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SIVATHERIUM (ARTIODACTYLA, RUMINANTIA, GIRAFFIDAE) FROM THE UPPER SIWALIKS, PAKISTAN

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ABSTRACT

A complete lower molar series of giraffid remains from the Pleistocene locality of the village Sardhok (Gujrat, Punjab, Pakistan) has been identified as belonging to *Sivatherium* sp. The comparison of the material was made with several Siwalik representatives of the giraffids. The giraffid *Sivatherium* is a gigantic giraffid found in the early Pleistocene sediments of the Upper Siwaliks. The village Sardhok locality has yielded one of the best collections of Giraffidae from the early Pleistocene of the Siwaliks. The locality belongs to the Pinjor Formation of the Upper Siwaliks (2.6-0.6 Ma).

Key words: Giraffids, *Sivatherium*, Upper Siwaliks, Pleistocene, Pinjor Formation.

INTRODUCTION

The fossil Chinese record shown by Bohlin (1927) and that of Asia shown by Colbert (1935) indicates that the giraffids had their origin in the Holarctic Region. The great variety found in the Pliocene Asiatic forms shows the rapidity of evolution in the family giraffidae. The Siwalik giraffes may be placed in three subfamilies i.e. Palaeotraginae, Sivatheriinae and Giraffinae. Palaeotraginae comprises the genus *Giraffokeryx*. Sivatheriinae includes the genera *Sivatherium, Bramatherium* and *Helladotherium*. Genus *Giraffa* is placed in the subfamily Giraffinae. These 3 subfamilies emerged simultaneously but their migration to the Siwalik region occurred at different times. Palaeotragines and Giraffines came earlier than the Sivatheriines (Akhtar *et. al*., 1991; Solounias, 2007).

The first scientific mention of the Siwalik giraffes goes back to 1836 when Falconer and Cautley described a large massive giraffe, *Sivatherium giganteum* from the Upper Siwaliks. Since that, a number of genera and species have been recorded from various formations of the Siwaliks by different workers such as Lydekker (1876, 1878), Pilgrim (1910) and Matthew (1929). Biostratigraphical status of the Siwalik giraffids was first reviewed by Matthew (1929) and then by Colbert (1935). The Siwalik giraffids are of two types, small and large giraffids. The small giraffids found in the Lower and Middle Siwaliks include *Giraffokeryx* and *Giraffa* (Colbert, 1935; Bhatti, 2005). The large Siwalik giraffids include the genera *Bramatherium*, *Helladotherium* and *Sivatherium* (Solounias, 2007; Harris *et al.,* 2010). All of these are known from the Middle and the Upper Siwaliks.

The material described here comes from the outcrops of the village Sardhok, Gujrat district, Punjab, Pakistan. In the Potwar Plateau, the Upper Siwalik is well exposed in the Pabbi hills situated in the east of the River Jhelum. The village Sardhok is situated in these low altitude hills, south of Lahore-Islamabad GT road (Fig. 1). The area surrounding this village offers the best exposure of the Upper Siwaliks and is famous for the presence of large giraffids typical of the lower Pleistocene age (Khan, 1987; Khan *et. al.,* 1993; Dennell *et al*., 2006, 2008).

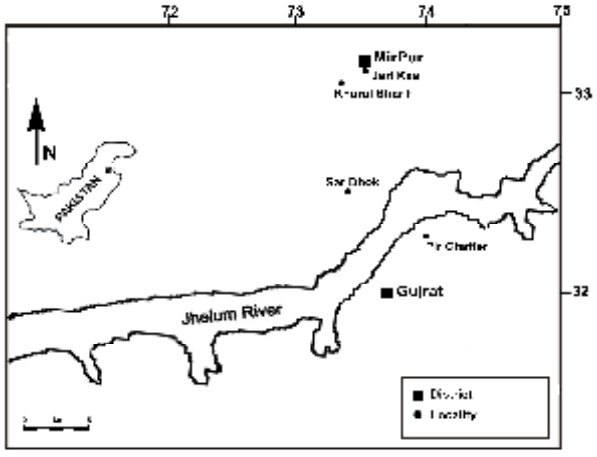

Fig. 1. Map of the Potwar Plateau indicating the studied area.

MATERIALS AND METHODS

The material is housed in the Palaeontology laboratory of the Zoology department, Punjab University, Lahore. The material was thoroughly washed and

removed the unwanted siliceous or clay material with the help of light hammers, chisels and fine needles (Falconer, 1845). Various types of adhesives were used during preparation of the material. The catalogue number of the specimens consists of series i.e., yearly catalogue number and serial catalogue number, so figures of the specimen represent the collection year (numerator) and serial number (denominator) of that year (e.g. 67/195). Uppercase letters with subscript number stand for lower dentition. The measurements are provided in millimeters.

