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New Fossil remains of *Giraffokeryx punjabiensis* from the Miocene outcrops of Chakwal, Punjab, Pakistan

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Abstract

New fossil remains of *Giraffokeryx punjabiensis* has been described here on the basis of taxonomic characters which were collected from the outcrops of Dhok Bun Ameer Khatoon (Lat. 32° 79′ 26.5″ N Long. 72° 92′ 35.8″ E). These outcrops are situated in district Chakwal, Punjab province, northern Pakistan. This locality of Late Miocene belongs to Chinji Formation, Lower Siwaliks of Pakistan with estimated age of 14.2–11.2 Ma. The described fossils of family Giraffokerycinae designated in this paper include isolated upper dentition including premolars and molars. The fossil giraffes indicate forests and woodland ecosystem at the time of deposition.

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Introduction

Like many other mammalian groups, Giraffidae is also well represented group in the Siwaliks of Pakistan. This family consists of almost fourteen species and four subfamilies included Progiraffinae, Giraffinae, Sivatheriinae and Giraffokerycinae of giraffids throughout the Siwaliks in Pakistan (Hamilton, 1978; Geraads, 1986; Janis and Scott, 1987; Gentry and Hooker, 1988; Bhatti, 2005; Khan and Farooq, 2006; Solounias, 2007). Progiraffinae includes the genus *Progiraffa* while Giraffinae includes genus *Giraffa*. Sivatheriinae contains the genera *Sivatherium*, *Hydaspitherium*, *Bramatherium*, *Helladotherium*. Giraffokerycinae comprises genus *Giraffokeryx* (Solounias, 2007; Bhatti, 2012a; Khan *et al*., 2014). Geologically Progiraffinae is older strata than Giraffinae and Giraffokerycinae which become visible in the fossil record before Sivatheriinae (Clobert, 1935; Barry *et al*., 2005). The well preserved giraffed remains in Asia, Africa and Europe indicate that just two living species i.e. *Okapia johnstoni* and *Giraffa camelopardalis* are present in Ethiopian areas (Churcher, 1979; West, 1981 Geraads, 1986; Solounias *et al*., 2000). *Okapia johnstoni* is restricted to the wide forests of Africa and *Giraffa camelopardalis* is found in Africa below the Sahara.

The ancestors of giraffa had been reported in the Early Miocene from Bugti hill in Pakistan (Barry *et al*., 2005) and first giraffid was recovered from the Kamlial Formation of the Lower Siwaliks during the early Miocene (Solounias, 2007). The large sized Siwalik genera *Helladotherium, Bramatherium, Vishnutherium* and *Sivatherium* appeared in the late Miocene and survived up to the Pleistocene of the Siwaliks while the small giraffids disappeared after the middle Miocene from the Siwaliks of Pakistan (Matthew, 1929; Colbert, 1935; Sarwar and Akhtar 1987; Sarwar, 1990; Barry *et al*., 2005; Bhatti, 2005; Bhatti *et al.,* 2007, 2012). The species *Giraffokeryx punjabiensis* evolved from *Progiraffa* (Gentry, 1990; Pilgrim, 1911). The Upper Miocene *Palaeotragus* and the Middle Miocene *Giraffokeryx* shares several similar characters but an additional pair of horn core is present on the frontals of *Giraffokeryx* (Garaads, 1935). The medium sized mixed feeder *Giraffokeryx* was disappeared about 10 Ma while the large giraffids were present in the rest of Miocene (Barry *et al.,* 2002).

Materials and methods

Collection of the fossils

During 2018 and 2019 various field trips were arranged to discover the fossils of the mammalian fauna from Chinji Formation of the Lower Siwaliks. The locality Dhok Bun Amir Khatoon was investigated thoroughly and different fossil teeth including premolar and molar were collected. The specimens unearthed were generally in excellent condition except some of those which were found on erosional surfaces. Surface collection was the initially method to collect the fossils from the locality. The material somewhat embedded in sedimentary rocks was intentionally evacuated with the assistance of the geological hammers, chisels, penknives, different kinds of fine needles and brushes. Cautious measures were taken during excavation of moderately embedded specimens in order to keep the fossils away from breaking. To study the taxonomic and morphological characters, every collected specimen was placed in cotton piece and wrapped with a tap to keep away from the shocks of transportation from locality to the Paleontology Laboratory, Zoology department, GC University, Faisalabad.

