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Radiographic anatomy aspects and gastrointestinal transit time in *Podocnemis unifilis* troschel, 1848 (Testudines, Podocnemididae).

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ABSTRACT. The present study analyzed the radiographic anatomy and determined the gastrointestinal transit time of *Podocnemis unifilis*. We used ten animals belonging to LAPAS from the Federal University of Uberlândia, Uberlândia, Minas Gerais State, Brazil. The animals were orally fed with a barium sulphate suspension at 10 mL kg^{-1} mixed with mineral oil, at a ratio of 70% of barium sulphate for 30% of mineral oil. Afterwards, the animals underwent radiography in a dorsum ventriloquoal position, with the X-ray device adjusted at 72 Kv and 200 mA, in time intervals to follow the permanency of contrast in the organism. Five minutes after the contrast was supplied, the stomach was filled. After sixteen hours the contrast advanced to the small intestine. In 48 hours, the whole small intestine and part of the colon were fulfilled. On the 9th day the stomach was empty and the contrast advanced to the colon. On the 11th day, the colon was totally fulfilled, and the contrast was close to cloaca. On the 18th day all contrast was eliminated by the animal. Total time for contrast elimination was, in average, 17.6 ± 2.4 days, with the minimum of 12 and maximum of 22 days, with temperature at 27ºC. The digestion of the food was slower in the duodenum, and faster in the colon-rectum, which presents lower indices of repletion.

Key words: radiology, digestive tract, diet, chelonian.

RESUMO. Aspectos anátomo-radiográficos e tempo de trânsito gastrintestinal em *Podocnemis unifilis* troschel, 1848 (Testudines, Podocnemididae). Avaliou-se aspectos anátomo-radiográficos bem como o tempo de trânsito gastrintestinal em *Podocnemis unifilis*. Foram utilizados 10 animais pertencentes ao Laboratório de Pesquisas em Animais Silvestres (LAPAS) da Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brasil. Aos animais foi administrada, por via oral, uma suspensão de sulfato de bário 10 mL kg^{-1} misturada com óleo mineral na proporção de 70% de sulfato de bário para 30% de óleo. Posteriormente, os animais foram radiografados dorso-ventralmente, com o aparelho de raios-X regulado para 72 Kv e 200 mA, em intervalos de tempo pré-estabelecidos. Em média, cinco minutos após a administração do contraste, a porção proximal do estômago estava preenchida. Após 16 horas, o contraste progrediu para o intestino delgado. Com 48 horas, todo o intestino delgado e parte do intestino grosso estavam preenchidos. No 9 dia o estômago apresentava-se vazio e o contraste progrediu para o cólon. No 11 dia, o contraste encontrava-se na região do reto e o duodeno encontrava-se vazio. No 14 dia, o intestino delgado já estava totalmente sem preenchimento. No 18 dia, todo o contraste foi eliminado. O tempo total de eliminação do contraste foi, em média, de 17,6 ± 2,4 dias, sendo o mínimo de 12 e o máximo de 22 dias em temperatura média de 27°C. A digestão do alimento foi mais lenta no duodeno e mais alta no cólon-reto, que alcançou menores índices de repleção.

Palavras-chave: radiologia, trato digestório, dieta, quelônios.

Introduction

Podocnemis unifilis and *Podocnemis expansa* are among the largest aquatic South American Testudines and present a wide geographical distribution, inhabiting rivers, streams, lakes, and wetlands in the basin of Amazon River and its tributaries. These species have been intensely exploited, for centuries, with their meat, viscera and eggs used for food, and their shells used as household utensils and ornaments by several indigenous and riverbank communities, and even today they remain illegally exploited in many localities (LUZ et al., 2003; FACHÍN-TERÁN et al., 2003).

The creation of wild animals for commercial purpose is an activity still under development in Brazil.

More than a new commercial activity, is a sustainable use of natural resources that promotes the appreciation of national wildlife resources and also represent a source of animal protein highly adapted to the real natural conditions of tropical South American environments (SÁ et al., 2004).

According to Luz et al. (2003), the scarcity of scientific information about Amazon Testudines makes difficult their cultivation at commercial scale to meet the demand for their meat, quite appreciated in urban areas mainly in North region.

