TRADITION AND MODERNITY IN VETERINARY MEDICINE, 2022, vol. 7, No 1(12): 92–98

MORPHOLOGICAL STUDIES ON THE BLOOD VESSELS AND NERVES OF THE CRUS OF THE BROWN BEAR (*URSOS ARCTOS*)

Iliana Ruzhanova-Gospodinova*, Georgi I. Georgiev, Ilian Georgiev, Lubomir Hristakiev

University of Forestry, Faculty of Veterinary Medicine, Sofia, Bulgaria
E-mail: iliana_ruzhanova@ltu.bg

ABSTRACT

The purpose of the present research is to investigate the major arteries, veins, and nerves of the crus in the brown bear through macro anatomical dissection and contrast radiography. The pelvic limbs of 4 bears were included in the study. The limbs were removed from the trunk and the vessels and nerves were dissected and photographed. For the radiography barium sulfas solution was introduced through the femoral artery and images in cranio-caudal and medio-lateral projection were made. The main arteries, veins and nerves and their branches supplying the structures of the crural region were identified and compared to the dog, cat and human.

Key words: brown bear, arteries, veins, nerves, crus.

Introduction

On morphological perspective, the bear family have all the carnivores' characteristics (Sienkiewicz et al. 2019). The brown bear, the American black, the Asiatic black, sun, giant panda, spectacled and sloth bears are the representatives of the Ursidae (Ferguson et al. 1999; Dahle & Swenson, 2003; Koehler & Pierce, 2003; Hwang et al. 2010; Castellanos, 2011; Tomiyasu et al. 2017). Little is known about the blood vessel and nerve branching of the limbs in the Brown Bear, in comparison with common domestic animals like the dog and the cat. Among Carnivora, the domestic cat and domestic dog have been broadly researched (Budras et al., 2007; Hermanson et al., 2020), while for numerous species, like the brown bear details of the blood supply and innervation of the limbs are not investigated. The muscles of the crural region of the Brown bear, Malayan sun bear, Giant panda and Polar bear were anatomically and osteometrically studied in relation to their adaptation in climbing (Sasaki et al. 2005). Dogăroiu et al. 2012 investigate the main osteological and radiological similarities and differences of the bear hind paw compared to the human foot.

The zeugopodium of the pelvic limb is supplied by the branches of the popliteal artery and vein and superficially are found the saphenous artery, vein, and nerve. The tibial and the peroneal nerves and their branches innervate this area, together with *n. cutaneus surae caudalis* (Sebastiani & Fishbeck, 2005; Budras et al., 2007; Hudson & Hamilton, 2010; Hermanson et al., 2020).

Materials and methods

The limbs from four brown bears (two male and two female) were included in this study. The limbs were detached from the body with subsequent microanatomical dissection of the arteries, veins, and nerves in the crural region. For the use of the contrast radiographic study $BaSO_4$ (Milve AD, Bulgaria) solution was introduced through the femoral artery. Images in craniocaudal and mediolateral projections were made on Eickemeyer® Vet, model E 7239X radiograph. Nomina Anatomica Veterinaria (N.A.V., 2017) was used to name the established blood vessels and nerves of the bear.

Results and Discussion

The superficial veins of the crural region – the lateral (Fig. 1) and the medial saphenous veins (Fig. 2), were established by us. *V. saphena medialis* is bigger than *v. saphena lateralis* like the described in cats (Sebastiani & Fishbeck, 2005; Schaller, 2007; Hudson & Hamilton 2010), but different from dogs, where the lateral saphenous vein is bigger (Hermanson et al., 2020). Like the other carnivora the lateral saphenous vein is accompanied by *n. cutaneus surae caudalis* (Fig. 1), and the medial one by the saphenous nerve (Fig. 2).