Cleaning the residue particles and Cataloging of the Fossils

The preparation of samples for clear observations and taxonomic determination, the specimens were carefully cleaned and washed. With the help of brushes and needles clay and dust particles were removed from the material. Phosphoric acid, Acetic acid and Hydrochloric acid were used to remove firmly attached hard particles from the samples. Coincidentally broken sections of specimens were rejoined by utilizing resins and gums, for example, Magic Stone, Elfy, Araldite, Peligom, Fixings and Elite. Hand lens was used for careful study of minute and indefinite morphological characters of small

fossils. Every described specimen was catalogued and given a specific collected year and the serial number (for example PC-GCUF 77/2018). The capital letter with superscript showed upper dentition and subscript for lower dentition (for example P^1 show to upper first premolar and P_1 indicates the lower dentition).

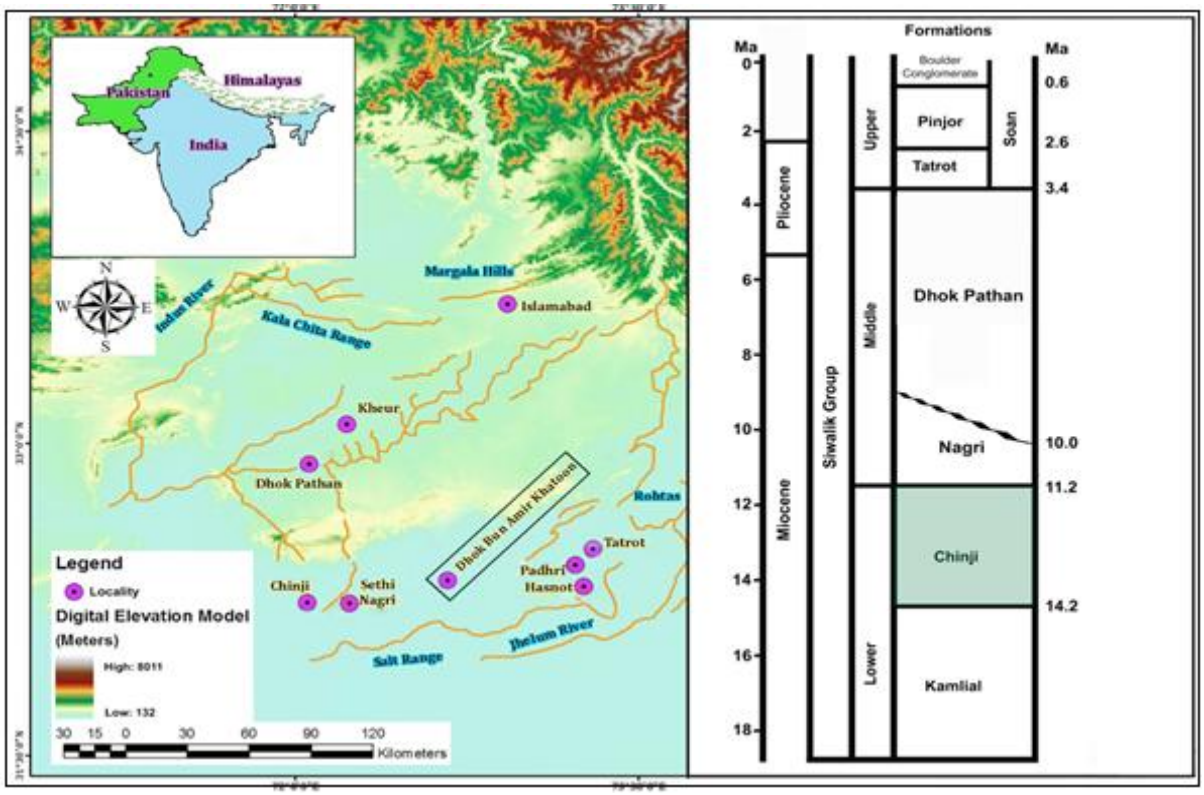

Fig. 1. Map of the study area Dhok Bun Ameer Khatoon, district Chakwal, Punjab, Northern Pakistan (Khan *et al.,* 2011; Samiullah, 2012, Draz *et al.,* 2019).

Measurements of the fossils

A measurement of the fossil material was taken with the help of electronic computerized Vernier caliper in millimeter. The width and length of the teeth was measured at maximum level of the lower molars.

Systematic and terminology

The systematics was described by following Solounias (2007), Samiullah *et al.* (2010, 2015) and the terminology was as per Hamilton (1973); Khan *et al.* (2009).

Comparison of the fossils

Comparison of the given study material was made with specimens from AMNH (American Museum of Natural History), BMNH (Natural History Museum, London), GSI (Geological Survey of India), GSP (Geological Survey of Pakistan), PUPC (Punjab University Paleontological Collection) and PC-GCUF (Paleontology Collection of Government College University, Faisalabad).

