



Bos (Mammalia: Bovidae) from the Pinjor Formation of Sardhok, Pakistan

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ABSTRACT

The new Bovini remains, referred to the genus *Bos*, are recovered from the Sardhok Pleistocene of Northern Pakistan. *Bos* appears for the first time in the Plio-Pleistocene of the Siwaliks. The best record of *Bos acutifrons* is found in the Siwaliks of Pakistan and India. Recently excavated *Bos* material in the Middle Pleistocene locality of Sardhok (Gujrat, Punjab, Pakistan) includes a complete horn-core that provides a better knowledge of the taxon's morphology.

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Authors' Contributions

MA conceived and designed the study. MKS acquired the data. MAK and AKS analyzed the data and wrote the article.

Key words

Artiodactyls, Bovini, Pleistocene, Pinjor, Siwaliks.

INTRODUCTION

The Upper Siwalik subgroup of the subcontinent was inhabited by early bovines: *Hemibos*, *Proamphibos*, *Bison*, *Bos* and *Leptobos* (Rütimeyer, 1878; Pilgrim, 1939; Khan *et al.*, 2010; Siddiq *et al.*, 2014). *Bos* was widespread in the Siwaliks and Eurasia during Pleistocene (Pilgrim, 1939; Martínez-Navarro *et al.*, 2007). In the Siwaliks, the oldest record of the genus is from the Tatrot Formation (3.5–2.6 Ma) of the Siwaliks (Pilgrim, 1939). The first occurrence of *Bos* coincides with those of *Equus* and *Elephas* in the Siwaliks. Nevertheless, *Bos* is a highly derived genus of the tribe Bovini.

The Sardhok village is located in the Gujrat district of Pakistan (Fig. 1). The outcrops coordinates are Lat. 32° 49' 39" N; Long. 73° 43' 51" E and vernacularly, the deposits are named Pabbi Hills. The low altitude land surface is furnished by water channels (locally called Kas), representing flash-flood conditions. The sediments comprise brown to grayish-brown, fine, medium to coarse-grained sandstones with pebbles and large-scale cross stratifications, brown mudstones, and embedded conglomerates (Dennell, 2008; Dennell *et al.*, 2008; Siddiq *et al.*, 2014). Chronologically, the Sardhok outcrops are dated to Pleistocene (2.6-0.6 Ma) (Cande and Kent, 1995; Dennell *et al.*, 2006; Nanda, 2002, 2008) and yielded early bovines of this age.

Remains of *Bos* have been found in many sites in the Plio-Pleistocene of Pakistan (Lydekker, 1877; Pilgrim, 1939; Hooijer, 1958; Akhtar, 1992; Dennell *et*

al., 2008). However, previously reported assemblages that retain horn-cores were badly preserved. A new partially complete horn-core from the middle Pleistocene of the Siwaliks in Pakistan is now more informative. The horn-core indicates the main diagnostic features of species.

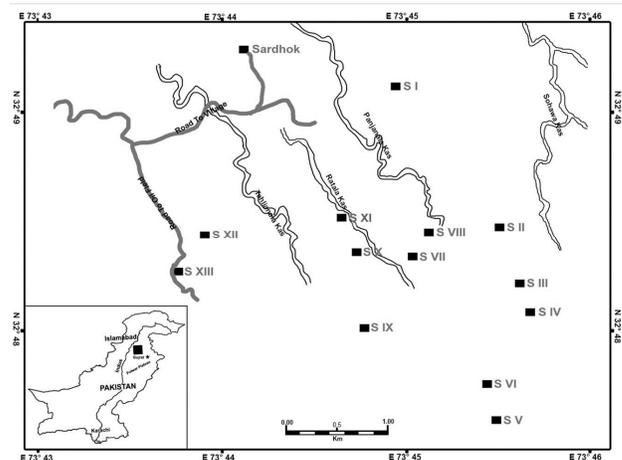


Fig. 1. Map of Pakistan (inset) enlarging the studied sites of Sardhok (= S), from Gujrat district, Punjab, Pakistan (modified after Dennell *et al.*, 2006).

MATERIALS AND METHODS

The measurements are in millimeters (mm). The inventory number on the specimen represents the collection year (numerator) and serial number (denominator) of that year. The comparative study was made with the material in the Natural History Museum at London, United Kingdom (BMNH), the Geological Museum at Leiden, Netherland (Coll. Dub.), and

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Fig. 2. *Bos acutifrons*: PUPC 10/80, right horn-core. Views: a, anterior; b, medial; c, lateral; d, posterior. Scale bar 30 mm.

