

## *Giraffa punjabiensis* (Giraffidae: Mammalia) from Middle Siwaliks of Pakistan

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**Abstract.**— *Giraffa* fossils constitute rare findings in the Dhok Pathan Formation of the Middle Siwaliks. The described remains comprise two maxillar fragments of *Giraffa punjabiensis*. This paper deals with the study of the upper dentition of *G. punjabiensis*, recovered from the Padhri outcrops of the Pakistani Middle Siwaliks (Late Miocene). The giraffid suggests a woodland habitat with swamps.

**Key Words:** Giraffids, Ruminantia, mammals, vertebrates, Siwaliks, Late Miocene.

### INTRODUCTION

*Giraffa* remains have been recovered from the Padhri outcrops of the Middle Siwaliks, Pakistan. The Padhri village is situated at about 57 km west of the Jhelum city in the Potwar Plateau of northern Pakistan (Fig. 1). Topographically, the locality represents water channels, levees and paleosols of varying length and width. Ponds and swamps may also be located but are less frequent. The fossil remains were collected from the site (32° 52' 009 N: 73° 18' 297 E) situated at the southeast of the Padhri village at an altitude of about 1083 ft (Fig. 1).

The fossiliferous Padhri outcrops are situated in the northwest of Hasnot and belong to the upper part of the Dhok Pathan Formation of the Middle Siwaliks, lithostratigraphically (isochronous to the European Late Turolian age, ca. MN 13), and the time of deposition ranges from 7 to 5 Ma (Badgley and Behrensmeyer, 1980; Barry *et al.*, 1982; Barry, 1987; Khan, 2008). The fossiliferous outcrops consist of well cemented, orange red claystone and, light gray sandstone with horizons of small conglomerates in the upper part. The fossil bearings sediments were probably deposited by a fluvial system which led to the formation of a complex

landscape exhibiting water bodies, reedy marshes, meadows of herbs and shrubs, wood lands and forests (Barry *et al.*, 2002).

During the last 100 years the Padhri outcrops have become famous for their Miocene mammal record, and the fossil collection and detailed investigation of the collected vertebrate fauna by several researchers (Colbert, 1935; Pilgrim, 1937, 1939; Akhtar, 1992; Khan, 2007, 2008). Despite the fact that the genus *Giraffa* was rather diversified during the Late Miocene, it is not well represented in any of the respective famous sites in the Siwaliks. However, Padhri has yielded two well-preserved *Giraffa* cranial part remains that probably belonged to a single individual. In this paper we describe these scarce remains, assigning them to the genus *Giraffa*.

### Abbreviations

PUPC, Punjab University Palaentological Collection; AMNH, American Museum of Natural History New York; GSI, Geological survey of India.

### MATERIALS AND METHODS

#### Materials

The studied material comes entirely from the Late Miocene deposits at Padhri, Jhelum district, Punjab province, Pakistan (Fig. 1). It comprises the following specimens: a right maxillar fragment with M<sup>1</sup>-M<sup>3</sup> (PUPC 86/84A) and a left maxillar fragment with P<sup>4</sup>-M<sup>3</sup> (PUPC 95/23). The studied material is

