http://dx.doi.org/10.1590/1678-4162-12609

Arq. Bras. Med. Vet. Zootec., v.74, n.5, p.825-832, 2022

Identification of the tributary branches of the hepatic portal vein in the common sloth, *Bradypus variegatus* Schinz, 1825 (Pilosa: Bradypodidae)

[*Identificação dos ramos tributários da veia porta hepática na preguiça-comum,* Bradypus variegatus *Schinz, 1825 (Pilosa: Bradypodidae*)]

N.E.O. *Nascimento*[1], M.J.A.A.L. *Amorim*[1], P.V. *Albuquerque*[1], M.E.L.C. *Miranda*[1], S.F. *Alcântara*[1], G.P. *Andrade*[1], E.P. *Mesquita*[2], T.Q.M. *Bittencourt*[1], A.A. *Amorim Júnior*[3]

[1]Universidade Federal Rural de Pernambuco (UFRPE), Recife, PE, Brasil
[2]Universidade Federal do Agreste de Pernambuco: Garanhuns, PE, Brasil
[3]Faculdade Tiradentes, Prazeres, Jaboatão dos Guararapes, PE, Brasil

ABSTRACT

Bradypus variegatus, the common sloth, belongs to the Bradypodidae family, being considered a biological model to be applied in multidisciplinary research. This study was developed with the aim of being applied to clinical medicine and to the adequate management of the common sloth. Ten sloths were utilized, obtained post-natural death. The animals were fixed and to obtain the results, they were submitted to the dissection technique. For 80% of the animals, the portal vein originated from five tributaries, which were: the resulting vein from the anastomosis of the cardia vein, fundic vein, and the pyloric branches; the mesenteric trunk; the vein formed by the confluence of the stomach body branches and the cranial portion of the cavity of the cardia; the pyloric vein and splenic vein. While in 20% of the animals, the portal vein was comprised of six tributaries, because the fundic vein and cardia vein form two direct anastomoses, arriving at the portal vein two tributary vessels. This pattern differs in number and arrangement of branches when compared to the main domestic species. Therefore, the hepatic portal system is responsible for the drainage of the stomach, spleen, pancreas and intestines.
Keywords: Blood vessels, vascularization, liver, venal drainage, hepatic portal system

RESUMO

Bradypus variegatus, *a preguiça-comum, pertence à família Bradypodidae, sendo considerada um modelo biológico a ser aplicado em pesquisas multidisciplinares. Este estudo foi desenvolvido a fim de ser aplicado à clínica médica e ao manejo adequado da preguiça-comum. Foram utilizadas 10 preguiças, obtidas após morte natural. Os animais foram fixados e, para a obtenção dos resultados, submeteram-se à técnica de dissecação. Em 80% das observações, a veia porta originou-se a partir de cinco tributárias, são elas: a veia resultante da anastomose da veia cárdia, da veia fúndica e dos ramos pilóricos; o tronco mesentérico; a veia formada a partir da confluência de ramos do corpo estomacal e da porção cranial da cavidade cárdica; a veia pilórica e a veia esplênica. Enquanto em 20% dos animais a veia porta é constituída por seis tributárias, a veia fúndica e a veia cárdica formam duas anastomoses diretas, chegando à veia porta dois vasos tributários. Esse padrão difere em número e em disposição dos ramos, quando comparado ao das principais espécies domésticas. Portanto, o sistema porta hepático é responsável pela drenagem do estômago, do baço, do pâncreas e dos intestinos.*

Palavras-chave: vasos sanguíneos, vascularização, fígado, drenagem venosa, sistema porta hepático

Corresponding author: nathalia_emmanuella@hotmail.com
Submitted: November 14, 2021. Accepted: May 19, 2022.

INTRODUCTION

Generally known as the common sloth, or the brown-throated sloth, *Bradypus variegatus*, is a species of the Bradypodidae family, belonging to the superorder Xenarthra, one of the largest clades of placental mammals and neotropical vertebrates (Pereira, 2015; Toledo, 2017).

