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Sex Wise Morphometrical Studies on the Mid Thoracic Ribs of Blue Bull (*Boselaphus tragocamelus*)

S. Sathapathy[1], B.S. Dhote[2], M. Mrigesh[2], S.K. Sahu[1],
N. Dahariya[1], S.K. Joshi[3], S.S. Biswal[4], I. Ali[5], S.M. Nanda[6]

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

Result: It was found that the average diameter of the head of the fourth rib was found to be 2.56±0.01 cm in adult Blue bull. Further, it was measured as 2.53±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 2.59±0.01 cm. The average cranio-caudal diameter of the cranial articular facet of the head of 5th rib was found to be 0.97±0.01 cm in adult Blue bull. Further, it was measured as 0.95±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.00±0.01 cm. The average diameter of the tubercle of sixth rib at the dorso-ventral aspect was found to be 1.66±0.01 cm in adult Blue bull. Further, it was measured as 1.64±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.69±0.02 cm. Similarly, the average minimum length of the neck of sixth rib at the cranial aspect was found to be 0.68±0.01 cm in adult Blue bull. Further, it was measured as 0.65±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.70±0.01 cm. The average diameter of vascular groove of seventh rib at the proximal aspect was found to be 0.56±0.01 cm in adult Blue bull. Further, it was measured as 0.52±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.60±0.01 cm.

Key words: Blue bull, Mid thoracic ribs, Morphology, Morphometry.

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, but has vanished from Bangladesh (Sathapathy *et al*., 2019a; Sathapathy *et al*., 2019b and Sathapathy *et al*., 2019c). 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). They are generally seen in day times in the meadow pasture, timberland areas and agricultural land area (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). Further, the skeleton of the Blue bull comprises of large and massive bones of axial and appendicular skeleton that not only protects the viscera,

[1]Department of Veterinary Anatomy and Histology, CVSc. and A.H., Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[2]Department of Veterinary Anatomy, College of Veterinary and Animal Sciences, G. B. Pant University of Agriculture and Technology, Pantnagar-263 145, Uttarakhand, India.
[3]Krishi Vigyan Kendra, Jharsuguda, Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[4]Department of Animal Reproduction, Gynaecology and Obstetrics, TVCC, CVSc. and A.H., Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[5]Department of Veterinary Pathology, CVSc. and A.H., Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
[6]Department of Veterinary and Animal Husbandry Extension, CVSc. and A.H., Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.

Corresponding Author: S. Sathapathy, Department of Veterinary Anatomy and Histology, CVSc. and A.H., Odisha University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India. Email: srinivas42.sathapathy@gmail.com

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but also provides shape and support to the heavy musculature (Sathapathy *et al*., 2020a and Sathapathy *et al*., 2020b). The present study developed a baseline data on the sex wise morphometrical differences in the mid thoracic ribs, *i.e.* fourth, fifth, sixth and seventh pairs of ribs of adult Blue bull that would immensely help the wild life anatomists and Veterinarians in species identification and solving forensic and vetero-legal cases as no previous work has been done in this field on the Blue bull.

MATERIALS AND METHODS

The present study was carried out on mid thoracic ribs, *i.e.* fourth, fifth, sixth and seventh pairs of ribs of six specimens of adult Blue bulls (*Boselaphus tragocamelus*) of either sex. The skeletons were taken out from the burial ground that was located in the premises of the office of the Deputy Conservator of Forest Wildlife (WL), Jodhpur. Afterwards, the specimens were processed as per standard technique given by (Choudhary *et al*., 2013). The different parameters such as average diameter of head, average dorso-ventral and cranio-caudal diameters of tubercle, average cranial and caudal lengths of neck, average length of shaft, average proximal, middle and distal widths of shaft, average cranio-caudal and dorso-ventral diameters of cranial and caudal articular facets of head, average proximal, middle and distal diameters of vascular groove, *etc.* of fourth, fifth, sixth and seventh pairs of ribs of Blue bull of either sex were measured with the help of thread, scale and digital Vernier's calliper. The recorded data were subjected to routine statistical analysis as per the standard methods 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 mid thoracic ribs, *i.e.* the fourth, fifth, sixth and seventh pairs of ribs of Blue bull consisted of a head, neck and a tubercle at the proximal end, shaft or body, distal end with a costal cartilage. The present findings were in agreement with (Getty *et al*., 1930) in cattle, sheep, goat, Grossman (1960) in camel, Frandson and Spurgeon (1992) in cattle, Sebastiani and Fishbeck (2005) in cattle and (Dyce *et al*., 2006) in dog. An accessory tubercle was located below the main tubercle of the fourth, fifth and seventh pairs of ribs at the caudal border of the shaft (Fig 1).

