



Morphological and Applied Anatomical Studies on the Head Region of Malayan Sun Bear (*Helarctos malayanus*)

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ABSTRACT

The Malayan sun bear is the smallest of the eight bear species. The aim of the research was to investigate the morphological and applied anatomical characteristics of the head region of the Malayan sun bear. The size of the head is large, broad and heavy in proportion to the body. The skull of the Malayan sun bear was mesocephalic according to the cephalic index (80.48). The skull length, skull width, cranial length and maximum skull height was 21.47 cm, 17.28 cm, 17.81 cm and 9.40 cm, respectively. The nasal length, nasal perpendicular height, nasal horizontal-transverse width and nasal circumference were 3.59 cm, 3.50 cm, 3.20 cm and 10.52 cm, respectively. The length and height of the mandible were 14.65 cm and 7.09 cm, respectively. There is no literature available on the regional applied anatomy of maxillofacial and mandibular regions of the Malayan sun bear. Therefore, this study was designed to provide information on morphological and applied anatomical studies on the head region of the Malayan sun bear. This is the first detailed study to provide morphological characteristics of the head region of Malayan sun bear and this information will aid the clinicians in the application of regional anaesthesia in Malayan sun bear.

Keywords: Malayan sun bear, skull, morphological, applied, cephalic index

The Malayan sun bear (*Helarctos malayanus*) is the only bear species inhabiting equatorial lowland rain forest (Servheen *et al.* 1999). In 1996, it has been classified as Data Deficient (DD) by IUCN red list of threatened species (IUCN, 1996), because of a lack of knowledge about its distribution, area of occupancy and population trends even though it was listed as a vulnerable (VU) species in 2008 (Nazeri *et al.* 2012). Due to lack of basic information regarding Malayan sun bear ecology, habitat loss, and human-caused mortality inhibits managers' abilities to prioritize threats and develop strategies to address the most important issues (Peyton *et al.* 1999). Bear Specialist Group recommended that the basic research on the Malayan sun bear is the highest priority need (Servheen, 1999). Without such information, the establishment and implementation of scientifically-sound conservation plans are difficult.

The regional anatomy of the head is a very important region for the animal because of the presence of vital organs and structures as the brain, tongue, eyes, ears, teeth, nose, lips, horn and skull. Thus the head is needed for coordinating the body as well as for deglutition, olfaction and defence (Dyce *et al.*, 2002; Olopade, 2003). The foramina in the skull are of clinical importance in regional anaesthesia around the head regions (Hall *et al.*, 2000). The information on the regional clinical anatomy of the head of the Malayan sun bear is scanty. Therefore, this study was designed to provide information on clinically important parameters and landmarks of the head. This information will aid the clinicians in the application of regional anaesthesia in Malayan sun bear.

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MATERIALS AND METHODS

The present study was conducted on the head region of the Malayan sun bear. The samples for the study were collected from Aizawl Zoological Park, Government of Mizoram with permission from the Department of Environment, Forest and Climate change, Government of Mizoram. The collected head samples of the Malayan sun bear were prepared using the boiling maceration technique for skeleton preparation (Simoens *et al.*, 1994; Choudhary *et al.*, 2013a & b). This study was designed to provide the maximum number of biometrical parameters of skull and some valuable information on clinically important parameters of the Malayan sun bear. The following measurements were taken for different bones of the skull and summarized in Fig 1 to 7.

Skull parameters

1. Skull length (SL): Distance between the highest points of the parietal bone to the middle of the rostral margin of the incisive bone.
2. Skull width (SW): Distance between two zygomatic arches.
3. Skull/Cephalic index (SCI): Skull width/ Skull length $\times 100$ (Miller *et al.*, 1964).
4. Cranial length (CL): Distance from the central point of the frontonasal suture to the middle point of the nuchal crest.
5. Maximum skull height (MSH).
6. Skull breadth at parietals (SBP).
7. Skull Height at the mastoid process (SHMP).
8. Skull breadth at the junction of frontal and parietal (Waist) (SBFP).
9. Height of Rostrum at Canine alveolus (HRA).

Nasal parameters

1. Nasal length (NL): Maximum distance across the nasal bones or maximum distance between the naso-maxillary sutures.
2. Perpendicular height (PH).
3. Horizontal- transverse width (HTW).
4. Circumference (NC).

