Original article

Gross anatomy of the gastrointestinal tract in the Brown Brocket deer (*Mazama gouazoubira*)

Pérez, W.* and Vazquez, N.

Área de Anatomía, Facultad de Veterinaria, Lasplaces 1620, 11600 Montevideo, Uruguay
*E-mail: vetanat@gmail.com

Abstract

We dissected and described the macroscopic anatomy of the stomach and intestines of five adult Brown Brocket deer (*Mazama gouazoubira*), a south american cervid species. The findings of our study as ruminal papillae evenly distributed across the rumen, papillated rumen pillars, the large reticulum with low reticular crests and the small omasum represent typical characteristics of browser ruminants. The ratio of the small intestine to the large intestine of 2.0 appears within the 'browser range'.

Keywords: cervidae, anatomy, forestomach, proventriculus, abomasum, abdomen.

1 Introduction

The brown brocket deer is found east of the dry, pre-Andean regions in Argentina and Bolivia, extending to the Atlantic coast on the west; its northern limit is south of the Amazon region and its southern limit includes all of Uruguay and up to the province of Entre Rios in Argentina (BLACK and VOGLIOTTI, 2008).

It eats a wide variety of plant species and is a selective feeder; it has pulses of frugivory depending on the area, season and availability (STALLINGS, 1984; RICHARD and JULIA, 2001).

The classification of ruminants into three groups according to their feeding types (browsers, intermediate feeders, grazers) has been linked to anatomical studies, mainly performed with African, European, and North American species (HOFMANN, 1973, 1988). South American species have been less investigated in this respect.

According to our knowledge, the macroscopic anatomy of the stomach and intestine of the brown brocket deer has not been described. To investigate this topic we dissected and described the stomachs and intestines of five brown brocket deer and compared anatomical measurements with other wild ruminant species.

2 Materials and methods

Five adult brown brocket deer, three males and two females, which lived in open grasslands, were used for this study. The mean body weight of the animals was 18.7 ± 2.15 kg. The cause of death of these was not determined. The animals were frozen until dissection. The ventral abdominal wall of each animal was removed, and the gastrointestinal tract was separated after sectioning the oesophagus just prior to the diaphragm and canal anal, and dissecting it away from its attachments to the dorsal abdominal wall. The stomach was removed after sectioning the pylorus just before the duodenum. Stomach contents were measured by weighing the unopened organ and re-weighing it after it had been opened and contents rinsed with tap water and dried with paper towels. Anatomical measurements were taken following standard procedures described in Hofmann (1969) or Clauss indications (personal communication); in brief, the ruminoreticulum was placed on its left side, and the height and length of the rumen and the reticulum, the length of the *Curvatura omasi* were measured with soft measuring tape. After incision and emptying of the stomach compartments, the dimensions of the Ostia intraruminale, ruminoreticulare and reticuloomasale were measured by tape; the thickness of the cranial and caudal rumen pillars, the maximum height of the reticular crests and the length of the *Papillae unguiculiformes* were measured with calipers. The intestines full and empty weights were registered. After dissection of all mesenteric attachments, the lengths of the different sections of the intestinal tract were taken on the anti-mesenteric side with a standard measuring tape. Pictures were taken with a Nikon digital camera. Terms are used in agreement with the Nómina Anatómica Veterinaria (2005).

3 Results

The stomach of the brown brocket deer was composed of the four classic compartments of the ruminants. The weight of the full stomach was 1192.5 ± 336.36 g.

The full ruminoreticulum mass was 1054.25 ± 296.42 g. Lengths of the dorsal and ventral sacs were 25.0 ± 1.63 cm (range 23.0 to 27.0 cm) and 18.75 ± 0.5 cm (range 18.0 to 19.0 cm), respectively. The height of the rumen was 25.25 ± 1.71 cm. The caudoventral blind sac extended more caudally than the dorsal blind sac and ended in a cone form. The dorsal sac communicated with the ventral sac by the intraruminal ostium, whose border was formed by the ruminal pillars, and which measured between 9.87 and 9.25 cm. The ruminal pillar (Figure 1) thickness measured 7.25 ± 4.35 mm (range 3.0 to 11.0 mm) and 10.0 ± 4.97 mm (range 4.0 to 15.0 mm) for the cranial and caudal pillars, respectively. The ruminoreticular ostium measured between 3.5 × 3.5 cm and 4.5 × 4.5 cm.

The ruminal papillae were evenly distributed across the rumen (Figures 1-3). The ruminal pillars had small papillae (Figure 1). The reticulum (Figure 1) was very large, and its external measures were 12.0 ± 1.41 cm of height, and 8.38 ± 1.49 cm in the craniocaudal length. The maximum

height of the reticular crests was smaller than 1.0 mm. The reticular cells were not divided and rarely contained secondary crests. All cells had conical papillae. Near the reticulo-omasal orifice, papillae unguiculiformes had a length of about 1.0 mm. The reticulo-omasal orifice measured 19.0 ± 1.73 mm (range 17.0 to 20.0 mm) in diameter.

Figure 1. Internal cranial view of the rumen of Mazama gouazoubira. PC: Pila cranialis.

