

# Anatomical study of the Iranian brown bear's skull (*Ursus arctos*): A case report

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## Key words:

anatomy, brown bear, skull

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Received: 12 April 2016

Accepted: 28 June 2016

## Abstract:

The Brown bear (*Ursus arctos*) is a species at risk of extinction. It is considered the largest carnivore and lives in northern Iran. Several studies on the structure of skull have been accomplished in different animals. The aim of this study was the inscription of gross anatomical characteristics of skulls of three Iranian adult male brown bears that were transferred to the Anatomical Department of the Faculty of Veterinary Medicine of Semnan University. After processing, that included cleaning, degreasing and bleaching, skulls were studied from the dorsal or frontal, ventral, lateral, rostral, caudal and medial views. The facial part of the brown bear's skull from dorsal view was small and the cranium was seen quadrilateral and larger than the dogs. The facial part of lacrimal bone and also the optic groove of presphenoid were absent. There was not articulation between maxillary and nasal bones. The interincisive canal was present and situated inter palatine processes of incisive bones. The orbital cavity was small in brown bear. Lacrimal canal was formed by lacrimal and maxillary bones. The interparietal bone and external sagittal crest in brown bear were seen as being shorter than the dogs. Tympanic bulla was very small and jugular foramen rounded. The external acoustic meatus was formed by squamous and tympanic part of temporal bone. In conclusion, the brown bear's skull has different important macroscopic characteristics compared to other carnivores.

## Case History

Many carnivores that live in Iran such as brown bears are at risk of extinction (McLellan et al., 2008). In recent years the Iranian wildlife has been exposed to various risks such as illegal hunting and road kill (Qashqaei et al., 2012). Ecological study was accomplished about the Iranian brown bear (Ataei et al., 2012). The Iranian Brown bear (*Ursus arctos*) is considered the largest carnivore living in the north of Iran and parts of Lorestan and Khuzestan (Ebrahimi et al., 2011). There are several

present studies about osteology of carnivorous animals (Evans and Christensen, 1964, Getty, 1975, Tomar et al., 2014). Several studies on the structure of skull have been conducted in different animals (Atalar et al., 2009., He et al., 2002., Jurgelenas et al., 2007., Petrov et al., 1992., Sarma et al., 2001., Singh, 1997).

The morphometrical skull of brown bear was studied in Golestan province of Iran (Movahedi et al., 2014). The length of brown bear's skull was reported 368mm and width 205mm. In another report about the skull of brown bear in Iran it was concluded that different parts of

the skull in males is stronger, whereas female skulls have been reported to have more length, and are narrower and weaker (Nezami and Eagdari, 2014). The length of Bulgarian brown bear's skull was clarified, 370mm and width 223/8mm (Mihaylov et al., 2013). To the best of the author's knowledge, there is no macroscopic study about Iranian brown bear's skull, therefore, this investigation, for the first time, was focused on the macroscopic skull features in Iranian brown bear in order to extend the knowledge in this field. Results were compared with the data available for other carnivores.

The specimens including the three skulls were obtained from the carcasses of brown bears in Golestan forest in Iran. These skulls were provided by the Department of Environment (DoE), Semnan, Iran and transmitted to the dissection part of the Faculty of Veterinary Medicine of Semnan University. The macroscopic features of skulls were studied from dorsal or frontal, ventral, lateral, medial and caudal views. Seventeen craniometrical indices of the brown bear's skull were measured in this study (Figures 1, 2, 3). Linear values of the head skeleton parameters were measured using a caliper (Petrov et al., 1990, Yamaguchi et al., 2009).

