COMPARATIVE STUDY ON CERTAIN PARAMETERS OF THE SKULL OF SOME CATS SPECIES GROWN IN CAPTIVITY IN ROMANIA

B. Georgescu[1], G. Predoi[1], Petronela Mihaela Roșu[1], C.Belu[1], Oana-Margarita Ghimpețeanu[1], Letiția Purdoiu[1], C. Vișoiu[2], C. Petrescu[2], P.B. Matei[3]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Veterinary Medicine; [2]Zoo Bucharest; [3] "Grigore Antipa" National Museum of Natural History

georgescubogdi@yahoo.com

Abstract

In Romania, 5 of the 6 species covered by this study - tiger (Panthera tigris), lion (Panthera leo), jaguar (Panthera onca), cheetah (Acinonyx jubatus) and puma (Puma / Felis concolor) - are present only in circuses or zoos, and the sixth species - the European wildcat (Felis silvestris silvestris) is present in our country in wild. The studied specimens were born and bred in captivity and have slightly smaller dimensions than wild specimens. The skulls come from the Anatomy museum, Faculty of Veterinary Medicine in Bucharest. There are not known the subspecies of tiger, lion, jaguar, cheetah or cougar from which the skulls belonged. The bodies of these cats that died of natural causes (old age) were donated by Bucharest-Baneasa Zoo and Circus N & Variete Globus Bucharest (cheetah and one tiger). Our measurements are based on studies conducted on wild cat skulls by Clara Stefen D. Heidecke (2012) and skulls of several species of mammals from archaeological sites by Angela von den Driesch (1976). Based on the measurements, the facial index, the cranial index, the skull volume, and the cranial cavity volume were calculated. It was observed that only the tiger and the wild cat facial and cranial indexes are close, while for the other species the facial index is higher than the head one. The biggest difference between the volume of the skull and cranial cavity volume is observed in tiger, and the smallest difference at the wildcat. Even if they are part of different kinds of cats, the cheetah (big cats category) and the puma (small cats category) presented similar values for the cranial cavity and cranial volume area.

Key words*: big cats, small cats, cranial cavity volume, skull volume, cranial index, facial index*

Introduction

The main objective of this work is to provide for professionals working in gardens and zoos, officers and other interested specialists tools for morphological recognition of endangered species based on particular aspects of the skull.

The research carried out in developing this work is justified concerns of many authors to ascertain the skeletal morphology on cats in zoos. However, in these areas there are still things less known or even unclear.

Cats' bones and especially skulls often appear as evidence in casuistry forensic on wildlife (especially in the United States and in most European countries) to imports of trophies, which are: cheetah, jaguar, leopard, puma, snow leopard/irbis, lion and tiger. Because these species have different degrees of protection under international law, it requires a thorough examination to identify the right species.

Comparative skeletal morphology is a classical method to study the degree of similarity between species, especially for taxonomic classification and differentiation.

Skulls of the big cats are overlapping and can be hard to find, especially when you do not know their geographic area. Articles about felids taxonomy and systematic (phylogenetic relationships) contain little information about comparative morphology, especially for the skulls (Werdein, 1985; Garcia-Perea, 1994). Angela von den Driesch (1976) described, designed and made standard measurements of the skulls of cats. Seymour (1999) compares the morphology of the skulls of small felids from South America and adds applicable features that were investigated in this study. Skull morphology of the small wild cats was described by

Lekagul and McNeely, 1988; de Oliveira, 1998; Garcia-Perea, 2002). Skull cats morphology in North America was described by Currier, 1983; Tumlison, 1987; Seymour, 1989; Lariviere and Walton, 1997; Murray and Gardner, 1997; de Oliveira, 1998 etc. Cat skull morphology of medium and large genus Panthera was partially described by Todd, 1966; Werdelin, 1983; Lamerichs, 1985; Seymour, 1989; Larsen 1997.

In Romania we have found only a few disparate data on skeleton description of some species of cats found in zoos or circuses menageries.

