

# MORPHOMETRIC ANALYSIS OF JAGUAR (*PANTHERA ONCA*) AND TIGER (*PANTHERA TIGRIS*) SKULLS - SPECIES ON THE "RED LIST" OF THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

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**Abstract:** *In Romania, the two species covered by this study - the jaguar (*Panthera onca*) and the tiger (*Panthera tigris*) are species found only in zoos or circuses. Romania, as an European Union border state, may be transited or used by collectors or by smugglers of exotic species, especially since the two species are subject to an extremely strict control. The tiger (*Panthera tigris*) according to the IUCN Red List is an endangered species and the jaguar (*Panthera onca*) is nearly endangered. These species have a common ancestor - *Proailurus lemanensis* - but have evolved in different environments, Indian jungles and the Siberian taiga (the tiger), all North and South American habitats (the jaguar). In order to perform the morphometric analysis there were used skulls of three adults tigers (*Panthera tigris*) and from a jaguar male (*Panthera onca*), skulls found under administration of the discipline's museum. Description, identification and homologation were made according to N.A.V .2005. Following the studies and measurements carried out, it appears that there is a little difference in size of the skulls of the two species, especially as the jaguar, unlike the tiger, is climbing, and the whole body must be lighter and smaller. The described and used graphics and reference points allow performing complex measurements, both on anatomically prepared skulls and on radiological images. It is observed that the jaguar's skull is slightly smaller than the tiger's one. The measurements that make the differences between the two skulls are those of the jaw. There are also differences on the dorsal and ventral facets of the skull as on the lateral side. There were identified eight reference points on which it can be determined to which species the skull being analyzed belongs.*

**Keywords:** *jaguar, tiger, skull, species, measurements*

## INTRODUCTION

The studied two species are present in Romania only in zoos and circuses. We consider that is of interest because one of the two species –the tiger (*Panthera tigris*) - is an endangered species (according to the Red List of the International Union for Conservation of Nature / IUCN), and also, in some Asian countries, it is the raw material for the production of herbal remedies. Our country, as an European Union border state, may be transited or used by collectors (declared or not) or by the Asian people established in the EU to traffic (legally or less legally) this species. The jaguar (*Panthera onca*) is less put at risk and it is possible to use it as species to replace (if only declarative) as a trophy (or raw material for remedies) the tiger in this type of traffic. Therefore we wanted to establish some differential dimensional criteria between the two species, criteria that can be used by customs officials in situations of uncertainty (especially with the lack of supporting documentation).

## MATERIAL AND METHOD

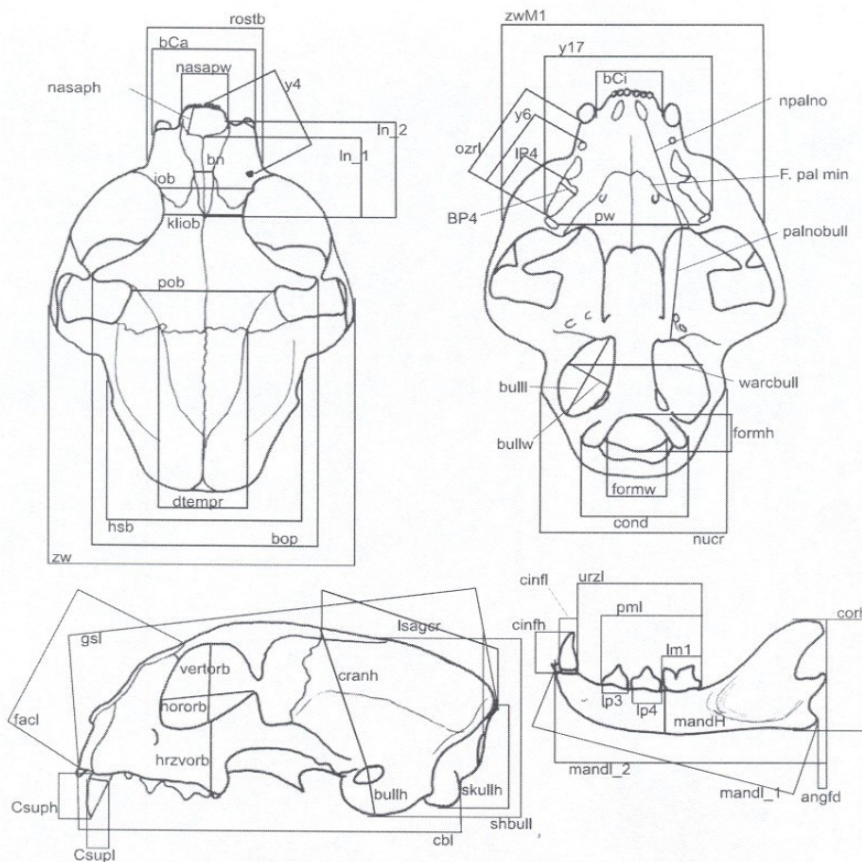
In order to perform the morphometric analysis there were used skulls of three adults tigers (*Panthera tigris*), 9, 11, and 12 years old, donated by Bucharest-Baneasa Zoo and by N & Variete Globus Circus for teaching purposes, and from a jaguar male (*Panthera onca*) with melanism, 24 years old, donated for teaching purposes by Bucharest Zoo.