The effective establishment of *P. unifilis* as a protein source commercially available will only be reality when we have a greater scientific knowledge related to its biology. In current literature there is available information on the morphology of digestive tract (MALVÁSIO et al., 2002) as well as behavior and food preference of Testudines (MALVÁSIO et al., 2003; MOLINA et al., 1998). Nevertheless, little is known about the gastrointestinal transit time of this reptile group, which suggests the need to conduct researches that may corroborate and/or produce new information, aiming to contribute with the creation of this species in captivity, as formulation of more suitable diet for the species and nutrient digestibility, thus decreasing human predation on these animals in nature.

For Morlock (1979), the Testudines may be considered rustic since they are not subjected to a number of diseases that usually affect wild and domestic species. The diseases that appear in tortoise in captivity are mostly related to poor health conditions.

In this way, radiographic studies have been conducted in Testudines in order to elucidate physiological and pathological processes, as well the knowledge of gastrointestinal transit time (BEREGI et al., 2000, 2002; MEYER, 1998). Thus, we aimed to uncover radiographic anatomy and emptying time of gastrointestinal tract in *Podocnemis unifilis*, using the technique of contrast radiography.

Material and methods

In the present study, we used 10 adult specimens of *P. unifilis*, 5 males and 5 females, with license nº 066/2004 IBAMA/RAN, weighing on average 1.08 ± 0.25 kg, derived from nature and kept in captivity in the Laboratory of Research in Wild Animal, Faculty of Veterinary Medicine from the Federal University of Uberlândia, Minas Gerais State, Brazil. The tortoise were submitted to previous clinical examination, and were considered wealthy and kept under fasting for five days, at water tank at 27ºC.

The animals were physically restrained, and using a hemostat we opened their mouths to administer the contrast material, via orogastric tube number 4.

The used contrast was a barium sulphate suspension (Bariogel®), at a dose of 10 mL kg^{-1}, mixed with mineral oil (Nujol®), at a ratio of 70% of barium sulphate for 30% of mineral oil.

Radiographs were made at dorsal-ventral position, since the lateral-lateral view presents difficulties on the interpretation of their images, due to the overlapping of gastrointestinal tract on other organic structures, including shell.

The X-ray equipment (Siemens, model RZ-9) was set at 72 kV, 200 mA and exposure time of 0.30 seconds for all animals, since they presented very close sizes. The used material was medical radiographic film (Fujifilm®) in size 30 x 40 cm and the mean time of disclosure was 45 seconds.

An X-ray sequence was established, after the administration of contrast material in 5 minutes, 2, 4, 16 and 2 hours, and followed by regular intervals of 24 hours until the last animal eliminate totally the contrast.

Results

Podocnemis unifilis presents stomach divided by a constriction into two compartments, one proximal siphon-shaped, and another distal elongated and transversely disposed in the coelomic cavity (Figure 1). The transition to duodenum is unobtrusive and this portion of the small intestine is short, a straight segment from right to left, where initiates the jejunum, ileum, which comprises the largest portion of small intestine, coiled and located on the right antimere. The large intestine is initially compounded by a dilation, the cecum, and follows towards the cloaca, taking the median portion, and forming the colon-rectum, until reach the pelvis (Figure 1).

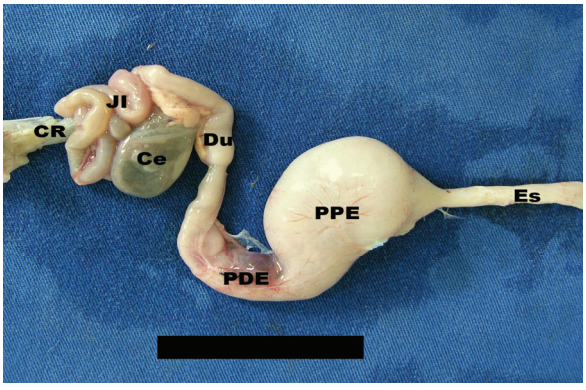

Figure 1. Gastrointestinal tract of *Podocnemis unifilis*. Es, esophagus; PPE, proximal portion of stomach; PDE, distal portion of stomach; Du, duodenum; JI, jejunum-ileum; Ce cecum; CR, colon-rectum. Bar = 5 cm.

Five minutes after the contrast administration, we observed that all animals presented the contrast material in the stomach (Figure 2). In duodenum, the contrast was observed, on average, in 17.7 ± 3.5 hours, after its administration, whereas at jejunum-ileum, only after 24 ± 13.0 hours (Figure 3).

Figure 2. Contrast radiography of *P. unifilis*. Contrast filling the proximal portion of stomach.

Figure 3. Contrast radiography of *P. unifilis*. Contrast filling the portions proximal and distal of stomach and duodenum.

