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GIRAFFA (GIRAFFIDAE, MAMMALIA) FROM THE LOWER SIWALIKS OF PAKISTAN

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ABSTRACT

New remains of *Giraffa priscilla* are recorded from the Middle Miocene localities of Pakistan. The material originates from Chinji Rest House, Rakh Wasnal, Dhok Bun Amir Khatoon, Dhulian, Ghungrilla, Dial, Lava, Phadial, Bhelomar and Ratial. These localities are also well known for the rich Middle Miocene mammalian fauna of the Siwaliks. The estimated age of these localities is 14.2–11.2 Ma, belonging to the Chinji Formation of the Lower Siwaliks. The findings contribute to our understanding of the presence of this species in the Middle Miocene of Pakistan.

Key words: Mammalia, Vertebrates, *Giraffa priscilla*, Miocene, Siwaliks.

INTRODUCTION

Siwalik Hills are famous for its mammalian fossil fauna (Pilgrim, 1910, 1911, 1913; Matthew, 1929; Colbert, 1935; Sarwar, 1977; Thomas, 1984; Akhtar, 1992; Barry *et al*., 2002; Bhatti *et al*., 2007, 2012a, b; Khan *et al*., 2008, 2009, 2010, 2011, 2012, 2013). The fossils of Giraffidae are reported throughout the Siwalik Early Miocene – Late Pleistocene. The Siwalik giraffids may be placed in three subfamilies i.e. Paleotraginae, Sivatheriinae and Giraffinae. Paleotraginae comprises the genus *Giraffokeryx*. Sivatheriinae includes the genera *Sivatherium*, *Bramatherium*, *Helladotherium* and *Hydaspitherium*. *Giraffa* is placed in the subfamily Giraffinae. These three 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).

Different species of *Giraffa* have been reported from Ethiopia, Kenya and Tanzania during Neogene and Quaternary (Geraads, 1987, 1988; Geraads *et al*., 2004a, b). *Giraffa sivalensis* was a descendent of *Giraffa punjabiensis* and had an Early Pleistocene age (Churcher, 1978; Solounias, 2007). It was extinct from the Upper Siwaliks of Pakistan by the Middle Pleistocene (Mitchell and Skinner, 2003). In Africa, *Giraffa* first appeared in Early Pliocene (Geraads *et al*., 2013). Fossils of *Giraffa camelopardalis* were recovered from Ethiopia (Asfaw *et al*., 2002), Israel (Haas, 1966; Bar-Yosef and Tchernov, 1972; Geraads, 1986), Northern Africa (Romer, 1928; Howe and Movius, 1947; Arambourg, 1952, 1979; Singer and Bone, 1960; Geraads, 1981), Central Africa (Brunet and M.P.F.T, 2000), Eastern Africa (Kent, 1942a, b; Vaufrey, 1947; Cooke, 1963) and Western Africa (Joleaud, 1936). *Giraffa jumae* identified from Turkey, Africa and Middle East (Leakey 1965; Harris *et al*., 1988; Bruent *et al*., 1998; Geraads, 1998; Suwa *et al*., 2003; Wynn *et al*., 2006). *Giraffa pygmaea* was smaller than *G. camelopardalis* and *G. stillei*. It has been recognized from Ethiopia, Kenya and Malawi (Taieb *et al*., 1976; Kalb *et al*., 1982; Harris, 1991; Schrenk *et al*., 1993; Bromage *et al*., 1995). *Giraffa stillei* was larger than *G. jumae* and *G. camelopardalis*. It is known from Ethiopia and Africa (Dietrich, 1942; Geraads, 1994; Ward *et al*., 1999). Arambourg (1947) diagnosed that it was synonym for *G. gracillis*.

Geography and geology: The Siwalik formations can be differentiated by percentage of sand. In the Chinji Formation, sand is less than 50%. In this Formation cross-bedded facies, sandstone facies, inter-bedded mudstone facies, siltstone and cross-laminated facies have been identified (Kafayat Ullah, 2009). Calcareous nodules are also present which vary in size (Behrensmeyer and Tauxe, 1982; Badgley, 1986). The fossils are collected from the ten Middle Miocene localiteis of the Chinji Formation; a detailed geography and geology of these localities have been reported in the earlier articles (e.g. Sarwar (1973, 1977, 1990), Barry *et al*. (2002), Cheema (2003), Khan *et al*. (2005, 2008, 2011, 2012).

