

## **The Discriminative Macroscopical Identification of the Bones of Sheep (*Ovis aries*), Goat (*Capra hircus*) and Roe Deer (*Capreollus capreollus*).**

### **1. Elements of the Forelimb Skeleton**

**Alexandru GUDEA<sup>1)</sup> Florin STAN<sup>1)</sup>**

<sup>1)</sup> Faculty of Veterinary Medicine Cluj Napoca, Dep. Of Comparative Anatomy, 1-3 Manastur str., Cluj Napoca, Romania; alxgudea@yahoo.com

**Abstract.** In order to establish some clear morphological data a number of 7 modern roe deer (*capreollus capreollus*) specimen skeletons have been carefully studied. The specimens originate mainly from road casualties or hunted specimens of roe deer individuals, as well as from numerous osteoogical specimens which are found in the comparative collection of the Anatomy Department (sheep/goat specimens). All skeleton fragments belong to individuals with known age and gender. All the significant morphological data were collected and marked in order to create a useful database and a working tool for the forensic specialists or veterinary anatomists. Important discriminative morphological aspects were noted in case of the scapula, humerus, radius and ulna as well as in the case of the metacarpals.

**Keywords:** osteology, goat, sheep, roe deer, discriminative morphological features

### INTRODUCTION

The specific identification of the bones of sheep, goat and roe deer has been always a challenge for the veterinary anatomists. There are several morphological criteria used for the distinction, but classical veterinary anatomists (Barone, 1996; Cotofan et al., 1999; Patea et al., 1978; Popovici et al., 1995; Sisson and Grossman, 1964) gave little attention to the fine-detailed description. Nowadays we are faced with a new perspective as arcaheozoological studies require this clear distinction based on fragmentary pieces as well as the legal forensic studies that seem to hold an increasingly quota of the services and investigations requested at the Comparative Anatomy and Pathological Anatomy Departments.

Previous works in the field of the sheep-goat-red deer distinction exist, but most of them compare either goat and sheep bones or only one of the domestic species with the wild ones (Boessnek, 1969; Cotofan et al., 1981; Hritcu, 2006; Stanojevic and Drekić, 1975, 1976; Stanojevic and Nikolic, 1975; Stanojevic et al., 1976) with little reference to the entire series of species. Worth-mentioning are two works- a PhD thesis elaborated under the supervision of Prof. L. Chaix, published in Bern (Swiss) as it deals with most of the Eurasian capriovids, and as such provides significant morphological and osteometrical data, constituting a reference work (Fernandez, 2001) and another PhD thesis coordinated by Prof. Cotofan in Iasi (Romania) which discusses the specific identification of capriovids from an forensic pathologist perspective (Hritcu, 2006).

## MATERIALS AND METHODS

The material of our study includes various items-7 complete carcasses of roe deer, being a donation of the county Association of Hunters and Sportive Fishermen (AJVPS), other deer specimens from the faculty's comparative collection, sheep and goat specimens from the ossuary and the museum of the department. More than 80 roe deer specimens come from the comparative collection of the department, the disparate specimens come from previous forensic investigations performed at our faculty, more than 150 pieces, sheep and goat specimens, belong to the ossuary and the museum of the department and three complete goat skeletons were specially prepared for the purpose during the previous year.

The complete deer and goat carcasses were initially assessed by the pathologists of our faculty and then evaluated by us in order to establish the best preparation method. Generally, we divided the carcasses into the trunk and neck segments, limb segments and head segments. The pieces were manually de-fleshed and then the pieces were set into the maceration tanks. The maceration was done in 36°C warm water for 48-72 hours. After the initial macerative stage, the pieces were washed and then evaluated. Depending on their estate, another macerative or a short simmering stage has been performed. Finally, the bones were cleaned with regular detergent and then slowly dried.



Fig.1. Angle of the acromion in roe deer



Fig.2. The greater tubercle in roe deer

The anatomical investigation was performed with the use of the normal observatory methods and techniques and, where necessary, a magnifying glass was used. All the anatomical differences were recorded and noted on paper, photographed and then evaluated in order to see how significant they are. A three stages scale was used to designate the importance of the noted differences in order to establish the relevance of the macroscopically observed discriminative data. (data with high significance- noted as MAJ, data with medium significance that must be used in conjunction with other morphological data- noted as MED and data with no great significance, probably minor skeletal differences as an individual characteristic- noted as MIN).

The obtained results are initially anatomically described and then summarized into a tabular form with the characteristics and the scale- assessment data.

