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MORPHOMETRIC BIODIVERSITY IN CHEETAH THORACIC LIMB BONES: A CASE STUDY

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Abstract

The study aims to analyze and describe the morphological characteristics of cheetah limb bone (Acinonyx jubatus), hoping to provide to veterinarians working in zoos and natural reserves and all professionals interested in this species, a number of elements on how to identify species based on morphological skeletal system. For this study it was used an adult cheetah, 7 years old, donated to the Faculty of Veterinary Medicine , Anatomy Department, by Circus & Variete Globus Bucharest. It should be mentioned that the presence of this cheetah specimen was an opportunity for the Anatomy Department, due to the fact that such specimens are included on the Red List of the International Union for Conservation of Nature classified as vulnerable and with a very scarce possibility to be dissected. Measurements were performed using the ruler, the calipers and the livestock compass. Forelimb bones morphological particularities were described in the study, concluding that the scapula and the long bones of the arm and forearm presents characteristics and proportions useful to determine the species to which they belong. During the study were observed not only anatomical features that appear only in cats (distal half of the humerus was rectilinear, the presence of supracondyloid foramen etc.) but also some different elements (overall appearance af the scapula, concave aspect of the caudal border of ulna etc), which were presented in detail. All these are important in bone analysis in order to their identification.

Key words*: cheetah, limb bone, long bone.*

INTRODUCTION

Cheetah is a species belonging to the order Carnivora, Felidae family, subfamily Felinae, that includes placental mammals, with a predominantly carnivorous diet. According to the Red List of the International Union for Conservation of Nature (IUCN) cheetah (Acinonyx jubatus), the species under study are in the following situation: vulnerability with a declining population trend, the population living in the wilderness is estimated between 7000 – 10.000 individuals.

The studies regarding this mammal's anatomy usually exhibits the general characteristics of big cats and less comparative data on skeletal morphology (Jackson, 2011, Kardong, 2009, Sunquist, 2002).

The study conducted on the bones of a cheetah specimen (*Acinonyx jubatus*), aimed at presenting some features on which it can be distinguished a bone or a cheetah bone fragment from parts belonging to other big cats. However in Romania has conducted a series of studies on indigenous cats (wild cat and lynx) (Cotta, 2008, Coțofan, 2003, Predoi 2011), they have not done research on the cheetah because the number of those animals in captivity are very low, so musculoskeletal morphology in this species has been very little studied (Hudson et col., 2011)

MATERIALS AND METHODS

The study material was represented by a cheetah individual (*Acinonyx jubatus*), that died of natural causes, donated to the Anatomy Department by Circus & Variete Globus Bucharest. The bones were thoroughly cleaned of soft tissue, then subjected to controlled soaking process, washed and degreased. Maceration was carried out in pots kept at a constant temperature for a long time (about 50 days), under constant supervision, assuming a long maceration process of putrefaction (directed, controlled, etc.). Washing was carried out in a first step in running water for

24-48 hours. Cleaning after maceration was performed using the tip of the knife to remove all organic waste.
Degreasing was carried out using cleaning detergents diluted in the washing water.
The material was washed with slightly acidified water and cleaned of any traces of organic matter. Drying bones was done under supervision for 48-56 hours at an average temperature of 18-22^{0}C to avoid cracking of the bony structures in order not to compromise their integrity. There were conducted measurements, the most interesting aspects have been described and photographed. Description, identification and approval were done according to the Nomina Anatomica Veterinaria (N.A.V.) 2005. The ruler, the calipers and the livestock compass were used for measurements.

RESULTS AND DISCUSSIONS

The scapula, a wide bone, has a length of 20.3 cm, from the edge of the dorsal to its glenoid angle, and the width measured on a perpendicular line to the mid-length is 11.2 cm. The ratio L / l is: 1.81
The lateral side of the scapula has a very high scapular spine with a length of 18.3 cm and a maximum height of 2.7 cm at the paracromion level. The ratio L /maximum height of the spine at the paracromion level are 6.77. In the middle third of the scapular spine it can observed elongated and reduced tuberosity. At the distal extremity of the supraspinatus fosse there is an obvious vascular hole of first order.
At the level of the thoracic angle of the scapula, on the medial side, there is an obvious tuber muscle for the insertion great round muscle.
Cervical angle is relatively well defined. This, as the high value of the ratio L / l makes the overall appearance of the scapula to be similar to that of canine than feline. Thoracic edge is slightly thickened, observing the distal edge an infraglenoidal relatively elongated tuber.
The thin cervical edge presents a scapular notch in the distal edge, with a length of about 3.8 cm. On the medial aspect of the distal scapula, near the neck scapula there is a vascular hole of vascular first order. At the level of glenoidal angle there is glenoidal cavity looking relatively circular with a diameter of 2.7 cm. Elongate supraglenoidal tuberosity starts from the top of the glenoid cavity, flanked by a low coracoid process.
The humerus is a long bone, slightly twisted, giving a relatively aspect of the letter S, with a length of 27.7 cm. The width at mid-length (measured in transverse direction) is: 2.9 cm. The ratio L / l is: 9.55. The articular head, pulled caudal, presents an elongated cranio-caudal surface.
The large undivided tubercle is slightly above the articular humeral head surface. Closely below this tubercle distinguishes infraspinata facies, having a relatively circular shape.
The small tubercle is reduced, having a rough and elongated surface. The bicipital slide is wide, situated on the medial side.
On the lateral of the corpus, at the proximal extremity, there is an obvious anconee spine, whose length is 2.8 cm, continued in a distal way by an obvious deltoid spine, having a relatively rough surface, whose length is 3.3 cm.