The common sloth presents strictly arboreal behavior and only descends to the ground once or twice a week to defecate and urinate or in order to change trees (Nowak, 1999). These animals are specialized herbivores ingesting food with low energy content such as leaves, branches, and shoots. Some of the vegetation consumed may be toxic. However, due to the low metabolism of these mammals the absorption of these toxic substances is minimized (Britton and Atkinson, 1938; Macnab, 1985; Gilmore *et al.*, 2001; Chiarello, 2008). Within the representatives of the genus *Bradypus* the brown-throated sloth is the most abundant, falling into the least threatened category of the red list of threatened species (Silva, 2013; Moraes-Barros *et al.*, 2014). However, the main risk to Bradypodids are anthropogenic effects, particularly deforestation, which reduces and fragments sloth habitats and thereby increases the threat of extinction of this species (Primack and Rodrigues, 2001).

When compared to other eutherians, sloths present morphological disparities and share uncommon characteristics (Gaudin and Croft, 2015). This peculiarity is shown in a pluricavitary stomach, with subdivisions, called gastric chambers, which are the cardia chamber; stomach bottom; diverticulum; Stomach body; Pre-pylorus (Mesquita *et al*, 2015). As such, they can be considered biological models that can be used in multidisciplinary research. Furthermore, there is a distinct lack of studies on the morphophysiological aspects of these animals (Amorim, 2000). For Dyce *et al*. (2010), the results obtained from studies on animal anatomy serve as references for medicine and are essential in the construction of diagnoses and in surgical procedures. Therefore, with the aim contribute comparative anatomy studies, fill some gaps about the characteristics of sloths, and apply knowledge to clinical medicine and to the adequate management of these mammals, the description of the affluent branches of portal the vein in Bradypus variegatus was done.

METHODS

In this study ten sloths were used, two females and eight males of the species B. variegatus, belonging to the Aréa de Anatomia do Departamento de Morfologia e Fisiologia Animal of the Universidade Federal Rural de Pernambuco DMFA/UFRPE, where the study was also done, and was authorized by the Comitê de Ética no Uso de Animais CEUA/UFRPE nº027/2018. The corpses were obtained, post-natural death, from the Centro de Triagem de Animais Silvestres CETAS/CPRH.

The specimens were fixed in a 20% formaldehyde aqueous solution, through the cannulation of the common left carotid artery and were then kept in a tank of 30% saline solution. To achieve the results of this study, the cadavers were dissected, and a midsagittal incision was made in the abdominal cavity using a scalpel, forceps, and scissors. Subsequently, the skin and muscles were removed, requiring the removal of the last three pairs of false ribs and a pair of floating ribs for better visualization and handling of abdominal organs and, therefore, access to the portal vein. The portal vein underwent a miniscule dissection to identify its tributary branches. After the analyses, schematic drawings and photographs were used for the better understanding of the results. For the naming of anatomical structures and some venous branches, the “International Committee on Veterinary Gross: Anatomical Nomenclature”, Nomica Anatomica Veterinaria 2017 was used. However, for terms not found in the Nomina Anatomica Veterinaria, a nomenclature based on the drainage region of the stomach was adopted.

RESULTS

From the data obtained, it was possible to verify that the portal vein is a large caliber vessel where the hepatic hilum enters and is formed by the union of the veins that drain the stomach, spleen, pancreas and intestines. For 80% of the study animals, the presence of five tributaries were observed in the portal system, which were: the resulting vein from the anastomosis of the cardia vein, fundic vein, and the pyloric branches; the

mesenteric trunk; the vein formed by the confluence of the stomach body branches and the cranial portion of the cardia cavity; the pyloric vein and splenic vein.

For 80% of the dissected sloths, the anastomosis of the confluence of the fundic vein, cardia vein and pyloric branches, formed a single tributary that deposits its blood contents to the left of the portal vein. The fundic vein drains the fundus of the stomach and extends to the gastric diverticulum, also collecting blood from this area. The cardia vein drains the cardia chamber, while the pyloric branches drain the pyloric region (Fig. 1, A).

