

## Gastrointestinal Anatomy of *Addax nasomaculatus*

William Pérez, Martín Lima  
Facultad de Veterinaria, Área de Anatomía, Instituto de Biociencias,  
Lasplacas 1550. CP 11600. Montevideo, Uruguay

**Abstract:** In the present study, using the Nomina Anatomica Veterinaria, the stomach and intestine of a lactating *Addax* is described. The stomach had the four compartments the smallest of which was the omasum. The small intestine had a similar appearance to that of the sheep. The ascending colon was divided in proximal, spiral and distal ansae. The proximal ansa was simple and straight. The spiral ansa had three centripetal gyri (o convolutions), a free central flexure and three centrifugal gyri. The last centrifugal gyrus accompanies the yeyunum in the same fashion as it does in the sheep. The distribution of the branches of the gastric and cranial mesenteric blood vessels was similar to that of the sheep.

**Key words:** Ruminant stomach, intestine, ascending colon, antelope anatomy

### INTRODUCTION

*Addax nasomaculatus* [Blainville, 1816] which Orders Artiodactyla, Belongs to Family Bovidae and subfamily is Hippotraginae, was once found throughout most of the Sahara desert. Due to excessive hunting, the addax has become one of the world's rarest mammals. This species was listed as Critically Endangered (United Nations Environment Programme)<sup>[1]</sup>. The addax is the antelope best adapted to the desert and lives the major part of its life with very scant water, most of which is obtained from the vegetation ingested. As far as we know no one has published any description about its digestive anatomy. We have consulted publications related to the stomach anatomy in eleven different Zambian game species and in *Kobus vardonii* (Puku) and *Kobus leche kafuensis* (Kafue lechwe)<sup>[2-4]</sup> and in deers<sup>[5]</sup>. As these animals belong to the Bovidae family it was logic to find anatomic similarities with the domestic ruminants. The domestic representatives of the Bovidae family have been studied extensively<sup>[6,7]</sup>.

In this case we have studied the gastrointestinal tract of a lactating *Addax*, described its parts and disposition, and some aspects of the gastrointestinal irrigation. The stomach had the four compartments described in the domestic ruminants. The ascending colon was divided in proximal, spiral and distal ansae. The ansa proximal was simple and straight. There were three centripetal and three centrifugal gyri in the spiral ansa. The last centrifugal gyrus of the spiral ansa moved away from it and accompanied the jejunum.

### MATERIALS AND METHODS

The stomach and intestine belonging to a one month old animal that died in a zoo constitutes the material used in this study. This material was fixed in a solution of formalin 10%. Both its external and internal configuration were studied and the arteries, veins and lymphatic nodules related to the intestine were dissected. Digital photos were taken. The Nomina Anatomica Veterinaria was used.

### RESULTS

The stomach had the four compartments: rumen, reticulum, omasum and abomasum. The rumen was situated to the left, the reticulum cranially and the omasum to the right. The abomasum was situated mainly to the right but also ventrally and to the left under the rumen.

The rumen was the second largest compartment after the abomasum. Externally two longitudinal sulcus (or grooves) could be identified, a right and a left one, that divided the rumen in dorsal and ventral sacs. The longitudinal sulcus connected with each other at both extremities of the organ by means of the cranial and caudal sulci. The left longitudinal sulcus gave insertion to the superficial wall of the greater omentum and the right sulcus to the deep one. The ventral sac of the rumen was enclosed inside the omental bursa and its blind caudoventral sac extended more caudally than its dorsal counterpart. Its interior surface had papillae found mainly in the atrium and in the ventral sac. The pillars found to be developed were the cranial, caudal and right ventral coronary pillars.

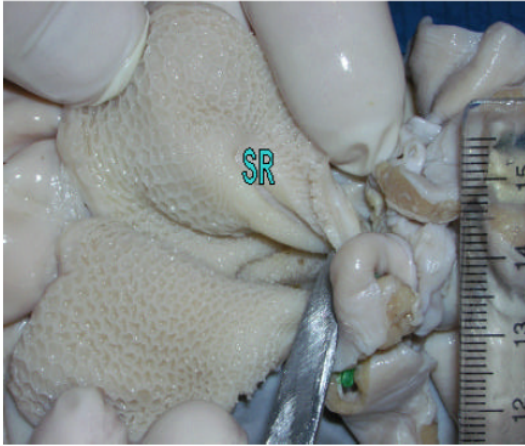


Fig. 1: Interior view of the reticulum and Sulcus Reticuli (SR)

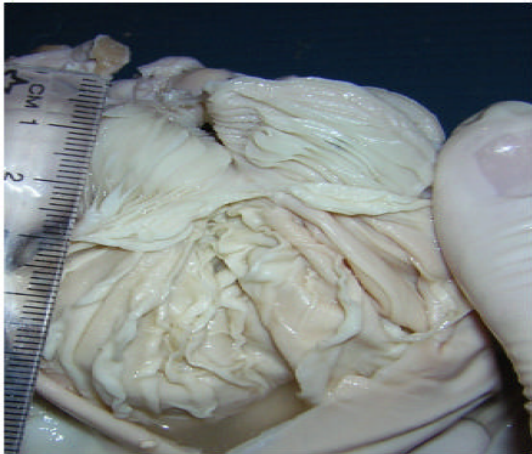


Fig. 2: Interior view of the omasum (superior part) and abomasum (inferior part).