### Clinical Presentation

Morphometrical findings were shown in Tables one, two and three. The mean of the condylobasal length or distance between the incisive and occipital condyle was 260.44mm. The mean of the rostral width of hard palate was 50.97 mm. The mean of greatest length of the skull and the mean of the dorsal length of the cranium were 289.31mm and 177.87 mm respectively. The mean of the zygomatic width was 165.55 mm. The mean of the width of the cranium of the brown bear's skull was 100.54 mm. The mean of the length of the mandible and the mean of the high of the ramus of the mandible were 192.27 mm and 83.26 mm re-

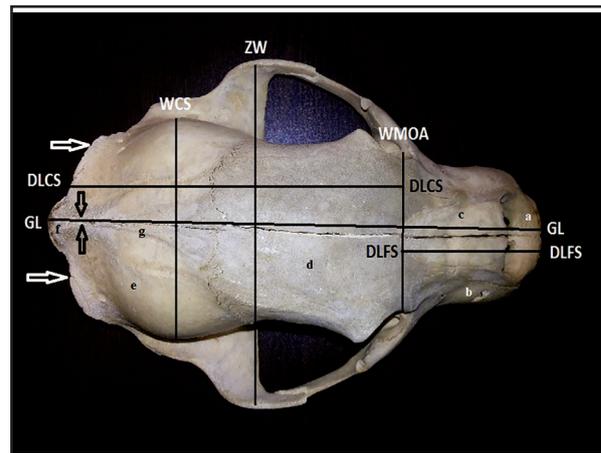


Figure 1. Dorsal view and craniometrical parameters of brown bear's skull showing: a. Incisive bone. b. Maxilla. c. Nasal bone. d. Frontal bone. e. Parietal bone. f. Interparietal bone. g. Temporal line. Black arrow: External sagittal crest. White arrow: Nuchal crest. (GL): Greatest length of the head skeleton. (WCS): Width of the Cranium of the Skull. (ZW): Zygomatic Width. (DLFS): Dorsal Length of the Face of the Skull. (DLCS): Dorsal Length of the Cranium of the Skull. (WMOA): Width between the Medial eye Angles.

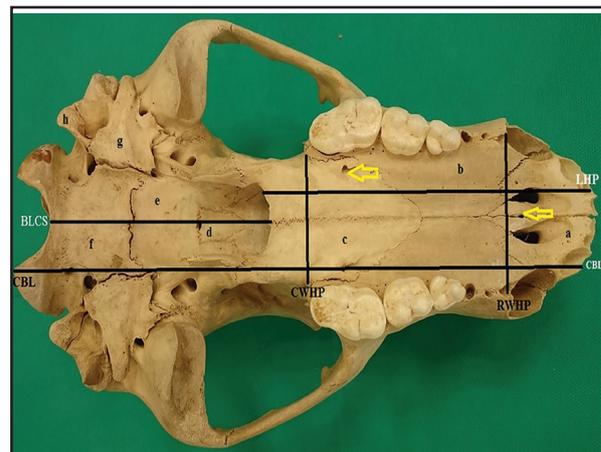


Figure 2. Craniometrical parameters of brown bear's skull (Ventral view): (RWHP): Rostral Width of the Hard Palate. (CWHP): Caudal Width of the Hard Palate. (LHP): Length of the Hard Palate. (CBL): Condylobasal Length of the head skeleton. (BLCS): Basal Length of the Cranium of the Skull. a. Incisive bone b. Palatine process of maxillary bone c. Horizontal plate of palatine bone. d. Presphenoid bone e. Basisphenoid bone. f. Basilar part of occipital bone. g. Tympanic bulla. h. Jugular process. Rostral arrow: Interincisive canal. Caudal arrow: Major and Minor palatine foramen.

spectively.

Macroscopically important specifications of the skull were explained from different views:

The skull of brown bear, like other animals, was divided into two portions. The rostral and