For 20% of the specimens, a variation was observed in which the fundic vein and the cardia vein perform two direct anastomoses in a transversal arrangement, thus opening two tributaries in the lateral left position of the portal vein (Fig. 1, B).

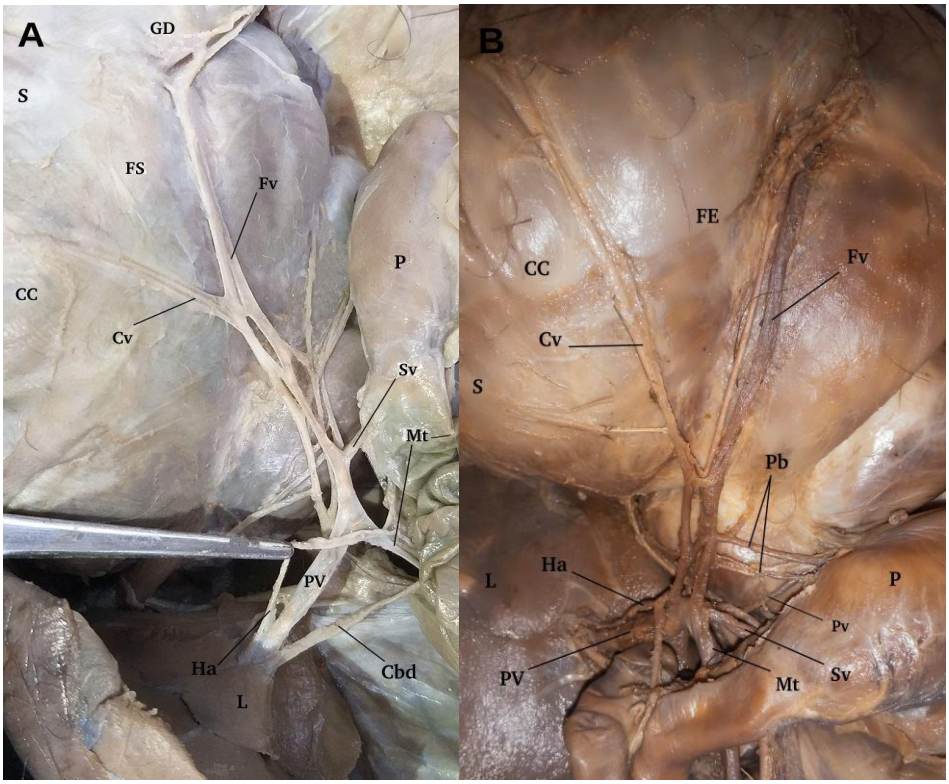

Figure 1. Identification of the tributary vein formed by the anastomosis of the confluence of the cardia, fundic vein and the pyloric branches (A) and the direct anastomosis with a transversal arrangement of the cardia vein and the fundic vein (B), in the sloth *Bradypus variegatus*. Liver (L), Stomach (S), Portal Vein (PV), Hepatic artery (Ha), common bile duct (Cbd), Pylorus (P), Fundus of the Stomach (FS), Gastric Diverticulum (GD), Cardia of Chamber (CC), Mesenteric trunk (Mt), Splenic vein (Sv), Cardia vein (Cv), Fundic vein (Fv), Pyloric branches (Pb), Pyloric vein (Pv).

The mesenteric trunk is positioned on the right of the portal vein and is formed by the cranial mesenteric vein and the caudal mesenteric vein. The cranial mesenteric vein extends throughout the mesentery, parallel to the cranial mesenteric artery, draining the small intestine and the initial and middle portions of the large intestine. The caudal mesenteric vein drains from the end region of the large intestine and is a satellite of the caudal mesenteric artery (Fig. 2, A and B).

The splenic tributary collects blood from the pancreas and the spleen. For 80% of the study animals, the splenic vein emptied into the right of the portal vein however, it was found that for 20% of the specimens, the splenic vein reached the dorsal face of the portal vein (Fig. 2, C).