MATERIALS AND METHODS

Giraffa priscilla was the oldest known Middle Miocene Lower Siwaliks giraffid (Matthew, 1929; Harris, 1991; Basu, 2004; Bhatti *et al*., 2012b). New remains of *Giraffa priscilla* have been reccorded from ten localities i.e. Chinji Rest House, Rakh Wasnal, Dhok Bun Amir Khatoon, Dhulian, Ghungrilla, Dial, Lava, Phadial, Bhelomar and Ratial of the Lower Siwaliks of Pakistan (Fig. 1). The sample provides new evidence of normal variability of giraffid teeth, may in resulting from a mixing of taxa, a previous hypothesis (Geraads, 1989).

The terminology and identification follow Hamilton, (1973), Janis and Scott (1987), Gentry (1994) and Khan *et al*. (2009).

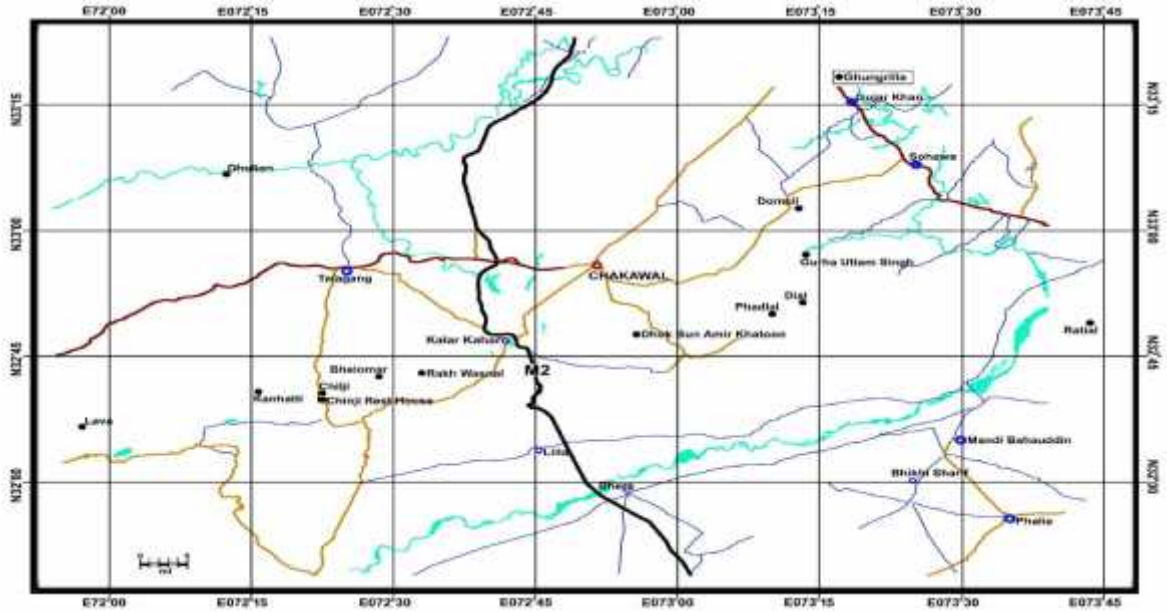

Fig. 1. The location of Chinji Rest House, Rakh Wasnal, Dhok Bun Amir Khatoon, Dhulian, Ghungrilla, Dial, Lava, Phadial, Bhelomar and Ratial in northern Pakistan from where the described material has been found. Boundary dates are from Barry *et al.* (2002) and Nanda (2002, 2008).