Photography of specimens

A digital camera (Canon EOS 1100 D) was utilized to take photograph of the examined samples. Hard copies were prepared by utilizing PC software (adobe Photoshop, coral draw).

Depository of specimen of the fossils

Finally, the described specimens were housed in the Paleontology Laboratory of the Zoology Department, Government College University, and Faisalabad, Pakistan.

Dhok bun ameer khatoon

Dhok Bun Ameer Khatoon is a small village in district

Chakwal, Punjab, Pakistan and Miocene deposits surround the village. Its geographical coordinates are (Lat. 32° 79′ 26.5″ N Long. 72° 92′ 35.8″ E). DBAK has two approaches, one from Chakwal and the other from Chua Seydan Shah, Punjab province. The area contains continuous geological record spamming around 4.5 BP to 18.5 Ma (Johnson *et al.,* 1982). The site is well known for fossil remains of Middle to Late Miocene mammalian faunas (Khan *et al.,* 2008, 2011, 2013; Samiullah, 2011; Samiullah *et al.,* 2015).

The outcrops of DBAK consist of grey sandstones, red brown mudstone, bright red and brown orange siltstones and unique reddish shale in a fluvial environment mainly filled by unweather igneous minerals (Barry *et al.,* 2002; Cheema, 2003).

The aim of this paper is to document the newly recovered *Giraffokeryx* material. The collected isolated upper right and left premolars and molars dentitions increase our knowledge on the anatomic and morphological features of *Giraffokeryx punjabiensis*.

Systematic Palaeontology

Kingdom Animalia Linnaeus, 1758
Phylum Chordate Linnaeus, 1758
Class Mammalia Linnaeus, 1758
Order Artiodactyla Owen, 1848
Suborder Rumnintia Scopoli, 1777
Infraorder Pecora Linnaeus, 1758
Superfamily Giraffoidea
Gray, 1821 Family Giraffidae
Gray, 1821 Subfamily Giraffokerycinae
Solounias, 2007 Genus *Giraffokeryx* Pilgrim, 1910

Type species

Giraffokeryx punjabiensis Pilgrim, 1910

Geographic distribution of species

Giraffokeryx punjabiensis is best recognized from the Siwaliks of Indian subcontinent and Europe (Geraads, 1986; Janis, 1987; Gentry and Hooker, 1988; Gentry, 1990; Khan *et al.,* 2010; Bhatti *et al.,* 2007, 2012), Russian Federation (Belomechetskaia), Kenya (Fort Ternan) Nepal (Dang Valley), Turkey (West *et al.,* 1991; Pickford *et al.,* 2000; Geraads and Aslan, 2003; Bhatti, 2005; Khan *et al.,* 2010). In Pakistan this genus is presently identified from the Lower to Middle Siwaliks (Pilgrim, 1910; Colbert, 1935; Geraads, 1986).

Generic diagnosis of species

The *Giraffokeryx* is a medium size genus with brachyodont cheek teeth with rugose enamel.

The main cusps are present in straight line in upper molars and parastyles, mesostyles and metastyles are absent or poorly developed.

Paracone has weak median rib while slightly developed cingulum on the anterior side of the protocone and median basal pillar is absent. *Giraffokeryx* has four horns cores; two are present at the anterior extremities while the others are at posterior side (Pilgrim, 1911; Matthew, 1929; Colbert, 1935; Bhatti, 2005; Solounias, 2007).

Giraffokeryx punjabiensis Pilgrim, 1910

Type Specimen

Lectotype GSI 502, a third molar of right maxilla.

Type locality

Chinji village, Lower Siwaliks, Punjab, district Chakwal northern Pakistan (Colbert, 1935).

Stratigraphic range

In Pakistan this genus is presently identified from the Lower to the lower part of the Middle Siwaliks (Pilgrim, 1910; Colbert, 1935; Geraads, 1986).

Material study

Upper dentition

rP^2 (PC-GCUF 77/2018); rP^3 (PC-GCUF 78/2018); rM^1 (PC-GCUF 81/2018); rM^{2}s (PC-GCUF 82/2018 and PC-GCUF 83/2018); lP^2 (PC-GCUF 84/2018); lP^3 (PC-GCUF 86/2018); lM^1 (PC-GCUF 88/2018); lM^2 (PC-GCUF 89/2018); lM^3 (PC-GCUF 90/2018).

Locality of species

Dhok Bun Ameer Khatoon, Chakwal district, Punjab

province, northern Pakistan.