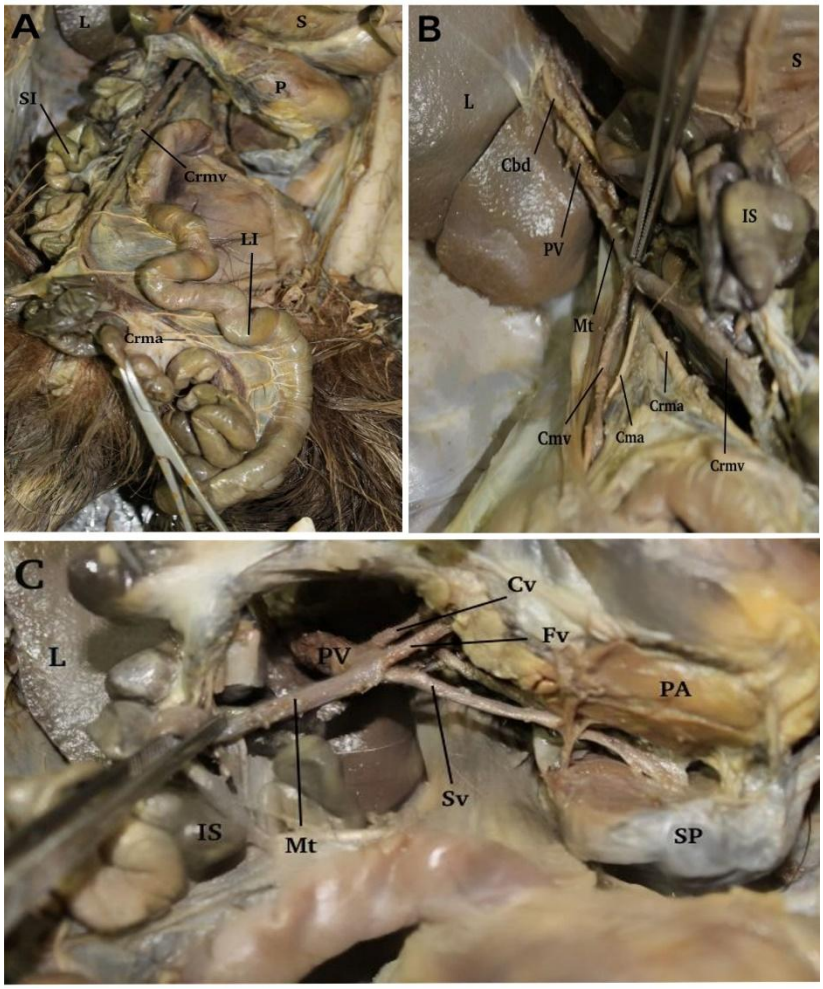

Figure 2. Indication of the cranial mesenteric vein (A), caudal mesenteric (B) and splenic vein (C), of the sloth *Bradypus variegatus*. Liver (L), Stomach (S), Pylorus (P), Small Intestine (SI), Large Intestine (LI), Cranial mesenteric vein (Crmv), Cranial mesenteric artery (Crma), Common bile duct (Cbd), Portal Vein (PV), Intestinal Segment (IS), Mesenteric trunk (Mt), Caudal mesenteric vein (Cmv), Caudal mesenteric artery (Cma), Spleen (SP), Pancreas (PA), Cardia vein (Vc), Fundic vein (Vf), Splenic vein (Sv).

It was observed that the pyloric vein empties into the dorsal face of the portal vein, being responsible for draining the pyloric region of the stomach (Figure 03, A). The tributary formed from the anastomosis of the confluence of branches that drain the stomach body and the cranial portion of the cardia chamber and transport blood to the dorsal face of the portal vein (Fig. 3, A and B).

All the tributaries found in 80% and 20% of the study specimens can be visualized in figure 04, A and B, respectively.