Materials and methods

The study was conducted on three tiger skulls (*Panthera tigris*), two lion skulls (*Panthera leo*) and one jaguar skull (*Panthera onca*), one cheetah skull (*Acinonyx jubatus*), one puma/cougar skull (*Puma/Felis concolor*) and one European wildcat skull (Felis silvestris silvestris) in the Department of the Anatomy Museum at the Faculty of Veterinary Medicine in Bucharest. The studied skulls are from specimens born and bred in captivity and have dimensions slightly smaller than specimens from the wild. There is not known the subspecies to which the tiger, lion, jaguar, cheetah or cougar skulls belonged. The bodies of these cats that died of natural causes (old age) were donated by Bucharest-Baneasa Zoo and Circus N & Variete Globus Bucharest (cheetah and one tiger). Description of skulls, identifying formations and their homologation was performed according to Nomina Anatomica Veterinaria (N.A.V.), 2005. The measurements were performed on pieces of bone (skull and jaw). For physical measurements there were used livestock compass, ruler and caliper (classical and electronic). Based on the measurements, there were calculated facial index, cranial index, skull volume index, and cranial cavity volume.

In zootechnical studies the cephalic index is the ratio of head length and breadth of its low orbit (zygomatic arches). According to this report the skulls are narrow (index of less than 43%), normal (index values between 44-45%) and large (cephalic index greater than 46%). Total facial index is the ratio between the bizygomatic diameter and the maximum vertical diameter of the face. According to this index, the skulls are systematized in dolichocephalic (narrow and high), mesocephalic (average) and brachycephalic (flat and wide). In Felids the skull can be outlined by an ellipsoid.

Starting from the 3D calculation of the volume of this geometric figure, we can find the skull volume, using standard margin of error of 0.12345 (6), the calculation formula that is $4/3\ \pi$ abc (a = half the maximum length of the skull, b = half the height of the skull and c= half the skull width in the zygomatic arch), and where $\pi = 3.14159$. The cranial cavity volume, which has also the shape of an ellipsoid, was calculated from measurements made on radiological images, using the formula $4/3\ \pi$ abc, with a (1/2 of anterior-posterior diameter), b (1/2 the dorsal-ventral diameter) and c (1/2 of the transverse diameter). Following the two types of measurements (total skull volume and cranial cavity volume) of the skull, for the studied skulls it can be calculated how much of the skull volume is the cranial cavity volume. Linear measurements were performed according to research on various species of cats conducted by Clara Stefen and Heidecke D. (2012). These measurements comply with the utmost anthropological references.

Radiographs were made at the Faculty of Veterinary Medicine, Radiology Service which is equipped with a Philips Bucky Diagnost FS Standard device for digital radiography which has a program of measurements (which we used for measuring parameters used in calculating cranial cavity volume).

Results and discussions

Nine felids skulls were morphometrically examined - belonging to both main categories (big cats - tiger, lion, jaguar, cheetah and small cats – puma and European wild cat).

Cranial measurements included those used on different species of felines by Clara Stefen and Heidecke D. (2012).

According to S. Larson (1997), studying both basal-condyle length and other morphological aspects of the skull, like canines' length, length and aspect of nasal profile, width of the skull, etc., can contribute to a more accurate determination of the origin of any studied skull.

Parameters were measured on lateral, dorsal, ventral and aboral (occipital) sides of the nine skulls. Some of the measured parameters were used to calculate the cranial and facial index of each studied skull. Also, by using some of the measured parameters, it was calculated the volume of each skull, and, on the basis of the radiologically measured parameters on the head cavity, it was calculated the volume of each head cavity. For the lion and tiger skulls there was calculated the average for each parameter.

The results are presented below in tabular form and suggestive graphics.