## RESULTS AND DISCUSSION

For the scapula, as an overall aspect, one must notice the fact that the scapula of the goat appears as more elongated than in the other species. The roe deer scapula appears as being straighter than the one of the sheep. The dorsal scapular margin appears as slightly curved, with a concave and then convex aspect in deer and goat as in sheep appears straight. The costal margin is straight in goat as in the other species it appears slightly curved. The scapular spine is straight in goat, helicoidal in deer and slightly curved in sheep as the spine tuberosity is slightly marked in goat and deer. The supra and subspinous fossae appear as perfectly triangular in goat as in sheep and deer they appear with a curved- helicoidally shaped margin. At the articular angle, a significant morphological aspect is given by the angle of the acromion, base of the spine and the bone axis- sharp angle in deer, almost straight angle in goat and a curved aspect in sheep. The supraglenoidian tubercle is well-developed in sheep, as in goat and deer it seems like not extending much over the line of the glenoidian cavity. The medial scapular surface appears as excavated, marked by 2 elevated margins in goat as in sheep and deer the margins are not so prominent.



Fig.3. Shape of the infraspinatus area in roe deer



Fig.4. The deltoid tuberosity in roe deer

For the humerus, the overall aspect shows a thinner gracile bone in deer, while in goat the bone appears robust with well-profiled extremities. At the proximal end, the anterior part of the greater tubercle appears well defined with a perpendicular position onto the bone axis (goat), as in sheep the tubercle describes a curved line, inclined over the articular head. In deer, the tubercle is the same way inclined, but longer and more gracile. The infraspinatus area (onto the greater tubercle) seems to be another discriminative element- in sheep it appears as a flattened rounded surface, in goat as an clearly elevated quadrilateral surface, forming a straight angle with the anterior tubercular part as in deer it appears as a slightly elevated and elongated shape. The medial tuberosity is well defined in deer as in sheep and goat it shows a large base with little elevation. The bicipital groove is large, flattened in sheep and goat as in deer is narrow and less obvious. The deltoid tuberosity is hardly marked in deer as in sheep and goat, the tuberosity is clearly marked, with a large base. The tricipital line is well marked in sheep and goat and it bears, near the humeral head, a clearly-marked tuberosity (sheep). In deer the previously-mentioned entities are hardly visible. Tuberosities are hardly distinguishable in deer, as in the other species the tuberosity is still visible. For the distal extremity, one must notice the aspect of the condyles- in sheep the formations fit into a trapezoidal shape, in goat

in a rectangular shape as in deer they fit into a square, the lateral diameter and the dorso-ventral diameter being almost equal. The coronoid fossa is isosceles triangularly shaped in deer as in goat and sheep, the fossa has the shape of a right-angled triangle. The lateral condyle has almost the same diameter as the medial one in deer, as in sheep and goat the asymmetry is clearly visible.

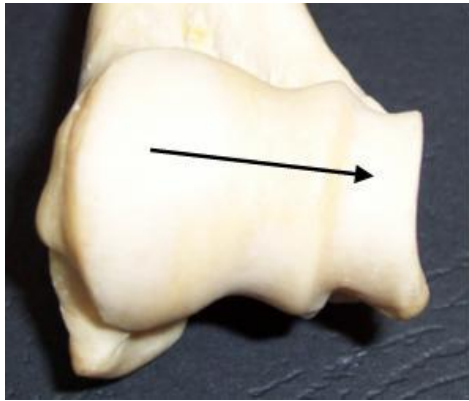


Fig.5. The distal epiphysis in roe deer- lateral condyle



Fig.6. Overall shape of the proximal articular surface in roe deer



Fig.7. The distal radial tendinous groove in roe deer



Fig.8. Overall aspect of the metacarpal bones in sheep, goat and roe deer (left to right)

For radius, as an overall aspect, one must notice the robust aspect visible in sheep and goat and the clearly visible gracility due to the elongated aspect of the deer radius. The proximal articular surface shows another significant difference between the three species. The overall shape of the surface is rectangular (2x width/length) in goat, trapezoidal in sheep as in roe deer the surface appears as asymmetrical due to the shortening of the corresponding humeral articular surface. The proximal medial articular surface shows a medial-orientated sharp expansion in goat that appears rounded in sheep and deer. The radio-ulnar line appears as clearly profiled, elevated in sheep as in deer is rough and hardly visible. The distal tendinous groove (for the carpo-radial extensor) shows the existence of 2 clear elongated

lateral crests in roe deer as in goat the formation is shorter and not so well profiled. The aspect in sheep is almost indistinguishable. The articular medial carpiar surface shows another significant distinctive feature: the surface is very well profiled and excavated, almost with the aspect of a trochlea (margined by 2 sharp rims) in roe deer as in sheep the same surface appears flat, with condilian aspect. In goat, the surface is slightly excavated.