Dr. Abu Bakr Fossil Display and Research Center, Department of Zoology, University of the Punjab, Lahore, Pakistan (PUPC).

The studied specimen is housed in the Dr. Abu Bakr Fossil Display and Research Center, Department of Zoology, University of the Punjab, Lahore, Pakistan. The terminology of horn-core follows Pilgrim (1939).

SYSTEMATIC PALAEOLOGY

Suborder Ruminantia Scopoli, 1777
 Family Bovidae Gray, 1821
 Subfamily Bovinae Gray, 1821
 Genus *Bos* Linnaeus, 1758

Bos acutifrons Lydekker, 1877

Stratigraphic range

Upper Siwaliks (Plio-Pleistocene).

Locality

Sardhok (S VII), district Gujrat, province Punjab, Pakistan.

New material

PUPC 10/80, right horn-core.

Description

The slight torsion of the horn-core is counter clockwise as indicated by heavy longitudinal grooves along the posterior surface (Fig. 2). The curvature is upward representing strong forward flexion. The cross section is pyriform (subtriangular) at the base and almost elliptical at the apex. The posterior keel is prominent. The sinuses are present. The horn-core is rather slender and decrease gradually in diameter towards the tip, moderately compressed dorso-ventrally and slightly narrow anteriorly.

Longitudinal furrows regularly ornament the horn-core. The length of the horn-core along the outer curve is 455 mm and along the inner curve is 356 mm. The total length along the chord is 385 mm. The antero-posterior diameter (DAP) at the base is 67 mm and the transverse diameter (DT) at the base is 92.5 mm giving an index of compression 72 (index of compression followed by Hooijer, 1958). The antero-posterior diameter (DAP) at

Table I.- Comparative measurements (mm) of *Bos acutifrons* with *Epileptobos groeneveldtii* and *Leptobos*. *: the studied specimen. The compression index is followed by Hooijer (1958).

Taxa	Inventory No.	Description	Measurement
<i>B. acutifrons</i>	PUPC 10/80*	Length along the outer curve	455
		Length along the inner curve	356
		Antero-posterior diameter (DAP) at the base	67.0
		Transverse diameter (DT) at the base	92.5
		Index of compression (DAP x 100/DT) at the base	72.0
		Antero-posterior diameter (DAP) at the apex	50.0
		Transverse diameter (DT) at the apex	62.0
		Index of compression (DAP x 100/DT) at the base	81.0
		Total length along the chord	385
<i>L. falconeri</i>	BMNH 48037	Length along the outer curve	ca 500
		Antero-posterior diameter (DAP) at the base	77.0
		Transverse diameter (DT) at the base	85.0
		Index of compression (DAP x 100/DT)	91.0
<i>L. etruscus</i>		Length along the outer curve	500
		Antero-posterior diameter (DAP) at the base	73.0
		Transverse diameter (DT) at the base	79.0
		Index of compression (DAP x 100/DT)	92.0
<i>L. vallisarni</i>		Length along the outer curve	330
		Antero-posterior diameter (DAP) at the base	77.0
		Transverse diameter (DT) at the base	88.0
		Index of compression (DAP x 100/DT)	88.0
<i>L. stenometopon</i>		Length along the outer curve	420
		Antero-posterior diameter (DAP) at the base	58.0
		Transverse diameter (DT) at the base	72.0
		Index of compression (DAP x 100/DT)	81.0
	Coll. Dub. No. 2833	Length along the outer curve	890
		Antero-posterior diameter (DAP) at the base	82.0
		Transverse diameter (DT) at the base	111
	Coll. Dub. No. 1696	Length along the outer curve	-
		Antero-posterior diameter (DAP) at the base	79.0
		Transverse diameter (DT) at the base	95.0
	Coll. Dub. No. 2765	Length along the outer curve	660+
		Antero-posterior diameter (DAP) at the base	86.0
		Transverse diameter (DT) at the base	102
	Coll. Dub. No. 2775	Length along the outer curve	84.0
		Antero-posterior diameter (DAP) at the base	84.0
		Transverse diameter (DT) at the base	97.0
	Coll. Dub. No. 2791	Length along the outer curve	87.0
		Antero-posterior diameter (DAP) at the base	87.0
		Transverse diameter (DT) at the base	87.0
	Coll. Dub. No. 2767	Length along the outer curve	-
Antero-posterior diameter (DAP) at the base		87.0	
Index of compression (DAP x 100/DT)		87.0	