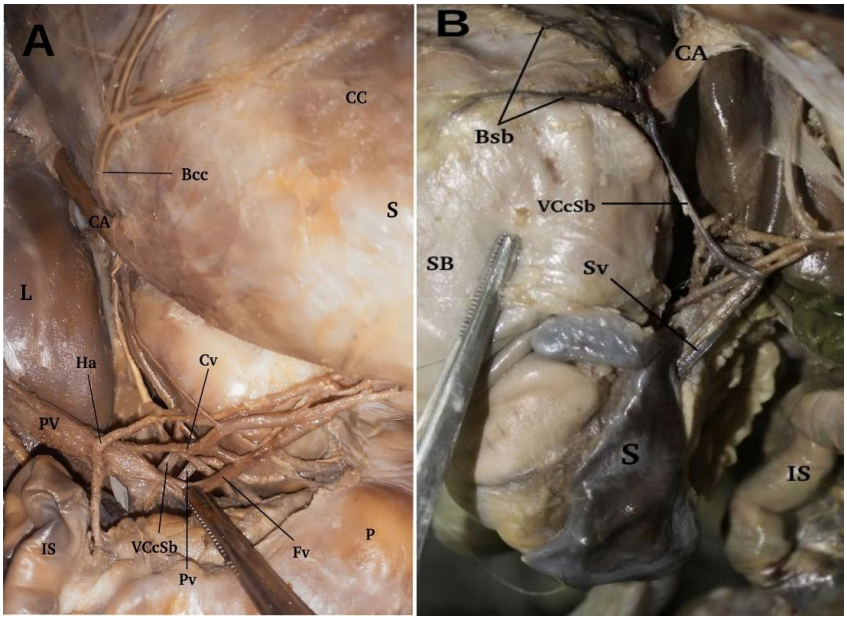

Figure 3. Identification of the pyloric vein and the vein formed by the confluence of branches that drain the cranial portion of the cardia chamber (A) with branches of the stomach body (B) in *Bradypus variegatus*. Liver (L), Stomach (S), Cardia of Chamber (CC), Portal Vein (PV), Hepatic artery (Ha), Intestinal Segment (IS), Cardia (CA), Pylorus (P), Cardiac vein (Cv), Fundic vein (Fv), Pyloric vein (Pv), Vein that drains the cranial portion of the Cardiac chamber and the Stomach body (VCcSb), Branches of the cardia chamber (Bcc), Splenic vein (Sv), Stomach Body (SB), Spleen (S), Branches of the stomach body (Bsb).