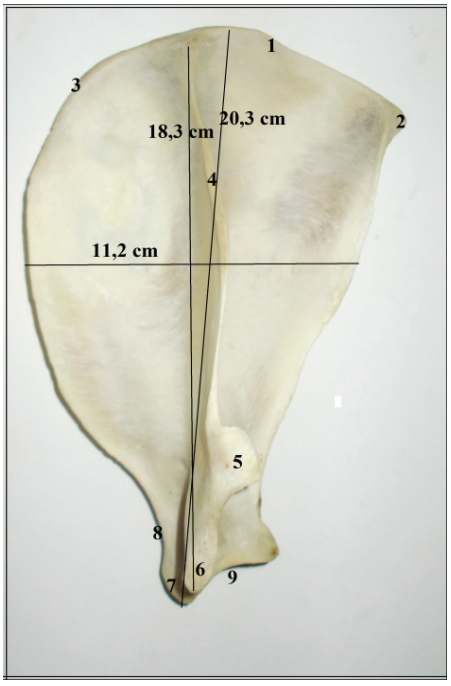

Fig 1. Scapula in cheetah *(Acinonyx jubatus)*- lateral view- 1. epiphyseal lip; 2. thoracic angle; 3. cervical angle; 4. tuberosity of scapular spina; 5. paraacromion; 6. acromion; 7. supraglenoid tuberosity; 8. scapular notch; 9. glenoid cavity

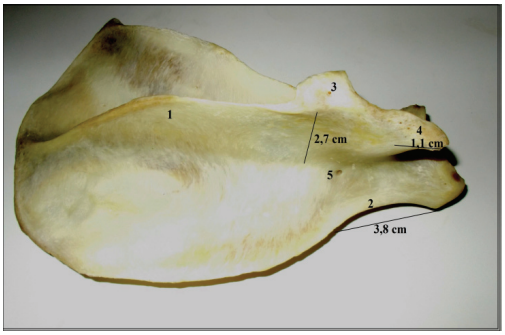

Fig. 2. Scapula in cheetah *(Acinonyx jubatus)*- lateral view- 1. spina of the scapula; 2. scapular notch; 3. paraacromion; 4. acromion; 5. first order vascular hole

The distal extremity of the humerus presents, on the caudal side, a wide olecranon fossa and,on the cranial side, a shallow radial fossa, positioned over humerus trochlee and smaller coronoid fossa, positioned above the condyle.

Fig. 3. Scapula in cheetah *(Acinonyx jubatus)*- medial view- 1. muscular tubercle for insertion of teres major muscle; 2. serrated surface; 3. subscapular fossa 4. first order vascular hole. 5. supraglenoid tuberosity; 6. glenoid cavity

The surface of the joint is represented by a reduced slightly oblique trochlea, having unequaled lips and higher and sharp medial side, with a height of 1.2.cm.

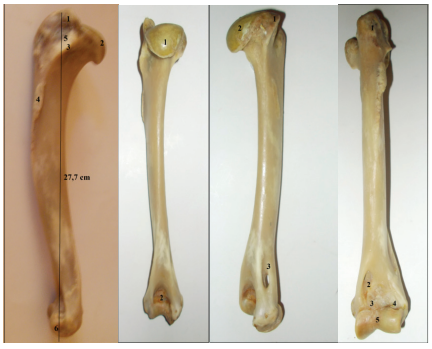

Fig. 4. The humerus in cheetach *(Acinonyx jubatus)*- ***A.*** lateral view- 1. great tubercle; 2. head of the humerus; 3. tricipital crest; 4. deltoid crest; 5. infraspinous surface; 6. condyl; ***B***. caudal view – 1. . head of the humerus; 2. olecranian foss; ***C***. medial view – 1. lesser tubercle; 2. . head of the humerus; 3. epitrochlear hole. ***D***. caudal view - 1. great tubercle; 2. epitrochlear hole; 3. radiar fossa; 4. coronoid fossa; 5. humeral trochleea.

The trochlea lateral lip is flanked on the lateral side by a small condyle.

Above the medial lip of the trochlea there is a epitrochlear hole, having a length of 1.4.cm. The distal articular surface is enclosed in the two epicondyles, lateral and medial.

The radius and the ulna, long bones, represent the anatomical basis of the forearm, which is the starting point of suspination and pronation movements. The two bones articulate with each other only at the level of extremities, defining a broad interosseous space.