Continued

Taxa	Inventory No.	Description	Measurement
		Transverse diameter (DT) at the base	99.0
		Index of compression (DAP x 100/DT)	88.0
	Coll. Dub. No.2622	Length along the outer curve	750
		Antero-posterior diameter (DAP) at the base	79.0
		Transverse diameter (DT) at the base	88.0
		Index of compression (DAP x 100/DT)	90.0
	Coll. Dub. No.2770	Length along the outer curve	590+
		Antero-posterior diameter (DAP) at the base	86.0
		Transverse diameter (DT) at the base	95.0
		Index of compression (DAP x 100/DT)	91.0
	Coll. Dub. No.8474	Length along the outer curve	-
		Antero-posterior diameter (DAP) at the base	80.0
		Transverse diameter (DT) at the base	88.0
		Index of compression (DAP x 100/DT)	91.0
	Coll. Dub. No.2813	Length along the outer curve	-
		Antero-posterior diameter (DAP) at the base	78.0
		Transverse diameter (DT) at the base	85.0
		Index of compression (DAP x 100/DT)	92.0
	Coll. Dub. No.2796	Length along the outer curve	-
		Antero-posterior diameter (DAP) at the base	76.0
		Transverse diameter (DT) at the base	83.0
		Index of compression (DAP x 100/DT)	92.0
	Coll. Dub. No.2766	Length along the outer curve	650
		Antero-posterior diameter (DAP) at the base	89.0
		Transverse diameter (DT) at the base	94.0
		Index of compression (DAP x 100/DT)	95.0
	Coll. Dub. No.2829	Length along the outer curve	-
		Antero-posterior diameter (DAP) at the base	82.0
		Transverse diameter (DT) at the base	86.0
		Index of compression (DAP x 100/DT)	95.0

the apex is 50 mm and the transverse diameter at the apex is 62 mm giving an index of compression 81 (Table I).

Comparison and discussion

The indication of sinuses in the horn-core associates this specimen to the bovine group Taurina (e.g., *Bos*, *Leptobos*, *Bison*) in distinction to the Bubalina group (e.g., *Hemibos*, *Amphibos*, *Proamphibos*) (Gentry, 1992). The absence of sharp keels excludes the horn-core from those of *Hemibos*, *Proamphibos* and *Bubalus* that are characterized in having the sharp keels. *Bibos* is also different in having flattened horn-cores at their bases (Pilgrim, 1939, 1947; Hooijer, 1958). The two primary keels are almost disappeared in *Leptobos*, *Bison* and *Bos*. Nevertheless, the primitive form of *Bos* represents a keel. *Bos* is also different in having strong forward flexion horn-cores.

The studied horn-core shows similar morphological characters with that of *Bos* in having strong forward flexion and posterior keel which is one of the characters of *Bos* primitive form. The studied horn-core represents

the persistence of a vestigial posterior keel. The overall pattern of the described horn-core is clearly different from that of *Epileptobos*, *Leptobos* and *Bison* and much more similar to the pattern observed in the Siwalik *Bos* primitive form *Bos acutifrons* (Pilgrim, 1939). Comparison with other Siwalik form (i.e. *B. namadicus*) also indicates great difference, as the later form shows circular cross section, almost disappearance of keels. Morphological and metric features of the Sardhok horn-core coincide with the Siwalik *Bos* primitive form, *Bos acutifrons*.

Originally, all Bovini employed the genus *Bos*. Earlier many bovine forms like *Leptobos*, *Bison*, *Eobison* and *Bibos* were considered the subgenera of *Bos* (Pilgrim, 1939). Later on, Pilgrim (1939) attributed the genus *Bos* to living *B. taurus* or allied fossil forms, and *Leptobos*, *Bison*, *Eobison* and *Bibos* were ranked to the generic level. Because the horn-cores of these bovines show a significant difference e.g., *Bison* forms show a clear double flexion and a significantly stronger upward curvature, *Eobison* shows strong dorso-ventral

compression, *Probison* represents an obvious twisting and stronger curvature and *Leptobos* represents disappearance of keels (Hooijer, 1958; Shani and Khan, 1968; Bukhsianidze, 2005; Khan *et al.*, 2010).

CONCLUSIONS

The new specimen of horn-core from Sardhok (PUPC 10/80) is attributed to *Bos acutifrons*. This species represent the primitive form of the genus *Bos* in having a vestigial posterior keel. Numerous records of *B. acutifrons* exist from the late Pliocene (Tatrot Formation) through the Pleistocene of the Siwaliks. *Bos acutifrons* at Sardhok is limited by a single horn-core and offered good evidence on the existence of this species in the Siwalik Pleistocene.

Statement of conflict of interest

Authors have declared no conflict of interest.

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