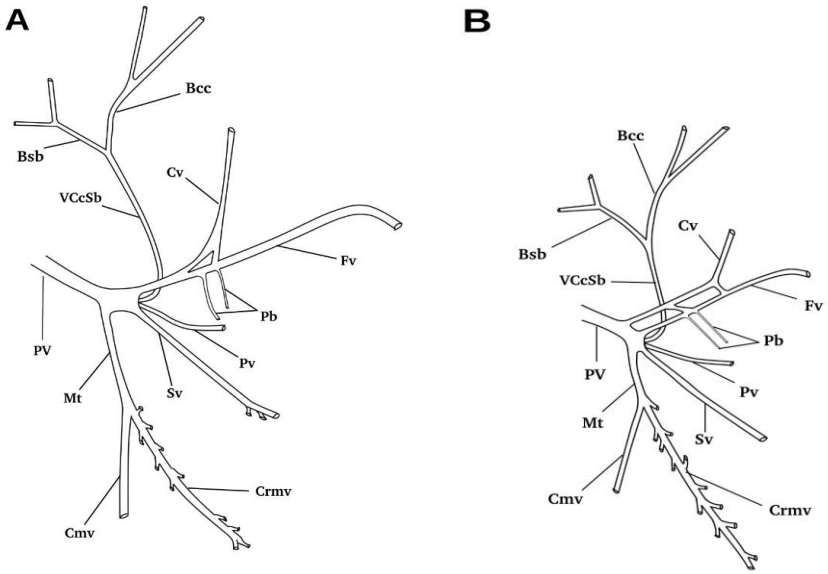

Figure 4. Drawing indicating the tributaries that form the hepatic vein in the common sloth. A – Profile observed in 80% of the specimens. B – Profile observed in 20% of specimens. Portal Vein (PV), Mesenteric trunk (Mt), Caudal mesenteric vein (Cmv), Cranial mesenteric vein (Crmv), Splenic vein (Sv), Pyloric vein (Pv), Pyloric branches (Pb), Fundic vein (Fv), Cardia vein (Cv), Vein that drains into the cranial portion of the Cardiac chamber and the Stomach body (VCcSb), Branches of the stomach body (Bsb), Branches of the cardia chamber (Bcc).

DISCUSSION

In the common sloth the hepatic portal vein drains the blood of the whole digestive system, together with the spleen, coinciding with reports on human beings (Gray and Goss, 1988), domestic animals (König, and Liebich, 2016; Dyce *et al.*, 2010) and with the findings of Menezes *et al.* (2001) and Oliveira *et al*. (2013), who studied the portal vein of Brazilian guinea pigs and agoutis, respectively. However, the literature indicates differences in the formation and path of this vein, especially in wild mammals (Menezes *et al*., 2001; Oliveira *et al*., 2013).

Studying the portal vein in agoutis, Menezes *et al*. (2001), found that this vessel presents secondary roots however, it is formed from the confluence of two main roots, the splenic vein, and the common mesenteric trunk or through the splenic vein and the cranial mesenteric vein, as was also described by Cook (1965), for laboratory rats. In Bradypodids, the mesenteric trunk and the splenic vein are tributaries of the portal vein, presenting an angioarchitecture which is similar to that described by Menezes *et al*. (2001).

According to Greene (1963), the portal vein, in laboratory rats, originates through the union of the superior mesenteric vein, splenic vein and the pyloric vein. In sloths, the pyloric vein also acts as a tributary for the portal vein, similar to Menezes *et al*. (2001) findings, in 90% of their analyses, however, the authors named this vein as the right gastric.

The mesenteric trunk, which is formed by the confluence of the caudal mesenteric vein with the cranial mesenteric vein, which was verified in this study, was also seen in chinchillas and in laboratory rats, as affirmed by Greene (1963), Cook (1965) and Castrol *et al*. (2007).

Oliveira *et al*. (2013), observed the portal vein in guinea pigs and reported that the gastroduodenal vein is presented as one of the tributaries of the portal vein in 80% of animals and is comprised of the gastroepiploic vein, the cranial pancreaticoduodenal vein, and the right gastric vein. The author described the right gastric vein as draining the blood from the smaller curvature of the stomach and of the fundic region, whereas in the common sloth, the tributary is formed by the anastomosis of the cardia and fundic veins and is responsible for collecting the blood from their respective stomach and gastric diverticulum chambers.

When studying the hepatic portal in moles rat, Blagojevic and Nikolic (1989) verified the presence of three vessels, the gastropancreaticoduodenal vein, which received the gastric vein, the gastrolienal formed by the union of the left gastric vein and the splenic vein and the common mesenteric vein, composed of the confluence of the caudal pancreaticoduodenal vein with the jejunal and iliac veins, as tributaries. This was not observed for sloths, as the number and formation of the tributaries was found to be different.

Heath and House (1970), when studying the portal vein in rabbits, reported that this vein is composed of the cranial mesenteric and the pancreaticoduodenal veins. However, for rabbits of the New Zealand race, the portal vein presented as tributaries of the gastrolienal vein, the pancreaticoduodenal vein, the jejunal trunk vein and the cranial mesenteric vein. The gastrolienal vein receives the splenic vein, the left and right gastric veins, the pancreaticoduodenal vein, formed through the union of the duodenal and duodenojejunal vessels and the jejunal trunk, originating from the confluence of the jejunal veins. In turn the cranial mesenteric vein presented itself as the largest vessel of the hepatic portal system in rabbits, as it receives the jejunal trunk, the pancreaticoduodenal vein, the caudal mesenteric vein, the ileocolic vein, the left colic vein, the right colic vein, and the middle colic vein (Birck *et al*., 2006). This result differs to the results found for *Bradypus variegatus*, as the cranial mesenteric vein only receives the caudal mesenteric vein and the splenic tributary is a unique vessel which drains the spleen and the pancreas, without having visualized the pancreaticoduodenal vein.