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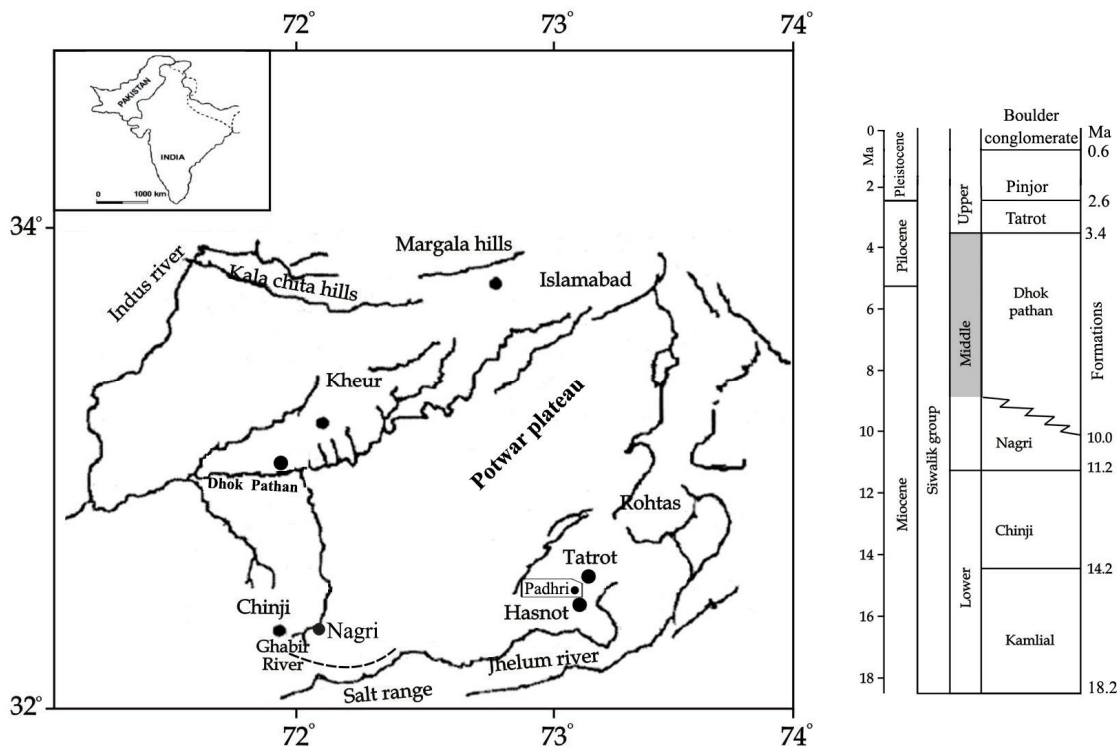


Fig. 1. Map of the Potwar Plateau, northern Pakistan with stratigraphic dates of the Siwalik formations; the studied locality is encircled and the studied chronostratigraphic context is shaded (data from Johnson *et al.*, 1982; Barry *et al.*, 2002; Nanda, 2002; Dennell *et al.*, 2006; Cohen and Gibbard, 2008).

compared with other *Giraffa punjabiensis* samples from the Siwaliks stored in the collection of the Geological Survey of India (GSI). Measurements were taken with caliper to the nearest 0.1 mm.

#### Nomenclature

We use the terminology of Gentry and Hooker (1988) and Gentry *et al.* (1999).

#### Source of the comparative material

Matthew (1929), Colbert (1935) and Bhatti (2005).

### SYSTEMATIC PALAEOLOGY

Order Artiodactyla Owen, 1848  
 Suborder Ruminantia Scopoli, 1777  
 Family Giraffidae Gray, 1821  
 Subfamily Giraffinae Gray, 1821  
 Genus *Giraffa* Brisson, 1762

#### *Giraffa punjabiensis* Pilgrim, 1911

*Synonyms:* *Giraffa punjabiensis* Pilgrim, 1910.

*Giraffa punjabiensis* Bohlin, 1927.

*Giraffa punjabiensis* var. Matthew, 1929.

*Giraffa punjabiensis* Matthew, 1929.

#### Type specimen

(Lectotype) – GSI B184, maxillary fragments.

#### Abbreviated diagnosis

Smaller than *Giraffa sivalensis* Falconer and Cautley, 1843 or *Giraffa camelopardalis*. Upper premolars relatively small and narrow, upper molars long with seldom tubercles in the median valleys, lower molars long, lobes of molars set less obliquely to the axis of the jaw than in the extant giraffe (Pilgrim, 1911; Colbert, 1935).

