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Histomorphology of the gastrointestinal tract of domesticated Grasscutter (*Thyronomys swinderianus*) in Northern Nigeria

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ABSTRACT:

The gastrointestinal tract was dissected from twelve matured domesticated grasscutters of both sexes. The stomach was J-shaped, simple monogastric relatively small in relation to the size of the animal. Its histological studies revealed three regions (cardiac, fundus and pylorus) with their gastric glands. Simple structure of the intestine; duodenum, jejunum and ileum and well developed large intestines; cecum, colon and rectum were also observed. Some common histological features of the intestine observed include: intestinal glands, the villi and goblet cells. The cecum with coma-shaped blind ended sac had three regions (base, body and apex) and *Teniae* with intervening *haustra* (sacculations) was the largest organ in the abdominal cavity and the largest segment of the intestine. The structure of the cecum suggests that it is the bacterial fermentation (digestion) vat, similar to that of the horse rumen in ruminant. The colon was the widest portion of the intestine and had fecal balls which were the indigestible portion of the fed that will pass through the rectum.

Keywords:
Histomorphology, gastrointestinal tract, grasscutter.

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INTRODUCTION

The grasscutter (*Thyronomys swinderianus*) is a wild herbivorous rodent and a close relative of porcupines and guinea pigs. It is the second largest African rodent after the Porcupine and is found only in Africa, South of the Sahara (Baptist and Mensah, 1986; Adoun, 1993). Although many varieties have been described (Thomas, 1894), they belong to two different species; the smaller (*Thryonomys gregorianus*) and larger (*Thyronomys swinderianus*).

Grasscutters are heavily built rodents with average adult weight of 3 kg for females and 4.5 kg for males (Eben, 2004). They are nocturnal and live in marshy areas, along the river banks, feeding on aquatic grasses in the wild. The grasscutter is a monogastric herbivore and very fond of sweet and salty foods. It adapts readily to diet like leguminous fodder, tubers (cassava, sweet potatoes), fruits (pawpaw, pineapple and mango) and food crops (rice, maize), making them a significant pests (Eben, 2004.

The grasscutter meat is the most expensive and preferred meat in West Africa (Asibey and Addo, 2000). Apart from its excellent taste like most bush meat, it is nutritionally superior to most domestic meat from domestic animals because of its higher protein and mineral content and low fat. As a consequence, grasscutters are being raised in cages for sale and so are sometimes refer to as micro livestock (National Research Council, 1991).

Grasscutters can be used as laboratory animals, but the effectiveness of using them in the laboratory needs the information on their dietary requirements and feeding habit which depend on the knowledge of their digestive tract. Its domestication is largely in the hands of peasant farmers in villages who keep these animals in boxes, empty drums and small pens. The constraint to large scale production of grasscutter is the unavailability of breeding stocking information: on housing, feeding, anatomy, physiology, and other useful knowledge to the few breeders (Adu *et al.,* 1999).

The morphology of the digestive tract of a given animal species is related to the nature of food, feeding habits, body size and shape (Smith, 1989). The study of healthy grasscutters in this study was aimed at presenting information on the normal morphological and histological pattern of the intestine which would contribute to the knowledge of pathological conditions and/or physiological alterations.

MATERIALS AND METHODS

Animal source

A total of twelve mature domesticated grasscutters of all sexes (6 males and 6 females) were used for this study. They were purchased from local breeders in Makurdi and Otukpo towns of Benue State, Nigeria. The animals were transported using laboratory rat cages (2 males for a cage and 2 females for a cage) to the Department of Veterinary Anatomy Laboratory, Ahmadu Bello University, Zaria.

The animals were acclimatized for three days prior to the research and had free access to elephant grass, commercial feed supplement and water. The animals were observed to be in good nutritional status on physical examination before euthanasia. They were all sedated using gaseous chloroform in a confined container and later sacrificed.

Gross anatomy

For each animal, an incision was made on the ventral midline immediately after sacrifice and the abdominal cavity was exposed. The stomach and intestines were dissected from the mesenteric and spread in a straight line. The gross anatomical structures of the stomach and the entire intestine were observed.

Photomacrographs were taken using a digital camera. Tissues samples were collected from the segments of the stomach, small intestine (duodenum, jejunum) and large intestine (cecum, colon) and fixed 10 % in buffered formalin for histology.

Histology

The fixed tissues (stomach, duodenum, jejunum, cecum and colon) were cut into blocks and identified. They were then dehydrated through a series of graded alcohols (70%, 80%, 90%, 95% and 100%). The blocks were cleared in xylene and then infiltrated with molten paraffin wax. Sections (5 µm) microns thick were cut from embedded tissue using Jung Rotary Microtome (model 42339).

