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COMPARATIVE ANATOMIC RESEARCH REGARDING THE RED DEER (*CERVUS ELAPHUS*) AND FALLOW DEER (*DAMA DAMA*) SKULLS

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Abstract

The comparative morphology of the skulls is a field of anatomy that can provide answers to questions related to the relationships between species, helping to classify them and to place in a taxonomic group. Till now, a number of morphometric studies have established some differences in red deer and fallow deer skulls, considered as criteria for identification according to the geographical area to which the animals belong, depending on sex or age. The works containing comparative descriptions are very few and the details are absent. Our study presents a number of important aspects for differentiation, of which we list: particularities regarding the drawing of the bone sutures and the profile line in lateral view of the skull, the different conformation of the retro-glenoid process of the temporal bone, differences regarding the relative size of the alveolar process of the maxilla as well as the topography of the infraorbital hole etc. The data provided are useful when making the skulls expertise in order to identify this.

Key words*: skull, red deer, fallow deer.*

INTRODUCTION

The red deer (*Cervus elaphus*) and the fallow deer (*Dama dama*) are two valuable game species in the Romanian fauna. Both belong to the *Cervinae* subfamily. The two species are morphologically similar, though the red deer is larger than the fallow deer. However, size cannot be the only differentiating criterion between species, considering that sometimes a female red deer can be compared, weight wise, to a more well developed fallow deer (Secașiu et al., 2019; Breda et al., 2013).

Following bibliographical research we can appreciate that the data in specialty literature strictly referring to the compared morphology of the two species is relatively lacking. Lister, A. (1996) offers one of the most detailed descriptions regarding the differences between the bones and teeth, but it makes no references to anatomical elements pertaining to the skull.

There is a series of works which manifest the interest of the authors regarding the morphology of the horns, being a known fact that these are present in all the males of the wild cervid species and they are game trophies, in some cases very valuable. The morphology of these organs is an indicator of the quality of the environment in which these species live (Yudha, 2019; Evans et al., 2005). Lastly, there are morphometric studies regarding the skulls of some cervid species (common deer, red deer, fallow deer) which deal with the differentiating criteria in relation with the area, age or sex of a certain individual (Markov, G., 2014; Onuk, B. et al., 2013).

Considering the reduced number of information referring to the comparative morphology of the two species of large cervids pertaining to the game fauna of Romania on the basis of which establishing the provenience of bones or bone fragments would be possible, we have decided to conduct this study.

The aim of this study is to identify a series of skull particularities, such as differences in conformation, size comparisons, or even the presence or absence of some anatomical elements on the basis of which the origin of the bone or bone fragment can be correctly deduced, as well as offering data for legal medicine which can provide answers regarding the origin of the bones that can be evidence in legal disputes.

MATERIALS AND METHODS

Our research was based on trophy skulls, ten belonging to red deer (*Cervus elaphus*) and eight to fallow deer (*Dama dama*).
The provenience, and their ages were very different. Some were provided by the General Association of Hunters and Sportive Fishers of Buzău County, while some originated from private collections. According to the evaluation data, all individuals were males of various ages, collected between 2005 and the present day.

RESULTS AND DISCUSSIONS

In both species, the following bones, listed caudo-rostrally, participate at the formation of the **dorsal side** of the skull: occipital bone, parietal bones, frontal bones and nasal bones. Some minor contributions can be attributed to the temporal, lacrimal, maxillary and incisive bones (Figure 1).

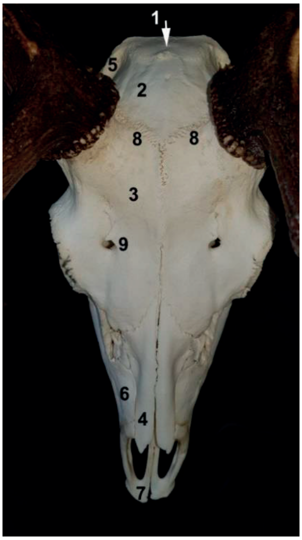

Figure 1. The dorsal side of the skull of the fallow deer (original): 1 - occipital; 2 - parietal; 3 - frontal; 4 - nazal; 5 -portion of the temporal bone; 6 - maxillary; 7 - incisive; 8 - fronto-parietal sutures; 9 - supraorbital foramen