*Geographic distribution*

*Giraffa punjabiensis* is known from the Middle Siwalik Hills of the subcontinent (Pilgrim, 1910, 1911; Matthew, 1929; Colbert, 1935).

*Studied material*

PUPC 95/23, left maxillar fragment with P<sup>4</sup>-M<sup>3</sup>; PUPC 86/84A, right maxillar fragment with M<sup>1</sup>-M<sup>3</sup>.

*Locality*

Padhri village, Jhelum district, Punjab province, Pakistan.

*Stratigraphic level*

Middle Siwaliks (Late Miocene).

*Description*

PUPC 95/23 is a left maxillar fragment bearing a fourth premolar and three molars (Fig. 2A). A shelf like palate part is present which is moderately thick. PUPC 86/84A represents right maxillar fragment with molar series (M<sup>1</sup>-M<sup>3</sup>).

*P<sup>4</sup>*: The premolar is in an excellent state of preservation and in early wear (Fig. 2A). The enamel is thick and rugose. The anteroposterior diameter of the tooth is smaller than the transverse diameter. The fossette formed by the union of the cusps is shallow. The major cusps are poorly developed. The para- and metastyles are fairly developed. The median rib is strong. It is slightly narrow at the tip and broad at the base of the crown.

*M<sup>1</sup>*: The major cusps are fairly developed and not in a straight line (Fig. 2A, B). Protocone is L-shaped. The prae-protocrista is slightly narrower than the post-protocrista. Paracone is broad in the middle with the prae-paracrista and post-paracrista. The prae-paracrista is united with the parastyle whereas the post-paracrista is just touching with the prae-metacrista. Metacone is well developed and slightly higher vertically than paracone. The prae- and postmetacrista are not fused. The prae-hypocrista is thick and the posthypocrista is bifurcated into two ridges. The styles are well developed: parastyle and mesostyles are strongly developed, metastyle is weakly developed, parastyle is the strongest among the styles, and it is expanded to the base of the crown and united with the

posterior side of the mesostyle. The enamel sculpture is rough and the fossettes are equally prominent on the anteroposterior lobes. The cingulum is poorly developed. The entostyle is weak and the median ribs are strong.

*M<sup>2</sup>*: The second molar is in an excellent state of preservation (Fig. 2A, B). The entostyle is present. The molar is rugose with slight traces of the cingulum. This molar is actually a large version of the first molar, thus the aforementioned description covers it as well.

*M<sup>3</sup>*: The third molar is in an excellent state of preservation like the other molars in the maxillary fragment (Fig. 2A, B). The entostyle is moderately developed. The slight indication of the cingulum can be seen on the lingual base of the tooth. The major cusps are fairly developed. The protocone is crescent shaped and isolated from the paracone. The wear is more confined to the post-cristae than to the prae-cristae. The styles are strongly developed and stout. The parastyle is connected to the paraconus rib. The mesostyle represents an isolated pillar. The metastyle is moderately developed in the M<sup>3</sup>, while it is weakly developed in the other two molars. The fossettes are relatively deep.

**COMPARISON AND DISCUSSION**

The specimens are characterized by their large size, the depth of the central enamel folds, the enamel rugosity and obliquity of the labial cusps (Fig. 2). These features associate them clearly to the giraffids' in distinction to the bovinds' specimens (Matthew, 1929; Colbert, 1935; Harris, 1987; Harris *et al.*, 2010; Khan *et al.*, 2010a, Bhatti *et al.*, 2012). As the teeth are brachydont, they can be compared with the genera *Giraffokeryx* and *Giraffa* and not with the larger Siwalik giraffids such as *Bramatherium* and *Sivatherium*. *Giraffokeryx* is recorded from the Lower Siwaliks (Matthew, 1929; Colbert, 1935; Khan *et al.*, 2010b) and a few findings are also reported from the lower portion of the Middle Siwaliks (Khan *et al.*, 2012a).