The tissues were then mounted on grease free clean glass slides. The slides were prepared at room temperature stained alternatively with Hematoxylin and Eosin (H & E). The prepared slides were studied using light microscope (Olympus binocular microscope). Photomicrographs of the prepared slides mounted on the binocular microscope were taken using a digital microscopic objective. These pictures were then transferred to a computer and detailed studies were carried out.

RESULTS

Gross Structure of the Stomach

The stomach of the grasscutter was observed to be simple relatively small in relation to the size of the animal, thin-walled and J-shaped with small distended bag-like when full. It had two surfaces; the parietal and the visceral, two curvatures; lesser and greater; two orifices, cardiac and pyloric and three regions; cardiac, fundus and pylorus (**Plate 1**).

Gross Structure of the Intestine

The intestine was observed to be divided into small intestine (duodenum, jejunum and ileum) and large intestines (cecum, colon and rectum). The duodenum was long and started at the pylorus region close to the stomach. The jejunum appeared to be convoluted or coiled, very long and occupied the abdominal floor between the stomach urinary bladder. The ileum was short and followed the jejunum and marked the end of the small intestine. The distal end of the ileum had a thick walled enlargement, *Sacculus rotundus* which mark the junction between the ileum, cecum and colon (Plate 1).

The cecum was observed to be the largest segment of the entire gastrointestinal tract and also the largest organ in the abdominal cavity. The cecum was seen to have a coma-shaped blind ended sac with three regions (base, body, and apex) and *Teniae* with intervening *haustra* (sacculations) on it entire length. The colon was the widest portion of the intestine and had fecal balls, particularly at it transverse and descending parts. The rectum was short, straight and marked the terminal portion of the gastrointestinal tract.

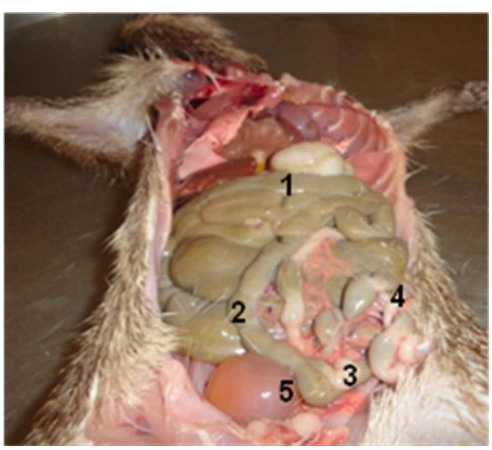

Plate 1: Grasscutter opened up *(in situ)* showing: 1, jejunum; 2, ascending colon; 3, transverse colon; 4, descending colon; 5, urinary bladder.

Histology of the Stomach

The histological studies of the stomach in this study revealed three regions (cardiac, fundus and pylorus). The stomach wall was observed to have the same structural layers (the mucosa, the sub mucosa, muscularis mucosae and muscular externa) within the three regions (**Plate 2 and 3**).

Plate 2 **Plate 3**

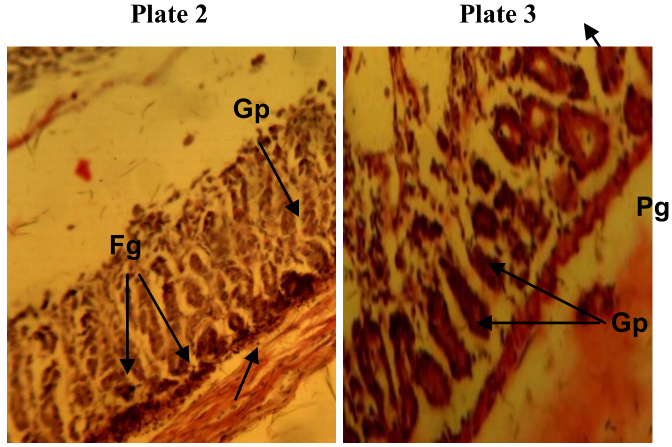

Plate 2 and 3: Photomicrographs of the fundic and pyloric region of the stomach respectively showing the fundic glands (FG), gastric pits (GP) and sub-mucosa (SM). The lamina propria contain the pyloric glands (PG). H & E Stain, x 100.

