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Anatomy of the digestive tube of toco toucan

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Abstract

A study was made of the anatomy of the digestive tract of 12 specimens of *Ramphastos toco* captured by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) of Uberlândia, MG. The birds comprised seven males and five females, six adults and six juveniles, with an average total length of 476.33 ± 103.49 mm. The birds' thoracic-abdominal cavity was opened to examine and identify the components of the digestive tube. The cervical esophagus, situated dorsolaterally to the trachea in the right antimere of the neck, continues as the thoracic esophagus in view of the absence of an ingluvium (crop) in this species. The thoracic esophagus leads ventrally to the lungs, joining the proventricle dorsally to the heart. The proventricle is cylindrical and is located in the left antimere of the cavity. The ventricle, in

turn, is rounded and in close contact with the dorsal side of the left hepatic lobe through an impression. The duodenum forms a U-shaped loop and is connected to the ventricle, the right hepatic lobe, and the jejunum-ileum and colon-rectum loops. The largest intestinal segment, the jejunum-ileum, is arranged in loops distributed along the caudal third of the thoracic-abdominal cavity. The large intestine consists solely of the colon-rectum, which circumvents the left kidney ventrally to the cloaca. The cervical esophagus, thoracic esophagus, proventricle, ventricle, duodenum, jejunum-ileum and colon-rectum represent, on average, 17.82%, 12.90%, 5.67%, 6.82%, 27.64%, 30.06% and 11.57%, respectively, of the bird's total length.

Keywords: birds, gut, stomach, esophagus, Ramphastidae

Anatomia do tubo digestório de tucano toco

Resumo

Realizou-se um estudo acerca da anatomia do trato digestório de 12 espécimes de *Ramphastos toco* capturados pelo IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) de Uberlândia, MG. Dentre os exemplares havia sete machos e cinco fêmeas, dos quais seis eram adultos e a outra metade era composta por animais jovens, com um comprimento corporal total médio de $476,33 \pm 103,49$ mm. A cavidade tóraco-abdominal das aves foi aberta para examinar e identificar os componentes do tubo digestório. O esôfago cervical, situado dorsolateralmente à traquéia no antímero direito do pescoço, se comunica diretamente com a sua parte torácica em vista à ausência do inglúvio nesta espécie. O esôfago torácico segue ventralmente aos pulmões e se une ao proventrículo dorsalmente ao coração. O proventrículo é cilíndrico e está localizado no antímero esquerdo da cavidade, já o ventrículo, possui forma arredondada e encontra-se em estreito contato com a região dorsal do lobo hepático esquerdo através de uma impressão. O duodeno forma uma alça em U e se comunica ao ventrículo, sob o lobo hepático direito, e as alças intestinais do jejuno-íleo e cólon-reto. O maior segmento intestinal, o

jejuno-íleo se distribui ao longo do terço caudal da cavidade tóraco-abdominal enquanto o intestino grosso é constituído apenas do cólon-reto, que contorna o rim esquerdo ventralmente à cloaca. O esôfago cervical, esôfago torácico, proventrículo, ventrículo, duodeno, jejuno-íleo e cólon-reto representam, em média, 17,82%; 12,90%; 5,67%; 6,82%; 27,64%; 30,06% e 11,57%, respectivamente, do comprimento corporal total na espécie.

Palavras-chave: aves, intestino, estômago, esôfago, Ramphastidae

Introduction

Toucans are wild birds of the genus *Ramphastos*, which comprises 41 different species, among them *Ramphastos toco*, which inhabits the forests of South America, especially those of Brazil (SICK, 1997). This species is common in gallery forests such as that of the Miranda River (southern Pantanal wetlands), particularly during the dry season, when fruit availability is relatively abundant (RAGUSA-NETTO, 2006).

Ramphastos toco, known popularly as *toco* toucan and *tucanuçu*, is the largest toucan species. Its habits are diurnal and its diet is omnivorous, consisting mainly of fruit, but including small insects, eggs and the young of other animals (SICK, 1997).

The digestive system of birds in general consists of an oropharynx, esophagus, stomach, duodenum, jejunum, ileum, paired ceca and colon, ending in the cloaca, which also serves the urogenital system (DYCE, SACK and WENSING, 1997). The digestive system differs from that of mammals, especially in that it includes a crop in the esophagus and a gizzard (muscular stomach) (SICK, 1997).

