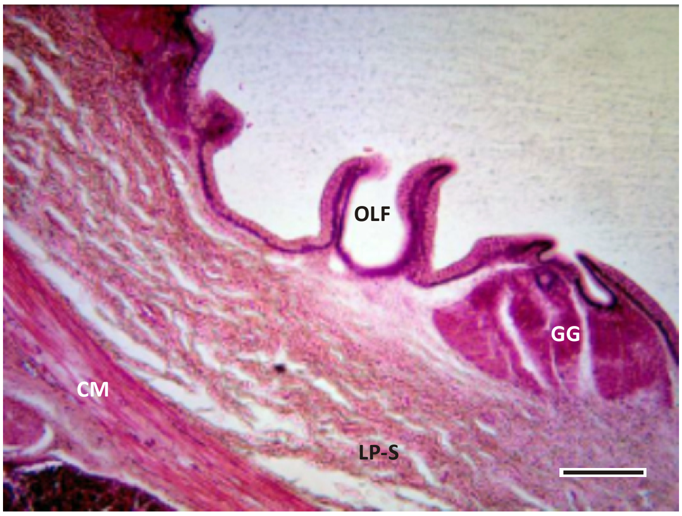

Fig. 2. Section of oesogaster showing the oesophageal longitudinal folds (OLF) in-between two gastric glands (GG), skeletal muscle in the circular layer (CM) of tunica muscularis. The oesogaster cavity (SC), collagen fibres in the lamina propria – submucosa (LP-S) are also shown. H&E. Scale bar = 50 µm.

strated using Alcian blue (AB) at pH 2.5 (Steedman, 1950; Lev & Spicer, 1964) and periodic acid Schiff (PAS) with or without prior digestion with diastase (Ikpegbu *et al.,* 2011). The PAS technique was employed in combination with AB for neutral and acid mucin (Bancroft & Stevens, 1977). Photomicrographs were taken with – Moticam 2001 camera attached to Olympus microscope.

RESULTS

The term oesogaster is describing the transition region between the cranial part of the stomach and caudal oesophagus (Fig. 1). Microscopically, the transition from esophageal stratified mucus cells to gastric simple columnar cell was not abrupt. Between two regions of gastric epithelium is a region of esophageal mucus cell epithelia – hence the name oesogaster, containing striated muscle in the tunica muscularis (Fig. 2, 3).

It presented a combination of the epithelia seen in both oesophagus and stomach (Fig 4, 5). The gastric mucosa had the presence of oxyntopeptic cells in the lamina propria but these cells were absent in the region with oesophageal epithelia (Fig. 5). Gastric pits were present. The serosa consisted of simple squamous epithelium.

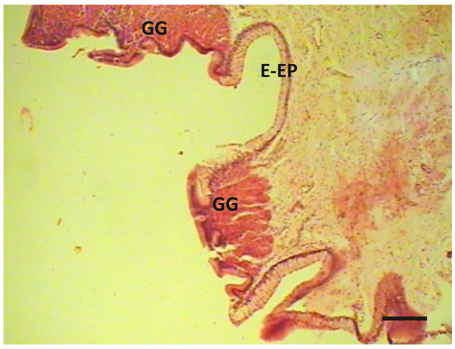

Fig. 3. Section of adult oesogaster with gastric gland (GG), oesophageal-like epithelium (E-EP) presenting no gastric gland in the lamina propria. H&E. Scale bar = 50 µm.

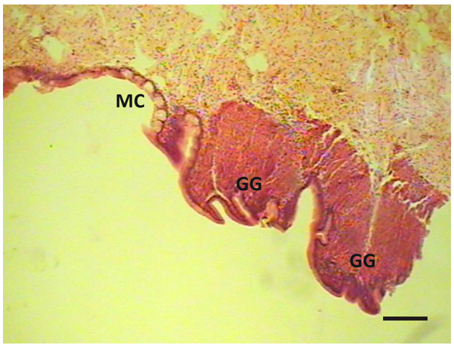

Fig. 4. Section of adult oesogaster with gastric gland (GG), oesophageal mucous cell (MC) presenting no gastric gland in the sub epithelial region. H&E. Scale bar = 50 µm.