The cardiac region was found to be surrounding the point of entry of the esophagus. Its lamina propria contained simple/branched tubular cardiac glands or mucosa which extended deep into the mucosa. The gastric pits of this region were deep and lined with a simple columnar epithelium. The pyloric glands were observed to be similar to those of the cardiac glands and were characterized by deep, large or open gastric pits and short coils pyloric glands (Plate 3).

The fundic region had the most numerous types of gastric glands. The region had shallow gastric pits, long branched tubular glands that contain several cell types like parietal cells and chief cells (Plate 2).

Histology of the Intestine

The three segments of the small intestine (duodenum, jejunum and ileum) were observed to have some common histological features (the villi and goblet cells) and some minor structural differences. The duodenal segment was observed to have the intestinal villi as an outgrowth of the mucosa projecting into the lumen. The goblet cells and duodenal glands (*Brunner's)* in the sub-mucosa were also noted as the major distinguishing features observed in the duodenum (**Plate 4 and 5**).

Plate 4

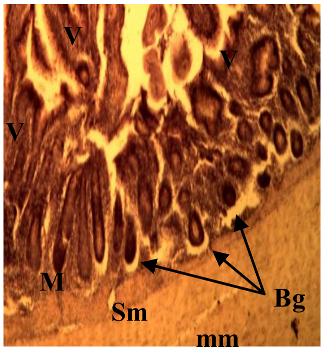

Plate 5

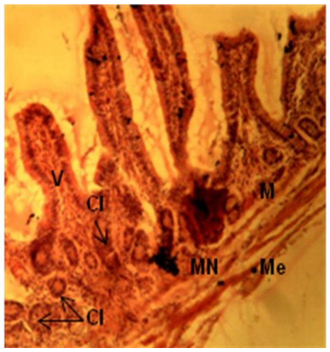

Plate 4: Photomicrograph of the duodenum showing the duodenal villi (V), the intestinal glands (*Brunner's glands* (Bg) and the wall of the intestine: mucosa (M), sub-mucosa (Sm), and muscularis mucosa (Mm). H & E Stain, x 50.

Plate 5: Photomicrograph of the jejunum showing the wall of the intestine: mucosa (M), sub-mucosa (Sm), muscularis mucosa (Mm) and the muscularis externa (Me), the villi (V) and the intestinal glands (*crypts of Lieberkuhn)* (Cl). H & E Stain, x 100.

The jejunum had numerous goblet cell and long leaf-like villi. Between these villi were the openings of the simple tubular glands called, the intestinal glands (crypts or glands of *Liberkuhn*). Each villus of the jejunum was observed to line by simple columnar epithelium cells. The striated border formed by microvilli present on the surface of the cell was clearly visible (Plate 4).

The large intestinal segments (the cecum, colon and rectum) had four intestinal wall tunics or layers similar to that observed in the small intestine. The intestinal glands were seen to be longer than that of the small intestine and the goblet cells were more numerous than were observed in the intestine (**Plate 6 and 7**).

The cecum had numerous goblet cell intestinal glands (crypts). Other prominent feature observed in the cecum was the external longitudinal muscles coat which has three bands, the *taeniae coli.* These longitudinal muscles push the "excess" mucosa to form pouches called the *hastra* (Plate 6). The colon was observed to have a wider lumen than any segment of the intestine and the mucosal surface lined by simple columnar epithelia cells. Crypts of *Lieberkuhn,* with abundant goblet cells were also observed in the colon. The muscularis external layer as in cecum was observed to have thick longitudinal bands called *taeniae coli* (Plate 7).

DISCUSSION

The stomach in this study was observed to be the simply monogastric type. This result corresponded well with those of the previous study documented for man and rabbit (Harold, 1992: Cathy, 2006). The stomach of dog though simple monogastric is in the form of a C-shape and rotated at 90^0 in a clock wise direction, with the divisions being similar to those of the monogastric animals (Millar, 1964).

Contrary to the stomach of grasscutter and dog, those of the ruminants (ox, sheep and goat), have compound stomach (Frandson, 1981; Ojo *et al*., 1987), the first three compartments (rumen, reticulum and omasum) are non-glandular, whereas, the fourth compartment (abomasum) is glandular and contains typical cardiac, fundus and pylorus regions similar to that observed in monogastric stomach (Banks, 1993).