SYSTEMATIC PALAEONTOLOGY

Superfamily GIRAFFOIDEA Gray, 1821
Family GIRAFFIDAE Gray, 1821
Subfamily GIRAFFINAE Zittel, 1893

Genus *GIRAFFA* Brisson, 1756

Geographic distribution. *Giraffa* is best known from Siwaliks of Pakistan and India, Ethiopia, Kenya, Malawi, Tanzania, South Africa and Uganda (Pilgrim, 1910; Hopwood, 1934; Colbert, 1935; Dietrich, 1942; Arambourg, 1947; Cooke, 1963; Leakey, 1965; Hendey, 1968, 1969; Mawby, 1970; Taieb *et al.*, 1976; Pickford, 1986, Harris *et al*., 1988 ; Harris, 1991; Schrenk *et al*., 1993; Geraads, 1994; Bromage *et al*., 1995; Ward *et al*., 1999; Basu, 2004; Bhatti *et al*., 2007, 2012b; Khan *et al*., 2005, 2010).

***Giraffa priscilla* Matthew, 1929**

Stratigraphic range. Lower Siwaliks (Matthew, 1929; Colbert, 1935; Basu, 2004; Bhatti, 2005; Khan *et al*., 2012).

New material (in parenthesis the inventory number and the locality name are given): *Upper dentition*: rP^2 (GCUPC 1155/09, Phadial), rM^{1s} (GCUPC 1174/09, Dial; GCUPC 1157/12 , Bhelomar), lM^{2s} (GCUPC 1142/09, Ratial; GCUPC 1159/12, Dhulian; GCUPC 724/12, Dial; GCUPC 1154/12, Lava; GCUPC 1189/12, Ghungrilla), rM^{2s} (GCUPC 1139/12, Dial; GCUPC 730/09, Dhulian; GCUPC 906/07, Lava; GCUPC 1186/12, Dhok Bun Amir Khatoon), lM^3(GCUPC 491/02, Chinji Rest House; GCUPC 1121/12, Phadial; GCUPC 490/02, Wasnal); *Lower dentition*: lI_3 (GCUPC 1151/12, Dhok Bun Amir Khatoon), lM_2 (GCUPC 673/09, Ratial), rM_2 (GCUPC 1168/12, Phadial), lM_3 (GCUPC 729/05, Wasnal).

Description

***Upper dentition*:** The P^2 is rectangular [Fig. 2(1)]. The enamel layer is rugose and somewhat shiny. The parastyle and the rib is strong. The fossette is large and somewhat linear. The molars are broad crown (Figs. 2-4). A thick layer of cingulum is present antero-lingually (Figs 2, 3). The postprotocrista is longer than the preprotocrista. The metaconule is present posterior to the protocone. The premetaconule crista is longer than the postmetaconule crista. It appears to be adjoining with protocone at its anterior end. It is supported by a thick layer of cingulum posteriorly. The paracone is contiguous with metacone through a narrow channel at the posterior side. The paracone extends forward and folds backward anteriorly to produce a very small parastyle. The meta- and mesostyles are incipiently developed. The transverse valley is open lingually. The longitudinal valley is linear antero-posteriorly.

***Lower dentition*:**The left lower incisor is in middle wear and spade shape [Fig. 4(3)]. The enamel boarder is pinched antero-posteriorly and shows a pressure mark at

the base which indicates that it is a last incisor. Lingually, the enamel is rough at outer side perhaps due to weathering whereas it is crenulated at the inner side. It has large and wide cutting furrows at the posterior edge, which is divided into major and minor lobes. The anterior lobe is narrow whereas the central and posterior ones are wide. The tooth is laterally compressed showing broad pressure marks caused by the adjacent teeth. The anterolabial side of the tooth is simple, convex and oriented backwardly.

The lower molars are rectangular in outline, nicely preserved and moderately worn teeth [Fig. 4(4-6)]. The major conids are not in straight line. The preprotocristid is longer than the postprotocristid. The both cristids of the hypoconid are contiguous with the protoconid and the entoconid antero-posteriorly. The enamel lining of the metaconid is inclined posteriorly. It is backwardly directed to form a vertical pillar like mesostylid. The metaconid is folded at lingual middle side to form a median rib. The metaconid extends anteriorly and entoconid posteriorly and outwardly to form a thick pillar like metastylid. The entoconid is also supported by a thick median rib. The hypoconulid is supported by a stylid in m3.