Fig. 5. Section of adult oesogaster with gastric gland (GG) beneath the gastric epithelium of simple columnar (G-EP), oesophageal epithelium (E-EP) of stratified mucous (SSE), presenting no gastric gland in the lamina propria region. H&E. Scale bar = 50 µm.

The gastric mucosa contained simple columnar epithelia with basally located nucleus and clear apical region filled with mucin (Fig. 5). No goblet cell was seen.

The stratified mucous epithelia and columnar cells of the oesogaster were Alcian blue negative (Fig. 6), Periodic Acid Schiff (PAS) positive (Fig. 7). The control slides after diastase treatment were PAS positive too, but slightly less intense. When stained with combined AB/PAS procedure after diastase treatment, the epithelia were PAS positive presenting only a magenta colour (Fig. 8).

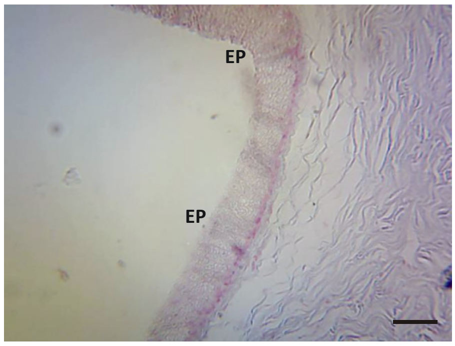

Fig. 6. Section of adult oesogaster showing AB negative epithelia mucin reaction (EP). Alcian Blue. Scale bar = 50 µm.

DISCUSSION

The histological studies of the alimentary canal across species of fish are becoming more valuable as the interest in fish culture expands and more information is required with regard to feeding and nutrition (Murray *et al*., 1994). According to Smith (1978), the gut retains considerable reserve ability to respond to new foods, new environments, and new opportunities. This versatility has been demonstrated in their adaptation to new niches, modes of feeding, utilising unexploited food resources by different fish in the same genus over short evolutionary periods of time.

Teleosts are well known to lack salivary gland (Micale & Muglia, 2011), the mucin from the oesogaster stratified mucous cells will help lubricate the gastric mucosa against abrasion from food components (Elbal & Agulleiro, 1986) and is also involved in pregastric digestion (Baglole *et al.,* 1997) as in the case of yellowtail flounder. Since it is known that there is intestinal goblet cell proliferation

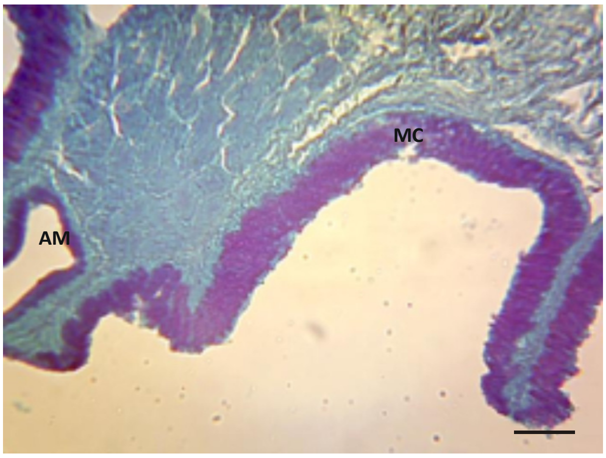

Fig. 7. Section of adult oesogaster showing PAS positive apical mucin (AM) in the columnar epithelium, and mucous cells (MC) of the oesogaster. PAS. Scale bar = 50 µm.