In terms of domestic animals, Silva, Menezes *et al.* (2008), when describing the formation of the hepatic portal vein in cats, found that this vessel is formed from four to seven tributaries. In all the observations performed by the authors, the cranial mesenteric vein, the caudal mesenteric

vein, and the splenic vein all drains in the portal vein.

In this study, it was possible to observe the large drainage network along the stomach and intestinal segment. This arrangement has a functional implication with the pluricavitary stomach and the sloth's feeding habits. This drainage network is efficient in taking to the liver possible toxins arising from ingested plants, since the bradipodidae are specially herbivores. Regarding other species of the superorder Xenarthra, no reports were found in the literature on the hepatic portal system.

CONCLUSION

In *B. variegatus*, the hepatic system collects the blood from the organs that comprise the digestive system, as well as the spleen. The portal vein is a large vessel which, in 80% of the analyzed specimens, drained from five tributaries. These were identified as the mesenteric trunk; the vein formed by the anastomosis of the confluence of the cardia vein, the fundic vein and pyloric branches; the vein from the result of the joining of the branches from the stomach body and the branches from the cranial portion of the cardia chamber; the pyloric vein and the splenic vein. In 20% of the animals studied, the portal vein was comprised of six tributaries, since the fundic vein and cardia vein perform two direct anastomoses with a transversal arrangement, arriving the portal vein as two vessel tributaries. No reports were found in the literature on the hepatic portal system in other species of this order, suggesting further studies in this area to contribute to the phylogenetic and morphophysiological knowledge in Xenarthras.

REFERENCES

AMORIM, M.J.A.A.L. *A placenta da preguiça, Bradypus variegatus – Schinz, 1825.* 2000. 78f. Tese (Doutorado em Medicina Veterinária e Zootecnia) - Universidade de São Paulo, SP.

BIRCK, A.J.; MIGLINO, M.A.; MACHADO, G.V.; SANTOS T.C. Formação da veia porta-hepática em coelhos da raça Nova Zelândia Branco (Oryctolagus cuniculus Linnaeus, 1758). *Braz. J. Vet. Res. Anim. Sci.*, v.43, p.87-94, 2006.

BRITTON, S.W.; ATKINSON, W.E. Poikilothermism in the sloth. *J. Mammal.*, v.19, p.94-98, 1938.

BLAGOJEVIC, Z.; NIKOLIC, Z. Extrahepatic veins of the portal system in the mole rat *Spalax-leucodon*. *Acta Vet.*, v.39, p.357-364, 1989.

CASTRO, T.F.; PEREIRA, P.C.G.; PEREIRA, M.A.M. *et al*. Formação do sistema venoso portal em *Chinchilla lanigera*. *Braz. J. Vet. Res. Anim. Sci.*, v.44, p.44-48, 2007.

CHIARELLO, A.G. Sloth ecology: an overview of field studies. In: VISCAÍNO, S.F.; LOUGHRY, W.J. (Eds.). *The biology of the xenarthra*. Flórida: [s.n], 2008.

COOK, M.J. *The anatomy of the laboratory mouse*. London: Academic Press, 1965.

DYCE, K.M.; SACK, W.O.; WENSING, C.J.G. *Tratado de anatomia veterinária*. Rio de Janeiro: Elsevier, 2010.

GAUDIN, T.J.; CROFT, D.A. Paleogene xenarthra and the evolution of South American mammals. *J. Mammal.*, v.96, p.622-634, 2015.

