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Morphometrical Studies on Skull Bones of Adult Blue Bull (*Boselaphus tragocamelus*)

S. Sathapathy, B.S. Dhote, S.K. Bharti, I. Singh

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ABSTRACT

Background: The Blue bull (*Boselaphus tragocamelus*) is regarded as one of the biggest antelopes in Asia and safeguarded beneath the IUCN since 2003 and under safeguard of 'Schedule III' of the Indian Wildlife Protection Act, 1972. This study focused on the detailed gross morphometrical study of mid thoracic ribs of Blue Bull (*Boselaphus tragocamelus*).

Methods: The present study was carried out on the skull of six specimens of adult Blue bull (*Boselaphus tragocamelus*) of either sex. The measurements of various parameters of skull bones were taken with the help of weighing machine, thread, scale and digital Vernier's calliper.

Result: The average length of skull was found to be 40.9±1.08 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 49.5±097 cm. Similarly, the average facial length was found to be 16.6±0.20 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 22.0±0.17 cm. The average left cranio-caudal length of tympanic bulla was found to be 4.1±0.15 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 4.5±0.19 cm. The average length of left zygomatic process of squamous temporal bone was found to be 5.7±0.11 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 7.1±0.08 cm. The average distance between the last incisor and first premolar teeth was found to be 6.3±0.12 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 8.2±0.17 cm.

Key words: Blue bull, Morphometry, Skull bones.

INTRODUCTION

The Blue bull (*Boselaphus tragocamelus*) is regarded as one of the biggest antelopes in Asia and is widely found in both the forests and adjoining villages with enough green grass (Sathapathy *et al*., 2017, Sathapathy *et al*., 2018a and Sathapathy *et al*., 2018b). It belongs to the family Bovidae and comes under the genus *Boselaphus* (Sathapathy *et al*., 2018c, Sathapathy *et al*., 2018d and Sathapathy *et al*., 2018e). The Blue bull is quite prevalent in northern and central parts of India especially in the foothills of Himalayas, eastern part of Pakistan and southern part of Nepal (Sathapathy *et al*., 2019a, Sathapathy *et al*., 2019b, Sathapathy *et al*., 2019c and Bharti *et al*, 2020). The adult male of the Blue bull appears like ox and so called as Blue bull (Sathapathy *et al*., 2019d and Sathapathy *et al*., 2019e, Sathapathy *et al*., 2019f, Sathapathy *et al*., 2019g and Sathapathy *et al*., 2019h). The Blue bulls are safeguarded beneath the IUCN since 2003 and also under safeguard of 'Schedule III' of the Indian Wildlife Protection Act, 1972 (Bagchi *et al*., 2004). The massive body of this animal can be attributed to the large skeleton of the antelope (Sathapathy *et al*., 2019i and Sathapathy *et al*., 2019j). Further, the skeleton of the Blue bull comprises of large and massive bones of axial skeleton especially of skull and appendicular skeleton that not only protect the viscera, but also provides shape and support to the heavy musculature (Sathapathy *et al*., 2020a, Sathapathy *et al*., 2020b, Sathapathy *et al*., 2021a and Sathapathy *et al*., 2021b). The present study developed a baseline data on the sex wise morphometrical differences in the skull of adult Blue bull that would immensely help the wild life anatomists and Veterinarians in species identification and solving forensic and vetero-legal cases due to availability of scanty literature in this field.

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MATERIALS AND METHODS

The present morphometrical study was carried out on the skull of six specimens of adult Blue bulls (*Boselaphus tragocamelus*) of either sex. The permission for the collection of skull bones was acquired from the Principal Chief Conservator of Forests (PCCF), Government of Rajasthan. The skeletons were taken out from the burial ground located in the premises of the office of the Deputy Conservator of

Forest Wildlife (WL), Jodhpur. Afterwards, the specimens were boiled in an aluminium vat for about one hour. They were taken out from the vat and air dried for 3-5 days (Choudhary *et al*., 2013). Different biometrical parameters of skull bones such as skull length, skull index, skull base length, cranial width, cranial height, cranial index, facial length, facial width, facial index, ventral length of upper jaw cheek teeth, length and width of palatine fissures, length and width of nasal bones, distance between two facial tuberosities, the length and width of zygomatic processes of squamous temporal and malar bones, length and width of tympanic bulla, occipital condyles, *etc.* were measured with the help of weighing machine, thread, scale and digital Vernier's calliper. The recorded data were subjected to routine statistical analysis as per standard technique given by Snedecor and Cochran (1994) and independent samples t-Test with Systat Software Inc, USA and SPSS 16.0 version software.