The branch from the cranial lateral saphenous vein – *r. anastomoticus cum v. saphena mediali* and *arcus dorsalis superficialis* – an arch at the level of the middle metatarsus that flows into the anastomotic branch, were established in the brown bear (Fig. 3) as in dogs (Schaller, 2007; Georgiev, 2014; N.A.V., 2017; Georgiev, 2020,), which is different from the cat, where the arch absence and only *r. anastomoticus cum v. saphena mediali* is presented (Schaller, 2007; N.A.V., 2017). In the cat at the anastomotic branch enter the 3rd and the 4th dorsal digital veins, but the second finishes at *ramus cranilis* of *v. saphena medialis* (Schaller, 2007; N.A.V., 2017), while in the brown bear *v. digitalis dorsalis communis I* continues at the same branch. The 2nd, 3rd, and 4th dorsal digital veins of the bear finish at the *arcus dorsalis superficialis* like in dogs (Schaller, 2007; Georgiev, 2014; Hermanson et al., 2020; Georgiev, 2020). In the brown bear the fifth abaxial dorsal digital proper vein flows in the cranial branch of the lateral saphenous vein, as in dogs (Schaller, 2007; Georgiev, 2014; Hermanson et al., 2020; Georgiev 2020) or into *ramus anastomoticus cum vena saphena mediali*.

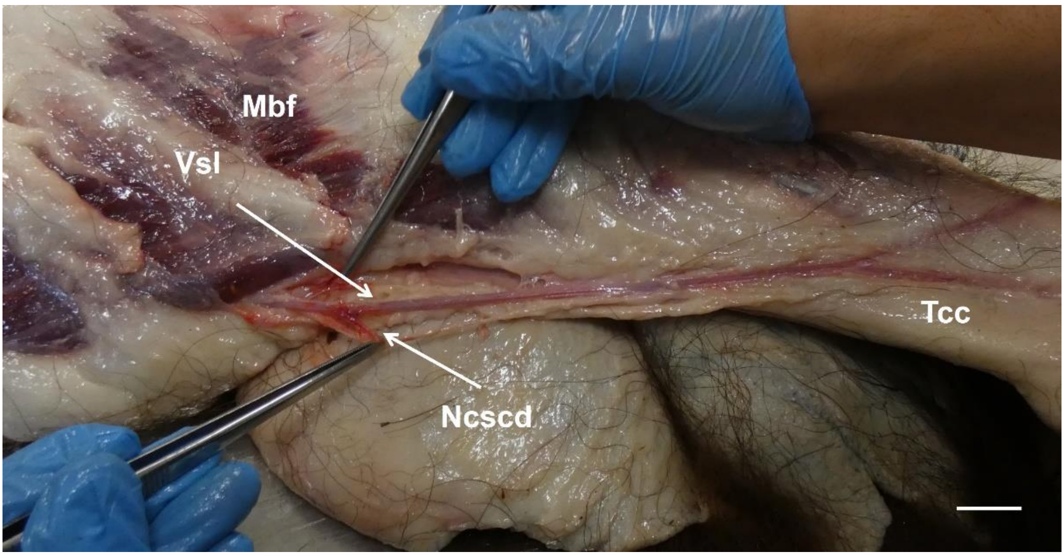

Figure 1: Brown bear, forethigh, lateral view: Vsl – vena saphena lateralis, Ncscd – nervus cutaneus surae caudalis, Mbf – m. biceps femoris, Tcc – tendo calcaneus communis; Bar – 2.4 cm