Table 1.

The anatomic elements and the relevance of the differences observed

<i>Species/ Anatomic element-relevance</i>	<i>Ovis Aries</i>	<i>Capra hircus</i>	<i>Capreollus capreollus</i>
<b>Scapula</b>			
Overall aspect	Min	Med	Min
Dorsal margin	Med	Min	Min
Costal margin	Min	Med	Min
Scapular spine	Maj	Min	Min
Supra/subscapular margins	Med	Maj	Min
Acromion's angle	Med	Med	Maj
Supraglenoidal tubercle	Med	Min	Min
Medial surface	Min	Min	Med
<b>Humerus</b>			
Overall aspect	Min	Min	Med
Greater tubercle-anterior part	Med	Maj	Med
Infraspinate area	Maj	Maj	Med
Medial tuberosity	Min	Min	Med
Bicipital groove	Min	Min	Med
Deltoidian tuberosity	Med	Med	Maj
Tricipital line	Maj	Med	Med
Tuber teres	Min	Min	Med
Distal condyles	Maj	Maj	Maj
Coronoid fossa	Med	Med	Maj
Lateral condyle	Med	Med	Maj
<b>Radius</b>			
Overall aspect	Min	Min	Maj
Overall proximal articular surface	Maj	Maj	Maj
Proximal medial articular surface	Min	Maj	Min
Caudal diaphysis- radio-ulnar line	Med	Med	Min
Distal diaphysis- tendinous groove	Min	Med	Maj
Distal articular surfaces- medial carpiar surface	Min	Med	Maj
<b>Ulna</b>			
Olecranian tuberosity	Min	Min	Maj
Trochlear notch	Min	Med	Min
<b>Metacarpals</b>			
Overall aspect	Med	Med	Maj
Proximal articular surfaces- separating line	Min	Med	Min
Medial proximal articular surface	Med	Min	Med
The intermetacarpian groove	Min	Med	Maj
Palmar surface	Med	Min	Maj
Overall aspect of the distal epiphysis	Min	Med	Med
Passage from diaphysis -distal epiphysis	Min	Min	Min

As far as ulna is concerned, one must state the fact that from the overall aspect's point of view only the olecranian part can be taken into consideration. The olecranian tuberosity appears as a simple tuberous entity (sheep), a little bit reduced as far as dimensions are concerned, but still simple tuberous (goat) but clearly divided by a transversal and one caudally placed, more rounded and tuberous (deer). The trochlear notch is formed by 2 articular surfaces, joined by a strictured part in sheep and deer while in goat the surfaces appear as being separated, at the basis of the lower one existing a visible fossa.

The carpal bones were not evaluated from this point of view.

On the other hand, the metacarpals show significant discriminative features. The overall aspect of the metacarpals in roe deer show a clearly elongated and gracile bone (1/3 longer), as the goat metacarpals are robust and widened when compared to the sheep bones. The proximal articular surface, consisting of 2 uneven surfaces (larger medial, reduced lateral) shows the existence of a slightly depressed separating line in goat as in sheep and deer they appear as being separated by an elevated crest. The medial surface itself may provide a distinctive minor element- in sheep is circularly curved, marked by a central depression as in goat is irregularly shaped. The same surface in roe deer is clearly elongated in cranio-caudal direction. The intermetacarpian groove is visible along the entire length of the diaphysis (deer), still visible on a significant part of the diaphysis in goat as in sheep remains perceived only at the extremities of the diaphyseal part. The palmar aspect of the diaphysis shows the existence of a clearly depressed U-shaped sector on the entire length of the sector (deer), only the proximal part (sheep) as in goat the flattened aspect prevails for the most of the surface. The distal articular extremity shows the widening of the entire epiphysis, with the existence of some tuberal-like lateral expansions in goat that are not visible in sheep. For roe deer one must notice the overall gracile aspect of the entire diaphysis. Other minor anatomical differences were observed in case of the passage area from the distal diaphysis towards the distal condilar entities. These differences regard the existence of small depressions above the extremal condyles (goat) that are not clearly visible in sheep and imperceptible in roe deer. The same goes for the same area from a medial perspective (medial condyle)- visible strictured structure visible in sheep (with a tiny tubercle above).

## CONCLUSIONS

The obtained macroscopical data are summarized in the listed table (see table 1), using the designations mentioned in the previous chapters. The mentioned elements must be used as a landmark for the initial investigations and then corroborated with the fine detailed anatomical data provided earlier in this paper.