The teeth of the studied specimens differ from that of *Giraffokeryx* in not having the major cusps in a straight line (Pilgrim, 1911) and also the enamel sculpture is not fine. On the contrary, the maxillar fragments show similar morphological

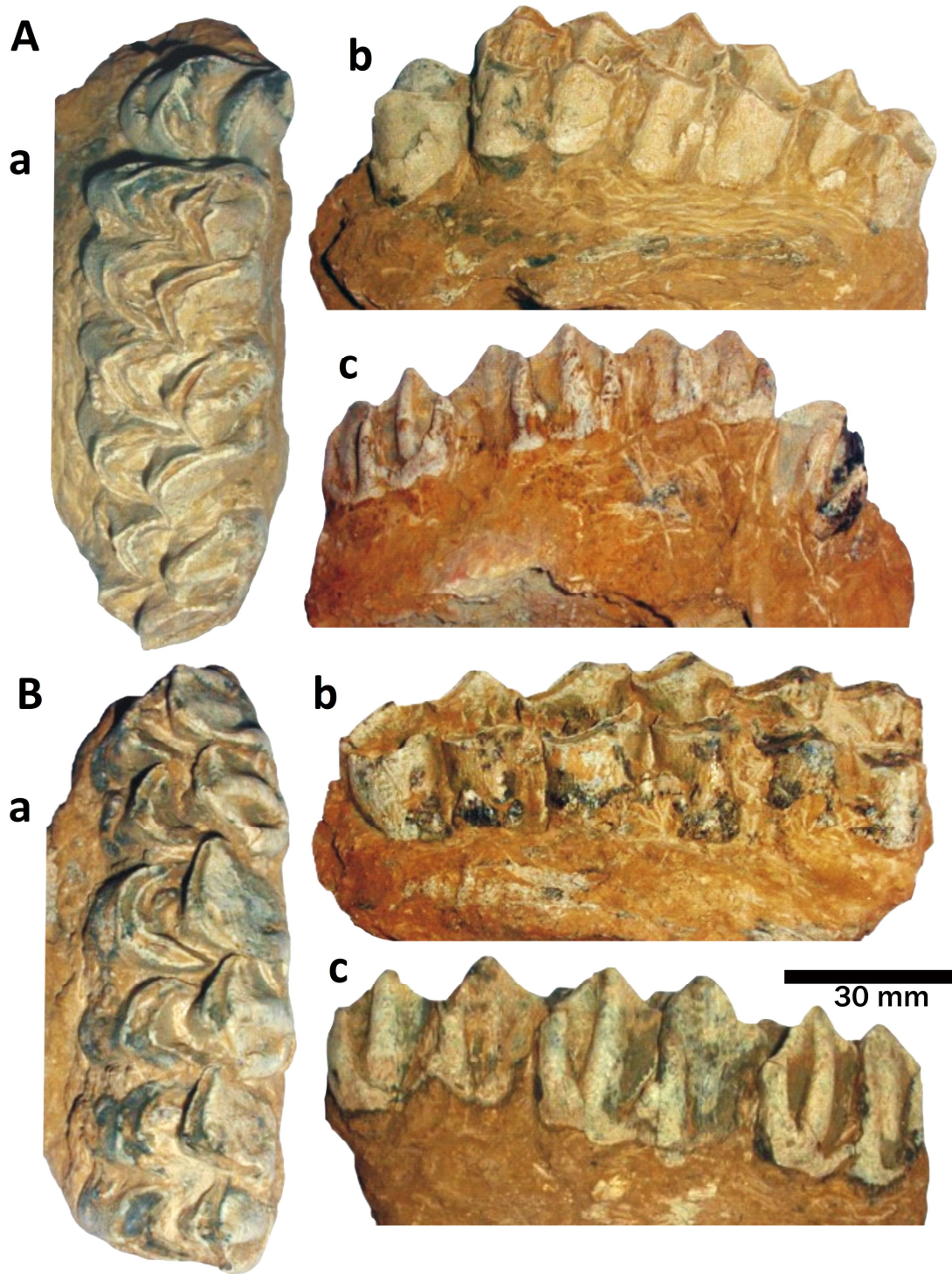


Fig. 2. *Giraffa punjabiensis*: A, PUPC 95/23, left maxillar fragment with P<sup>4</sup>-M<sup>3</sup>; B, PUPC 86/84A, right maxillar fragment with M<sup>1</sup>-M<sup>3</sup>. Views are occlusal (Aa, Ba), lingual (Ab, Bb) and labial (Ac, Bc). Scale bar equals 30 mm.

**Table I.- Comparative measurements of the maxillar fragments of *G. punjabiensis* in mm. Referred data are taken from Matthew (1929), Colbert (1935) and Bhatti (2005).**

Taxa	Number	Nature/Position	Length	Width	W/L ratio
<i>G. punjabiensis</i>	PUPC 95/23*	IP <sup>4</sup>	20	23	1.15
		IM <sup>1</sup>	31	27	0.87
		IM <sup>2</sup>	34	28	0.82
		IM <sup>3</sup>	31	23	0.74
	PUPC 86/84*	rM <sup>1</sup>	21	28	1.33
		rM <sup>2</sup>	34	27	0.79
		rM <sup>3</sup>	31	24	0.77
	GSI K13/349	P <sup>4</sup>	22	20	0.90
		M <sup>1</sup>	30	24	0.80
		M <sup>2</sup>	32	24	0.75
		M <sup>3</sup>	30	22	0.73
	AMNH 19318	rP <sup>4</sup>	24	20	0.83
		rM <sup>1</sup>	27	22	0.81
		rM <sup>2</sup>	26	25	0.96
GSI B182	M <sup>3</sup>	29	31	1.06	
<i>G. priscilla</i>	PUPC 02/99	M <sup>3</sup>	25	28	1.12
<i>G. sivalensis</i>	PUPC 68/317	M <sup>3</sup>	27	29	1.07
	PUPC 67/484	M <sup>3</sup>	28.0	28.0	1.00

\* The studied specimens. l = left, r = right.