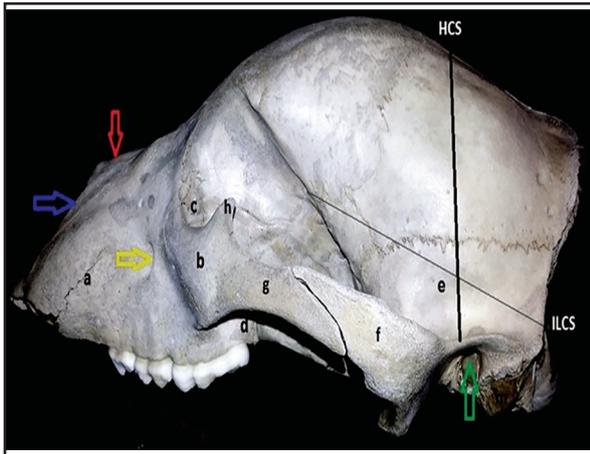


Figure 3. Craniometrical parameters of brown bear's skull (Lateral view): (HCS): Height of the Cranium of the Skull. (ILCS): Internal Length of the Cranium of the Skull. a. Maxilla. b. Zygomatic bone. c. Lacrimal bone. d. Maxillary tubercle. e. Squamous temporal bone. f. Zygomatic process of temporal bone. g. Temporal process of zygomatic bone. h. Frontal process of zygomatic bone. Red arrow: Nasal bone. Blue arrow: Nasal process of incisive bone. Yellow arrow: Infraorbital foramen. Green arrow: External acoustic meatus.

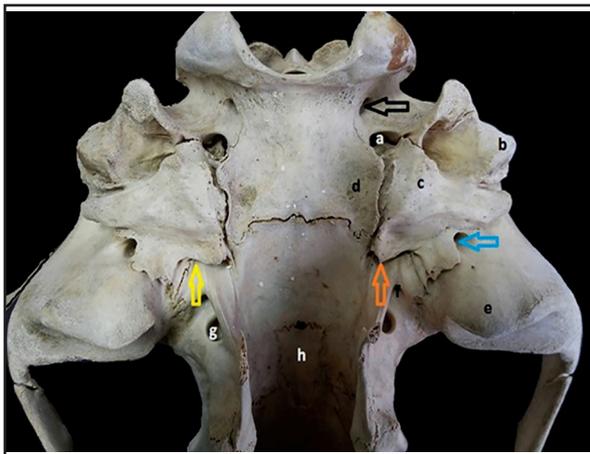


Figure 4. Cranium of brown bear's skull (Ventral view): a. Jugular foramen. b. Mastoid process. c. Tympanic bulla. d. Muscular tubercle. e. Retroarticular process. f. Oval foramen. g. Caudal alar foramen. h. Presphenoid bone. Black arrow: Hypoglossal foramen in condyloid fossa. Blue arrow: Retroarticular foramen. Yellow arrow: Carotid foramen. Orange arrow: Auditory opening.

small part was the face and the caudal part was the cranium. The cranium was observed quadrilateral shape from dorsal view. Frontal, nasal, parietal and interparietal bones were seen from this view (Fig. 1).

Frontal bone covered half of the cranium's roof approximately. External surface of fron-

tal bone was crossed by temporal line, which extends in a curve from external sagittal crest to short zygomatic process. Temporal line was not prominent (Fig. 1). The nasal part of frontal bone was long, which fits between nasal bone and maxilla. This part was rostrally joined with the nasal process of incisive bone (Fig. 6). External sagittal crest was short and less prominent. This crest was formed by two parietal bones (Fig. 1). The rostral end of interparietal bone was narrower than the caudal end. The caudal ends of two nasal bones were convex and form the semicircular border, which was caudolaterally joined with the nasal part of frontal bone and the nasal process of incisive bone, rostrolaterally (Fig. 1, 3, 6).

The nuchal crest at the dorsal part of the squamous occipital was high and the external occipital protuberance was formed by the occipital and interparietal bones. The median occipital crest was sharp and extended to foramen magnum. The jugular process was short and hypoglossal canal present in condyloid fossa.