The study of the anatomical and functional aspects of the digestive system is extremely important due to the fact that this organic system is responsible for processing food, through which are obtained the essential nutrients for the proper working and interaction of all the tissues of a living organism. Knowledge of the anatomy of the digestive tube of *Ramphastos toco*

is therefore fundamental to allow the nutritional needs of these birds in captivity to be met adequately.

Material and Methods

This research involved 12 specimens of *Ramphastos toco* (toco toucan), seven males and five females, six juveniles and six adults, which were apprehended by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources) of Uberlândia, MG and sent to the Wild Animal Research Laboratory (LAPAS) of the Federal University of Uberlândia (UFU) Faculty of Veterinary Medicine.

The birds were marked and identified by sex. Their thoracic-abdominal cavity was then opened by means of two incisions between the ribs on each side to remove the plastron, exposing the viscera, which were left in their respective anatomical positions for the topographical description.

Care was taken during the dissection to maintain the integrity of the components of the digestive tube. Having identified the individual organs, they were described in terms of shape, using a pachymeter with a precision of 0.05 mm to measure the length and diameter (in millimeters) of all the segments of the digestive tube of each specimen, except the ventricle, whose length, width and thickness were measured (in millimeters). The total length of each bird was determined by measuring the distance from the proximal end of the beak to the distal end of the tail (in millimeters), with the bird lying on its back and its neck extended.

To analyze and describe the findings, we considered the relation between the length of each segment of the digestive tube and the total length of the respective bird, in percentage. The anatomical description follows the terminology accepted by the *Nomina Anatomica Avium* handbook (BAUMEL, 1993).

A schematic diagram was drawn representing the digestive tube of the species (Figure 1), as well as a table (Table 1) listing the dimensions of each of the digestive tube segments in the specimens under study.

Results

The *Ramphastos toco* specimens evaluated here presented a total mean length of 476.33 ± 103.49 mm.

The cervical esophagus begins ventrally, veering to the right side of the proximal third of the neck, remaining aligned dorsolaterally with the trachea throughout its trajectory. It is longer than the thoracic portion, representing on average 17.82% of the bird's total length.

This species does not possess an ingluvium and the thoracic esophagus is the portion subsequent to the cervical portion. It follows the syrinx, the tracheal bifurcation and the base of the heart dorsally, and the lungs ventrally, joining the proventricle at the level of the heart. On average, it is equivalent to 12.90% of the bird's total length.

With its cylindrical shape similar to that of the esophagus, the proventricle differs from this segment basically by its larger external diameter. It is located dorsally to the caudal half of the heart, the cranial third of the hepatic lobe, and ventrally to the final third of the left lung and the spleen. On average, it represents 5.67% of the bird's total length.

The ventricle is rounded, representing on average 6.82% of the bird's total length. It begins at the level of the middle third of the left hepatic lobe and is in close contact with the dorsal face of the liver, indicated by a clear hepatic impression. It is also related with the caudal third of the right hepatic lobe, through its right lateral face. It is located ventrally to the final portion of the jejunum-ileum and to the initial portion of the colon-rectum.

The duodenum begins in the cranial portion of the right lateral face of the ventricle, dorsally to the caudal third of the right hepatic lobe, through the descending duodenum loop. This is equivalent, on average, to 13.12% of the bird's total length and continues caudally to close to the cloaca, where the beginning of the ascending loop begins ventrally to the final portion of the colon-rectum. This segment follows the opposite trajectory dorsally to the descending loop, joining the jejunum-ileum at the level of the caudal half of

the right hepatic lobe, caudally to the right gonad in males. It represents, on average, 14.52% of the total length of the bird.

The jejunum-ileum is the largest of the intestinal segments and is equivalent, on average, to 30.06% of the bird's total length. It is arranged in a few loops attached by mesentery and distributed along the caudal third of the thoracic-abdominal cavity, ventrally to the medial and caudal renal lobes and the colon-rectum, and dorsally to the duodenum and ventricle.