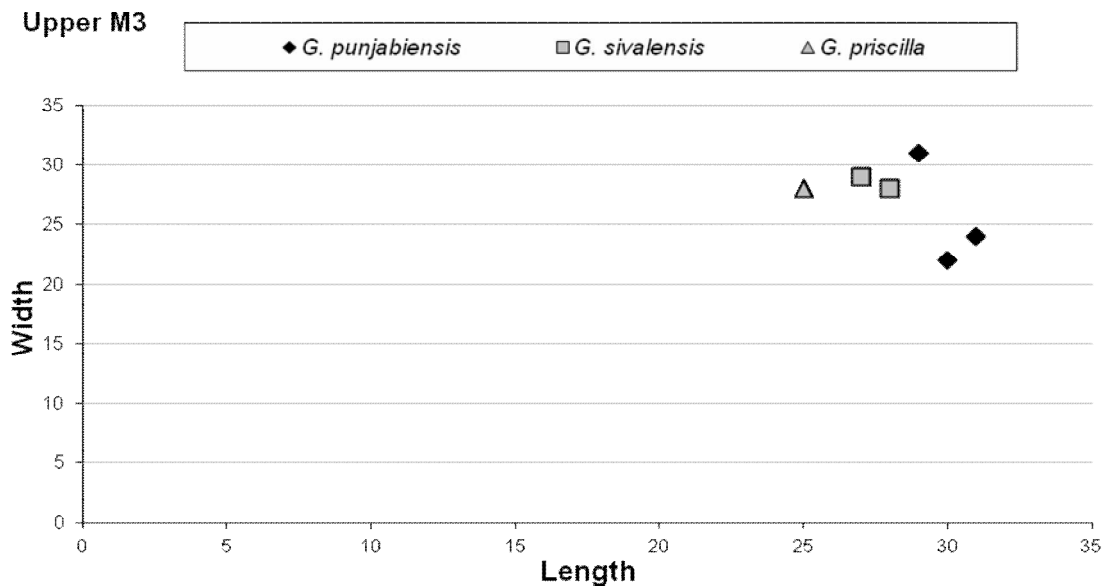


Fig. 3. Scatter diagram showing dental proportions of the Siwalik *Giraffa* species. Referred data are taken from Matthew (1929), Colbert (1935) and Bhatti (2005).

characters with those of *Giraffa*, in which the labial cusps are not located in a straight line and the enamel sculpture is rough. Several fossil *Giraffa*

species have been proposed on the basis of tooth size and of the shape (Harris *et al.*, 2010). The studied sample differs from *G. jumae* Leakey, 1967;

*G. pygmaea* Harris, 1976 and *G. stillei* Arambourg 1947 in the smaller size and the relatively less massive and shorter teeth (Harris *et al.*, 2010). Three species of *Giraffa* have been recorded from the Siwaliks: *G. sivalensis* Falconer & Cautley, 1843 from the Pleistocene of the Upper Siwaliks, *G. punjabiensis* Pilgrim, 1911 from the Late Miocene-Pliocene of the Middle Siwaliks and *G. priscilla* Matthew, 1929 from the Middle Miocene of the Lower Siwaliks (Matthew, 1929; Colbert, 1935) (Fig. 3). The studied specimens differ from *G. sivalensis* mainly in the less reduced posterior lobe (Colbert, 1935). *Giraffa priscilla* represents more brachyodont teeth with prominent metastyles than those of the listed specimens (Matthew, 1929). Morphometrically, the teeth match with the Late Miocene-Pliocene *G. punjabiensis* (Figs. 2-3; Table I). The anatomical and ontogenetic matching of the maxillar remains strongly suggests that the fossils belong to a single individual.

#### Palaeoecology

The Padhri outcrops are remarkably famous for their spectacular mammalian fossils. Fossils associated with the Padhri site include crocodiles, snakes, *Gazella*, *Pachyportax*, *Selenoportax*, *Hydaspitherium*, *Tragoportax*, *Dorcatherium*, *Chilotherium*, *Sivalhippus* and *Stegolophodon* (Sarwar, 1977; Ghaffar, 2005; Khan, 2007, 2008; Khan *et al.*, 2009, 2012a). The presence of *Sivalhippus* implies a restricted savannah area (Khan *et al.*, 2011). *Dorcatherium* preferred a habitat of swamp and patches of dense forests (Khan *et al.*, 2012b). The large forms (*Pachyportax*, *Selenoportax*, *Hydaspitherium*, *Giraffa*) indicate a habitat of open woodland intervened by some grassland and a relatively humid environment. The rhinocerotid *Chilotherium* as well as other grazer forms are common elements of the Late Miocene fauna of the Siwaliks. They prefer savannah habitats with patches of bushes (Heissig, 1972). The faunal elements of the Padhri fauna correlate better with those of the other Siwalik Late Miocene localities (Khan *et al.*, 2009, 2010a). Therefore, it is suggested that the Padhri outcrops are characterized by the predominance of woodland to savannah habitats with some swamps and patches of dense forest.

## CONCLUSIONS

The Late Miocene in the Padhri area has yielded cranial remains of *G. punjabiensis*. The Padhri locality is one of the richest Late Miocene Siwalik localities. Concerning palaeoenvironmental indications, *Giraffa* remains are found in deposits that accumulated in woodland or savannah near swamps and lakes, and the giraffids suggest the presence of woodland in the Padhri region at the time of deposition.