## AKNOWLEDGEMENTS

The present study is part of a much larger study funded by the Social European Fund within the frame of the postdoctoral contract POSDRU/89/1.5/S/62371.

The study deals with the specific macroscopic morphological features of the skeleton of the mentioned species as a first stage of the project. The second stage of the project will try to assess osteometrical criteria useful for the correct distinction of the species and its last part will deal with micromorphological data as a criterion for the same specific identification.

The final goal of this project is to provide to the veterinary specialists- anatomists or forensics- an interdepartmental tool useful for the clear distinction of the species, either from macroscopical, metrical or microscopical point of view.

## REFERENCES

1. Barone, R., 1996, Anatomie comparee de mammiferes domestiques. Tome 1. Osteologie. Vigot, Paris, 750 p.
2. Boessnek, J., 1969, Osteological Differences between Sheep (*Ovis aries* Linne) and Goat (*Capra hircus* Linne), In: Brothwell, D., Clark, G. (Eds.) Science and Archaeology. Thames and Hudson, London.
3. Cotofan, V., Palcica, R., Hritcu, V., Enciu, V., 1999, Anatomia animalelor domestice, vol I, Aparatul de sustinere si miscare. Orizonturi Universitare, Timisoara.
4. Cotofan, V., Siko, S., Hritcu, V., 1981, Aspecte comparative ale capului osos de oaie, capra si caprioara. Lucrari Stiintifice Institutul Agronomic "Ion Ionescu De La Brad", seria Zootehnie-Medicina Veterinara 25, 19-24.
5. Fernandez, H., 2001. Osteologie comparee de petites ruminants eurasiatiques sauvages et domestiques (genres *Rupicapra*, *Ovis*, *Capra* et *Capreollus*): diagnose differentielle du squelete appendiculaire. doctorat. Universite de Geneve, Geneve.
6. Hritcu, A., 2006. Criterii morfologice de diferentiere între oasele provenite de la unele specii de vânat si animale domestice, utile în expertiza sanitara veterinara. Phd thesis. Universitatea de Stiinte Agricole si Medicina Veterinara Ion Ionescu De la Brad, Iasi.
7. Patea, E., Muresianu, E., Constantinescu, G., Cotofan, V., 1978, Anatomia comparativa si topografica a animalelor domestice. Editura Didactică si Pedagogică, Bucuresti.
8. Popovici, I., Damian, A., Papuc, I., Cristea, E., Popovici, N.C., Chirilean, I.D., 1995, Anatomie comparată Osteologia-Artrologia-Miologia, 3 Edition. Ed.Genesis, Cluj Napoca.
9. Sisson, S., Grossman, J.D., 1964, The Anatomy of the Domestic Animals. W.B.Saunders Company, Philadelphia and London, 980 p.
10. Stanojevic, D., Drekcic, D., 1975, Uporedne karakteristike pojedinih kostiju zadnjeg ekstermiteta srne (*capreollus capreolus*) i ovce (*ovis aries*) u cilju utvrdivanja zivotinja. Comparative characteristics of some bones of hind extremity in the doe (*capreollus capreollus*) and sheep (*ovis aries*) for the purpose of establishment of the species of the animals. Veterinarski glasnik Br 8/1975, 597-602.
11. Stanojevic, D., Drekcic, D., 1976, Uporedne karakterisike kostiju glave srne (*capreollus capreollus*) i ovce (*ovis aries*) u cilju utvrdivanja zivotinja. Comparative characteristics of the bones of the head of the doe (*capreollus capreollus*) and sheep (*ovis aries*) for the purpose of the determination of the species of animals. Veterinarski glasnik Br 6/1976, 559-564.
12. Stanojevic, D., Nikolic, Z., 1975, Uporedne karakteristike pojedinih kostiju zadnjeg ekstermiteta srne (*capreollus capreolus*) i ovce (*ovis aries*) u cilju utvrdivanja pripadnosti vrste zivotinja. Comparative characteristics of some bones of the anterior extremity in the doe (*capreollus capreollus*) and sheep (*ovis aries*) for the purpose of establishment of the species of the animals. Veterinarski glasnik Br 4/1975, 291-295.
13. Stanojevic, D., Nikolic, Z., Drekcic, D., 1976, Uporedne karakteristike pojedinih kostiju distalnog dela prednjeg i zadnjeg ekstermiteta srne (*capreollus capreolus*) i ovce (*ovis aries*) u cilju utvrdivanja pripadnosti vrste zivotinja. Comparative characteristics of some bones of the distal part of extremities in the doe (*capreollus capreollus*) and sheep (*ovis aries*) for the purpose of establishment of the species of animals. Veterinarski glasnik Br.8/1976, 701-708.