Measurements were performed and the most interesting aspects were photographed. Description, identification and homologation were made according to Nomina Anatomica Veterinaria (N.A.V) 2005. For measurement there were used zootechnical compass, ruler and beam compass.

## RESULTS AND DISCUSSION

Following the carried out studies and measurements, it appears that there is a little dimensional difference between the skulls of the two species, especially as the jaguar, unlike the tiger, is climbing, and its whole body must be lighter. But it appears that the jaguar has a stronger bite than the tiger, proved by a deeper masseteric fossa.

The described plans and reference points allow the performance of complex measurements, both on anatomically prepared skulls and on radiological images (with a modern imaging system, as the one of Bucharest Faculty of Veterinary Medicine Clinic, which is equipped with automatic program for morphometry) (figure no 1).



**Fig. 1. Reference points for feline skull measurements (Clara Stefen and D. Heideck, 2012).**

The results of carried out measurements are shown in the tables below ( table no 1, 2, 3, 4, 5).

**Table 1. Measurements of the ventral facet of the jaguar (*Panthera onca*) skull, and tiger (*Panthera tigris*) skull**

Measurements	Species - Values (cm)			
	Jaguar ( <i>Panthera onca</i> )	Tiger ( <i>Panthera tigris</i> )		
		Specimen 1	Specimen2	Specimen3
bCi (distance between canines)	4,3	4,5	5,8	6,1
y17(the largest width measured at the maxillary PM4)	8,2	10,0	13,0	14,0
pw (palatine width between molars 1)	7,1	10,6	10,6	11,0
ozrl (maxilla length from canine to premolar 4)	5,9	7,8	8,0	9,0
y6 (dental arch length from premolar 2 to premolar 4)	5,7	6,0	7,0	7,0
IP4 (premolar 4 alveolar length)	3,0	3,0	3,5	3,0
BP4 (premolar 4 alveolar width)	1,3	2,0	2,0	2,1
zwM1 (maximum width of the skull at the molar 1)	12,9	15,0	16,0	16,0
npalno (distance from the nasal cavity to the palatine anterior suture)	6,5	7,0	10,0	11,0
palnobull (distance from the palatine anterior suture to the tympanic bulla notch at the styloid process base)	8,2	9,0	11,0	10,0
warcbull (width of the skull at the tympanic bulla)	7,5	8,0	10,0	10,0
bullw (tympanic bulla width)	2,7	2,0	3,8	3,0
bulll (tympanic bulla length)	4,1	3,6	4,7	4,0
formh (the large occipital foramen height)	2,1	3,0	3,1	3,0
formw (maximum width of the large occipital foramen)	2,4	3,0	3,1	3,0
cond (maximum width at the occipital condyles)	5	5,8	11,0	10,0
nucr (maximum width at the nuchal crest)	10,7	12,0	14,5	14,0

**Table 2. Measurements of the dorsal facet of the jaguar (*Panthera onca*) skull, and tiger (*Panthera tigris*) skull**

Measurements	Species - Values (cm)			
	Jaguar ( <i>Panthera onca</i> )	Tiger ( <i>Panthera tigris</i> )		
		Specimen 1	Specimen2	Specimen3
y4 (distance from the incisive to the center of the infraorbital foramen)	7,0	10,0	12,0	11,0
In_1 (nasal cavity length at the median suture)	6,0	8,0	9,0	9,0
In_2 (maximum length of nasal bones)	7,1	9,8	14,0	14,0
bn (width of nasal bones in the incisor-maxilla-frontal sutures)	2,0	3,0	3,2	3,0
iob (interorbital width at the angular vein of the eye)	5,3	6,7	6,0	6,0
kliob (interorbital width measured at the smallest distance between the orbits)	5,6	6,1	7,0	7,0
pob (width at the posterior of the orbital processes)	5,4	4,8	12,0	12,0
nasaph (maximum height of the internal nasal aperture)	4,4	4,4	6,5	6,0
nasapw (maximum width of internal nasal aperture)	3,9	4,9	4,2	4,0
bCa (width at the right maxilla canines)	7,3	8,0	9,5	8,0
rostb (maximum width of the snout)	7,0	10,0	10,0	8,7
dtempr(distance between the fronto-parietal edges at the intersection with frontoparietal sutures)	2,8	4,6	4,5	5,0
hsb (maximum width of the skull at the temporal scale)	9,7	7,0	7,8	8,7
bop (width at the orbital processes)	7,4	11,0	14,0	11,0
zw (maximum width of the skull at the zygomatic arch)	17,0	20,5	24,0	20,0

**Table 3. Measurements of the lateral facet of the jaguar (*Panthera onca*) skull, and tiger (*Panthera tigris*) skull**