RESULTS AND DISCUSSION

The skull of adult Blue bull formed the skeleton of head and face of the animal and comprised of seven types of cranial and nine types of facial bones. The cranial bones consisted of paired frontal bone, paired interparietal bone, paired parietal bone, single sphenoid bone, single occipital bone, single ethmoid bone and paired temporal bone. The facial bones comprised of paired lacrimal, malar, maxilla, pre-maxilla, palatine, nasal, pterygoid, turbinate bones and single vomar bone. The present findings were in line with the reports of Getty *et al*. (1930) in cattle, sheep, goat, Grossman (1960) in camel, Frandson and Spurgeon (1992) in cattle and Sebastiani and Fishbeck (2005) in cattle.

Biometrical observations

The biometrical observations of various parameters of different bones of skull of Blue bull revealed characteristic differences between the sexes. The average length of skull was found to be 40.9±1.08 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 49.5±097 cm. The skull index was 0.54 and 0.53 for female and male Blue bull respectively. The average skull base length was found to be 37.0±0.87 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 43.7±0.91 cm. The average cranial width was found to be 10.1±0.51 cm in female, which was significantly more (P<0.05) than that of males, where it was recorded as 8.4±0.27 cm. The cranial index was 0.59 and 0.47 for female and male Blue bull respectively. The average cranial height was found to be 4.4±0.15 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.0±0.08 cm. The average facial length was found to be 16.6±0.20 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 22.0±0.17 cm. Similarly, the average facial width was found to be 13.6±0.42 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 21.1±0.36 cm. The facial index was 0.81 and 0.95 for female and male Blue bull respectively.

The average lengths of left and right palatine fissures (Fig 1) were found to be 3.0±0.04 cm and 2.9±0.02 cm in female, which were significantly less (P<0.05) than that of males, where they were recorded as 3.4±0.01 cm and 3.2±0.04 cm respectively. The average width of right palatine fissure was found to be 0.92±0.02 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 1.2±0.03 cm. But the average width of left palatine fissure was found to be non-significant between the sexes. The average distance of torus frontalis from left caudo-lateral angle of frontal bone was found to be 3.7±0.07 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 4.1±0.09 cm.

The average length of left and right horns was found to be 18.7±0.41 cm and 17.5±0.52 cm respectively in male Blue bull. The average distance between the two horns at apex, middle and base was found to be 15.5±0.86 cm, 12.7±0.61 cm and 8.9±0.37 cm respectively in male Blue bull. The average length of nasal bone was found to be 12.1±0.29 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 17.3±0.42 cm. Similarly, the average width of nasal bone was found to be 13.6±0.19 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 21.1±0.21 cm. The average dorsal distance between the facial tuberosities was found to be 14.1±0.23 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 19.6±0.27 cm.