Abbreviations: PUPC, Punjab University Palaeontological Collection; AMNH, American Museum of Natural History; BMNH, British Museum of Natural History; WM, Wembere – Manonga; M, molar; W, Maximum preserved crown width; L, Maximum preserved anteroposterior crown.

SYSTEMATIC PALAEONTOLOGY

Order ARTIODACTYLA Owen, 1848
Suborder RUMINANTIA Scopoli, 1777
Family GIRAFFIDAE Gray, 1821
Subfamily SIVATHERIINAE Bonanparte, 1850
Genus *SIVATHERIUM* Falconer and Cautley, 1835

***Sivatherium* sp.**

(Figure 2; Table 1)

Type species: *Sivatherium giganteum*, Falconer and Cautley, 1835.

Referred material: PUPC 67/195, a right mandibular ramus with a complete molar series (M_{1-3}).

Locality: Sardhok, district Gujrat, Punjab, Pakistan.

Horizon: Upper Siwaliks.

Diagnosis: A gigantic Pleistocene giraffid, with four horns in the male, an anterior conical pair, arising from the frontals, and a posterior, palmate pair situated on the parietals. As in the other gigantic Siwalik giraffids there are deep pits in the temporal fossa for the temporal muscles, and on the supraoccipital for the neck muscles. The face is very short, the nasals being retracted and strongly curved. The teeth are large, with rugose enamel. Body and limbs heavy, limbs not elongated. P^4 external rib and parastyle are prominent (Colbert, 1935).

Abbreviated diagnosis: The molars are hypsodont. The front central fossette is transversely compressed across its centre. The labial lobes (protoconid and hypoconid) are less pointed. The lingual ribs in the lower molars are outbowed. Robust small ectostylid is present like tubercle.

Description: The molar teeth are rectangular in shape and we can certainly deduce that it belongs to lower jaw. The metaconids and the entoconids are crescentic in appearance while the protoconids and the hypoconids are much higher than the parallel going conids, which shows that it is the right side of the lower jaw (Fig. 2A-C). The jaw-bone bearing the molar series is poorly preserved. The molar series is excellently preserved except the metaconid and the protoconid of the first molar. According to the numerical seriation there are 1^{st}, 2^{nd} and 3^{rd} or last molars in the specimen provided. As the teeth are too high so they are included in the category of hypsodont. In the sense of wear, 1^{st} and all proceeding molars are moderately worn. The cingulum is not clearly visible around all the molars anywhere. There is a strong enamel thickness and its surface is rugose externally and internally (Fig. 2A-C).

M_1: Its metaconid is badly damaged but by observing the other conids it might have been spindle-shaped. The protoconid is somewhat crescentic in appearance. It is thicker in the central part with dentinal material well exposed because the inner enamel lining of the conid is broken. The praeprotocristid of the protoconid is damaged. The protoconid is quite rugose buccally with no visibly distinct cingulum. The root is very much obvious at the base of conid.

The proto- and metaconids have a highly compressed transverse valley. It has almost obliterated. The enamel layer is rugose buccally. The inner enamel lining of this cusp makes a well compressed longitudinal valley. The tooth is obscured posteriorly. The hypoconid is spindle-like from the top view. Its enamel lining at external side of the conid is contiguous with inner lining of the entoconid at the sides of their cristids and consists of a longitudinal valley that is compressed. The dentinal material has a dentinal valley in the centre that separates the two limbs of the same conid anteriorly and posteriorly. The inner most enamel lining or layer is free at both ends. It is very thin in the centre because a small piece is chipped off internally.

M_2: The tooth is four cusped with crescentic conids. The metaconid is spindle-shaped with thick median rib in the centre and a style-like structure anteriorly. The enamel lining is moderate and rugose. The innermost lining is contiguous with that of the protoconid. The metaconid is higher than the protoconid. The prae-and postprotocristids are nearly of equal length. There is also a mark of median dentinal valley, which shows that it is well compressed. The protoconid is crescentic in shape and its dentinal material seems to be continuous with that of the entoconid. There is quite thickened part in the centre of the cusp which is referred as median lobe. It is steep towards the buccal side. This cusp is much worn unlike that of others. There is a highly compressed longitudinal valley between the metaconid and the protoconid, which is almost obliterated in the centre dividing the valley into two. The hypoconid is similar to that of the protoconid but much worn unlike the internal row of the conids with the praehypocristid short and the poshypocristid long giving its L-shaped appearance. The

enamel layer is moderate around the conid but very thin towards the posterior side because of the pressure created by the anterior part of the last molar. The longitudinal valley is also highly pinched as in the frontal conids. The entoconid is higher than the hypoconid and the protoconid but it is less high than the metaconid. It is also spindle-shaped with a dentinal valley in between the dentinal material. Anterior limb is contiguous through dentinal material with protoconid and the metaconid. The postentocristid is shorter than the praeentocristid.