The occipital bone participates at the formation of this side through its squamous portion. The dorsal side of this portion is separated by the nucal portion through a very wide crest, laterally continued through a nucal crest. A sagittal external crest cannot be identified, rather some reliefs (rough spots) of muscular insertion, disposed medially. Rostral to the occipital bone is the territory of the parietal bones, which are slightly concave rostro-caudally in the red deer. This territory also sees a series of muscular insertion fossae.
The symmetrical parieto-frontal sutures form an approximately 90 degree angle. The temporal lines are distanced from the median plane, with 5-6 cm between them at their closest, their rostral side reaching the aforementioned suture (Figure 2). The frontal bones delimit the largest area of the dorsal side, and include, in males, the thick horn processes, distanced from the orbit. The rostral extremity of the frontal bones is articulated with the caudal edge of the nasal bones. This rostral edge forms an acute angle with the lateral edge. In the fallow deer this angle is rounded.

Figure 2. The dorsal side of the neurocranium in the red deer (original): 1 - the scvamosal part of the occipital bone which participates in forming the dorsal side; 2 - temporal lines

The nasal bones are rectilinear aboral-rostrally in the fallow deer and convex in the red deer (Figure 3 A). Transversally they are convex in both species. Both species present a large fronto-lacrimal-maxillo-nasal fissure. Each nasal bone has an apex oriented in the continuation of the lateral edge. Between the apexes of the two bones there is a slight arcade. In the red deer, the rostral processes of the nasal bones are better developed.
In the lateral view, at an initial analysis, two distinct elements can be observed between the skulls: the profile of the dorsal side of the neurocranium is concave in the red deer and

convex in the fallow deer, while the maxillary region has the superior edge convex in the red deer and rectilinear in the fallow deer. Moreover, the line of the diastema is slightly concave in the red deer and rectilinear in the fallow deer (Figure 3 B).

In the temporal region, the drawing of the sutures is almost identical in both species, but the nucal crest describes a line curved dorso-ventrally at the red deer and broken at the fallow deer. Also in this region it can be observed that in the red deer the temporal crest is very well represented, prominent at the level at which the zygomatic process of the squamous portion of the temporal bone detaches (Figures 3-7).

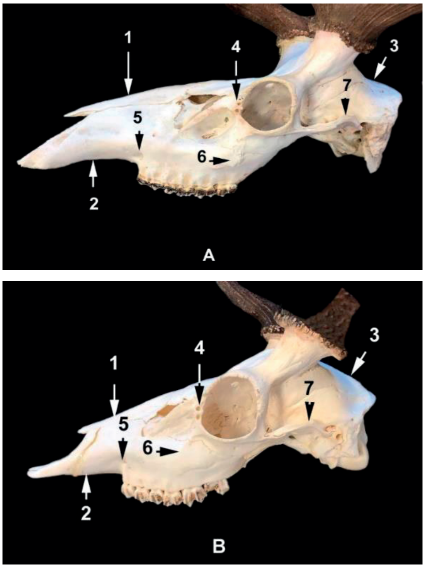

Figure 3 The lateral aspect of the skull for the red deer (A) and fallow deer (B) (original): 1 - the profile of the nasal bone; 2 - the line of the diastema; 3 - the profile of the dorsal side of the neurocranium; 4 - lacrimal holes; 5 - infraorbital hole; 6 - facial tubercle; 7 - temporal crest

The retroarticular process, visible on the lateral-ventral side, is notably different in both species. Its lateral and medial angles are equal in the fallow deer, while at the red deer the medial angle is rounded and better represented than the lateral angle (Figure 4).