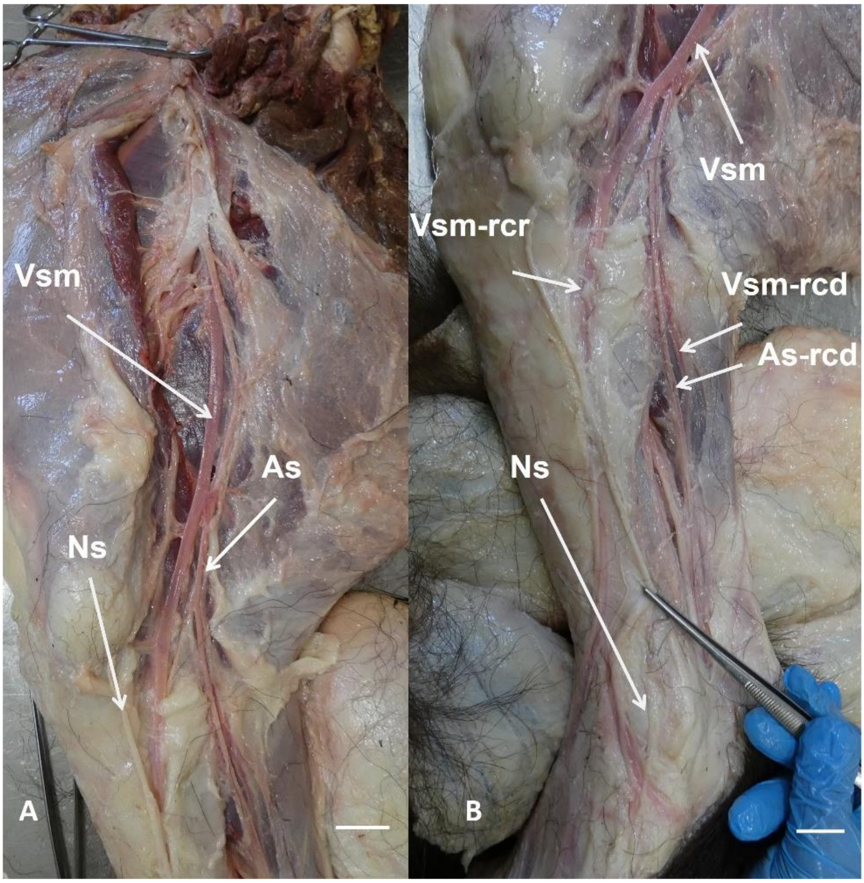

Figure 2: Brown bear, pelvic limb, medial view; A – proximal, B - distal: Vsm – vena saphena medialis, Ns – nervus saphenous, As – arteria saphena, Vsm-rcr – vena saphena medialis – ramus cranialis, Vsm-rcd – vena saphena medialis – ramus caudalis, As-rcd – arteria saphena – ramus caudalis; Bar (A, B) – 2.4 cm

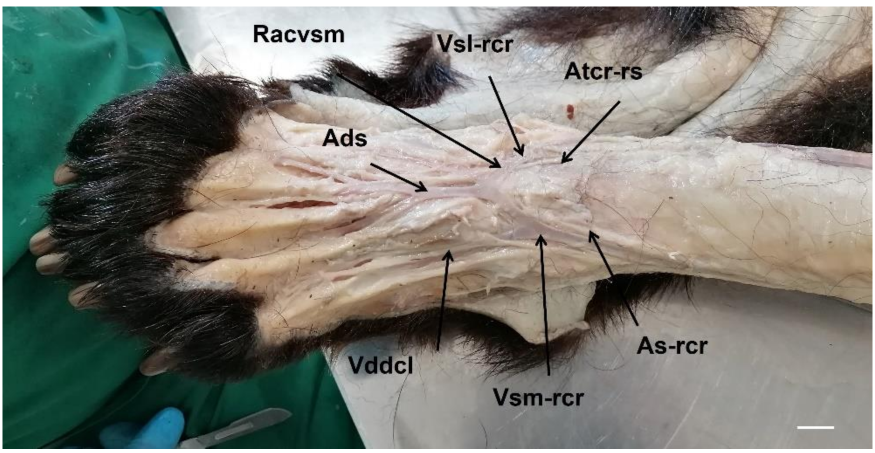

Figure 3: Brown bear, hind paw, dorsal view: Atcr-rs – ramus superficialis of arteria tibialis cranialis, As-rcr – ramus cranialis of arteria saphena, Vsl-rcr – ramus cranialis of vena saphena lateralis, Vsm-rcr – ramus cranialis of vena saphena medialis, Racvsm – ramus anastomoticus cum vena saphena mediali, Ads – arcus dorsalis superficialis, VddcI – vena digitalis dorsalis communis prima; Bar - 2.4 cm

The saphenous nerve in the brown bear gives greater innervation, compared to dog and human. In dogs in the presence of 1st digit, the saphenous nerve reaches the skin of its proximal phalanx, and the dorsal digital common first is given by *n. peroneus superficialis*, and in the absence of 1st digit nervus saphenous innervates the skin on the proximal phalanx of the 2nd digit, as in the cat (N.A.V., 2017; Hermanson et al., 2020). In the human, like the dog, the dorsal digital common first is given by *n. peroneus superficialis* (Snell, 2011; Hermanson et al., 2020), which is different from the established by us in the brown bear, where the nerve supply of the 1st digit is given fully by the saphenous nerve (Fig. 2). It gives *nervus digitalis dorsalis proprius primus abaxialis* and *a. digitalis dorsalis communis prima*, that will give the nerve supply for the axial surface of the first and the abaxial of the second digit.