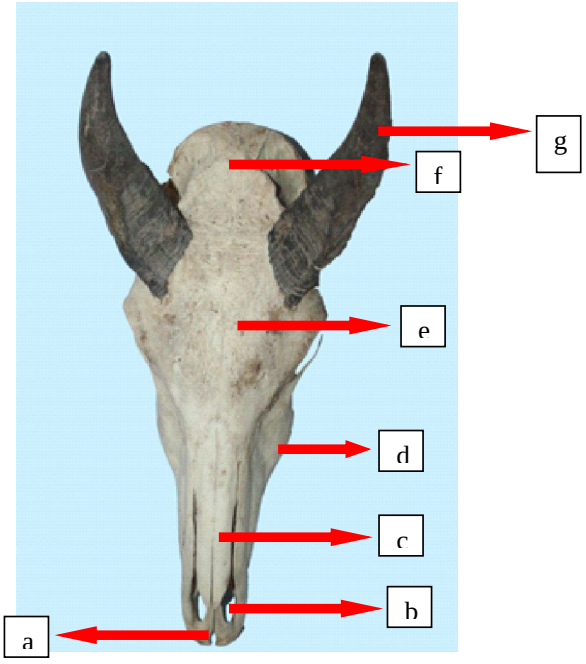

Fig 1: Dorsal view of skull of adult male Blue bull (*Boselaphus tragocamelus*) showing a) Inter-incissival fissure b) Left palatine fissure c) Nasal bone d) Left facial tuberosity e) Frontal bone f) Torus frontalis g) Left Horn.

Similarly, the average ventral distance between the facial tuberosities was found to be 16.1±0.31 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 19.6±0.36 cm.

The average left and right cranio-caudal lengths of tympanic bulla (Fig 2) was found to be 4.1±0.15 cm and 4.1±0.11 cm in female, which were significantly less (P<0.05) than that of males, where they were recorded as 4.5±0.19 cm and 3.6±0.07 cm respectively. The average right latero-medial width of tympanic bulla was found to be 3.4±0.12 cm in female, which was significantly more (P<0.05) than that of males, where it was recorded as 2.1±0.09 cm.

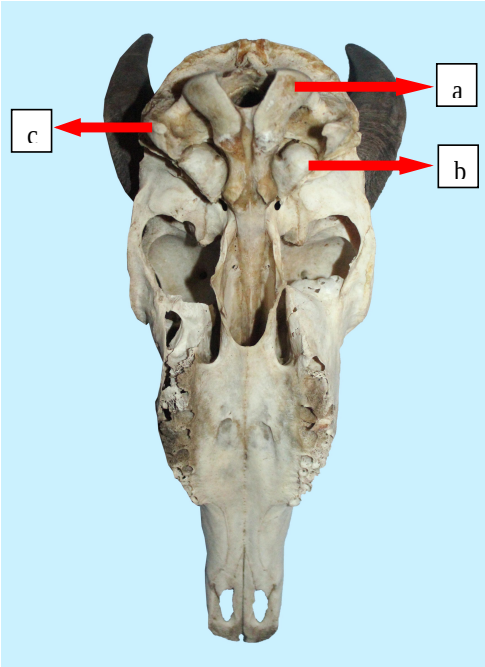

Fig 2: Ventral view of skull of adult male Blue bull (*Boselaphus tragocamelus*) showing a) Left occipital condyle b) Left tympanic bulla c) Right paramastoid process.

The average lengths of left and right zygomatic processes of squamous temporal bone (Fig 3) were found to be 5.7±0.11 cm and 5.8±0.07 cm in female, which were significantly less (P<0.05) than that of males, where they were recorded as 7.1±0.08 cm and 7.7±0.10 cm respectively. The average widths of left and right zygomatic processes of squamous temporal bone were found to be 0.6±0.01 cm in females, which were significantly less (P<0.05) than that of males, where they were recorded as 1.2±0.02 cm and 1.1±0.02 cm respectively. The average length of right zygomatic process of malar bone was found to be 7.7±0.18 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 10.1±0.21 cm.

The average cranio-caudal lengths of left and right occipital condyles were found to be 3.7±0.10 cm and 3.8±0.08 cm in female, which were significantly less (P<0.05) than that of males, where they were recorded as 7.2±0.14 cm and 7.7±0.21 cm respectively. The average cranial width of right occipital condyle was found to be 2.0±0.09 cm in female, which was significantly more (P<0.05) than that of males, where it was recorded as 1.6±0.07 cm. The average width of left occipital condyle at the middle was found to be 2.6±0.11 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 3.6±0.12 cm.