Biometrical observation

The biometrical observations revealed characteristic differences between the sexes of the Blue bull.

Fourth rib

The biometrical observation showed that the average weight of the fourth rib was found to be 72.04±0.21 gm in adult Blue bull. Further, it was measured as 71.48±0.07 gm in females that was significantly less (P<0.05) than that of males, where it was found to be 72.60±0.25 gm. The average diameter of the head of the fourth rib was found to be 2.56±0.01 cm in adult Blue bull. Further, it was measured as 2.53±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 2.59±0.01 cm. The average diameter of the tubercle at the dorso-ventral aspect was found to be 1.72±0.01 cm in adult Blue bull. Further, it was measured as 1.69±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.74±0.01 cm. The average diameter of the tubercle at the cranio-caudal aspect was found to be 1.04±0.01 cm in adult Blue bull. Further, it was measured as 1.02±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.07±0.02 cm.

The average minimum length of the neck at the cranial aspect was found to be 0.93±0.01 cm in adult Blue bull. Further, it was measured as 0.90±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.97±0.01 cm. Similarly, the average maximum length of the neck at the caudal aspect was found to be 1.04±0.01 cm in adult Blue bull. Further, it was measured as 1.01±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.06±0.02 cm. The average length of the shaft was found to be 33.55±0.08 cm in adult Blue bull. Further, it was measured as 33.43±0.08 cm and 33.67±0.13 cm in females and males respectively. The average width of the shaft at the proximal aspect of the rib was found to be 0.81±0.01 cm in adult Blue bull. Further, it was measured as 0.78±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.85±0.01 cm. Similarly, the average width of the shaft at the middle was found to be 1.86±0.01 cm in adult Blue bull. Further, it was measured as 1.83±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.89±0.01 cm. The average width of the shaft at the distal end of the rib was found to be 2.64±0.01 cm in adult Blue bull. Further, it was measured as 2.61±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 2.68±0.01 cm. The average cranio-caudal diameter of the cranial articular facet of the head was found to be 0.74±0.01 cm in adult Blue bull. Further, it was measured as 0.71±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.76±0.01 cm. Similarly, the average dorso-ventral diameter of the cranial articular facet of the head was found to be 1.43±0.01 cm in adult Blue bull. Further, it was measured as 1.41±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.46±0.01 cm. The average cranio-caudal diameter of the caudal articular facet of the head was found to be 0.71±0.01 cm in adult Blue bull. Further, it was measured as 0.69±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.74±0.01 cm. Similarly, the average dorso-ventral diameter of the caudal articular facet of the head was found to be 1.02±0.01 cm in adult Blue bull. Further, it was measured as 0.99±0.01 cm in females that was

significantly less (P<0.05) than that of males, where it was found to be 1.04±0.01 cm.

The average diameter of vascular groove at the proximal aspect was found to be 0.67±0.01 cm in adult Blue bull. Further, it was measured as 0.65±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.69±0.01 cm. The average diameter of vascular groove at the middle was found to be 0.45±0.01 cm in adult Blue bull. Further, it was measured as 0.42±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.49±0.01 cm. The average diameter of vascular groove at the distal aspect was found to be 0.39±0.01 cm in adult Blue bull. Further, it was measured as 0.36±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.41±0.01 cm (Table 1).