Occipital parameters

1. Foramen magnum height (FMH).
2. Foramen magnum width (FMW).
3. Foramen magnum Circumference (FMC).
4. Intra condylar distance (ICD).
5. External occipital crest (EOC).

Ventral parameters

1. Palatine
2. Total palatal length (TPL).
3. Breadth between canines (BBC).
4. Between last molar (BLM).

Maxilla parameters

1. Infraorbital foramina distance (IOFD): Maximum distance between two infraorbital foramen.
2. Diameter of Infraorbital foramina (DIOF): Maximum distance between the two edges of infraorbital foramina.
3. Distance from the process of alveolar socket of canine tooth to the infraorbital canal (H).
4. Infra-orbital canal to the root of the alveolar tooth (I).

Mandible parameters

1. Mandibular length (ML): From the level of the cranial extremity of the alveolar root of the incisor to the level of the caudal margin of the mandible.
2. Mandibular height (MH): From the basal level of the mandible to the highest level of the coronoid process.
3. Mandibular foramen to the base of mandible (MBM): Vertical line from the ventral limit of the mandibular foramen to the base of the mandible.
4. Caudal border of the mandible to below mandibular foramen (CMMF): length from the caudal most margin of the mandible to the vertical line produced by a description of the measurement of the mandibular foramen to the base of the mandible.

5. Caudal border of the mandible to the level of mandibular foramen (CMM).
6. Mandibular foramen to the margin of mandibular angle(A): Shortest distance from the mandibular foramen to the extreme caudal margin of the angle of the mandible.
7. Mental foramen to the caudal mandibular border (MFCM): From the level of the mental foramen to the extreme caudal margin of the mandible.
8. Lateral alveolar root to mental foramen (LAMF): From the mental foramen to the lateral extent of the alveolar root of the lower incisor.

These parameters of the skull were measured using Vernier caliper and subjected to routine statistical analysis Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The Malayan sun bear is a tropical bear species inhabiting lowland tropical rain forests throughout much of Southeast Asia. It is the smallest of the eight bear species available. The size of the head is large, broad and heavy in proportion to the body. The teeth are massive as proportion to the size of the animal. The size of the palate is broad in proportion to the skull. Similar finding was reported by Servheen (1999). However, the skull shows shorter in length but wider in donkey (Zhu *et al.*, 2014). The skull was elongated in shape as also reported in blackbuck (Choudhary and Singh, 2016a & 2016b).

The skull of the Malayan sun bear was mesocephalic according to the cephalic index as reported by Ilayperuma (2011). However, the skull was mesaticephalic in dog (Miller *et al.*, 1964) and dolichocephalic in Zovawk pig (Choudhary *et al.*, 2019).

The skull or cephalic index of Malayan sun bear was 80.48, However, it was 38.23 ± 0.85 in donkey (Zhu *et al.*, 2014), 46.51 ± 0.29 cm in dromedary camel (Choudhary *et al.*, 2016) and 70.56 ± 0.22 in Indian wild pig (Choudhary *et al.*, 2017).

In the present study, the skull length, skull width, cranial length, maximum skull height, skull breadth at parietals, skull height at mastoid process, skull breadth at the junction of frontal and parietal (Waist) and height of rostrum at canine alveolus were 21.47 cm, 17.28 cm,

17.81 cm, 9.40 cm, 8.00 cm, 8.30 cm, 7.00 cm and 4.10 cm, respectively. Saber and Gummow (2015) reported that mean skull length, skull width, cranial length and cranial width of cat was 8.4 ± 1.5 cm, 6.8 ± 1.4 cm, 3.4 ± 0.4 cm, and 4.1 ± 0.2 cm respectively. Choudhary *et al.* (2016) mentioned that the skull length, skull width and cranial length for the dromedary camels were 48.75 ± 0.244 cm, 22.66 ± 0.108 cm and 32.73 ± 0.484 cm, respectively. Choudhary *et al.* (2019) in Zovawk pig reported that skull length, skull width, cranial length, height of the skull with mandible, of the Zovawk were 3.49 ± 0.01 cm, 6.55 ± 0.01 cm, 28.26 ± 0.03 cm, 15.11 ± 0.26 cm, 13.17 ± 0.04 cm, 24.55 ± 0.13 cm, and, respectively.