M_3: This molar is the last tooth of the right jaw and unlike the previously described two molars it is a five cusped tooth with the hypoconulid (talonid), present at the end of the jaw. The anterior-most conid present lingually is the metaconid which is of spindle-shape with a thick median lobe in the centre. This conid is less worn than the protoconid. The prae- and postmetacristids are making stylids anteriorly and posteriorly. The exposed dentinal material has a compressed dentinal valley in the centre, which makes a line between two extremes of the prae- and postmetacristids. The dentinal material is contiguous with that of the protoconid. The protoconid is crescentic and is much worn than that of the metaconid, showing a bowl like structure in the centre. The metaconid internally, and the protoconid externally have a quite rugosed enamel surface. The hypoconid has a less compressed transverse valley between the metaconid and itself. The entoconid is roughly spindle-shaped with a less deep longitudinal valley in the centre, which separates the hypoconid and the entoconid. But this valley gradually seems to be getting deep towards the anterior side. The dentinal material is continuous with that of the meta- and protoconids. The postentocristid is making a style posteriorly while lthe preentocristid has a small spur anteriorly towards the longitudinal valley. The hypoconulid is V-shaped with both the cristids directed forward. The comparative measurements are provided in table 1.

Table 1: Comparative measurements of the lower cheek teeth of the Siwalik giraffids. *The studied specimens. Referred data are taken from Colbert (1935), Gentry (1997) and Bhatti (2005).

taxa	Number	Natura / Position	Length	Width	W/L ratio
Sivatherium sp.	PUPC 67/195*	r M_1	44.2	31.7	0.71
		rM_2	49.2	33.6	0.68
		rM_3	68.7	32.1	0.46
?*Sivatherium* sp.	WM 715/90	M_1	45.0	27.0	0.60
S. giganteum	BMNH 40677	M_1	55.0	-	-
	AMNH 19802	M_2	58.0	38.0	0.65
		M_3	67.0	33.0	0.49
	AMNH 19797	M_2	54.0	39.0	0.72
	AMNH 29835	M_3	68.0	33.0	0.48
	AMNH 19828	M_3	57.0	29.0	0.50
		rM_2	32.5	19.0	0.58
H. megacephalum	AMNH 19669	rM_3	44.0	19.0	0.43
	PUPC 97/17	lM_2	38.0	28.0	0.73
		lM_3	50.0	28.5	0.57
	PUPC 95/24	lM_3	44.0	20.0	0.45
	PUPC 67/195	rM_2	50.0	34.0	0.68
H. magnum		rM_3	68.0	32.0	0.47

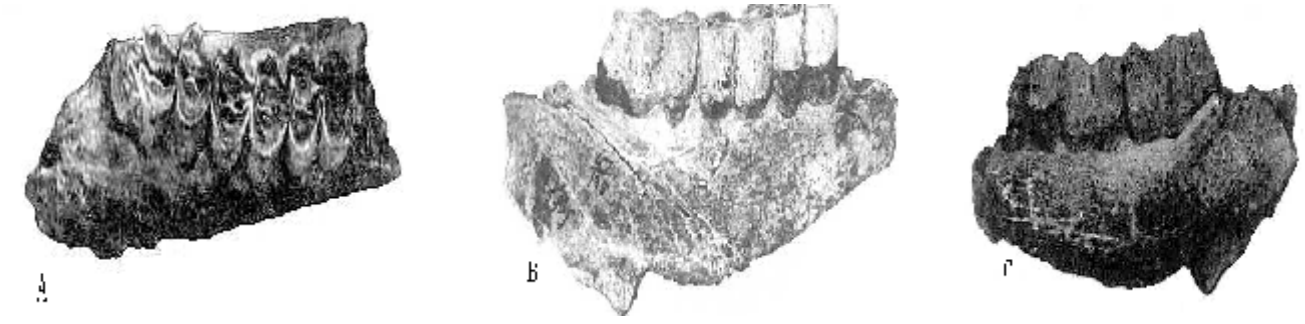

Fig. 2. *Sivatherium* sp. PUPC 67/195 – a right mandibular ramus with M_{1-3}. A = occlusal view. B = buccal view. C = lingual view. Photos ½ of the actual size.