Externally the reticulum had the same parts that are described in the *Nomina Anatomica Veterinaria*, and internally there were reticular cells and a well developed reticular groove (Fig. 1). The reticular groove was devoid of cells and papillae. The cells had up to tertiary crests that subdivided them, with papillae on every side of the crests and also in their free border.

The omasum was smaller than the reticulum and had well demarcated laminae (Fig. 2). In a transverse section lamellar circles were evident with up to third order laminae. The laminae had papillae on both sides.

The abomasum also had the same parts as are described by the *Nomina Anatomica Veterinaria*. The mucosal folds were permanent (Fig. 2). The velum abomasicum corresponded with the two folds that lied

closer to the omasoabomasal orifice. There was a well developed torus pyloricus.

The celiac artery ended in three branches: the splenic artery, the left gastric artery and the hepatic artery. The splenic artery reached the spleen without branching before entering it. Its first collateral artery corresponded to the left ruminal artery. This artery crossed the right side of the cranial sac of the rumen and passed along the cranial groove of the rumen to the left side.

The left gastric artery distributed itself between the reticulum, omasum and abomasum. It gave the left gastroepiploic artery which went towards the greater curvature of the abomasum. The left gastric artery went towards the lesser curvature of the abomasum. These two vessels anastomosed with their right counterparts that proceeded from the hepatic artery.

Reticular lymphatic nodules were seen at the union between reticulum and omasum.

The total length of the small intestine was 6.18 m and that of the large intestine was 2.05 m. The small intestine had the three usual parts found in domestic animals. The duodenum, with a length of 43 cm, was divided in a cranial part, cranial flexure, descending part, caudal flexure, transverse and ascending parts. At the cranial part of the duodenum was the major duodenal papilla, where the common bile duct and the pancreatic duct ended. A minor duodenal papilla was not identified.

The ascending part of the duodenum was united to the descending colon by means of the duodenocolic plica. The jejunum had a length of 5.6 m, and was arranged in tight circumvolutions at the periphery of the mesentery. The ileum was similar to the jejunum in diameter but had a straighter trajectory. Its length was 15 cm. The caecum,

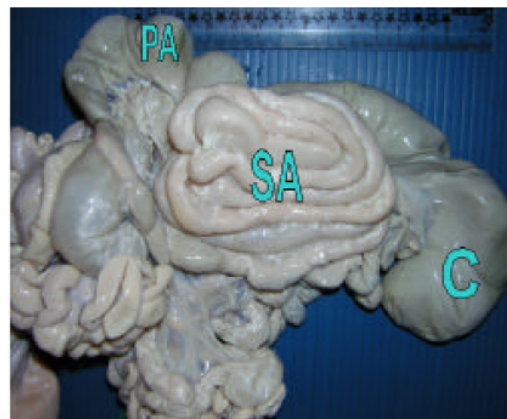


Fig. 3: Left view of intestinal mass. C: Caecum, PA: Proximal anseae of ascending colon, SA: Spiral anseae of ascending colon

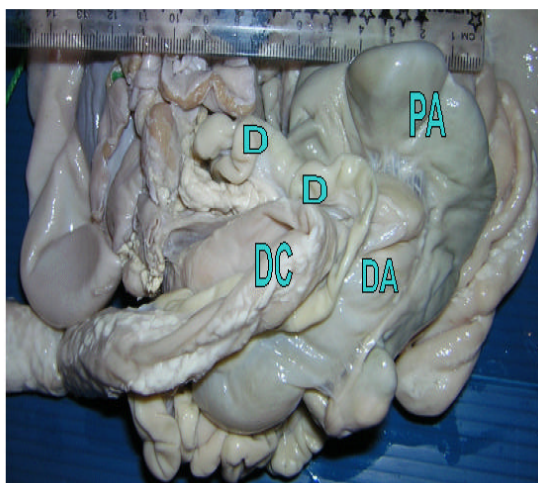


Fig. 4: Dorsal view of the intestinal mass in position. PA: Proximal Ansa of Ascending Colon, DA: Distal Ansa of Ascending Colon, D: Duodenum, DC: Descending Colon