Measurements	Species - Values (cm)			
	Jaguar ( <i>Panthera onca</i> )	Tiger ( <i>Panthera tigris</i> )		
		Specimen 1	Specimen2	Specimen3
Csuph (maxillary canine crown height)	3,5	5,0	5,0	5,0
Csupl (thickness of maxillary canine at the dental isthmus)	2	2,9	3,1	3,0
facL (facet length)	11,3	8,7	14,0	13,0
gsl (the longest length of the skull)	29,8	32,9	37,5	37,0
lsagr (sagittal crest length)	11,8	14,0	13,0	12,0
vertorb (maximum vertical diameter of the orbit)	4,8	6,0	5,8	6,0
hororb (horizontal diameter of orbit)	3,9	4,8	7,0	6,5
hzvorb ( the vertical distance from the orbit to the maxilla between premolar 4 and molar 1)	5	10,0	11,2	12,1
cranh (skull height at the dorsal auditory meatus point to the sagittal intersection of frontoparietal sutures)	7,9	12,0	14,0	14,0
bullh (tympanic bulla height)	2,6	2,8	2,9	3,1
cbl (condyle basilar length)	23,3	26,0	28,0	29,0
skullh (skull height from the condyles to the nuchal crest)	6,2	6,5	9,5	9,0
shbull (skull height measured vertically from the tympanic bulla)	9,1	12,0	12,0	13,0

**Table 4. Measurements of the mandible to the jaguar (*Panthera onca*), and tiger (*Panthera tigris*)**

Measurements	Species - Values (cm)			
	Jaguar ( <i>Panthera onca</i> )	Tiger ( <i>Panthera tigris</i> )		
		Specimen 1	Specimen2	Specimen3
cinfh (mandibular canine height)	5,9	4,5	4,5	4,3
cinfl (mandibular canine socket length)	2,2	2,2	2,6	3,0
lp3 (premolar 3 width)	1,5	1,5	1,5	2,0
lp4 (premolar 4 width)	2,1	2,0	2,5	2,2
lm1 (molar 1 crown width)	2,3	2,0	3,0	2,3
pm1 (molars arch alveolar length)	6,0	6,0	7,5	7,5
urzl(mandible dental arch length from the distal edge of the canine to the distal edge of molar 1)	7,5	8,7	10,0	10,0
mandH (mandibular height between premolar 4 and molar 1)	3,2	3,8	6,0	4,0
mandl_2 (jaw length from the incisor socket to the condiloid process. parallel to the ventral edge of the mandible)	19,3	22,0	24,0	24,0
mandl_1 (jaw length from the incisor socket to the aboral edge of angular process, sagittal plan)	16	20,0	23,0	23,0
angfd (imaginary line that starts from the condiloid process to the coronoid process)	1,8	2,1	2,2	2,0
corh (jaw height at the coronoid process)	7,7	10,0	11,0	10,5

**Table 5. Measurements of the skull and cranial cavity volume to the jaguar (*Panthera onca*), and tiger (*Panthera tigris*), according to the irregular ellipsoid formula ( $\frac{4}{3}\pi abc$ )**

Measurements	Species - Values (cm)			
	Jaguar ( <i>Panthera onca</i> )	Tiger ( <i>Panthera tigris</i> )		
		Specimen 1	Specimen2	Specimen3
a (half of the maximum length of the skull - from the incisive to the nuchal crest)	14,9	16,45	18,75	18,5
b (half of the maximum length of the skull - the skull height from the dorsal auditory meatus point to the intersection of sagittal frontoparietal sutures)	3,95	6,0	7,0	7,0
c (half of the maximum width of the skull - measured at the zygomatic arch)	8,5	10,25	12,0	10,0
Skull volume according to the formula: $\frac{4}{3}\pi abc$ (cm <sup>3</sup> )	2412,59	4237,69	6597,34	5424,48
a (half of the anterior-posterior diameter of the cranial cavity)	4,6	4,45	5,35	5,75
b (half of the dorso-ventral diameter of the cranial cavity)	3,15	2,75	3,15	3,35
c (half of the transverse diameter of the cranial cavity)	3,75	3,5	4,5	5,0
The volume of the cranial cavity according to the irregular ellipsoid formula ( $\frac{4}{3}\pi abc$ )(cm <sup>3</sup> )	227,49	179,41	316,66	403,43

## CONCLUSIONS

1. It is observed that the jaguar skull is slightly lighter than the tiger one.
2. Measurements that may be considered differences between the two skulls are those of the mandible, respectively **mandl\_1** and **mandl\_2** (the mandible length from the incisor socket to the aboral edge of the angular process, the sagittal plan, and the mandibular length from the incisor socket to the condiloid process, parallel to the ventral edge of the mandible).
3. There are also differences on the dorsal facet, respectively **zwm1** (maximum width of the skull at molar 1).
4. On the ventral facet, there are differences at **ty17** (the largest measured width at maxillary PM4) **ozrl** (maxilla length from canine to premolar 4) and **pw** (palatine width between molars 1).

5. On the lateral side, the reference point of difference is the **hsvorb** (the vertical distance from the orbit to the maxilla between premolar 4 and molar 1) and **cranh** (skull height at the dorsal auditory meatus point to the sagittal intersection of frontoparietal sutures).
6. Based on the measurements of the eight reference points we can determine to which species the skull belongs.

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