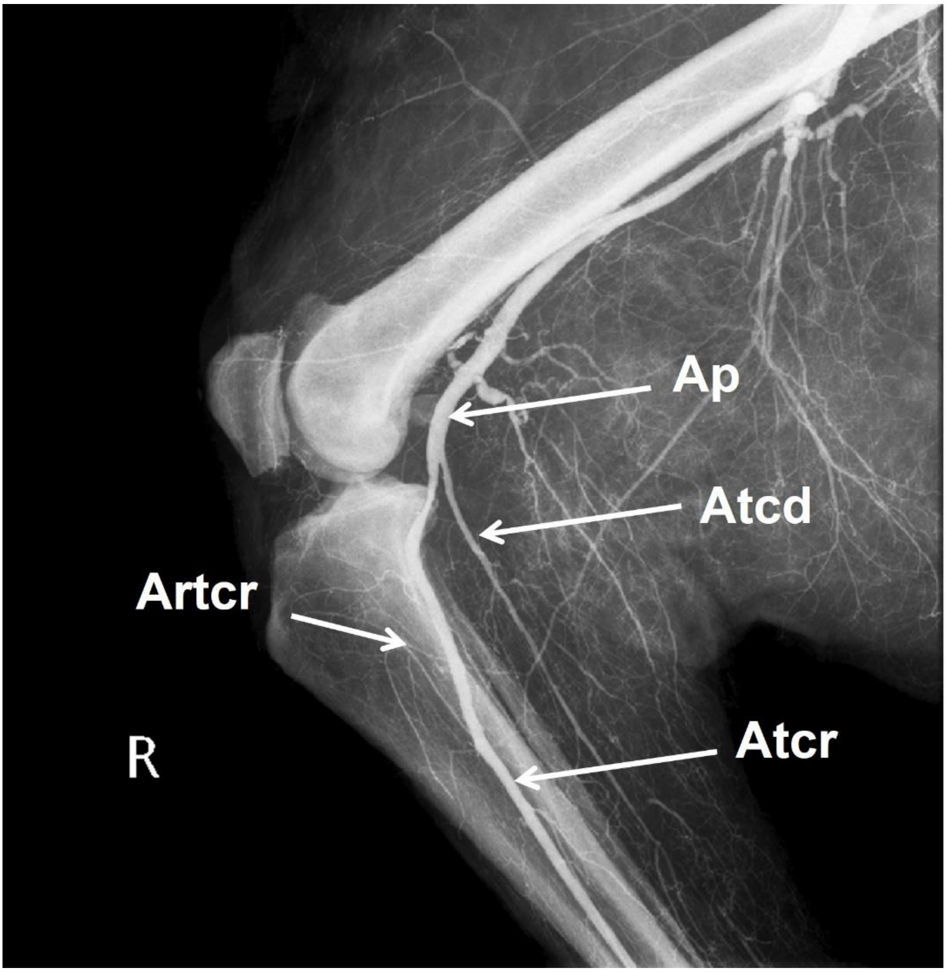

Figure 4: Brown bear, knee, contrast radiographic image, medio-lateral view: Ap – arteria poplitea, Atcr –arteria tibialis cranialis, Atcd –arteria tibialis caudalis, Artcr – arteria recurrens tibialis cranialis