The emptying of stomach occurred, on average, 9.1 ± 2.8 days after the beginning of the experiment, and the animals eliminated completely the solution after 17.6 ± 2.4 days.

After 57.6 ± 12.4 hours, we verified the presence of contrast in the cecum region of all individuals of *P. unifilis*, and at colon-rectum, after 62.4 ± 16.7 hours (Figure 4).

Figure 4. Contrast radiography of *P. unifilis*. Contrast only in the region of large intestine.

Discussion

The use of radiographic examinations is efficient for the diagnosis and therapeutic orientation. This has been evidenced in the researches from Frye (1972) in the diagnosis of cystic calculi, from Rahal et al. (1998) and Helmick et al. (2000) in intestinal obstruction, from Innis and Boyer (2002) in reproductive disorders, and from Hyland (2002) and Bosso et al. (2006) in surgical removal of foreign body in esophagus and stomach.

A study accomplished by Lopes (2006), with *Podocnemis expansa*, indicated that the stomach is flattened, with the pyloric region well developed, and curved, the small intestine is long and quite coiled, the large intestine begins with a dilation, and the cecum is very short. These anatomical characteristics match those from *Podocnemis unifilis*. Nevertheless, we observed the presence of a constriction in the stomach, dividing into proximal and distal portions.

According to Silverman and Janssen (1996), the dietary habits of reptiles and mammals are distinct. The reptiles have a quite long time of intestinal transit, as also recorded for *P. unifilis*, with average time of 17.6 days, although the gastrointestinal tract is short in relation to mammals.

For Spencer et al. (1998), due to ectotherm behavior, the digestion in Testudines is

influenced by environmental temperature, as reported by Meyer (1998), for *Testudo hermanni*, stating that the residence time of the contrast in the gastrointestinal tract was relatively short, and were not observed, satisfactorily, details of intestinal mucosa. Unlike, in *P. unifilis*, the transit time of contrast was long, maintaining the room temperature at 27°C.

Regarding the stomach emptying, we perceived some similarities between *P. unifilis*, the *Testudo graeca* (HOLT, 1978) and the *Geochelone carbonaria* (PIZZUTTO et al., 2001), however the differences are quite clear when comparing with *P. expansa* (LOPES, 2006) and *Phrynops geoffroanus* (BRITO, 2007). The total time of gastrointestinal transit in *P. unifilis* (17.6 days; minimum 12, and maximum 22 days) was longer than observed for *Testudo pardalis* (seven days) (TAYLOR et al., 1996), *Testudo hermanni* (2.6 hours) (MEYER, 1998) and 4.6 days registered for Brito (2007) for *Phrynops geoffroanus*. On the other hand, the total time of gastrointestinal transit in *P. unifilis* shorter than in *Testudo graeca* (HOLT, 1978) (26.5 days), *Geochelone carbonaria* (PIZZUTTO et al., 2001) (42 days) and *Podocnemis expansa* (22.5 days) (LOPES, 2006).

Rick and Bowman (1961), in a study relating the break dormancy and germination of seeds in digestive system from Galápagos tortoises, determined that the time of gastrointestinal transit in these animals ranged from seven and 21. As this experimental method is different from that used by most studies (BRITO, 2007; HOLT, 1978; LOPES, 2006; MEYER, 1998; TAYLOR et al., 1996; PIZZUTTO et al., 2001) this may be the reason of differences in transit times.

The feeding strategies in breeding farms with commercial or conservation purposes of Testudines should aim to optimize the growth indices with consequent reduction of waste in the environment. The development of successful strategies may be favored by the knowledge of patterns of food intake, as well the gastrointestinal transit time of these reptiles (LUZ et al., 2003). The study on gastrointestinal transit time in *P. unifilis*, *Phrynops geoffroanus* (BRITO, 2007), *Testudo hermanni* (MEYER, 1998), *Geochelone carbonaria* (PIZZUTTO et al., 2001) and *Podocnemis expansa* (LOPES, 2006) through radiographic method, is of great applicability in the orientation of practical issues, whether clinical interventions, or formulation of specific diets, where the type or composition of diets used in feeding may change this time.

Conclusion

The gastrointestinal transit time obtained at 27ºC was, on average, of 17.6 ± 2.41 days. A slow time when compared to mammals, but expected in relation to an ectothermic species. The digestion of the food was slower in duodenum, and faster at colon-rectum that reached best repletion indexes.

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