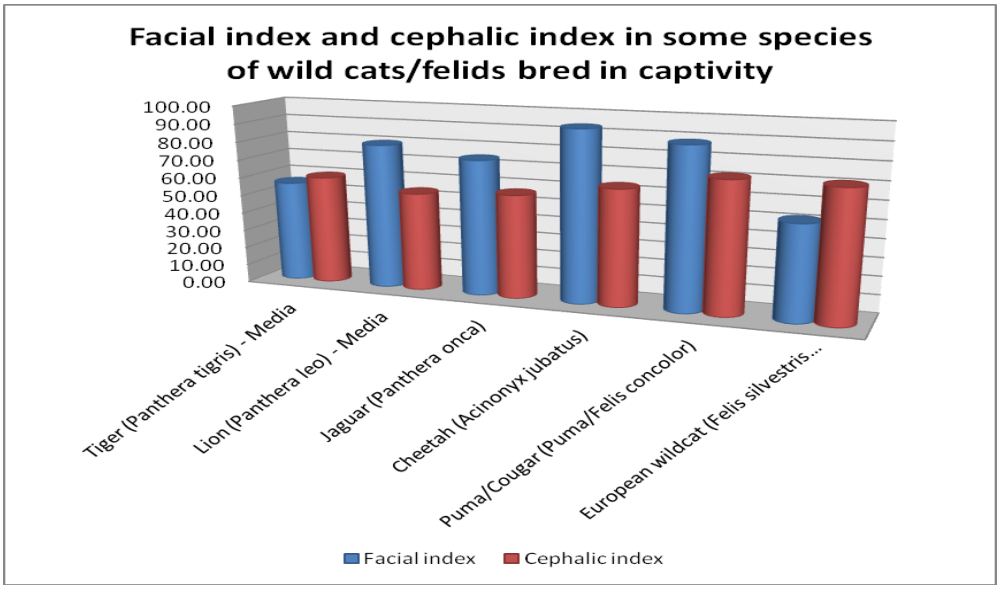
Table 1.

Parameters used to calculate the facial index, cranial index, cranial volume and cranial cavity volume

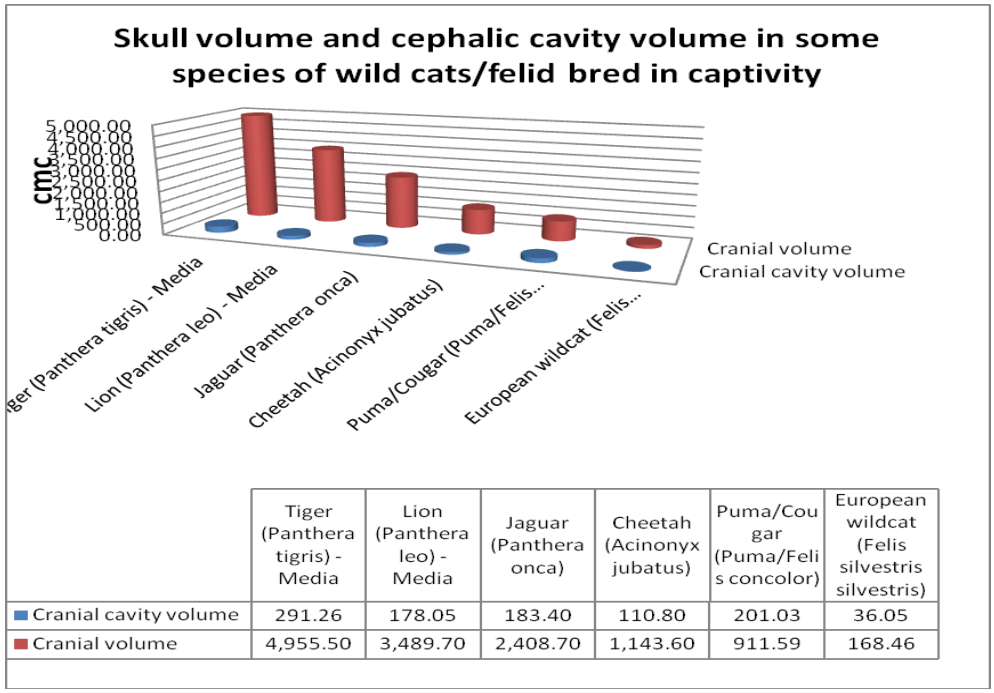
Measurements	Cats species					
	Tiger - Media	Lion - Media	Jaguar	Cheetah	Puma /Cougar	European wild cat
kliob	6.7	6.0	5.6	4.6	3.8	1.2
ln_1	12.0	7.5	6.0	4.9	4.3	2.3
zw	21.5	19.5	17.0	12.9	13.4	7.0
gsl	35.8	35.9	29.8	20.2	18.6	9.8
shbull	12.33	9.45	9.1	8.4	7.0	4.7
Facial index	55.83	80.0	74.66	93.87	88.37	52.17
Cephalic index	60.05	54.31	57.04	63.86	72.04	71.42
Skull volume	4955.5	3489.7	2408.7	1143.6	911.59	168.46
anterior-posterior diameter of the cranial cavity	10.0	8.5	9.2	7.1	9.0	5.1
Dorso-ventral diameter of the cranial cavity	6.4	5.45	6.3	4.9	5.9	3.3
Transversal diameter of the cranial cavity	8,6	7.4	7.2	6.1	7.5	4.1
Cranial cavity volume	291.26	178.05	183.4	110.8	201.03	36.05
Report skull volume/cranial cavity volume	5.37	5.16	7.61	9.68	22.05	21.39