The ventral surface of basioccipital was concave and the lateral border of basioccipital at the tympanic bulla reflected ventrally. The muscular tubercle was not prominent. Jugular foramen was seen round and formed by basioccipital, lateral part of occipital and tympanic part of temporal bones (Fig. 4). The body of basisphenoid was seen wide and concave ventrally. Infratemporal fossa was small and presents oval and caudal alar foramens in this region. The groove was seen between the body and wing of the basisphenoid. This groove continued to the auditory opening of tympanic bulla caudally and choanal opening rostrally, which transmits the auditory tube (Fig. 4). The small body of presphenoid was present in the ventral wall or floor of cranium, rostral to the basisphenoid (Fig. 4). There were four foramens, including ethmoidal, optic, orbital and rostral alar, on the wing of presphenoid, at the caudal part of the orbit. These fo-

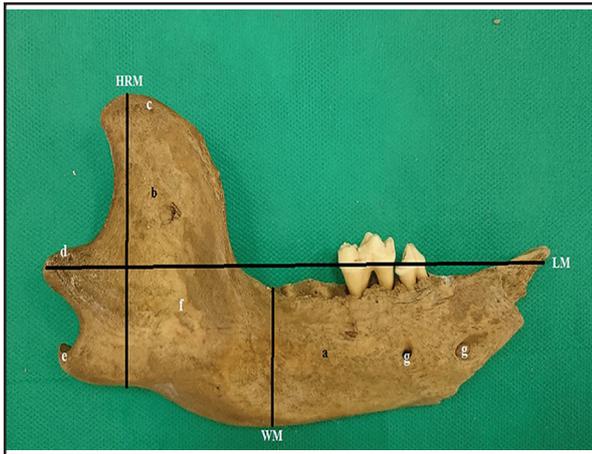


Figure 5. Lateral view of brown bear's mandible: (LM): Length of the Mandible. (WM): Width of the Mandible. (HRM): High of the Ramus of Mandible. a. Body of mandible. b. Ramus of mandible. c. Coronoid process. d. Condylar process. e. Angular process. f. Masseteric fossa. g. Mental foramen.

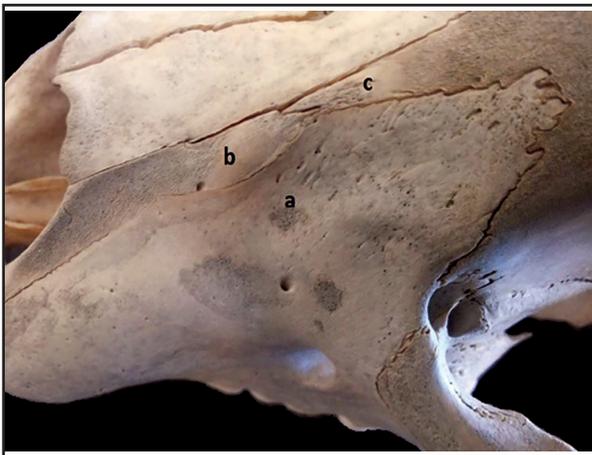


Figure 6. Face of brown bear's skull (Dorsolateral view): a. Maxilla. b. Nasal process of incisive bone. c. Nasal part of frontal bone.

ramens were situated respectively from dorsal to ventral and approximately the same distance from each other. The round foramen opened to the rostral alar foramen.

The palatine bone was situated in the caudal portion of the hard palate. The horizontal plate was approximately large. On the oral surface of horizontal plate, caudal part of palatine groove was present, extending to the major palatine foramen. The minor palatine foramen presents in each side, but was not separated from the major palatine foramen (Fig. 2). The caudal part of perpendicular plate was thick and joined medially with pterygoid bone and

laterally with pterygoid process of basisphenoid. The Hamulus or muscular process of pterygoid bone was thick and large. The ramus of mandible was short and wide. The wider coronoid process, condylar and angular process were present in the ramus. The masseteric fossa was not depressed. The ventral border of the mandible was direct and not convex. There were two mental foramen rostrally of the body of mandible (Fig. 5). Interincisive canal was observed between the right and left palatine process of the incisive bones. The nasal process of incisive bone was extended to the rostral part of the nasal bone laterally and joined with the nasal part of the frontal bone. The nasoincisive notch was not clear or absent (Fig. 1, 3, 6).