The average lengths of left and right paramastoid processes were found to be 4.0±0.18 cm and 3.3±0.19 cm in female, which were significantly less (P<0.05) than that of males, where they were recorded as 6.7±0.22 cm and 7.1±0.28 cm respectively. The average distance between the two paramastoid processes was found to be 6.2±0.26 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 8.1±0.17 cm. The

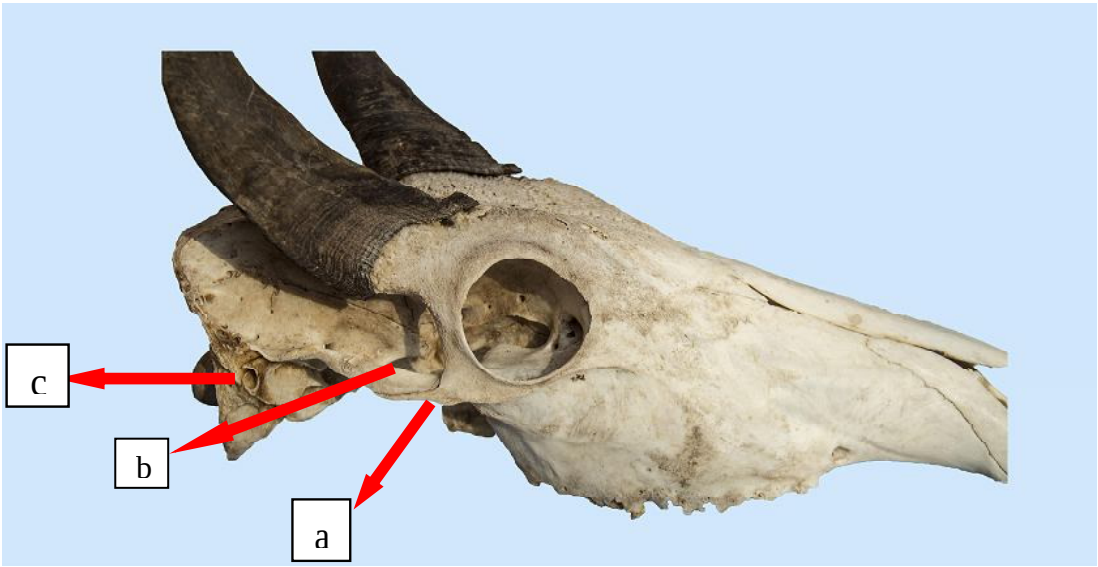

Fig 3: Right lateral view of skull of adult male Blue bull (*Boselaphus tragocamelus*) showing a) Zygomatic process of malar bone b) Zygomatic process of squamous temporal bone c) Right external acoustic meatus.

average diameter of right external acoustic meatus was found to be 0.6±0.001 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 1.1±0.001 cm.

Odontometric observation

The average distance of diastema was found to be 6.3±0.12 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 8.2±0.17 cm. The average length of first premolar teeth was found to be 4.9±0.09 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 5.8±0.10 cm. The average length of second premolar teeth was found to be 5.3±0.12 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.1±0.14 cm. Similarly, the average length of third premolar teeth was found to be 5.4±0.08 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.3±0.11 cm. The average length of first molar teeth was found to be 5.5±0.19 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.4±0.15 cm. The average length of second molar teeth was found to be 5.8±0.11 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.6±0.13 cm. Similarly, the average length of third molar teeth was found to be 6.1±0.14 cm in female, which was significantly less (P<0.05) than that of males, where it was recorded as 6.9±0.17 cm.

The recorded odontometric data could not be compared due to availability of scanty literature in this field.

CONCLUSION

The various parameters of different bones of skull of Blue bull such as skull length, skull index, skull base length, cranial width, cranial height, cranial index, facial length, facial width, facial index, ventral length of upper jaw cheek teeth, length and width of palatine fissures, length and width of nasal bones, distance between two facial tuberosities, the length and width of zygomatic processes of squamous temporal and malar bones, length and width of tympanic bulla, occipital condyles, *etc.* showed characteristic sexual variations. There is no previous information on these parameters in skull bones of Blue bull, nor in any other domestic animals with which comparisons could be made. We therefore believe that the data presented above would form a baseline for further work especially comparability and compatibility are now desirable traits as efforts are geared up towards massive improvement in the livestock sector of the international economy.

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