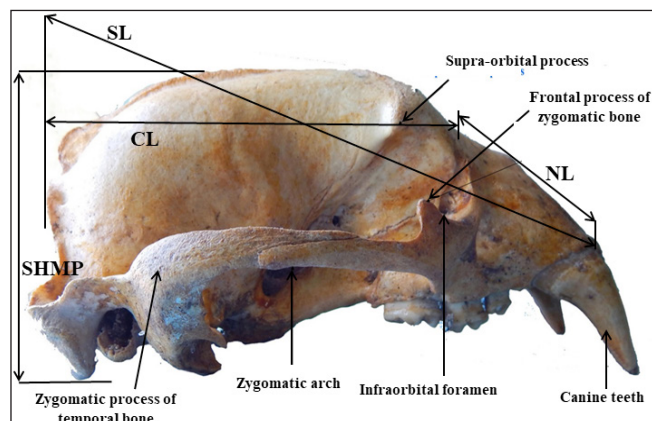


Fig. 1: Measurement of the skull of Malayan sun bear (lateral surface) showing skull length (SL), cranial length (CL), nasal length (NL) and skull Height at mastoid process (SHMP)

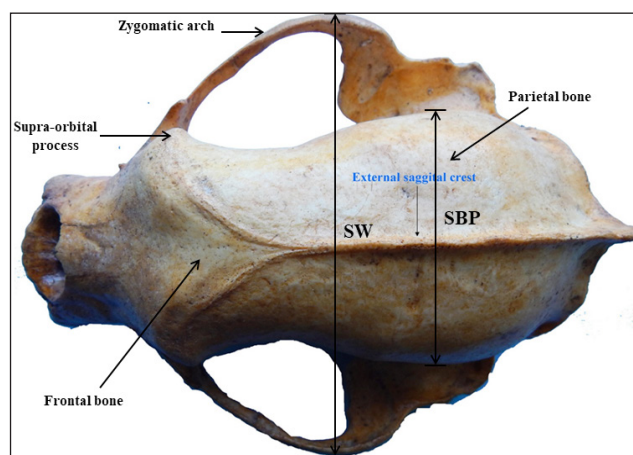


Fig. 2: Measurement of the skull of Malayan sun bear (dorsal surface) showing skull width (SW) and skull breadth at parietals (SBP)

The nasal length, nasal perpendicular height, nasal horizontal- transverse width and nasal circumference were 3.59cm, 3.50cm, 3.20cm and 10.52cm, respectively. Monfared (2013) mentioned that the nasal length in Iranian one-humped camels was 13.3 cm. Choudhary and Singh (2015b) also reported that the length and width of the nasal bone in blackbuck was 5.69 ± 0.01 cm and 1.29 ± 0.01 cm, respectively, however, it was 13.79 ± 0.02 cm and 4.95 ± 0.02 cm, respectively in Zovawk pig (Choudhary *et al.*, 2019).

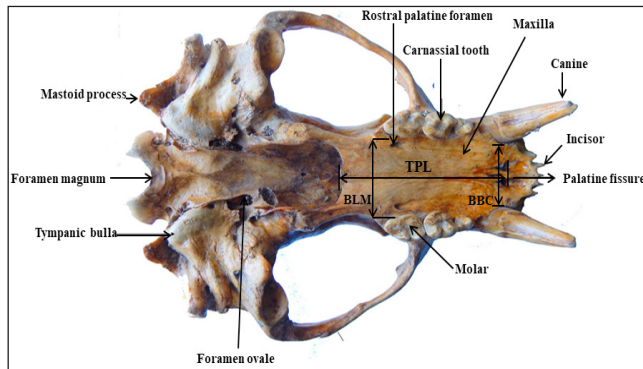


Fig. 3: Measurement of the skull of Malayan sun bear (ventral surface) showing total palatal length (TPL), breadth between canines (BBC) and between last molar (BLM)

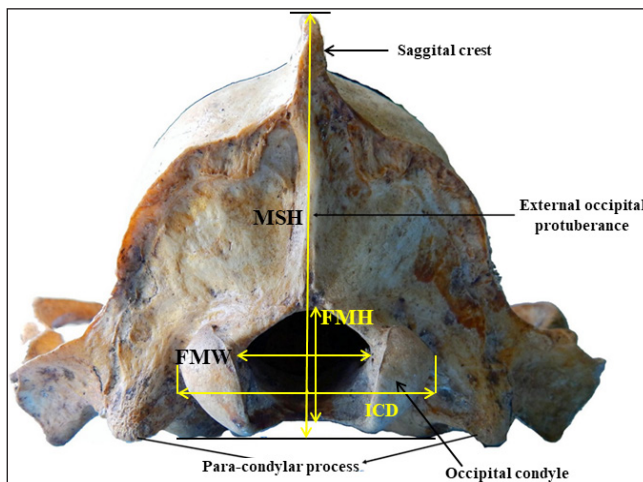


Fig. 4: Measurements of the skull of Malayan sun bear (basal surface) showing maximum skull height (MSH), foramen magnum height (FMH), foramen magnum width (FMW) and intracondylar distance (ICD)