Fifth rib

The biometrical observation showed that the average weight of the fifth rib was found to be 76.06±0.12 gm in adult Blue bull. Further, it was measured as 75.85±0.19 gm and 76.26±0.08 gm in females and males respectively. Similarly, the average diameter of the head of the fifth rib was found to be 2.53±0.17 cm in adult Blue bull. Further, it was measured as 2.38±0.24 cm and 2.67±0.24 cm in females and males respectively. The average diameter of the tubercle at the dorso-ventral aspect was found to be 2.04±0.01 cm in adult Blue bull. Further, it was measured as 2.00±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 2.08±0.01 cm. The average diameter of the tubercle at the cranio-caudal aspect was found to be 1.12±0.02 cm in adult Blue bull. Further, it was measured as 1.09±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.16±0.02 cm. The average minimum length of the neck at the cranial aspect was found to be 0.44±0.01 cm in adult Blue bull. Further, it was measured as 0.42±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.47±0.01 cm. Similarly, the average maximum length of the neck at the caudal

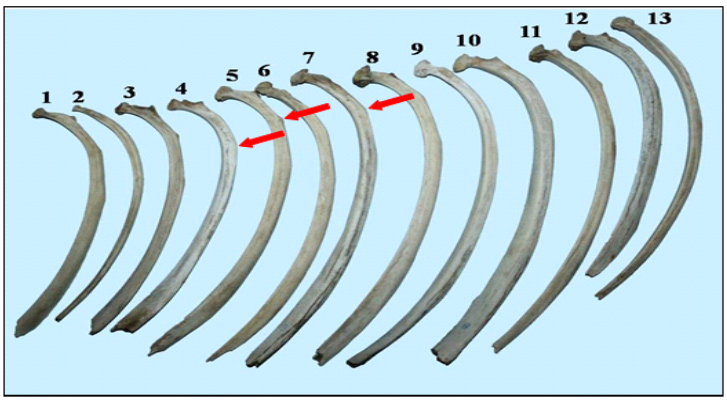

Fig 1: Lateral view of ribs (13 numbers) of left side of adult female Blue bull (*Boselaphus tragocamelus*) with red arrow showing the accessory tubercle in 4th, 5th and 7th ribs.

Table 1: Measurements of fourth rib of Blue bull in cm.

Parameters			Range	Mean	SD	SE	Female (Mean±SE)	Male (Mean±SE)
Diameter of head			2.49-2.62	2.56	0.04	0.01	2.53*±0.01	2.59±0.01
Diameter of tubercle		Dorso-ventral	1.63-1.79	1.72	0.04	0.01	1.69*±0.02	1.74±0.01
		Cranio-caudal	0.99-1.11	1.04	0.04	0.01	1.02*±0.01	1.07±0.02
Length of neck		Cranial (Minimum)	0.85-1.02	0.93	0.05	0.01	0.90*±0.01	0.97±0.01
		Caudal (Maximum)	0.97-1.10	1.04	0.04	0.01	1.01*±0.01	1.06±0.02
Length of shaft			33.2-34.1	33.55	0.28	0.08	33.43±0.08	33.67±0.13
Width of shaft	Proximal		0.73-0.90	0.81	0.05	0.01	0.78*±0.02	0.85±0.01
	Middle		1.78-1.94	1.86	0.05	0.01	1.83*±0.02	1.89±0.01
	Distal		2.57-2.70	2.64	0.05	0.01	2.61*±0.01	2.68±0.01
Diameter of articular facets of head	Cranial	Cranio-caudal	0.69-0.79	0.74	0.03	0.01	0.71*±0.01	0.76±0.01
		Dorso-ventral	1.37-1.51	1.43	0.04	0.01	1.41*±0.01	1.46±0.01
	Caudal	Cranio-caudal	0.64-0.79	0.71	0.04	0.01	0.69*±0.01	0.74±0.01
		Dorso-ventral	0.96-1.10	1.02	0.04	0.01	0.99*±0.01	1.04±0.01
Diameter of vascular groove	Proximal		0.59-0.72	0.67	0.04	0.01	0.65*±0.02	0.69±0.01
	Middle		0.39-0.52	0.45	0.04	0.01	0.42*±0.01	0.49±0.01
	Distal		0.31-0.43	0.39	0.04	0.01	0.36*±0.01	0.41±0.01

Values bearing superscript (*) differ significantly in column P<0.05.

aspect was found to be 0.81±0.01 cm in adult Blue bull. Further, it was measured as 0.77±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.84±0.01 cm.