Stratigraphic range
Lower Siwaliks

Description

Upper Dentition (Fig. 1)

rP² (PC-GCUF 77/2018)

The specimen under study (PC-GCUF 77/2018) is isolated upper right second premolar. It is in an excellent stage of preservation, and is in the late phase of wear. It is low and narrow crowned. The weak central cavity is seen in the tooth. Anterio-posterior length of the specimen is more than the transverse width. The enamel is moderately thick with the rugosity being progressively prominent on the lingual side, when compared with the buccal side of the tooth. A cingulum is absent. The pressure mark is present on both sides of the tooth. All the major cones are well preserved except metacone which is slightly broken down posteriorly. All the major cones are well preserved.

rP³ (PC-GCUF 78, /2018)

The specimen is upper right third premolar. It is well preserved and in early stage of wear. All the basic cones are well preserved. The shallow cavity is found between cones of the tooth. The enamel is moderately rugose and thick. The lingual side of the entire tooth has more rugosity as compared to buccal side. A cingulum is absent. The parastyle and mesostyle are well developed. Crown height is prominent at the buccal side of the tooth. Parastyle and mesostyle are moderately developed.

rM¹ (PC-GCUF 81/2018)

The specimen is upper right first molar having prominent protocone, paracone, hypocone while broken metacone. It is brachyodont and narrow crowned tooth. The enamel layer is extremely thick and crenulated with rugosity. The wrinkles are progressively prominent on the buccal side. The metaconule is surrounded by thick layer of enamel. The median basal pillar is absent. The cingulum is present posteriorly. Styles and median ribs are strongly developed. The paracone bears a parastyle which is thick proximally however narrow distally. Premetacrista and postmetacrista are practically equivalent in size. The metastyle and mesostyle are broken at its posterior side. The paracone has strong median rib but metacone bear faint median ribs.

The molar is antero-posteriorly extended and labio-lingually round and hollow. The spur can be seen in the anterior fossette of the tooth. The main cavities of specimen are deep and crescent in shape. The major cusps are in a straight line.

rM² (PC-GCUF 82, 83/2018)

The teeth under study are isolated upper right second molars. They are in the middle stage of wear and in an excellent state of preservation. Teeth are brachyodont and narrow crowned.

The wrinkles of thick enamel are observed on the lingual side. All the major cones of teeth are well developed and the external cones are somewhat taller than the internal ones. Parastyle, mesostyle and metastyle are prominent. The cavities are shallow. A well-developed protocone is present at the anterior and lingual side of both teeth.

The paracone is connected with the metacone through pillar like structure recognized as the mesostyle. The metacone is slightly taller than the paracone. The median ribs are well developed but the anterior median rib is more prominent than that of the posterior.

lP² (PC-GCUF 84/2018)

The described specimen is isolated upper left second premolar. It shows all the essential features such as the depth of enamel folds and the rugosity around the whole of the given specimen referred to *G. punjabiensis*. Anterio-posterior length is more than the transverse width. Paracone and metacone are more extensive while protocone and hypocone are shorter. There is no definite limit between protocone and hypocone of the specimen. The central cavity is framed between the major cusps. The tooth bears a

very strong parastyle.

lP³ (PC-GCUF 86/2018)

PC-GCUF 86/2018 is an isolated upper left third premolar with narrow crown. Cingulum is absent. Central cavity is moderately developed. Metastyle and mesostyle are well developed and parastyle is slightly damaged on anterior side. The tooth is in the middle stage of wear. The fossette are deep. The preparacrista is shorter than postparacrista. The enamel coating of postparacrista expands posteriorly and of premetacrista anteriorly to form a mesostyle which is slightly higher than parastyle and metastyle.

lM¹ (PC-GCUF 88/2018)

The upper left first molar is well preserved. The tooth is in the middle stage of wear. Anterior and posterior fossettes are present. Protocone and paracone are well preserved. Anterior median rib is prominent. The preprotocrista is similar to the postprotocrista while prehypocrista is higher than posthypocrista. Around metacone premetacrista and postmetacrista are approximately equal in size. The cingulum is laterally present. The enamel layer is thick and rogues. The molar is anteroposteriorly elongated and labiolingually cylindrical.

lM² (PC-GCUF 89/2018)

In general contour, the preserved upper left second molar is squared in form. A pressure mark is present anterior and posterior sides of the tooth, which indicate that they are second molar. Protocone is thick and rough. The paracone is sloped posteriorly and directed posteriorly to form a parastyle. Mesostyle and metastyle are very thick and strong. The specimen has almost equivalent length and width. The paracone and metacones contain very strong and thick labial ribs.