The lateral surface was smooth and depression rostrally to the infraorbital foramen. Maxilla formed the rostral portion of the orbital cavity, dorsal to the zygomatic bone. The lacrimal canal in the orbital cavity was formed by maxilla and lacrimal bone (Fig. 3, 6, 7). Zygomatic process of maxillary bone was attached to the ventromedial aspect of the rostral part of zygomatic arch. This process was articulated with lacrimal bone under the maxillary foramen. The maxillary tubercle was prominent, sharp and clear. The caudal palatine foramen had formed between the maxillary tubercle and pterygopalatine fossa. The sphenopalatine foramen was situated in pterygopalatine fossa next to the caudal palatine foramen (Fig. 7). The facial surface of lacrimal bone was absent (Fig. 6, 7). The maxillary foramen was situated medial to the zygomatic bone and formed by the lacrimal bone. The zygomatic bone had two processes including the high frontal process and long temporal process (Fig. 3).

The external acoustic meatus was formed between squamous and tympanic part of temporal bone. The tympanic bulla was small and indicates short muscular process. The prominent mastoid process was situated between the squamous temporal and lateral part of occipital

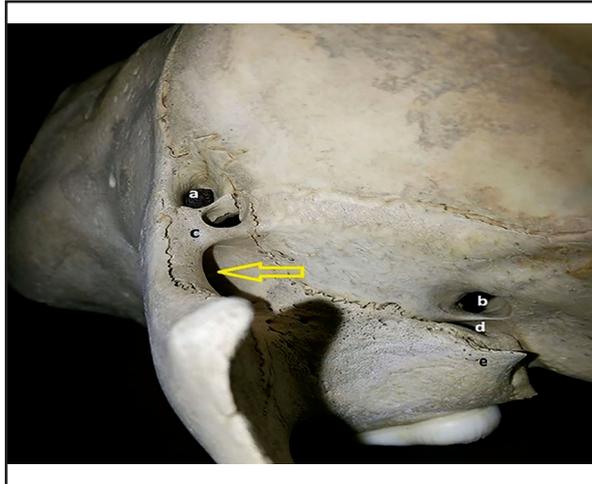


Figure 7. Rostral part of orbit of brown bear's skull: a. Lacrimal canal. b. Sphenopalatine foramen. c. Lacrimal bone. d. Caudal palatine foramen. e. Maxillary tuber. Yellow arrow: Maxillary foramen.



Figure 8. Cranium of brown bear's skull (Medial view): a. Septum between cerebellum and right cerebral hemisphere. b. Internal acoustic meatus. c. Dorsum sellae. d. Hypophyseal fossa. e. Optic canal. f. Cribriform plate of ethmoid. g. Ethmoidal turbinate.

bone (Fig. 3, 4).

The dorsum sellae was present and prominent on the dorsal surface of basisphenoid. The optic groove was absent in brown bear's skull and entrance of the optic canals was separated from them (Fig. 8).

## Discussion

This study shows that the skull of the brown bear is the same as the skull of the other carnivores but there were different points between

them. The skull of brown bear was wide and the facial part, small, like the tiger (Singh, 1997) and ferret (He et al., 2002). The results of this study show a groove is present between the body and the wing of basisphenoid. This groove continues to the auditory opening of tympanic bulla caudally and choanal opening rostrally, which transmits the auditory tube. To the best of the author's knowledge there is not a report about this groove in other carnivores.

This research showed that optic groove is absent in the brown bear's skull and optic canals are separated from each other. The optic groove was present on the dorsal surface of presphenoid in the dogs and cats (Dyce et al., 2010).

The results of this study revealed that the facial part of lacrimal bone is not present in the brown bear, but the orbital part of lacrimal bone is greater than that of the dog (Getty, 1975) and composed the maxillary foramen medially to the rostral part of zygomatic arch. This study showed that maxillary bone is not articulated with the nasal bone and composed the dorsal part of rostral border of orbit and partially to the lacrimal canal. The maxillary bone in *felis bengalensis* built the rostral part of orbit (Sarma et al., 2001).