The average length of the shaft was found to be 38.18±0.09 cm in adult Blue bull. Further, it was measured as 37.97±0.08 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 38.38±0.10 cm. Similarly, the average width of the shaft at the proximal aspect of the rib was found to be 1.14±0.02 cm in adult Blue bull. Further, it was measured as 1.10±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.19±0.01 cm. The average width of the shaft at the middle was found to be 1.40±0.01 cm in adult Blue bull. Further, it was measured as 1.37±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.42±0.01 cm. The average width of the shaft at the distal end of the rib was found to be 2.46±0.01 cm in adult Blue bull. Further, it was measured as 2.42±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 2.50±0.01 cm.

The average cranio-caudal diameter of the cranial articular facet of the head was found to be 0.97±0.01 cm in adult Blue bull. Further, it was measured as 0.95±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.00±0.01 cm. The average dorso-ventral diameter of the cranial articular facet of the head was found to be 1.70±0.01 cm in adult Blue bull. Further, it was measured as 1.69±0.01 cm and 1.72±0.01 cm in females and males respectively. Similarly, the average cranio-caudal diameter of the caudal articular facet of the head was found to be 1.00±0.01 cm in adult Blue bull. Further, it was measured as 0.98±0.01 cm and 1.02±0.01 cm in females and males respectively. The average dorso-ventral diameter of the caudal articular facet of the head was found to be 1.45±0.01 cm in adult Blue bull. Further, it was measured as 1.42±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.48±0.02 cm. The average diameter of vascular groove at the proximal aspect was found to be 0.64±0.01 cm in adult Blue bull. Further, it was measured as 0.61±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.68±0.01 cm. The average diameter of vascular groove at the middle was found to be 0.71±0.01 cm in adult Blue bull. Further, it was measured as 0.69±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.73±0.01 cm. Similarly, the average diameter of vascular groove at the distal aspect was found to be 0.58±0.02 cm in adult Blue bull. Further, it was measured as 0.55±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.61±0.02 cm (Table 2).

Sixth rib

The biometrical observation showed that the average weight of the sixth rib was found to be 88.92±0.32 gm in adult Blue bull. Further, it was measured as 87.93±0.10 gm in females that was significantly less (P<0.05) than that of males, where it was found to be 89.90±0.25 gm. The average diameter of the head of the sixth rib was found to be 3.11±0.07 cm in adult Blue bull. Further, it was measured as 2.97±0.07 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 3.25±0.09 cm (Table 3). The average diameter of the tubercle at the dorso-ventral aspect was found to be 1.66±0.01 cm in adult Blue bull. Further, it was measured as 1.64±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.69±0.02 cm. The average diameter of the tubercle at the cranio-caudal aspect was found to be

Table 2: Measurements of fifth rib of Blue bull in cm.