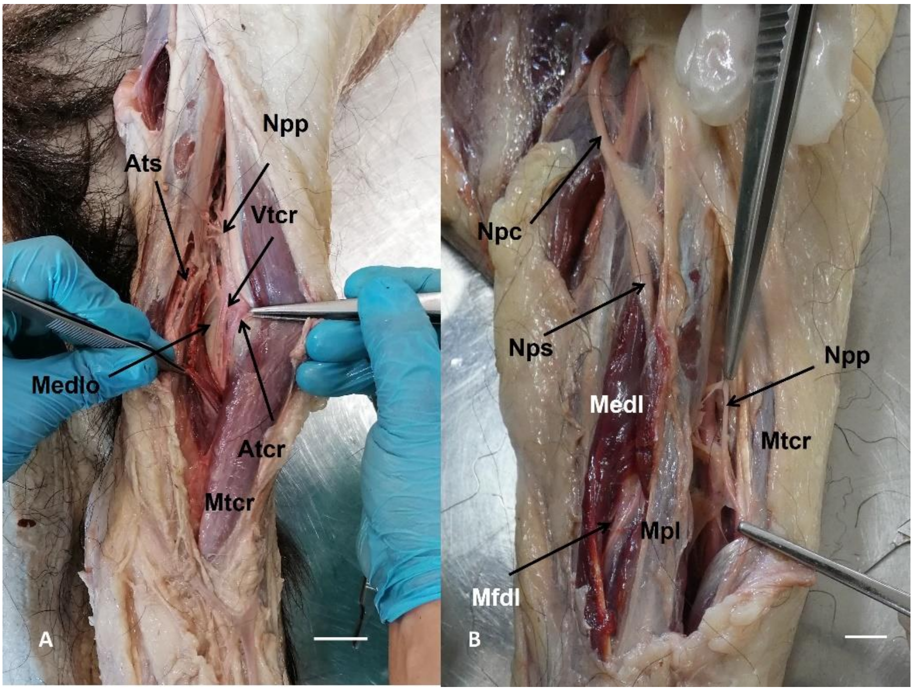

Figure 5: Brown bear, forethigh, lateral view (A, B): Atcr –arteria tibialis cranialis, Vtcr – vena tibialis cranialis, Ats – arteria tibialis superficialis, Npp – nervus peroneus profundus, Npc – nervus peroneus communis, Nps – nervus peroneus superficialis, Medl – m. extensor digitalis lateralis, Medl – m. extensor digitalis longus, Mtcr – m. tibialis cranialis, Mfdl – m. flexor digitalis lateralis, Mpl - m. peroneus longus; Bar (A) – 2.4 cm, (B) – 1.7 cm

The popliteal artery divides to the cranial and caudal tibial artery at the flexor angle of the stifle joint, visualized on the x-ray (Fig. 4), which is different from the established in dogs in our previous research (Ruzhanova-Gospodinova, 2021), where they divide at the level of the proximal tibia and fibula. The cranial tibial artery was found between the medial margin of the superficially positioned *m. tibialis cranialis* and the deep *m. extensor digitalis longus* together with *v. tibialis cranialis* and *n. peroneus profundus* (Fig. 5). The superficial tibial artery – *a. tibialis cranialis* was also detected (Fig. 5). On the radiographic image was established the recurrent cranial tibial artery as a branch from *a. tibialis cranialis* (Fig. 4), where in the dog the same can come from the cranial tibial (Ruzhanova-Gospodinova, 2021) or from the popliteal artery (Hermanson et al., 2020). The common peroneal nerve was detected on the lateral side of the *m. flexor digitorum lateralis* (Fig. 5). Its two branches were established – the superficial, found more caudally and leaving the lateral side of the common nerve between *m. peroneus longus* and *m. extensor digitalis lateralis* and distally the long peroneal and the lateral flexor as the described by Hermanson et al. 2020 in dogs. The deep peroneal nerve, the cranial branch of the parent nerve, accompanies the cranial tibial vessels (Fig. 5) between the lateral digital flexor and lateral digital extensor muscles caudally, again confirming the literature data for dogs (Hermanson et al., 2020).