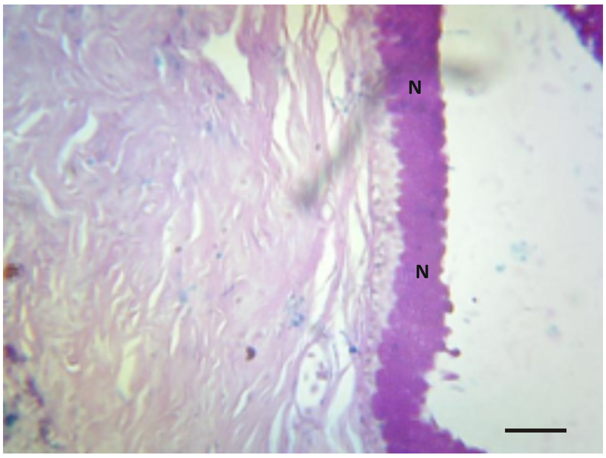

Fig. 8. Section of adult oesogaster showing neutral (N), mucin in the oesogaster. AB/PAS. Scale bar = 50 µm.

during starvation in teleost (Bovic *et al.,* 2001), the presence of the mucous cells may be an adaptation to prevent proteolytic auto-digestion or response to the stress of domestication (Reid *et al.,* 1988; Elbal *et al.,* 2004), since these fish in farmed situation are restricted to feed as provided by a feeding regimen of twice daily. Also, it is known that carnivorous teleosts poorly absorb carbohydrates in comparison to protein and lipids (Mazlan & Groove, 2002), and African catfish are omnivores tending towards more animal content (Smith, 1978). It may be suggested that the mucous cells are adding the extra needed carbohydrates (Kapoor *et al*., 1975; Ferraris & Ahearn, 1984).

Also, body structures develop according to their importance for primary living functions (Stoner & Livingston, 1984; Osse & Van den Boogaart, 1995; Sagnes *et al.,* 1997; Sala *et al.,* 2005). Thus in several species, developmental modifications may be closely linked to ontogenetic changes in habitats and resource use (Webb & Weihs, 1986; Hernandez & Motta, 1997; Ward-Campbell & Beamish, 2005), hence it is strongly suggested that the presence of this oesogaster is an adaptation to intensive aquaculture in concrete ponds. The presence of striated muscle has been reported in *Micropogonias furnieri* stomach and is related to voluntary acceptance or rejection of food from teleost stomach (Diaz *et al.,* 2008). The PAS positive reaction indicates presence of neutral mucin. The slightly intense PAS reaction after diastase treatment indicates the presence of glycogen in the neutral mucin (Cao & Wang, 2009), the glycogen present may be adding extra carbohydrate to the fish diet (Kapoor *et al.,* 1975; Ferraris & Ahearn, 1984).

This result showing the presence of only neutral mucin has been reported in other teleosts stomach. Hence, it may be suggested that this oesogaster neutral mucin is an extension of gastric mucin. Neutral mucin is associated with promotion of food absorption and transportation of large molecules across the plasma membrane. The neutral mucins of the oesogaster may be involved in buffering the effect of acid content of the stomach which is high (Scocco *et al.,* 1996; Morrison & Wright, 1999; Petrinec *et al*., 2005; Chatchavalvanich *et al.,* 2006; Cao & Wang, 2009). This result does not agree with that reported in racer gobly *Neogobius gymnotrachelus* which produced both PAS and AB positive reactions (Jaroszewska *et al*., 2008). The presence of both AB and PAS positive reaction reported may be due to the fact that racer gobly is a stomachless fish so that the esophageal epithelium actively extended into the secretory oesogaster. The AB negativity seen in this study signifies that there are no carboxylated or sulphated acid mucins. Even though this region of the digestive tract has been described as the oesogaster, the presence of only neutral mucin as revealed by this histochemical study, re-establishes that the African catfish has a true stomach.

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Paper received 15.01.2013; accepted for publication 18.03.2013

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