The foramen magnum height, width and circumference of Malayan sun bear were found to be 3.50 cm, 3.20 cm

and 10.52 cm, respectively. Choudhary and Singh (2015b) reported in blackbuck that height, width and circumference of the foramen magnum was 1.74 ± 0.008 cm, 2.03 ± 0.006 cm and 8.22 ± 0.01 cm, respectively and 1.56 ± 0.01 cm, 1.87 ± 0.01 cm and 5.78 ± 0.06 cm, respectively in the Zovawk by Choudhary *et al.* (2019). The Intra condylar distance and external occipital in Malayan sun bear was found to be 2.00cm and 3.20cm, respectively. However, the intercondylar and inter-paracondylar width was 4.62 ± 0.01 cm and 5.29 ± 0.01 cm, respectively in blackbuck by Choudhary and Singh (2015b) and 5.07 ± 0.02 cm and 5.75 ± 0.01 cm, respectively in Zovawk by Choudhary *et al.* (2019).

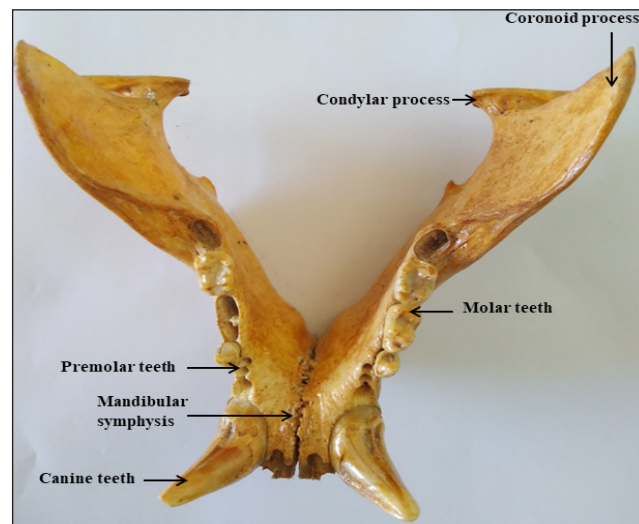


Fig. 5: Photograph showing the floor of the mandible of Malayan sun bear

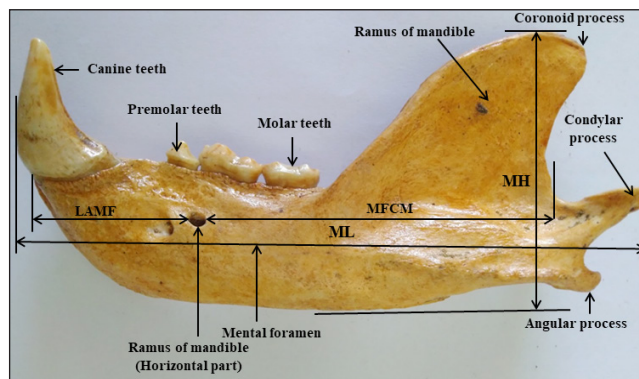


Fig. 6: Measurements of the mandible (lateral view) of Malayan sun bear showing mandibular length (ML), mandibular height (MH), lateral alveolar root to mental foramen (LAMF) and mental foramen to the caudal mandibular border (MFCM)

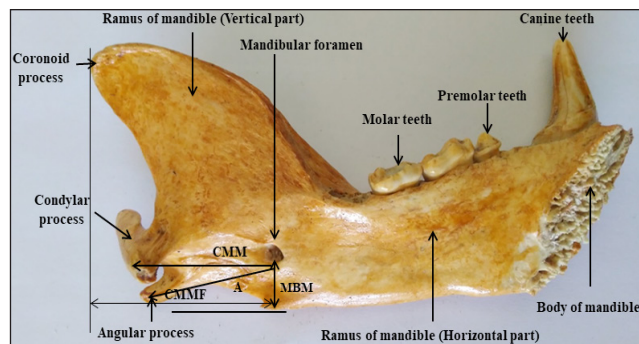


Fig. 7: Measurements of the mandible (medial view) of Malayan sun bear showing mandibular foramen to base of mandible (MBM), caudal border of mandible to below mandibular foramen (CMMF), caudal border of mandible to the level of mandibular foramen (CMM) and mandibular foramen to the margin of mandibular angle (A)