Table 1: Mean length and standard deviation (mm) of the segments of the digestive tube of toco toucan. Uberlândia, 2011

| Segments of the digestive tube | Mean ± Standard Deviation | |
|---------------------------------------|---|---------------|
| | Length (mm) | Diameter (mm) |
| Cervical esophagus | 84.05 ± 18.74 | 7,90 ± 2,63 |
| Thoracic esophagus | 59.47 ± 7.05 | 6,96 ± 1,20 |
| Proventricle | 26.10 ± 3.34 | 8,92 ± 1,81 |
| Ventricle ¹ | 30.95 X 20.81X 19.42 ± 3.05 X 5.18 X 3.61 | |
| Esophagus + proventricle + ventricle | 200.58± 22.22 | 10.80 ± 1.569 |
| Descending duodenum loop | 59.67 ± 7.94 | 9.40 ± 2.01 |
| Ascending duodenum loop | 65.54 ± 8.68 | 9.42 ± 1.89 |
| Jejunum-ileum | 136.77 ± 19.30 | 9.24 ± 2.91 |
| Thin intestine | 261.98 ± 27.44 | 9.45 ± 1.879 |
| Colon-rectum (thick intestine) | 52.30 ± 5.99 | 10.12 ± 2.53 |

¹Length X Width X Thickness (mm)

mm – millimeters

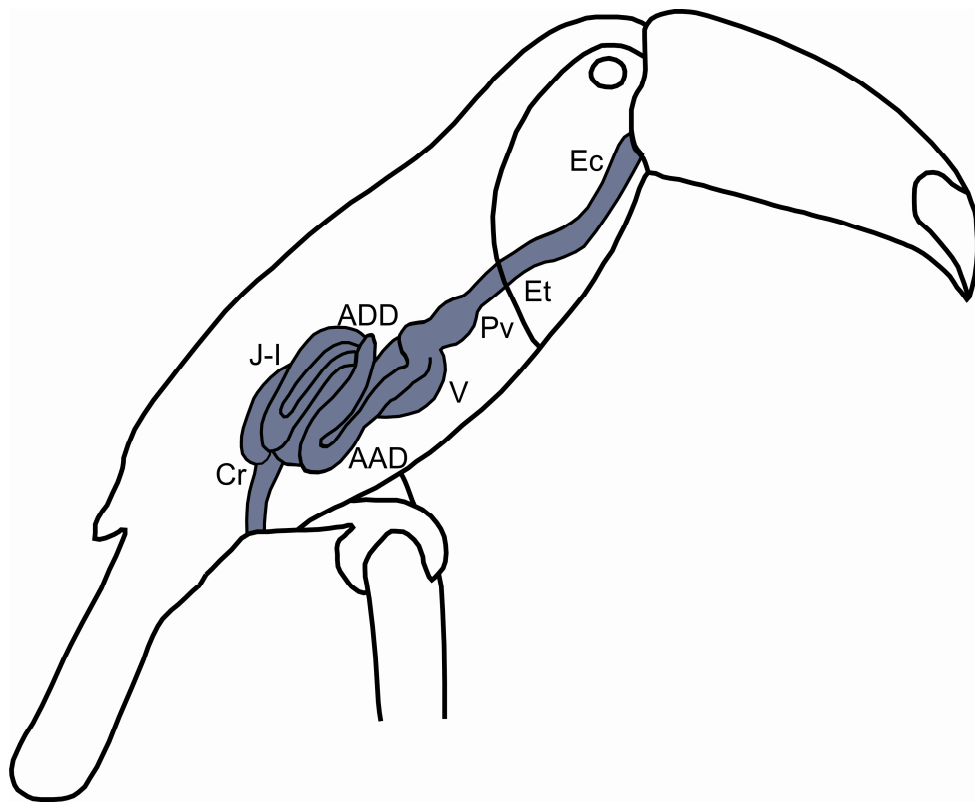


Figure 1 – Right lateral view of the topographical arrangement of the segments of the digestive tube of toco toucan: cervical esophagus (Ec), thoracic esophagus (Et) proventricle (Pv) ventricle (V), descending duodenum loop (AAD) ascending duodenum loop (ADD), jejunum-ileum (J-I) and colon-rectum (Cr).