## REFERENCES

- AKHTAR, M., 1992. *Taxonomy and Distribution of the Siwalik Bovids*. Ph.D. Diss. (unpublished), University of the Punjab, Lahore, Pakistan, pp. 372.
- BADGLEY, C. AND BEHRENSMEYER, A. K., 1980. Paleocology of Middle Siwalik sediments and faunas. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, **30**: 133-155.
- BARRY, J. C., 1987. The history and chronology of Siwalik cercopithecoids. *J. Human Evolut.*, **2**: 47-58.
- BARRY, J. C., LINDSAY, E. H. AND JACOBS, L. L., 1982. A biostratigraphic zonation of the middle and the upper Siwaliks of the Potwar Plateau of northern Pakistan. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, **37**: 95-130.
- BARRY, J., MORGAN, M., FLYNN, L., PILBEAM, D., BEHRENSMEYER, A. K., RAZA, S., KHAN, I., BADGELY, C., HICKS, J. AND KELLEY, J., 2002. Faunal and Environmental change in the Late Miocene Siwaliks of Northern Pakistan. *Paleobiology*, **28**: 1-72.
- BHATTI, Z. H., 2005. *Taxonomy, Evolutionary History and Biogeography of the Siwalik Giraffids*. PhD Diss. (unpublished), University of the Punjab, Lahore, Pakistan, pp. 352.
- BHATTI, Z. H., KHAN, M. A. AND AKHTAR, M., 2012. *Hydaspitherium* (Artiodactyla, Giraffidae) from the Dhok Pathan Formation of the Middle Siwaliks, Pakistan: New Collection. *Pakistan J. Zool.*, **44**: 799-808.
- COHEN, K. M. AND GIBBARD, P. L., 2008. Global chronostratigraphical correlation table for the last 2.7 million years. *Episodes*, **31**: 243-247.
- COLBERT, E. H., 1935. Siwalik Mammals in the American Museum of Natural History. *Trans. Am. phil. Soc. N.S.*, **26**: 1-401
- DENNELL, R., COARD, R. AND TURNER, A., 2006. The biostratigraphy and magnetic polarity zonation of the Pabbi Hills, northern Pakistan: An Upper Siwalik (Pinjor Stage) Upper Pliocene-Lower Pleistocene fluvial sequence. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, **234**: 168-185.
- GENTRY, A. W. AND HOOKER, J. J., 1988. The phylogeny