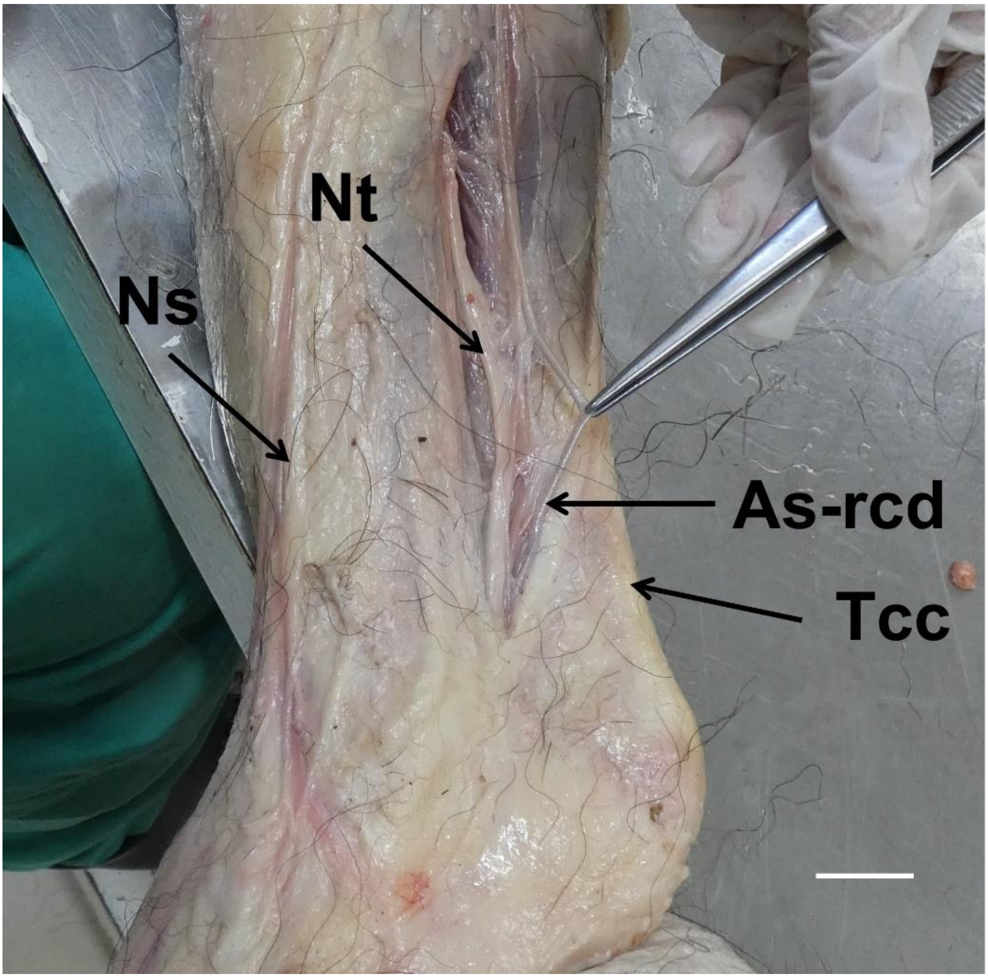

Figure 6: Brown bear, forethigh, distal end, lateral view: Nt – nervus tibialis, As-rcd – ramus caudalis of arteria saphena, Ns – nervus saphenous, Tcc – tendo calcaneus communis; Bar – 2.4 cm

The saphenous artery (Fig. 3) divides in cranial and caudal branches. *Ramus cranialis* of *a. saphena* together with the superficial branch from the cranial tibial artery form an anastomosis at the level of the venous at the proximal tarsal joint (Fig. 3). *Ramus caudalis* of *a. saphena* passes medially of the tibia and is accompanied by the tibial nerve (Fig. 6) as in dogs (Budras et al., 2007; Hermanson et al., 2020) and cats (Sebastiani & Fishbeck, 2005; Hudson & Hamilton, 2010).

Conclusion

To our knowledge this is the first study to describe the blood vessels and nerves of the crus of the brown bear. The present research confirms most of the arteries, veins, and nerves model of branching as those in the dog and the cat, but also established some differences. The saphenous nerve was detected as the main nerve to supply the abaxial surface of the second and axial surface of the first digit which is different from human despite its very well developed first digit.