Discussion

Comparative studies of the anatomical aspects of domestic birds and mammals have been reported by several authors. The esophagus of birds has a relatively larger diameter than that of mammals (Mc LELLAND, 1986). The anatomy of the digestive tube of domestic birds is very well described (NICKEL, SCHUMMER and SEIFERLE, 1977, SCHWARZE and SCHRÖDER, 1980, McLELLAND, 1986, MACARI, FURLAN and NAKAGHI, 1994, DUKE, 1996), as are the positions of the organs in the body (BENNETT and DÊEM, 1996, DÊEM and BENNETT, 1996, DUKE, 1996, DYCE, SACK and WENSING, 1997).

In domestic birds, some authors highlight the presence of a sac-like diverticulum, the crop, which consists of a ventral dilatation of the cervical esophagus close to its entrance into the thoracic cavity (McLELLAND, 1986, DYCE, SACK and WENSING, 1997). The same does not apply to the birds of this study, which complete absence of an ingluvium. The thoracic esophagus of *Ramphastos toco* is similar to that of domestic birds.

The stomach is divided by a constriction into glandular and muscular parts (proventricle and ventricle) (NICKEL, SCHUMMER and SEIFERLE, 1977, McLELLAND, 1986, DYCE, SACK and WENSING, 1997), as was observed in the present study. This organ occupies a retroperitoneal position (RODENBUSCH, CANAL and SANTOS, 2004). Unlike reports McLelland (1986) and Dyce, Sack and Wensing (1997), the ventricle of toco toucan displayed a rounded shape.

Birds, as well as mammals, have a division that differentiates the intestinal canal into thin and thick intestines (NICKEL, SCHUMMER and SEIFERLE, 1977). Contrary to the reports of some authors (NICKEL, SCHUMMER and SEIFERLE, 1977, McLELLAND, 1986), the thin intestine in the species under study could not be divided clearly into duodenum, jejunum and ileum. We therefore opted for the division into duodenum and jejunum-ileum (MACARI, FURLAN and NAKAGHI, 1994, DUKE, 1996).

According to McLelland (1986) and in line with what we observed in this study, the duodenum consists of a loop with parts – the proximal one descending and the distal one ascending. However, according to Nickel, Schummer and Seiferle (1977), the duodenum is constituted of a descending left ventral branch and an ascending right ventral branch.

The jejunum extends caudally, with various loops arranged loosely and situated on top of each other (McLELLAND, 1986), similar to that of the jejunum-ileum segment in toco toucan, which is distributed along the caudal third of the thoracic-abdominal cavity. Other authors report a continuation linking the final portion of the jejunum to the ileum (McLELLAND, 1986, DYCE, SACK and WENSING, 1997).

In chickens, ducks and geese, the final end of the ileum presents an external superficial strangulation, which separates it from the thick intestine (SCHWARZE and SCHRÖDER, 1980, McLELLAND, 1986).

There are descriptions that divide the thick intestine into ceca and colon (NICKEL, SCHUMMER and SEIFERLE, 1977, DYCE, SACK and WENSING, 1997), while others divide it into ceca and rectum (SCHWARZE and SCHRÖDER, 1980, McLELLAND, 1986). The ceca are relatively long in chickens and turkeys and very short in passeriform birds and in doves, but are absent from psittacids (DYCE, SACK and WENSING, 1997) and now from *Ramphastos toco*.

Although most authors adopt the term "colon" or "rectum" for the final portion of the intestine, there is the term colon-rectum (McLELLAND, 1986), which was adopted in this study.

The literature describes a series of alterations involving the digestive tube, which put the health of birds at risk, especially those kept in captivity. This fact highlights the need for constant researches focusing on the digestive anatomy and physiology, which are indispensable in avian medicine.

Examples of this are the importance of the help of the X-ray technique in the detection of disorders such as pathological dilatation of the proventricle (common in young birds), using basic knowledge about the position and dimensions of the organs (SMITH and SMITH, 1997). Another study discusses the presence of distended proventricle and slightly hemorrhagic intestines in birds suffering from megabacteriosis when compared with the anatomy, morphology and general aspects of the digestive organs of provenly healthy birds (FLORES et al., 2005). According to another report, the excessive intestinal absorption of iron has been the main cause of death of ramphastids kept in captivity. This disease leads to hemochromatosis, which affects principally tucanuçu (*Ramphastos toco*) [RODENBUSCH, CANAL and SANTOS, 2004).

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