Fig. 5: Vessels and a large Lymphatic Node (LN) in the mesentery

from the end of the ileum, continued with the ascending colon. The ileum and the caecum had 15 cm in length each. The ascending colon was divided in proximal, spiral and distal ansae (Fig. 3). The proximal ansa was simple, straight and crossed to the left as spiral ansa. The spiral ansa had three centripetal gyri, a free central flexure situated to the outside of the spiral, and three centrifugal gyri (Fig. 3). The spiral ansa was adhered to the left leaf of the mesentery. The last centrifugal gyrus of the spiral ansa moved away from the spiral ansa and accompanied the jejunum. It then continued as distal ansa of the ascending colon and the other classical parts of the

intestine. The distal ansa occupied great part of the left side of the mesentery. The length of the three parts of the colon (ascending, transverse and descending) was of 1.9 m. Dorsally, the duodenum, the descending colon and the proximal ansa of the ascending colon in the right, and the distal ansa of the ascending colon in the left, were very close to each other (Fig. 4).

The intestine was irrigated mainly by branches of the cranial mesenteric artery. The middle colic artery was distributed to the transverse colon and to the distal ansa of the ascending colon. The cranial mesenteric artery gave caudally the iliocolic artery which irrigated part of the proximal ansa of the colon, several colic branches and the right colic arteries destined to the spiral ansa of the colon. The colic branches were distributed in the centripetal gyri and the right colic arteries in the centrifugal gyri of the spiral ansa. These arteries were found on the right side of the spiral ansa. After the ileal opening we saw the cecal artery in the iliocecal fold directing itself towards the apex of the cecum. There wasn't an antimesenteric ileal branch. The rest of the cranial mesenteric artery was distributed in the jejunum-ileum. There was no collateral branch. The jejunal and ileal arteries gave the classical distribution in anastomosed arches. The jejunal arteries also irrigated the last centrifugal gyrus of the spiral ansa that accompanies the jejunum. All the arterial vessels were accompanied by satellite veins which formed the cranial mesenteric vein. The lymphatic nodules of the cranial mesenteric lymphocentrum were scarce; there was one elongated (Fig. 5) and three smaller ones. One of these nodules surrounded the iliocecal artery ventrally to the terminal part of the ileum.

## DISCUSSION

This animal presented the typical arrangement of the digestive anatomy of the ruminant. The stomach had four parts as in the domestic ruminants. As in the sheep, the caudoventral blind sac extended more caudally than the dorsal one and the omasum was the smallest compartment. The omasum is absent or rudimentary in some antelopes<sup>[6,8]</sup> but it has been well studied in various antelopes<sup>[2-4]</sup>.

In this case and similar to what happens in the newborn calf and lamb, the abomasum predominated, and the development of each part, as well as the development of the papillae of the rumen were in accordance to the age of the animal studied.

The arterial irrigation of the stomach follows the same pattern described for the domestic ruminants<sup>[9]</sup>. The reticular lymphnodes contrary to what is described for the domestic ruminants were notorious<sup>[9]</sup>.

The length of the different parts of the small and large intestines are in accordance with the proportions cited for the domestic ruminants<sup>[6,7]</sup>, were the small intestine predominates.

The common biliar duct and the pancreatic duct ended in the major duodenal papilla. It could not be established if they united previously between them or not. We did not see the minor duodenal papilla nor the accessory pancreatic duct. This disposition of the ducts is similar to that found in the sheep.

The proximal ansa of the ascending colon did not describe a flexure with the form of the letter S as is described in the domestic ruminants, but instead it described a curve and continued as the first centripetal gyrus of the spiral.

*Addax* had three centripetal gyrus and more than three centrifugal gyrus in the spiral ansa, in the small domestic ruminants there are two to three of these gyri and in the bovine only two. Having a certain similarity with the camels, they have the caecum and immediately the spiral ansa which describes four gyri in each direction<sup>[6]</sup>. In other antelopes the spiral ansa of the ascending colon also has more than three gyri in each direction<sup>[5]</sup>.

As it happens in the sheep and the goat the last centrifugal gyrus of the spiral ansa separated clearly and went in the vicinity of the jejunum.

The arterial and venous irrigation was quite similar to that described for the ovine<sup>[9]</sup>. There was no collateral branch as is described in the bovine nor the ileal antimesenterial branch. The number of mesenteric lymphnodes was notoriously inferior to that of the ovine.

As a final conclusion we can say that the gastrointestinal anatomy of *Addax nasomaculatus* is not very different to that described for the domestic ruminants<sup>[6,7]</sup> or for other antelopes and deers<sup>[2-5]</sup>. And also, all the members of the suborder Ruminantia described share many similarities in their digestive anatomy.

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