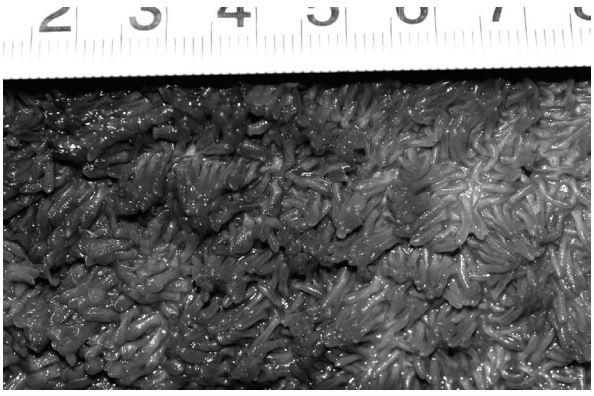

Figure 2. Internal view of the Saccus dorsalis of the rumen of *Mazama gouazoubira*. Note the presence of papillae.

Figure 3. Internal view of the Saccus ventralis of the Rumen of *Mazama gouazoubira*. Note the presence of papillae.

The omasum was the smaller gastric compartment. The curvatura omasi measured 18.0 ± 5.6 cm (range 10.0 to 23.0 cm). There were 11 primary omasal lamellae, 16 secondary lamellae, and small tertiary lamellae represented by small lineal elevations. The abomasum had about 10 abomasal folds and a small torus pyloricus was present.

The length of the total small intestine was 636.25 ± 116.29 cm (mean ± SD), the length of the caecum and colon was 307.5 ± 50.08 cm. Therefore, the small intestine: gross intestine ratio was 2.0. The caecum (Figure 4) was a smooth, cylindrical sac, without haustrae. The colon was externally smooth, without haustrae. The ascending colon had three ansae: the proximal ansa, the spiral ansa, and the distal ansa. The proximal ansa of the ascending colon (Figure 4) was S-shaped, directed first cranially, then turned over itself caudally, adhering to the cranial part of the caecum, and finally turned medially where it attached to the left sheet of mesentery. The spiral ansa appeared short, and included 1 ½ centripetal gyri, a central flexure and 1 ½ centrifugal gyri situated in the concavity formed by the former.

4 Discussion

According to our knowledge, this is the first anatomical description of the stomach of the brown brocket deer, which facilitates a comparison with other descriptions from the literature.

According to Clauss, Hofmann and Fickel et al. (2009) and the distribution of ruminal papillae across the rumen, we presumed a lack of a distinct rumen contents stratification and then the whole rumen acts as an absorptive organ in this browser species.

The height of the reticular mucosa crests represents a dietary adaptation in Ruminants (CLAUSS, HOFMANN, STREIC et al., 2010). Reticulum size is more or less constant in ruminants both across body sizes and the feeding types (CLAUSS, HOFMANN, STREIC et al., 2010).

According to Hofmann (1989) and Clauss, Hofmann and Hummel et al. (2006) the omasum is distinctively larger in grazing than in browsing ruminants.

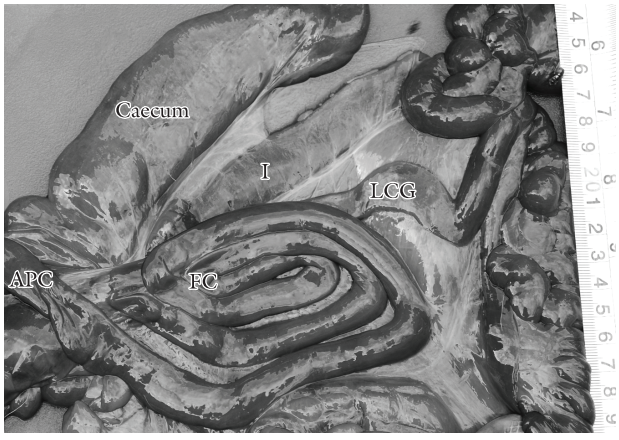

Figure 4. Gross intestine of *Mazama gouazoubira*. I: ileum; APC: ansa proximalis coli; FC: flexura centralis; LCG: last centrifugal gyri of the spiral ansa.

The ascending colon of the brown brocket deer had three ansae (proximal, spiral and distal) as it is described for bovines, ovines and caprines (SMITH, 1955a, b, 1959; SMITH and MEADOWS, 1956,), giraffe (PÉREZ, LIMA, CLAUSS et al., 2009), Ozotoceros bezoarticus (PÉREZ, CLAUSS, UNGERFELD et al., 2008) and for other deer (WESTERLING, 1975). Also in agreement with the literature of the domestic ruminants, the spiral ansa consisted of centripetal gyri, a central flexure and centrifugal gyri (NÓMINA…, 2005).

In relation to ecological niche partitioning among ruminants, the comparative ratio of the small intestine to the large intestine, in terms of length measurements, is of interest. In this respect, Hofmann (1989) suggested that this ratio was 1.9-2.7 in browsing and 4.0-4.5 in grazing ruminants, respectively. The ratio of 2.0 in brown brocket deer appears within the 'browser range' as suggested by Hofmann (1989). At 2.0, the ratio of brown brocket deer it's included at the range of 1.9-2.7 given for typical browsing species.

The findings of our study as ruminal papillae evenly distributed across the rumen, papillated rumen pillars; the large reticulum with low reticular crests and the small omasum represent typical characteristics of browser ruminants. This is in accordance with previous studies about the diet of this animal (STALLINGS, 1984; RICHARD and JULIA, 2001).

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