- of Artiodactyla. In: *The phylogeny and classification of the tetrapods, Vol. 2: Mammals* (ed. M.J. Benton), Systematics Association Special Volume No. 35B Clarendon, Oxford, pp. 235-272.
- GENTRY, A. W., ROSSNER, G. E. AND HEIZMANN, E. P. S., 1999. Suborder Ruminantia. In: *The Miocene land mammals of Europe* (eds. G.E. Rossner and K. Heissig). Dr. Friedrich Pfeil Verlag, Munchen, pp. 225-258.
- GHAFFAR, A., 2005. *Studies on equids, cervids and carnivora from the Siwalik Hills of Pakistan*. Ph.D. Diss., University of the Punjab, Lahore, Pakistan, pp. 375.
- HARRIS, J. M., 1987. Fossil Giraffidae from Sahabi, Libya. In: *Neogene paleontology and geology of Sahabi* (ed. N.T. Boaz, A. El-Arnauti, A.W. Gaziry, J. de Heinzelin and D.D. Boaz), Alan R. Liss, New York, pp. 317-321.
- HARRIS, J., SOLOUNIAS, N. AND GERAADS, D. 2010. Giraffoidea. In: *The Cenozoic mammals of Africa* (eds. L. Werdelin and W. J. Sanders), University of California Press, pp. 797-811.
- HEISSIG, K., 1972. Palaontologische und geologische Untersuchungen im Tertiär vom Pakistan, 5. Rhinocerotidae (Mamm.) aus den unteren und mittleren Siwalik- Schichten. *Bayer. Akad. Wissensch. Mathematisch-Naturwissensch. Klasse, Abhandl., Neue Folge*, **152**: 1-112.
- JOHNSON, G. D., ZEITLER, P., NAESER, C. W., JOHNSON, N. M., SUMMERS, D. M., FROST, C. D., OPDYKE, N. D. AND TAHIRKHELLI, R. A. K., 1982. The occurrence and fission-track ages of Late Neogene and Quaternary volcanic sediments, Siwalik group, northern Pakistan. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, **37**: 63-93.
- KHAN, M. A., 2007. *Taxonomic studies on fossil remains of ruminants from tertiary Hills of Hasnot, Pakistan*. Ph.D. Diss. (unpublished), University of the Punjab, Lahore, Pakistan, pp. 292.
- KHAN, M. A., 2008. Fossil bovids from the Late Miocene of Padri, Jhelum, Pakistan. *Pakistan J. Zool.*, **40**: 25-29.
- KHAN, M. A., ILIOPOULOS, G. AND AKHTAR, M., 2009. Boselaphines (Artiodactyla, Ruminantia, Bovidae) from the Middle Siwaliks of Hasnot. Pakistan. *Géobios*, **42**: 739-753.
- KHAN, M. A., AKHTAR, M. AND IQBAL, M., 2010a. The late Miocene artiodactyls in the Dhok Pathan type locality of the Dhok Pathan Formation, the Middle Siwaliks, Pakistan. *Pakistan J. Zool., Suppl. Ser.*, **10**: 1-90.
- KHAN, M. A., BUTT, S. S., KHAN, A. M. AND AKHTAR, M., 2010b. A new collection of *Giraffokeryx punjabiensis* (Giraffidae, Ruminantia, Artiodactyla) from the Lehri outcrops, Jhelum, Northern Pakistan. *Pakistan J. Sci.*, **62**: 120-123.
- KHAN, M. A., MANZOOR, F., ALI, M., BHATTI, Z. H. AND AKHTAR, M., 2011. A new collection of hipparionine from the type locality of the Dhok Pathan Formation of the Middle Siwaliks. *J. Anim. Pl. Sci.*, **21**: 83-89.
- KHAN, M. A., AKHTAR, M. AND IKRAM, T., 2012a. True ungulates from the Nagri type locality (Late Miocene), northern Pakistan. *J. Anim. Pl. Sci., Suppl. Ser.*, **1**: 1-59.
- KHAN, M. A., AKHTAR, M., ILIOPOULOS, G. AND HINA, 2012b. Tragulids (Artiodactyla, Ruminantia, Tragulidae) from the Middle Siwaliks of Hasnot (Late Miocene), Pakistan. *Riv. Ital. Paleontol. Stratigr.*, **118**: 325-341.
- MATTHEW, W. D., 1929. Critical observations upon Siwalik Mammals. *Bull. Am. Mus. nat. Hist.*, **56**: 437-560.
- NANDA, A.C., 2002. Upper Siwalik mammalian faunas of India and associated events. *J. Asian Earth Sci.*, **21**: 47-58.
- PILGRIM, G. E., 1910. Notices of new Mammalian genera and species from the Tertiaries of India. *Rec. geol. Surv. India*, **40**: 63-71.
- PILGRIM, G. E., 1911. The fossil Giraffidae of India. *Mem. Geol. Surv. India Palaeont. Ind., N.S.*, **4**: 1-29.
- PILGRIM, G. E., 1937. Siwalik antelopes and oxen in the American Museum of Natural History. *Bull. Am. Mus. nat. Hist.*, **72**: 729-874.
- PILGRIM, G. E., 1939. The fossil Bovidae of India. *Pal. Ind., N.S.*, **26**: 1-356.
- SARWAR, M., 1977. Taxonomy and distribution of the Siwalik Proboscidea. *Bull. Dept. Zool. Univ. Punjab, N. S.*, **10**: 1-172.

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