Fig. 2: *Giraffa priscilla*. 1. GCUPC 1155/09, rP^2. 2. GCUPC 1174/09, rM^1. 3. GCUPC 1142/09, lM^2. a, occlusal view; b, lingual view; c, labial view (Scale bar 10 mm).

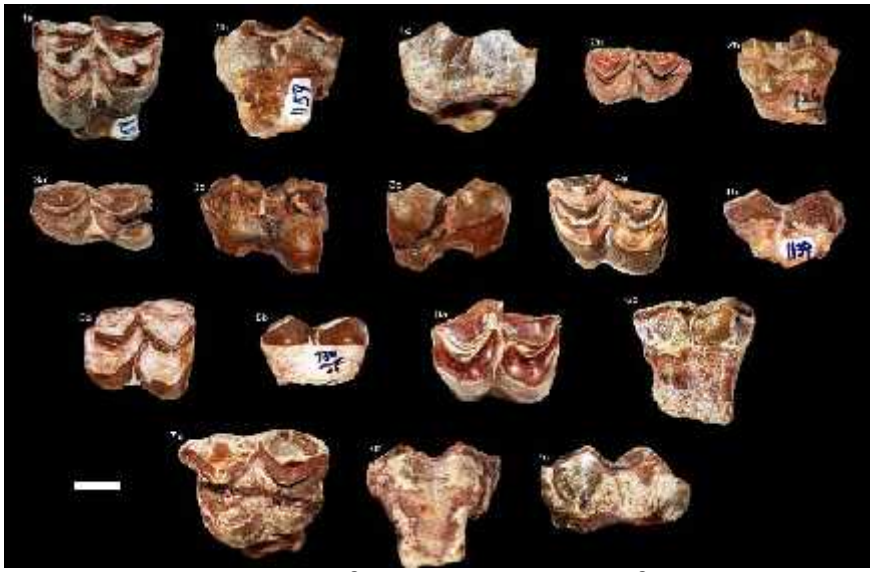

Fig. 3: *Giraffa priscilla*. 1. GCUPC 1159/12, lM^2. 2. GCUPC 724/12, lM^2 3. GCUPC 1154/12, lM^2. 4. GCUPC 1139/12, rM^2. 5. GCUPC 730/09, rM^2. 6. GCUPC 906/07, rM^2. 7. GCUPC 491/02, lM^3. a, occlusal view; b, lingual view; c, labial view (Scale bar 10 mm).