The orbital region is characterised through a complete orbit, with prominent edges. In both species there are two lacrimal holes, placed on the contour of the orbit, caudally from the external lacrimal fossa. The latter is very deep at the red deer

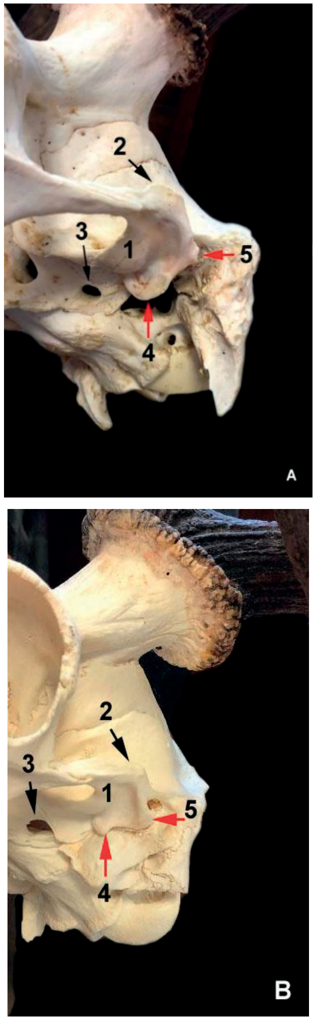

Figure 4. The base of the zygomatic process of the temporal bone in the red deer (A) and fallow deer (B) (original): 1 - condyle; 2 - temporal crest; 3 - oval hole; 4 - medial angle of the retromuscular process; 5 - lateral angle of the retroglenoidian process

The ethmoid hole is situated on the medial wall of the orbit, on the suture between the wing of the presphenoid and the orbitary portion of the frontal bone. In the orbitary hiatus the hole for the optic nerve can be identified, situated dorso-rostrally from the orbital-rotund foramen. We appreciate that the muscular tubercle which covers the latter orifice laterally is better represented in the red deer.

Making a rapport of the length between the alveolar process of the maxillary bone (measured between the oral edge of the first alveola and the aboral edge of the last alveola)

and the distance between the last molar and the rostral edge of the zygomatic process of the temporal bone, an average of 1.23 was obtained for the fallow deer and 0.87 for the red deer, in other words the molar arcade and implicitly the occlusal surface is larger in the fallow deer.
The positioning of the infraorbitary foramen is different. The length between the maxillo-incisive suture and the first alveola (Figure 5 a), in rapport to the distance between the contour of the infraorbitary foramen and the diastema (Figure 5 b) is on average 9.54 in the red deer and 3.07 in the fallow deer, which means the infraorbitary orifice for the former species is very close to the diastema (Figure 5).

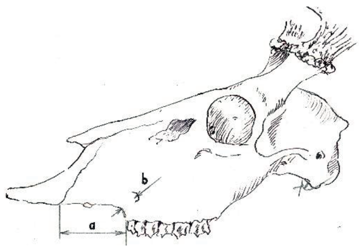

Figure 5. Topography of the infraorbitar hole (original scheme)

The facial tubercle, located under the external lacrimal fossa, is well developed in the red deer and rather dull in the fallow deer. A final appreciation regarding comparative aspects of the skull in a lateral view is represented by the rapport between the total length measured between the rostral extremity of the incisive and the most aboral portion of the occipital in a straight line (Figure 6 a), and the height of the skull at the level of the supraorbitary hole (Figure 6 b). This rapport is of 6.12 in the red deer and 4.07 in the fallow deer. Observations have proved that this value at the red deer is influenced by the development of the splachnocranium.

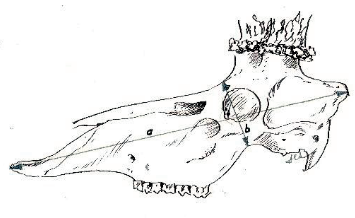

Figure 6. The ratio between the length and height in skull in *Cervidae* (original scheme)

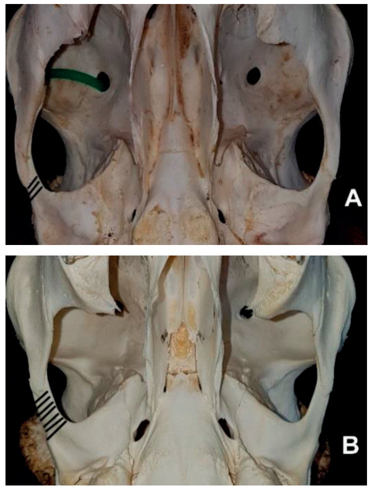

Figure 7. Differences regarding the development of the zygomatic arcade in the red deer (A) and fallow deer (B) (original)