Parameters			Range	Mean	SD	SE	Female (Mean±SE)	Male (Mean±SE)
Diameter of head			1.7-3.3	2.53	0.58	0.17	2.38±0.24	2.67±0.24
Diameter of tubercle		Dorso-ventral	1.97-2.12	2.04	0.05	0.01	2.00*±0.01	2.08±0.01
		Cranio-caudal	1.04-1.23	1.12	0.05	0.02	1.09*±0.02	1.16±0.02
Length of neck		Cranial (Minimum)	0.38-0.49	0.44	0.04	0.01	0.42*±0.01	0.47±0.01
		Caudal (Maximum)	0.71-0.87	0.81	0.05	0.01	0.77*±0.02	0.84±0.01
Length of shaft			37.6-38.7	38.18	0.31	0.09	37.97*±0.08	38.38±0.10
Width of shaft	Proximal		1.06-1.23	1.14	0.05	0.02	1.10*±0.01	1.19±0.01
	Middle		1.33-1.42	1.40	0.04	0.01	1.37*±0.01	1.42±0.01
	Distal		2.39-2.54	2.46	0.05	0.01	2.42*±0.01	2.50±0.01
Diameter of articular facets of head	Cranial	Cranio-caudal	0.89-1.01	0.97	0.04	0.01	0.95*±0.02	1.00±0.01
		Dorso-ventral	1.66-1.74	1.70	0.03	0.01	1.69±0.01	1.72±0.01
	Caudal	Cranio-caudal	0.93-1.06	1.00	0.04	0.01	0.98±0.01	1.02±0.01
		Dorso-ventral	1.39-1.54	1.45	0.05	0.01	1.42*±0.01	1.48±0.02
Diameter of vascular groove	Proximal		0.59-0.72	0.64	0.04	0.01	0.61*±0.01	0.68±0.01
	Middle		0.66-0.75	0.71	0.03	0.01	0.69*±0.01	0.73±0.01
	Distal		0.49-0.66	0.58	0.05	0.02	0.55*±0.02	0.61±0.02

Values bearing superscript (*) differ significantly in column P<0.05.

1.05±0.02 cm in adult Blue bull. Further, it was measured as 1.01±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.09±0.02 cm. The average minimum length of the neck at the cranial aspect was found to be 0.68±0.01 cm in adult Blue bull. Further, it was measured as 0.65±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.70±0.01 cm. The average maximum length of the neck at the caudal aspect was found to be 1.01±0.01 cm in adult Blue bull. Further, it was measured as 0.99±0.01 cm and 1.03±0.02 cm in females and males respectively. The average length of the shaft was found to be 40.69±0.11 cm in adult Blue bull. Further, it was measured as 40.60±0.08 cm and 40.78±0.21 cm in females and males respectively. The average width of the shaft at the proximal aspect of the rib was found to be 1.05±0.02 cm in adult Blue bull. Further, it was measured as 1.01±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.09±0.02 cm. Similarly, the average width of the shaft at the middle was found to be 1.82±0.01 cm in adult Blue bull. Further, it was measured as 1.80±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.85±0.01 cm. The average width of the shaft at the distal end of the rib was found to be 1.74±0.15 cm in adult Blue bull. Further, it was measured as 1.71±0.22 cm and 1.78±0.23 cm in females and males respectively.

The average cranio-caudal diameter of the cranial articular facet of the head was found to be 1.08±0.02 cm in adult Blue bull. Further, it was measured as 1.04±0.02 cm and 1.12±0.03 cm in females and males respectively. Similarly, the average dorso-ventral diameter of the cranial articular facet of the head was found to be 1.27±.0.01 cm in adult Blue bull. Further, it was measured as 1.25±0.02 cm and 1.30±0.02 cm in females and males respectively. The average cranio-caudal diameter of the caudal articular facet of the head was found to be 1.22±0.01 cm in adult Blue bull. Further, it was measured as 1.20±0.01 cm and 1.24±0.02 cm in females and males respectively.

The average dorso-ventral diameter of the caudal articular facet of the head was found to be 1.54±0.01 cm in adult Blue bull. Further, it was measured as 1.52±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.56±0.01 cm. The average diameter of vascular groove at the proximal aspect was found to be 0.77±0.01 cm in adult Blue bull. Further, it was measured as 0.74±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.81±0.01 cm. The average diameter of vascular groove at the middle was found to be 0.44±0.01 cm in adult Blue bull. Further, it was measured as 0.41±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.46±0.01 cm. Similarly, the average diameter of vascular groove at the distal aspect was found to be 0.46±0.01 cm in adult Blue bull. Further, it was measured as 0.43±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.48±0.01 cm (Table 3).