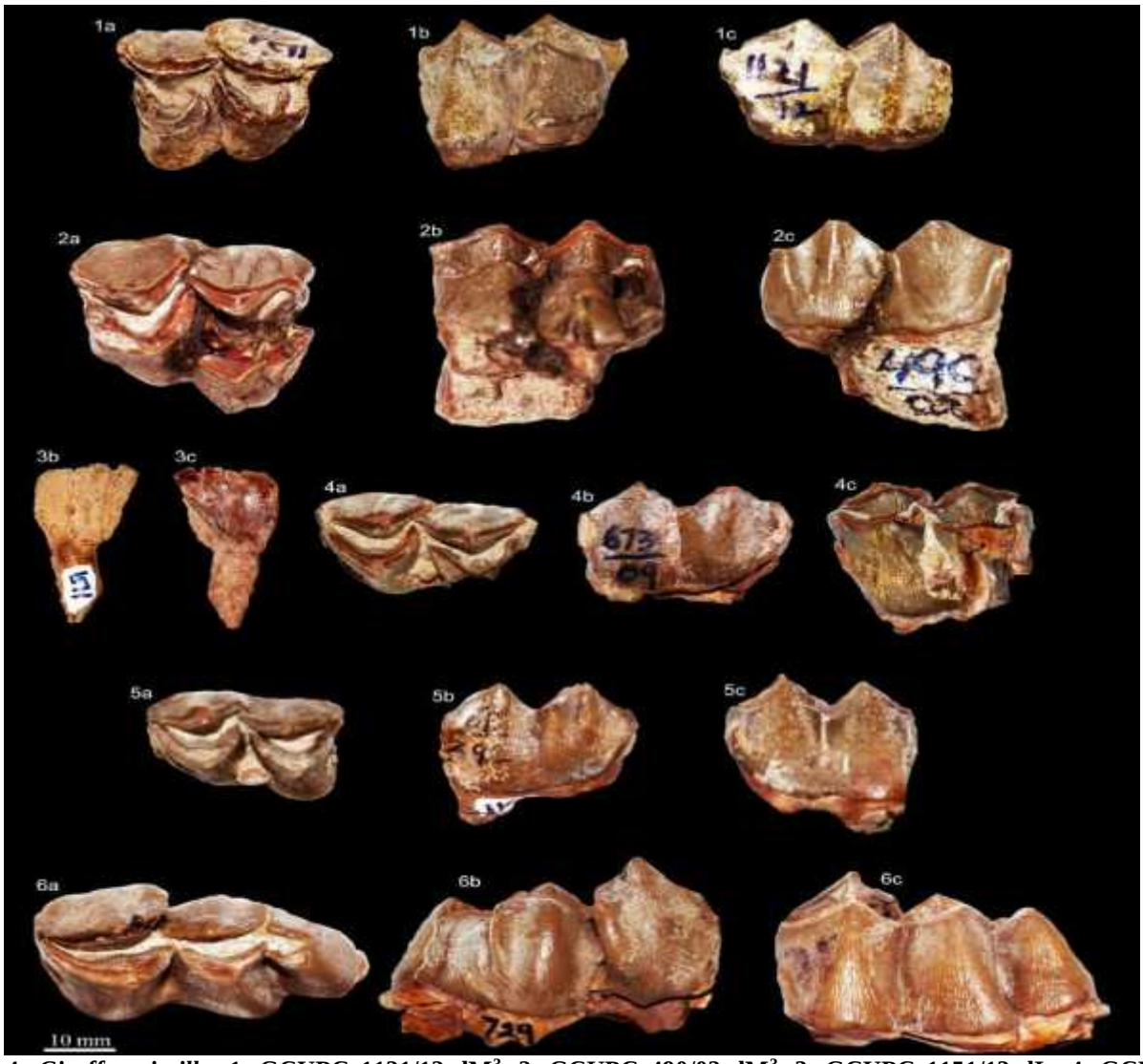

Fig. 4: *Giraffa priscilla*. 1. GCUPC 1121/12, lM^3. 2. GCUPC 490/02, lM^3. 3. GCUPC 1151/12, lI$_3$. 4. GCUPC 673/09, lM$_2$. 5. GCUPC 1168/12, rM$_2$. 6. GCUPC 729/05, lM$_3$. a, occlusal view; b, lingual view; c, labial view (Scale bar 10 mm total).

COMPARISON AND DISCUSSION

The studied specimens are brachydont and small in size having thick enamel sculpture, so they resemble best with the Lower Siwalik genera *Giraffokeryx* or *Giraffa* (Colbert, 1935; Bhatti, 2005; Khan *et al.*, 2010). *Giraffokeryx* have weakly developed styles and median ribs; the stylids are absent; the spur can be observed in the anterior fossette (Fig. 5). The major cusps and conids are in a straight line (Pilgrim, 1910; Matthew, 1929; Colbert, 1935; Bhatti, 2005; Bhatti *et al*., 2012a). The genus *Giraffa* has strong and pillar like styles, clear stylids, strong median ribs and comparatively broad crown. The spur is absent in the anterior fossette and major cusps and conids are not in a straight line. It differs from other genera of the Lower Siwaliks by having reduced posterior half of the tooth (Pilgrim, 1911; Matthew, 1929; Colbert, 1935; Bhatti, 2005; Bhatti *et al*., 2012b).

The studied material has strong styles/stylids and median ribs, broad crown and obliquely present cusps/conids (Fig. 2-5, Table 1). The posterior half of the tooth is also reduced as compared to *Giraffokeryx.* These features resemble with *Giraffa priscilla* (Pilgrim, 1911; Matthew, 1929; Colbert, 1935; Basu, 2004; Bhatti, 2005; Bhatti *et al*., 2012b) *Giraffa priscilla* is only recorded from the Lower Siwaliks of Pakistan. However a few specimens have been reported from the base of the Nagri Formation (Middle Siwaliks). The species completely disappeared around 10 Ma from the Subcontinent (Khan *et al.*, 2012).