DISCUSSION

The specimen has been recovered from the "Siwalik Series" indicating that it is a eutherian mammalian lower jaw. It is because of the fact that the strata is younger in age than the upper Miocene (Colbert, 1935), and the proto- and metatheres are absent from Asian Tertiary (Beaufort, 1951; Darlington, 1957; Romer, 1974). The molars are squared and tetratuberculated that they may belong to some herbivorous mammalian group. The crescentic shape of the cusps shows its relation with suborder Ruminantia of the order Artiodactyla. Due to the very large size of the molars and strongly rugose enamel surface, the specimen can be placed in the family giraffidae (Zittel, 1925; Romer, 1974). The giraffids can be separated into two groups according to their size i.e. small giraffids and large giraffids. The small giraffids are further divided into three genera i.e., *Giraffokeryx*, *Progiraffa* and *Giraffa*. The large forms include the genera *Sivatherium*, *Hydaspitherium*, *Bramatherium*, *Vishnutherium*, *Indratherium* and *Helladotherium* (Pilgrim, 1910).

The protocone is truly crescentic with its praeprotocrista projected backwardly in the genus *Sivatherium* (Falconer and Cautley, 1836). In the genus *Vishnutherium*, the molars are with the truly crescentic inner cusps (Lydekker, 1876). The molars in the genus *Indratherium* resemble with those of the species *Hydaspitherium grande* (Pilgrim, 1910). In the genus *Bramatherium*, the protocone is L-shaped rather than truly V-shaped. In the genus *Helladotherium*, molars are provided with an enamel island in the hypocone (Gaudry, 1861). In the genus *Hydaspitherium*, teeth are large, quadrate with rugose enamel, limbs are massive and not extraordinary elongated (Lydekker, 1876).

The fossil teeth size is in practice the only distinguishing criterion to identify the Siwalik giraffid species in addition to presence of styles/stylids, obliteration in the central fossettes and the rugosity (Gentry, 1997). The described sample is large enough to exclude it from the small Siwalik giraffids (*Giraffokeryx* and *Giraffa*) and furthermore, the small size giraffids have not been recorded from the Upper Siwaliks. The Upper Siwalik giraffids include *Hydaspitherium*, *Bramatherium*, and *Sivatherium* (Fig. 3). The sample is large enough to be compared with *Hydaspitherium megacephalum* holotype AMNH 19669 and about close to *Hydaspitherium magnum* (Colbert, 1935). But there is no outbowing lingual wall in *Hydaspitherium magnum*, a character which is prominent in the studied sample. The large size Pleistocene genus *Sivatherium* has transversely compressed central fossettes that can be seen in the studied sample. The lower molars of the sample are about as long as the holotype teeth of *Sivatherium giganteum* (Colbert, 1935). In addition, the less pointed labial lobes of the teeth (protoconid and hypoconid), outbowing lingual ribs and the robust basal pillar confirm its inclusion to *Sivatherium giganteum*. The sample will here be referred to *Sivatherium* and not to *Hydaspitherium*, *Bramatherium* (Fig. 2-3; Table 1). The material comprises only the lower molar series and a more material is required for the specific identification. Therefore, *Sivatherium* sp. is assigned for the sample recovered from the Pleistocene sediments of the village Sardhok.

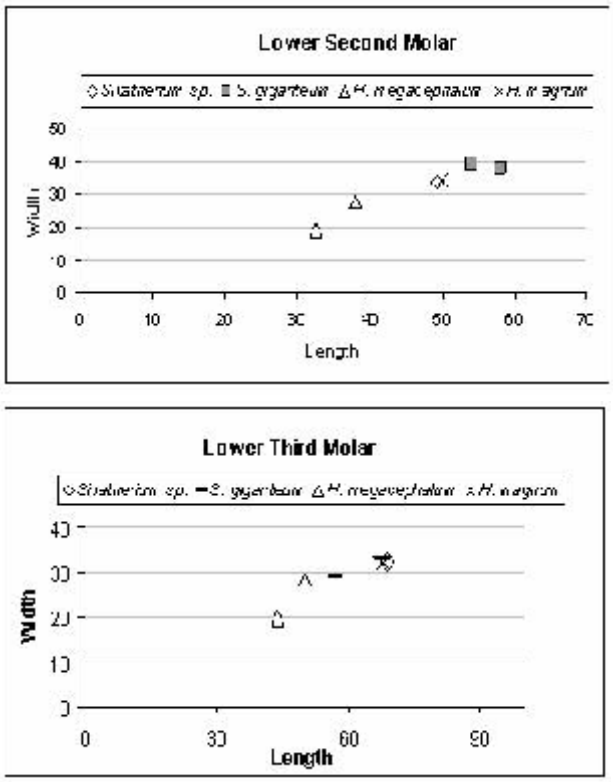

Fig. 3. Scatter diagrams showing dental proportions in the large Siwalik giraffids.

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