Seventh rib

The biometrical observation showed that the average weight of the seventh rib was found to be 111.39±0.16 gm in adult Blue bull. Further, it was measured as 111.27±0.18 gm and 111.52±0.26 gm in females and males respectively. The average diameter of the head of the seventh rib was found to be 2.93±0.01 cm in adult Blue bull. Further, it was measured as 2.90±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be

Table 3: Measurements of sixth rib of Blue bull in cm.

Parameters			Range	Mean	SD	SE	Female (Mean±SE)	Male (Mean±SE)
Diameter of head			2.7-3.6	3.11	0.24	0.07	2.97*±0.07	3.25±0.09
Diameter of tubercle		Dorso-ventral	1.60-1.74	1.66	0.05	0.01	1.64*±0.02	1.69±0.02
		Cranio-caudal	0.97-1.15	1.05	0.05	0.02	1.01*±0.01	1.09±0.02
Length of neck		Cranial (Minimum)	0.59-0.74	0.68	0.04	0.01	0.65*±0.02	0.70±0.01
		Caudal (Maximum)	0.95-1.10	1.01	0.04	0.01	0.99±0.01	1.03±0.02
Length of shaft			39.8-41.2	40.69	0.38	0.11	40.60±0.08	40.78±0.21
Width of shaft	Proximal		0.97-1.13	1.05	0.05	0.02	1.01*±0.01	1.09±0.02
	Middle		1.76-1.89	1.82	0.04	0.01	1.80*±0.01	1.85±0.01
	Distal		1.18-2.29	1.74	0.53	0.15	1.71±0.22	1.78±0.23
Diameter of articular facets of head	Cranial	Cranio-caudal	0.97-1.23	1.08	0.08	0.02	1.04±0.02	1.12±0.03
		Dorso-ventral	1.19-1.35	1.27	0.04	0.01	1.25±0.02	1.30±0.02
	Caudal	Cranio-caudal	1.16-1.28	1.22	0.04	0.01	1.20±0.01	1.24±0.02
		Dorso-ventral	1.47-1.58	1.54	0.04	0.01	1.52*±0.01	1.56±0.01
Diameter of vascular groove	Proximal		0.72-0.84	0.77	0.04	0.01	0.74*±0.01	0.81±0.01
	Middle		0.39-0.51	0.44	0.04	0.01	0.41*±0.01	0.46±0.01
	Distal		0.40-0.53	0.46	0.04	0.01	0.43*±0.01	0.48±0.01

Values bearing superscript (*) differ significantly in column P<0.05.

2.97±0.02 cm. The average diameter of the tubercle at the dorso-ventral aspect was found to be 1.72±0.01 cm in adult Blue bull. Further, it was measured as 1.70±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.74±0.01 cm. The average diameter of the tubercle at the cranio-caudal aspect was found to be 1.16±0.01 cm in adult Blue bull. Further, it was measured as 1.13±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.20±0.01 cm.

The average minimum length of the neck at the cranial aspect was found to be 0.66±0.01 cm in adult Blue bull. Further, it was measured as 0.63±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.69±0.01 cm. Similarly, the average maximum length of the neck at the caudal aspect was found to be 1.10±0.01 cm in adult Blue bull. Further, it was measured as 1.07±0.02 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.13±0.01 cm. The average length of the shaft was found to be 41.91±0.15 cm in adult Blue bull. Further, it was measured as 41.60±0.22 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 42.22±0.09 cm. The average width of the shaft at the proximal aspect of the rib was found to be 2.52±0.45 cm in adult Blue bull. Further, it was measured as 2.47±0.66 cm and 2.57±0.67 cm in females and males respectively. Similarly, the average width of the shaft at the middle was found to be 1.97±0.09 cm in adult Blue bull. Further, it was measured as 1.85±0.17 cm and 2.09±0.02 cm in females and males respectively.