The external surface of frontal bone was smooth and slightly convex like that of the dog (Evans and Christensen, 1964). This surface is more convex in the *felis bengalensis* (Sarma et al., 2001) and tiger (Singh, 1997), but in the wolf it is slightly concave (Atalar et al., 2009). The zygomatic process of the frontal bone in the brown bear's skull, like the most carnivores, was short, while this process is longer in cats (Evans and Christensen, 1964) and the *felis bengalensis* (Sarma et al., 2001). The results of this study shows the external sagittal crest and temporal line are present, but not prominent like the *felis bengalensis* (Sarma et al., 2001) and fox (Atalar et al., 2009). The orbital cavity in the brown bear was small against the greater skull and resembles the

Table 1. Values of the investigated ventral of cranium indices. **T.S:** This study. **I.S.M:** Iranian study by Movahhedi. **B.S.M:** Bulgarian study by Mihaylov.

Parameters	T.S	I.S.M	B. S.M
<b>LHP-</b> Length of hard palate (mm)	149/47	-	152/75
<b>CBL-</b> Condylbasal length (mm)	260/44	266/8	292/83
<b>BLCS-</b> Basal length of cranium of skull (mm)	103/83	-	145/23
<b>RWHP-</b> Rostral width of hard palate (mm)	50/97	66	71/27
<b>CWHP-</b> Caudal width of hard palate (mm)	56/87	-	82/22

Table 2. Values of the investigated dorsal of cranium indices. **T.S:** This study. **I.S.M:** Iranian study by Movahhedi. **B.S.M:** Bulgarian study by Mihaylov.

Parameters	T. S.	I.S.M	B.S.M
<b>GL-</b> Greatest length of the skull (mm)	289/31	290	319/05
<b>DLFS-</b> Dorsal length of face of skull (mm)	111/55	-	112/75
<b>DLCS-</b> Dorsal length of cranium of skull (mm)	177/87	-	207
<b>WMOA-</b> Width between of medial ocular angles (mm)	71/08	66/7	78/45
<b>ZW-</b> Zygomatic width (mm)	165/55	171	189/5
<b>WCS-</b> Width of cranium of skull (mm)	100/54	101	107/23
<b>ILCS-</b> Internal length of cranium of skull (mm)	106/79	-	138/73
<b>VCS-</b> Volume of cranium of skull (cm <sup>3</sup> )	320		343
<b>HCS-</b> High of cranium of skull (mm)	90/34	-	91/23

Table 3. Values of the investigated of mandible. **T. S:** This study. **I.S.M:** Iranian study by Movahhedi.

Parameters	T.S.	I.S.M
<b>LM-</b> Length of mandible (mm)	192/27	189/5
<b>WM-</b> Width of mandible (mm)	38/35	-
<b>HRM-</b> High of ramus of mandible (mm)	83/26	-

dogs' near to the median line. It was a distant median line in cats (Miller et al., 1964). The infraorbital foramen, the same as the tiger (Singh, 1997), felis bengalensis (Sarma et al., 2001) and ferret (He et al., 2002), was situated rostroventrally near the orbital cavity. The maxillary tubercle in the skull of brown bear was raised and sharp, but it is small in the dogs (Miller et al., 1964). The frontal process of the zygomatic bone in brown bear was longer than the dogs. The nuchal crest was shorter in brown bear than the dogs. The external occipital protuberance was distinguished and median occipital crest present and sharp, similar to the fox (Atalar et al., 2009). The median occipital crest is not present or not prominent in other carnivorous animals (Dyce et al., 2010, Evans and Christensen, 1964, Getty, 1975). In this

study the interincisive canal present between the right and left palatine process of incisive bones was observed, but this canal exists in the interbody of incisive bones in dogs (Nickel et al., 1986). The minor palatine foramen in the brown bear is present in each side, but not separated from the major palatine foramen, while the minor palatine foramen is independently present in tiger (Singh, 1997), and absent in felis bengalensis (Sarma et al., 2001).

The jugular process was short in the skull of brown bear. The jugular process was reported short and sharp in felis bengalensis (Sarma et al., 2001). Atalar et al., (2009) observed the long jugular process in fox and wolf. The hypoglossal foramen was seen in condyloid fossa, while it was observed rostrally to the condyloid fossa in the dogs (Miller et al., 1964).