References

1. Budras K., P. McCarthy, W. Fricke, R. Richter. (2007). *Anatomy of the dog, 5th revised edition*. Schlutersche, Germany, 16–25, 76–84.
2. Castellanos A. (2011). *Andean bear home ranges in the Intag region, Ecuador*. Ursus 22, 65–73.
3. Dahle B, Swenson JE. (2003). Sea*sonal range size in relation to reproductive strategies in brown bears Ursus arctos*. J Anim Ecol 72, 660–667.
4. Dogăroiu, C., D. Dermengiu & V.Viorel. (2012). *Forensic comparison between bear hind paw and human feet*. Romanian Journal of Legal Medicine. 20, 131–134.
5. Ferguson SH, Taylor MK, Born EW, et al. (1999). *Determinants of home range size for polar bears (Ursus maritimus)*. Ecol Lett 2, 311–318.
6. Georgiev G. I. (2014). *Morphologic stadies of the dog`s autopodium blood supply*. PhD Thesis, University of Forestry, Sofia, 267, (BG).
7. Georgiev G. I. (2020). *Examination methods for blood vessels, caudal vena cava and portal system in dogs*. Intel Entrance, Sofia, 109, (BG).
8. Hermanson J. W., Evans, H., A. Lahunta. (2020). *Miller's anatomy of the dog, 5th edition*. St. Louis, Missouri, Sanders and Elsevier, 469–493.
9. Hudson L. C., Hamilton W. P. (2010). *Atlas of Feline Anatomy for veterinarians, 2nd edition*. Teton NewMedia, 108–110.
10. Hwang MH, Garshelis DL, Wu YH, et al. (2010). *Home ranges of Asiatic black bears in the Central Mountains of Taiwan: gauging whether a reserve is big enough*. Ursus 21, 81–96.
11. Koehler GM, Pierce DJ. (2003). *Black bear home-range sizes in Washington: climatic, vegetative, and social influences*. J Mammal 84, 81–91.
12. Nomina Anatomica Veterinaria. (2017). *International Committee on Veterinary Gross Anatomical Nomenclature, Hanover (Germany), Ghent (Belgium), Columbia, MO (U.S.A.), Rio de Janeiro (Brazil), 6th edition*. 91–166.
13. Ruzhanova-Gospodinova, I. S. (2021). *Morphological studies on the blood and lymph vessels of the elbow and stifle region in the dog*. PhD Thesis, University of Forestry, Sofia, 213. (BG)
14. Sasaki, M., Endo, H., Wiig, Ø., Derocher, A.E., Tsubota, T., Taru, H., Yamamoto, M., Arishima, K., Hayashi, Y., Kitamura, N. and Yamada, J. (2005). *Adaptation of the hindlimbs for climbing in bears*. Annals of Anatomy-Anatomischer Anzeiger, 187(2), 153–160.
15. Schaller, O. (2007). *Angiology, Arteries, Illustrated veterinary anatomical nomenclature, 2nd edition*. Ferdinand Enke Verlag, Stuttgart, 324–325.
16. Sebastiani, A. M., Fishbeck D. W. (2005). *Mammalian Anatomy: The Cat, 2nd edition*. Morton Publishing Company, 145–151.
17. Sienkiewicz T, Sergiel A, Huber D, Maslak R, Wrzosek M, Podgórski P, ´ Reljic S and Pa ´ sko Ł. (2019). *The Brain ´ Anatomy of the Brown Bear (Carnivora, Ursus arctos L., 1758) Compared to That of Other Carnivorans: A Cross-Sectional Study Using MRI*. Front. Neuroanat. 13–79.
18. Snell, R. S. (2011). *Clinical anatomy by regions*. Lippincott Williams & Wilkins, 437, 479-486.
19. Tomiyasu, J., Kondoh, D., Sakamoto, H., Matsumoto, N., Sasaki, M., Kitamura, N., & Matsui, M. (2017). *Morphological and histological features of the vomeronasal organ in the brown bear*. Journal of anatomy, 231(5), 749–757.
20. Vodenicharov, A. (2021). *Angiology. In: Anatomy of Domestic Animals, vol. 3, 6th edition*. eds G. Kovachev, G. D. Georgiev & A. Vodenicharov, Kota publishing, Bulgaria, pp. 34, 165–168 (BG).