The average width of the shaft at the distal end of the rib was found to be 2.37±0.04 cm in adult Blue bull. Further, it was measured as 2.33±0.05 cm and 2.40±0.05 cm in females and males respectively. The average cranio-caudal diameter of the cranial articular facet of the head was found to be 1.12±0.01 cm in adult Blue bull. Further, it was measured as 1.10±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.15±0.01 cm. Similarly, the average dorso-ventral diameter of the cranial articular facet of the head was found to be 1.41±0.01 cm in adult Blue bull. Further, it was measured as 1.38±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.43±0.01 cm. The average cranio-caudal diameter of the caudal articular facet of the head was found to be 1.02±0.04 cm in adult Blue bull. Further, it was measured as 0.95±0.04 cm and 1.08±0.06 cm in females and males respectively.

The average dorso-ventral diameter of the caudal articular facet of the head was found to be 1.46±0.01 cm in adult Blue bull. Further, it was measured as 1.43±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 1.50±0.01 cm. The average diameter of vascular groove at the proximal aspect was found to be 0.56±0.01 cm in adult Blue bull. Further, it was measured as 0.52±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.60±0.01 cm. Similarly, the average diameter of vascular groove at the middle was found to be 0.64±0.01 cm in adult Blue bull. Further, it was measured as 0.61±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.67±0.01 cm. The average diameter of vascular groove at the distal aspect was found to be 0.47±0.01 cm in adult Blue bull. Further, it was measured as 0.44±0.01 cm in females that was significantly less (P<0.05) than that of males, where it was found to be 0.50±0.01 cm (Table 4).

Due to availability of the very scanty literature on the biometrical studies on the ribs of Blue bull and other animals, the data could not be compared.

Table 4: Measurements of seventh rib of Blue bull in cm.

Parameters			Range	Mean	SD	SE	Female (Mean±SE)	Male (Mean±SE)
Diameter of head			2.88-3.02	2.93	0.04	0.01	2.90*±0.01	2.97±0.02
Diameter of tubercle		Dorso-ventral	1.68-1.75	1.72	0.03	0.01	1.70*±0.01	1.74±0.01
		Cranio-caudal	1.09-1.22	1.16	0.04	0.01	1.13*±0.01	1.20±0.01
Length of neck		Cranial (Minimum)	0.58-0.71	0.66	0.04	0.01	0.63*±0.01	0.69±0.01
		Caudal (Maximum)	1.01-1.17	1.10	0.04	0.01	1.07*±0.02	1.13±0.01
Length of shaft			40.8-42.2	41.91	0.51	0.15	41.60*±0.22	42.22±0.09
Width of shaft	Proximal		0.98-4.05	2.52	1.54	0.45	2.47±0.66	2.57±0.67
	Middle		1.01-2.14	1.97	0.31	0.09	1.85±0.17	2.09±0.02
	Distal		2.19-2.54	2.37	0.12	0.04	2.33±0.05	2.40±0.05
Diameter of articular facets of head	Cranial	Cranio-caudal	1.05-1.19	1.12	0.04	0.01	1.10*±0.01	1.15±0.01
		Dorso-ventral	1.32-1.44	1.41	0.04	0.01	1.38*±0.01	1.43±0.01
	Caudal	Cranio-caudal	0.8-1.3	1.02	0.14	0.04	0.95±0.04	1.08±0.06
		Dorso-ventral	1.40-1.54	1.46	0.05	0.01	1.43*±0.01	1.50±0.01
Diameter of vascular groove	Proximal		0.49-0.64	0.56	0.05	0.01	0.52*±0.01	0.60±0.01
	Middle		0.57-0.71	0.64	0.04	0.01	0.61*±0.01	0.67±0.01
	Distal		0.38-0.54	0.47	0.05	0.01	0.44*±0.01	0.50±0.01

Values bearing superscript (*) differ significantly in column P<0.05.

CONCLUSION

The various parameters of mid thoracic ribs of Blue bull like the average diameter of head, average dorso-ventral and cranio-caudal diameters of tubercle, average cranial and caudal lengths of neck, average length of shaft, average proximal, middle and distal widths of shaft, average cranio-caudal and dorso-ventral diameters of cranial and caudal articular facets of head, average proximal, middle and distal diameters of vascular groove showed characteristic sexual variations. There is no previous information on these parameters in the fourth, fifth, sixth and seventh pairs of ribs 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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