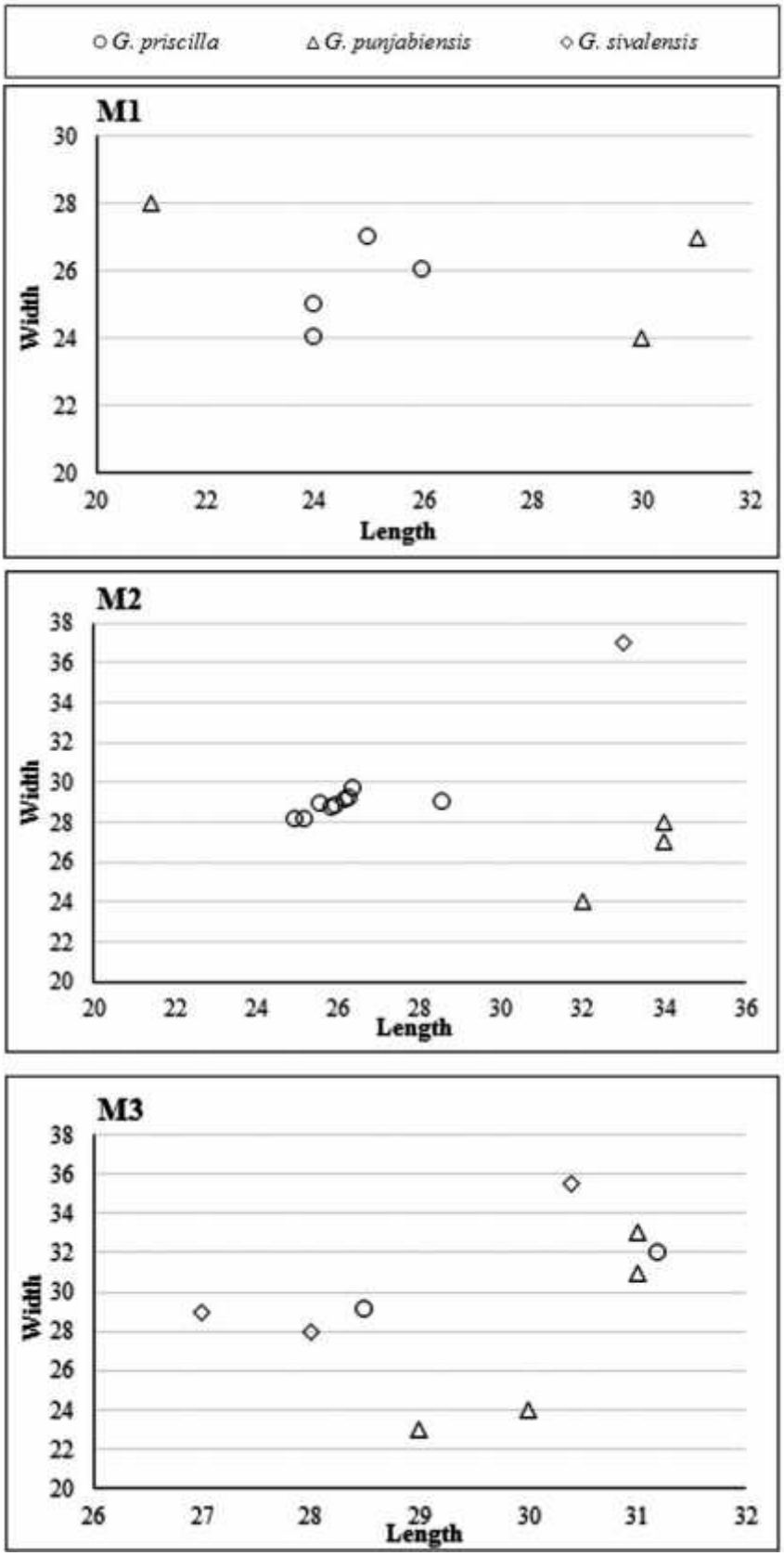

Fig. 5. Bivariate plot (in mm) of the Middle Miocene Siwalik giraffids, showing size variation.