GILMORE, D.P.; COSTA, C.P.; DUARTE, D.P.F. Sloth biology: an update ontheir physiological ecology, behavior and role as vectors of arthropods and arboviruses. *Braz. J. Med. Biol. Res.*, v.34, p.9-25, 2001.

GRAY, H.F.R.S.; GOSS, C.M. As veias do sistema porta. In: GOSS, C.M. (Ed.). *Gray anatomia.* 29.ed. Rio de Janeiro: Guanabara Koogan, 1988.

GREENE, E.C. Anatomy of the rat. *Am. Philos. Soc.*, v.2, p.227-228, 1963.

HEATH, T.; HOUSE, B. Origin and distribution of portal blood in the cat and rabbit. *Am. J. Anat.*, v.127, p.71-80, 1970.

KONIG, H.E.; LIEBICH, H.G. Órgãos do sistema circulatório. In: _____. *Anatomia dos animais domésticos, texto e atlas colorido, órgãos e sistemas.* São Paulo: Artmed, 2016. p.451-480.

MACNAB, B.F. Energetics, population biology and distribuition of Xenarthrans, living and extinct. In: MONTGOMERY, G.G. *The evolution and ecology of Armadillos, Sloths and Vermilinguas*. Washington: Smithsonian Institution Press, 1985.

MENEZES, D.J.A.; CARVALHO, M.A.M.; CAVALCANTE FILHO, M.F.; SOUZA, W.M.S. Configuração do sistema venoso portal na cutia (*Dasyprocta aguti*, Rodentia). *Braz. J. Vet. Res. Anim. Sci.*, v.38, p.263-266, 2001.

MESQUITA, E.P.; ALBUQUERQUE, P.V.S.; CORRAL, F. *et al*. Estudo anatômico do estômago da Bradypus variegatus-Shinz, 1825 (Mammalia, Xenarthra). *Cienc. Vet. Tróp*., v.18, p.295-298, 2015.

MORAES-BARROS, N.; CHIARELLO, A.; PLESE, T. *Bradypus variegatus:* red list of threatened species. Suíça: IUCN, 2014. Available in: 2305/IUCN.UK.2014-1.RLTS.T3038A47437046.en. Accessed in: 20 Mar. 2019.

NOMINA Anatomica Veterinaria. 6.ed. ICVG, 2017. 178p. (Anatomical Nomenclature).

NOWAK, R.M. *Walker's mammals of the world*. 6.ed. London: The Johns Hopkins University Press, 1999.

OLIVEIRA, G.B.; RODRIGUES, M.N.; SILVA, R.S.B. *et al*. Veia porta do preá (*Galea spixii* Wagler, 1831). *Biotemas*, v.26, p.185-194, 2013.

PEREIRA, K.F. *Antrozoologia e Hematologia de preguiças comuns (Bradypus variegatus) de áreas urbanas*. 2015. 58f. Dissertação (Pós-graduação em Biologia Animal) - Universidade Federal de Viçosa, Viçosa, MG.

PRIMACK, R.B.; RODRIGUES, E. *Biologia da conservação*. Londrina: [s.n], 2001.

SILVA, R.M.; MENEZES, I.L.; SANTOS, A.L.Q. Formação da veia porta e suas tributárias em gatos sem raça definida (*Felis catus* Linnaeus, 1758). *Biosci. J.*, v.24, p.112-117, 2008.

SILVA, S.M. *Contribuições para a conservação de Bradypus variegatus (preguiça camum*): processos histórico e demográficos moldando a diversidade nuclear. 2013. 30f. Tese (Doutorado em Biologia) - Universidade de São Paulo, São Paulo, SP.

TOLEDO, N.; BARGO, M.S.; VIZCAÍNO, S.F. *et al*. Evolution of body size in anteaters and sloths (Xenarthra, Pilosa): phylogeny, metabolism, diet and substrate preferences. *Earth Environ. Sci. Trans. R. Soc. Edinburgh*, v.106, p.289-301, 2017.