This study showed the external acoustic meatus in brown bear, formed by the squamous and tympanic part of temporal bone, while in dogs, this meatus is formed by the tympanic part of temporal bone (Miller et al., 1964). This study revealed that the tympanic bulla in brown bear was small and short like the equids (Nick-

el et al., 1986). The tympanic bulla is large in dogs and muscular process is long (Miller et al., 1964). The large tympanic bulla is present in tiger (Singh, 1997), *Felis bengalensis* (Sarma et al., 2001) and ferret (He et al., 2002). This research showed that the prominent and clear mastoid process is present in brown bear as the same as equine (Nickel et al., 1986). The mastoid process was reported large in the wild cat (Atalar et al., 2009).

The mandible is described in dogs (Evans and Christensen, 1964) and in tiger (Tiwari et al., 2011). The mandible of brown bear closely resembled that of other carnivores.

The masseteric fossa of the mandible of the brown bear's skull was not depressed and the ventral border of the body of this bone was approximately direct, the same as the mandible of tiger (Tiwari et al., 2011), while it was convex in dogs and cats (Getty, 1975).

## Acknowledgements

The author would like to thank Dr. Salimi-Bejestani, for reviewing this manuscript and the following individuals for different roles that they played, Dr. Mirbehbehani, and Dr. Rasouli from the Department of Anatomy, Mr. Rostami and Mr. Pourafshar the senior technologist of Faculty of Veterinary Medicine, Semnan, Iran, Dr. Behnam and Mr. Adiby from the Department of Environment, Semnan, Iran.

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## مطالعه آناتومیکی جمجمه خرس قهوه ای ایرانی (*Ursus arctos*): گزارش موردی

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(دریافت مقاله: ۲۴ فروردین ماه ۱۳۹۵، پذیرش نهایی: ۹ تیر ماه ۱۳۹۵)

### چکیده

خرس قهوه‌ای از جمله گونه‌های جانوری در حال انقراض در گستره زیستی ایران است که در شمال ایران زندگی می‌کند و در زمره بزرگترین گوشتخواران ایران به حساب می‌آید. مطالعات متعددی روی جمجمه حیوانات صورت گرفته است. این مطالعه با هدف مشاهده و ثبت ویژگی‌های آناتومیکی ساختمان جمجمه سه فالاده خرس قهوه‌ای نر بالغ، انجام شد. ساختار ماکروسکوپی جمجمه‌ها از شش نمای پشتی، شکمی، عقبی، جلویی، جانبی و داخلی مطالعه گردید. این مطالعه نشان داد که بخش صورتی جمجمه کوچک و حفره سری وسیع و چهار گوش به نظر رسیده و از گوشتخوارانی مثل سگ بزرگتر بود. بخش صورتی استخوان اشکی و شیار چشمی استخوان پیش پروانه‌ای در جمجمه خرس قهوه‌ای دیده نشد. بین استخوان آرواره و استخوان بینی مفصلی وجود نداشت. مجرای بین‌ثناپایی حدفاصل زائده‌های کامی استخوان‌های ثنایا وجود داشت. حفره چشمی در جمجمه خرس قهوه‌ای کوچک بود. مجرای اشکی با مشارکت استخوان‌های اشکی و آرواره ساخته شده بود. استخوان آهیانه و ستیخ سهمی خارجی در جمجمه خرس قهوه‌ای در مقایسه با جمجمه سگ‌ها کوتاه‌تر به نظر رسید. حباب صماخی در جمجمه خرس قهوه‌ای خیلی کوچک بود و سوراخ وداجی گرد دیده شد. مجرای شنوایی خارجی در جمجمه خرس قهوه‌ای بوسیله بخش فلسی یا مسطح استخوان گیج گاهی و بخش صماخی استخوان گیج گاهی تشکیل شده بود. نتیجه اینکه بخش‌های مختلف جمجمه خرس قهوه‌ای در مقایسه با سایر گوشتخواران تفاوت‌هایی را نشان می‌دهد.

واژه‌های کلیدی: آناتومی، خرس قهوه‌ای ایران، جمجمه

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