On the ventral view, the junction of the zygomatic bone with the zygomatic process of the temporal bone is very close to the articular surface of the latter, while in the fallow deer this junction is approximately halfway to the zygomatic arcade (Figure 7).
The roof of the oral cavity has an rostral palatine foramen situated in the territory of the palatine process of the maxillary bone in the red deer, while in the fallow deer this orifice is placed on the maxillo-palatine suture (Figures 8, 9).

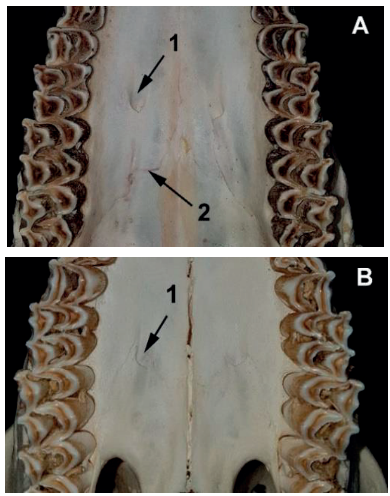

Figure 8. Differences regarding the topography of the rostral palatine foramen at the red deer (A) and fallow deer (B) (original): 1 - palatin rostral hole; 2 - maxilopalatin suture

Other differences in the region of the premolars and molars are insignificant, however it can be noted that the prealveolar portion of the maxillary bone is much longer in the red deer (Figure 9). It has been proven that the rapport between the length of the alveolar process of the maxillary bone and the length of its prealveolar portion, measured from the first alveola to the caudal side of the palatine fissure, is of 1.4 in the red deer and 2.2 in the fallow deer (Figures 9, 10). This proves that the splachnocranium of the red deer is more elongated than that of the fallow deer. In both species the spheno-basioccipital muscular tubercles are strong and well developed.

On the caudal view, the occipital foramen magnum is delimited by two condyles which are similar in shape for both species. The rapport between the width of the occipital foramen to the length of the skull was 16.33 in the red deer and 11.4 in the fallow deer, which proves that the orifice is more spacious for the fallow deer.

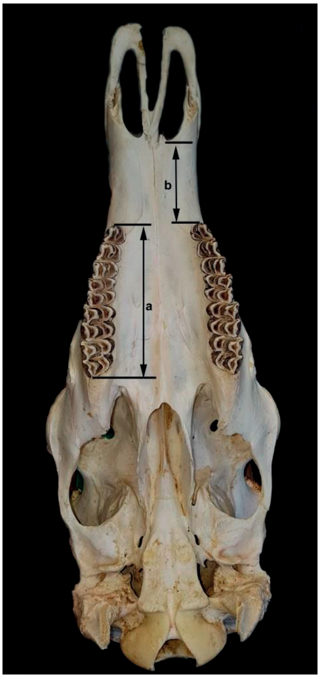

Figure 9. The ventral side of the skull in the red deer (original)

Figure 10. The ventral side of the skull in the fallow deer (original)

CONCLUSIONS

A first general conclusion is the fact that the different size between the two species cannot constitute a differentiating criteria of the skulls, especially when it comes to fragments.

The lateral exposure of the two types of skulls provides important differential aspects, namely the different profiles of the dorsal side of the neurocranium and splachnocranium, as well as the diastema.

The nucal lines and the temporal crests are distinct from a conformational point of view.

There are specific particularities regarding the topography of the infraorbitary foramen, the rostral palatine foramen and especially the retromuscular process. The measurements have allowed obtaining some clues through rapports between dimensions we have considered representative, totally different in the two species.

The final conclusion is that the large quantity. The data obtained is useful in establishing the origin of skull fragments when situations impose this, although the subject can very well be explored in the future.

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