Histological results of this study indicate that the wall of the stomach was lined with glandular mucosa and having all the layers of a typical tubular organ (George, 1973; Dellmann and Brown, 1987; Kansas, 2007; Thomas, 2007). It is generally accepted that based on the histological characteristics, the stomach of different species can be classified into different types. For example, simple unisaccular stomach (found in man and carnivores) lined with glandular mucosa only (Dellmann, 1971), the compound unisaccular stomach (example horse and pig) has a small part lined with cutaneous mucosa and the rest with glandular mucosa (Rudolf and Stromberg, 1976),

Plate 6:

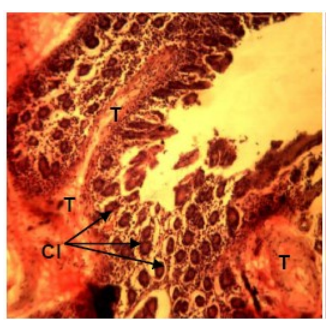

Plate 7:

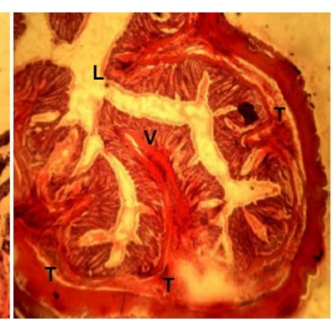

Plate 6: Photomicrography of the cecum of the grasscutter showing intestinal glands *(crypts of Lieberkuhn)* (CL) and the thick band of longitudinal muscle, the *taeniacoli (*T).H & E Stain, x 100.

Plate 7: Photomicrograph of the colon showing the thick longitudinal muscle band, the *taenia coli* (T), the lumen (L) and the intestinal villi (V). H & E Stain, x 50.

while the compound multisaccular stomach (ruminants) consists of a non glandular part (rumen, reticulum, and omasum) and glandular part (abomasum) (Eurell and Dellman, 1998).

The grasscutter stomach observed in this study may be more of chemical digestion and not fermentative digestion as experienced in animals with compound stomach like cattle and sheep. Chemical digestion relies mainly on the fundic glands which has chief cells that secrete gastric enzymes (pepsin, rennin and gastric lipase) and the parietal cells (oxyntic cells) secret hydrochloric acid, potassium and “intrinsic factor” essential for intestinal absorption of vitamin B_{12} (Banks, 1993; Paul, 2007). This has also been reported in the cat (Dellman, 1971).

In the present study, the tunica submucosa of the duodenum was observed to contain the *Brunner’s glands.* The lamina propria also had abundant intestinal glands (crypts of *Lieberkuhn*) in addition to the goblet cells within the epithelial cells. Charlotte (2004) had determined the location of the *Brunner’s glands* to be in the initial and middle part of the duodenum in the dog, cat, man and small ruminants. But in the pig, horse and large ruminants, they were beyond the duodenum. The research on the glands, the villi and goblet cells has been widely executed (Millar, 1964; Dellman, 1971; Harold, 1992).

The absorption capacity of the small intestine is an important parameter for the growth of grasscutter. In the present study, the jejunal villus surface was larger than the duodenal villus surface; suggesting that the absorption capacity being highest in the jejunum than duodenum. This finding is in agreement with Wise *et al. (*2003) who reported that absorptive capacity is highest in the jejunum than in the duodenum when they conducted research on the morphology of the small intestine of weaned piglets.

With regards to diet, the grasscutter is a monogastric herbivore; it adapts readily to a variety of diets like grasses, leguminous fodder, fruits, tubers and food crops (Eben, 2004). Digestion of cellulose by this animal cannot take place in the stomach because of the lack of fermentation like ruminants. The cecum described in this study resembled the ruminant rumen (abundant papillae) and that of the horse. Many authors (Dellmann, 1971; Ohio, 2007) have reported that in monogastric herbivores (especially in the horse) the cecum act as the bacterial fermentation (digestion) vat, similar to the rumen in cow. The microbes in the cecum break down feed that was not digested in the small intestine, particularly fibrous feeds like hay or pasture.

Monogastric herbivores like the rabbits and rodents have shorter but prominent cecum (George 1973) documented that the cecum in rabbit is the largest internal organ in the abdomen and fermentation of the intestinal contents occurs there. And that periodically the cecum contracts and the fermented ingesta are propelled into the colon and then out of the anus.

In addition to the vitamins and fatty acids absorption in the colon, water is also said to be absorbed, resulting in the fecal ball formations. These fecal balls (as observed in our study), is said to be the indigestible portion of the fed which will then pass through the rectum as in the horse (Ohio, 2007). In rabbit, the fecal pellets are directly ingested by the animal in a process called coprophagy or cecotrophy, meaning the ingestion of feces. The cecotropes or night feces as they are called are coated with mucus which acts as a barrier to the acidic pH of the stomach, ensuring that the content will be absorbed from the small intestine.

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