The total palatal length, palatal breadth between canine and premolars in Malayan sun bear were found to be 9.50 cm, 3.00 cm and 3.90 cm, respectively. Choudhary and Singh (2015b) reported that the length and width of palatine bone was 6.04±0.046 cm and 3.23±0.022 cm, respectively in Indian blackbuck. Whereas it was 15.47±0.04 cm and 5.07±0.01 cm, respectively in Zovawk pig (Choudhary *et al.*, 2019).

The infraorbital foramina distance, diameter of infraorbital foramina and Infra-orbital canal to the root of the alveolar tooth in Malayan sun bear were 6.07±cm, 0.81±cm and 1.35±cm, respectively. Monfared (2013) reported that the infraorbital foramina distance is in 6.43 cm in the Iranian one-humped camels, 6.54±0.063 cm in Indian wild pig by Choudhary *et al.* (2015) and 6.55±0.01 cm in Zovawk Choudhary *et al.* (2019). Kataba *et al.* (2014) reported that Infra-orbital canal to the root of the alveolar tooth in Gwembe valley goat, wad goat and Markhoz goat was 1.13±0.11 cm, 1.3±16 cm and 1.7±0.08 cm respectively. Whereas, in Indian blackbuck was 0.72±0.01 cm Choudhary and Singh (2015). The distance from the process of alveolar socket of canine tooth to the infraorbital canal in Malayan sun bear was 3.84cm. However, in Iranian native cattle was 2.8 cm by Monfared (2013), in Indian wild pig was 5.40±0.048 cm by Choudhary *et al.* (2017) and in Zovawk was 4.77±0.04 cm by Choudhary *et al.* (2019).

The length and height of the mandible were 14.65 cm and 7.09 cm, respectively in Malayan sun bear. Monfared

(2013) reported that length and height of the mandible in Iranian one-humped camels 39.9 cm and 9.92 cm, in dromedary camel was 42.98±0.624 cm and 22.58±0.287 cm, respectively Choudhary *et al.* (2016) and 25.02±0.09 cm and 10.54±0.07 cm, respectively in Zovawk by Choudhary *et al.* (2019).

The distances from the mandibular foramen to the base of the mandible, caudal border of the mandible to below mandibular foramen, caudal border of the mandible to the level of the mandibular foramen and the mandibular foramen to the margin of mandibular angle were 1.29 cm, 4.17 cm, 3.77 cm and 3.29 cm, respectively. Choudhary *et al.* (2016) reported in dromedary camel that the distances from the mandibular foramen to the base of the mandible, caudal margin of mandible to the level of mandibular foramen and the mandibular foramen to the margin of mandibular angle were 8.84±0.085 cm, 5.88±0.055 cm and 8.29±0.079 cm, respectively, 7.44±0.069 cm, in Indian wild pig was 7.04±0.05 cm and 7.13±0.082 cm, respectively (Choudhary *et al.*, 2017) and in Zovawk was 4.56±0.01 cm, 3.81±0.00 cm and 4.84±0.002 cm, respectively (Choudhary *et al.*, 2019). Olopade and Onwuka (2005) reported that the caudal margin of the mandible to below mandibular foramen in West African dwarfs goats was 1.57±0.44 cm.

The distance from the mental foramen to the caudal mandibular border and lateral alveolar root to mental foramen was 10.71 cm and 3.91 cm, respectively. Whereas in Iranian one-humped camels was 13.43±0.081 cm (Monfared, 2013), in dromedary camel was 32.12±0.165 cm by (Choudhary *et al.*, 2016) and in Zovawk was 18.47±0.01 cm by Choudhary *et al.* (2019). Choudhary and Singh (2015) reported that lateral alveolar root to the mental foramen in Indian blackbuck was 2.45± 0.01 cm.

CONCLUSION

The morphometric data obtained from the head region of the Malayan sun bear are of great significance in paleontological studies. It can be used as baseline data for further research in the field of applied anatomy. Furthermore, these results are of clinical importance that will aid the regional anaesthesia of the various nerves around the head, especially during the treatment of head injury, dental extraction and mandibular fractures in Malayan sun bear.



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