Table 1. Comparative dental measurements (mm) of *Giraffa priscilla*. *the studied specimens. Referred data are taken from Pilgrim (1911), Matthew (1929), Colbert (1935), Bhatti (2005), Bhatti *et al*. (2012b) and Khan *et al*. (2012).

Taxa	Number	Nature	Length (mm)	Width (mm)	W/L
G. priscilla	GCUPC 1155/09*	P^2	22.2	14.9	0.67
	GCUPC 1174/09*	M^1	24.0	24.0	1.00
	GCUPC 1157/12*	M^1	26.0	26.0	1.00
	GCUPC 1142/09*	M^2	25.6	28.9	1.13
	GCUPC 1159/12*	M^2	28.6	29.0	1.01
	GCUPC 724/12*	M^2	25.0	28.1	1.12
	GCUPC 1154/12*	M^2	26.4	29.6	1.12
	GCUPC 1189/12*	M^2	26.3	29.2	1.11
	GCUPC 1139/12*	M^2	25.9	28.7	1.11
	GCUPC 730/09*	M^2	26.2	29.1	1.11
	GCUPC 906/07*	M^2	26.0	28.8	1.11
	GCUPC 1186/12*	M^2	25.2	28.1	1.12
	GCUPC 491/02*	M^3	28.8	30.1	1.05
	GCUPC 1121/12*	M^3	28.5	29.1	1.02
	GCUPC 490/02*	M^3	31.2	31.9	1.02
	GCUPC 1151/12*	I_3	13.6	6.7	0.49
	GCUPC 673/09*	M_2	26.8	16.6	0.62
	GCUPC 1168/12*	M_2	26.0	15.8	0.61
	GCUPC 729/05*	M_3	41.2	22.5	0.55
	PUPC 02/99	P^4	19.5	21.0	1.08
		M^1	24.0	24.0	1.00
		M^2	25.0	28.0	1.12
	PUPC 07/131	M^1	25.0	25.0	1.00
	PUPC 07/89	M^1	27.0	27.0	1.00
	PUPC 02/9	M_3	40.0	17.0	0.43
G. punjabiensis	GSI	P^4	20.5	26.6	1.30
		M^1	28.2	30.8	1.09
		M^2	31.5	34.5	1.10
		M^3	32.0	31.5	0.98
	GSI K 13/349	P^4	22.0	20.0	0.91
		M^1	30.0	24.0	0.80
		M^2	32.0	24.0	0.75
		M^3	30.0	22.0	0.73
	GSI B 182	M^3	29.0	31.0	1.06
	GSI K 13/348	M^3	31.0	33.0	1.06
	PUPC 95/23	P^4	20.0	23.0	1.15
		M^1	31.0	27.0	0.87
		M^2	34.0	28.0	0.82
		M^3	31.0	23.0	0.74
	PUPC 86/84	M^1	21.0	28.0	1.33
		M^2	34.0	27.0	0.79
		M^3	31.0	24.0	0.77
	GSI	M_2	28.3	32.2	1.14
		M_3	43	23.2	0.54
	AMNH 19318	M_2	26.0	25.0	0.96
G. sivalensis	GSI	M^2	33.0	37.0	1.12
		M^3	30.4	35.5	1.17
	PUPC 69/123	P^4	18.0	22.5	1.25
	PUPC 68/317	M^3	27.0	29.0	1.07
	PUPC 67/484	M^3	28.0	28.0	1.00
	GSI	M_3	43.5	25.2	0.58

Conclusions: *Giraffa priscilla* is present Middle to earliest Late Miocene of the Siwaliks and it is common faunal elements in the Middle Miocene of the Siwaliks. It can be differentiated from the other Lower Siwalik giraffid genera by strong and pillar like styles and stylids, prominent median ribs and comparatively broad crown. The species was disappeared before the onset of the Dhok Pathan Formation (ca. 10.2 Ma).

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