The radius in cheetah presents a very convex cranial corpus, having a length of 25.6 cm. The width at half length is 2.1 cm. The ratio of L / l is 12.19.

In the proximal extremity there is a glenoid cavity having an oval appearance, a length of 2.3 cm and a width of 1.2 cm.

The medial tubercle is more obvious in the proximal extremity of the medial edge. The distal extremity, the cranial surface of the corpus have 3 plain tendon slippery dimples, two longitudinally and one distal-lateral oblique. The distal articular surface appears elongated.

The ulna longer than the radius – 29.2 cm has an obvious olecranon, with a olecranon tuberosity divided on the anterior side by a median ditch, resulting two tubercles, lateral and medial, the medial being more protuberant.

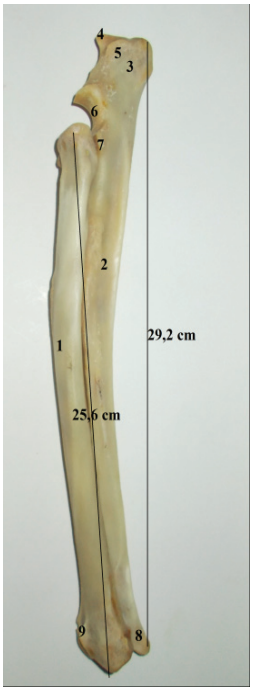

Fig. 5. Radius and ulna in cheetach *(Acinonyx jubatus)*- lateral view- 1. radius; 2. ulna; 3. olecran; 4. medial tubercle; 5. lateral tubercle; 6. ulnar notch; 7. lateral coronoid process; 8. stiloid process; 9. tendinous slip slide

The olecranon height, measured from the medial coronoid process of the ulna at the highest point of the olecranon (medial tubercle, resulted from the split olecranon tuberosity) by the median ditch is 6.3 cm. The width at half of the olecranon is 2.5 cm. The ratio L / l of olecranon are 2.52. The ratio between the length of the ulna and that of the olecranon is 4.63. The radial notch is bounded by ulnar coronoid processes, the medial one being more developed.

The caudal edge of the ulna is concave along its entire length, characteristics which is encountered in the canine ulna and distinct from that of the cat. The styloid process has rounded form, presenting a reduced articular surface of the carpal bones.

There are 7 carpal bones and the largest one is the scafolunar bone. There are 5 metacarpals and the shortest one is the metacarpal I. The metacarpal V has, in its proximal extremity, a plain tubercle for muscular insertion. The phalanx of finger I is the shortest.

The bones at the level of thoracic autopodium are less important in identifying the morphological differences between the species.

CONCLUSIONS

Cheetah's scapula is closer in resemblance to that of the canine, that the feline, presenting a lower rounding at the cervical angle level.

At the distal extremity of the scapula, on both sides was a first vascular foramen. At the level of thoracic angle, on the medial face, was a proieminent muscular tubercle for the insertion of the teres major muscle. The scapular spine has a reduced and elongated tuberosity.

The humerus appears as if it were twisted, being much closer in form to the canine. On the lateral side of the diaphysis, the tricipital crest and deltoid spine can be observed very prominently.

Above the humeral trochlea, was a superficial radial fossa and above the condyle, a smaller coronoid fossa.

The shaft of radius was convex on cranial face. At the proximal extremity of the medial edge was an obvious tubercle.

The ulna presents an obvious olecranon, endowed with a tuberosity which is divided cranially by a median groove, resulting two tubercles, the medial being more obvious. Radial notch was bounded by two tubercles, in which the medial is more developed. Entirely caudal edge in cheetah is concave, while in cat is convex in the proximal half.

Besides the aforementioned descriptive aspect, the most important anatomical differential elements are the ratios of the various measured sizes, which broadly represents constants in different species.

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REFERENCES

Cotta V., Bodea M., Mincu I., 2008. Vânatul și vânătoarea în România. Tehnica ocrotirii și recoltării vânatului. Ed. Ceres.

Coţofan V., Predoi G., 2003. Anatomia topografică a animalelor domestice. Ed. BIC All, 2003, Bucureşti.

Hudson E.P. et col., 2011. Functional anatomy of the cheetah (*Acinonyx jubatus*) forelimb. Journal of Anatomy, 218(4): 375-385.

Jackson T., 2011. The world encyclopedia of animals. Annes Publishing Ltd., Hermes House, London.

Kardong K.V., 2009. Vertebrates comparative anatomy, function, evolution. Fifth edition, McGraw-Hill Companies.

Predoi G., Georgescu B., Belu C., Dumitrescu, I., Anca Șeicaru, Petronela Roşu, 2011. Anatomia comparată a animalelor domestice. Osteologie, artrologie, miologie. Ed. Ceres, Bucureşti.

Sunquist M., Sunquist Fiona, 2002. Wild cats of the world. The University of Chicago Press, Chicago.