Legend:

- **kliob** = interorbital width measured at the level of the smallest distances between orbits,
- **ln_1** = nasals length of the median suture,
- **zw** = maximum width of the skull at zygomatic arch,
- **gsl** = maximum length of the skull,
- **shbull** = skull height vertically measured from the tympanic bubble.

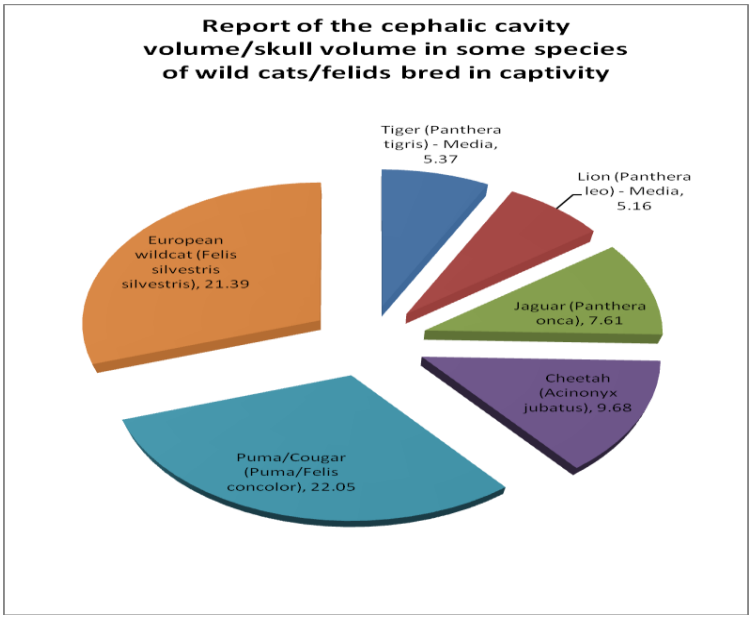


Graphic 1. Facial index and cephalic index in some species of wild cats/felids bred in captivity



	Tiger (Panthera tigris) - Media	Lion (Panthera leo) - Media	Jaguar (Panthera onca)	Cheetah (Acinonyx jubatus)	Puma/Cougar (Puma/Felis concolor)	European wildcat (Felis silvestris silvestris)
Cranial cavity volume	291.26	178.05	183.40	110.80	201.03	36.05
Cranial volume	4,955.50	3,489.70	2,408.70	1,143.60	911.59	168.46

Graphic 2. Skull volume and cephalic cavity volume in some species of wild cats/felids bred in captivity



Graphic 3. Report of the cephalic cavity volume/skull volume in some species of wild cats/felids bred in captivity

It appears that only the tiger and the wild cat facial and cranial indexes are close in value, for other species the facial index is higher than the head one. The biggest difference between the volume of the skull and cranial cavity volume is observed at the tiger, and the smallest difference at the wildcat. Even if part of different kinds of cats, cheetah (big cats category) and puma (small feline category) presented close values of the cranial cavity and cranial volume area.

Conclusion

Based on measurements, the facial index, the cranial index, skull volume, cranial cavity volume were calculated.

1. It was observed that only the tiger and the wild cat facial and cranial indexes are close, while for the other species facial index is higher than the head one.
2. The biggest difference between the volume of the skull and cranial cavity volume is observed in tiger, and the smallest difference at the European wildcat.
3. Even if they are part of different kinds of cats, cheetah (big cats category) and puma (small cats category) presented similar values of the cranial cavity and cranial volume area.
4. It appears that there are similarities between the different measured parameters to felids born and bred in the wild.
5. Parameters of the specimens born and bred in captivity have dimensions slightly smaller than wild specimens (cage effect).

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