The preparacrista and postparacrista are about the same in size as compared to premetacrista which is elongate to postmetacrista. The metastyle and mesostyle are wide and strong. Median basal pillar is absent. The anterior and posterior cavities are V shaped and are encompassed by thick layer of enamel outline. The cingulum is strongly developed on the both sides of the tooth.

lM³ (PC-GCUF 90/2018)

It is an isolated upper left third molar and present in excellent stage of preservation. The enamel is thick and rugose. On the lingual side, the wrinkles are progressively prominent when compared with the buccal side of tooth. The median basal pillar is absent. The cingulum is well developed on anterior and posterior sides of the tooth. All the cones are well developed and the outer cones are slightly taller than the inner cones. A well-developed protocone is present on the buccal side of the tooth.

The anterior limb is larger than the posterior ones. The paracone is medially pointed and is present at the antero-buccal side of the tooth. At the posterior side it is connected with the metacone which is well developed. The metacone is equivalent to the paracone. The ribs are strong and prominent. A well-developed hypocone is present on the posterior lingual side of the tooth having no connection with the protocone. V shaped fossettes are present in the specimen.

Comparison and discussion

The specimens described here are of typical giraffid form due to the presence of essential features such as the depth of enamel folds, crescentic cusps, and rugosity, relatively weak styles and median ribs. When the specimen under study PC-GCUF 77/2018 is compared with AMNH 19475, GCUPC 1161/12, PUPC 08/35 and GCUPC 1140/12, it is evident that the anterio-posterior length and crown width are comparable.

The specimen PC-GCUF 78/2018 is smaller in size with the type specimen. The measurements of third upper premolar described here strongly looks like PUPC 08/33, AMNH 19475, GCUPC 1173/09, GCUPC 1172/09, PUPC 09/67, AMNH 19475 and AMNH 19930. PC-GCUF 81/2018 is an upper right first molar with narrow crowned. The median ribs and styles are less pronounced and the measurements and

tooth morphology resemble a close association with the type specimens PUPC 08/31, PUPC 08/105, AMNH 19311 and AMNH 19334. PC-GCUF 81/2018 and PC-GCUF 82/2018 are upper right second molars and are practically identical to PUPC 08/18, PUPC 08/28, GCUPC 1184/12, PUPC 07/133, AMNH 19475 and AMNH 19472 (Table 1).

Table 1. Comparative dental measurements of the *Giraffokeryx punjabiensis* cheek teeth in mm (millimeters).

Number	Position	Length	Width	W/L ratio
PC-GCUF 77/2018*	rP^2	19.92	19.52	0.97
PUPC 08/97	rP^2	20.50	18.00	0.87
AMNH 19475	rP^2	22.00	19.00	0.86
GCUPC 1161/12	rP^2	16.10	9.10	0.57
GCUPC 1140/12	rP^2	18.00	10.00	0.56
PUPC 08/35	rP^2	22.00	19.00	0.86
PC-GCUF 78/2018*	rP^3	21.78	20.29	0.93
PUPC 08/33	rP^3	23.00	21.50	0.93
AMNH 19475	rP^3	20.50	20.00	0.98
GCUPC 1173/09	rP^3	22.70	21.40	0.94
GCUPC 1172/09	rP^3	22.50	19.40	0.86
PUPC 09/67	rP^3	25.00	22.00	0.88
AMNH 19475	rP^3	20.50	20.00	0.97
AMNH 19930	rP^3	22.00	20.00	0.91
PC-GCUF 81/2018*	rM^1	25.77	25.80	1.00
PUPC 08/31	rM^1	25.50	25.00	0.98
PUPC 08/105	rM^1	24.00	23.00	0.96
PUPC 08/113	rM^1	26.00	26.00	1.00
PUPC 94/07	rM^1	25.00	17.00	0.68
AMNH 19311	M^1	25.50	25.00	0.98
AMNH 19334	M^1	24.00	24.00	1.00
AMNH 19593	M^1	23.00	22.00	0.96
PC-GCUF 82/2018*	rM^2	25.77	25.80	1.00
PC-GCUF 83/2018*	rM^2	27.35	26.80	0.98
PC-GCUF 82/2018*	rM^2	26.00	27.00	1.03
PUPC 08/18	rM^2	28.50	27.00	0.95
PUPC 08/28	rM^2	30.00	29.00	0.97
GCUPC 1184/12	rM^2	29.40	28.10	0.95
PUPC 07/133	rM^2	25.60	27.00	1.05
AMNH 19475	rM^2	25.00	27.00	1.08
AMNH 19472	rM^2	27.00	25.50	0.94
PC-GCUF 84/2018*	lP^2	20.00	13.00	0.65
PUPC 08/35	lP^2	22.00	19.00	0.86
PUPC 08/97	lP^2	20.50	18.00	0.87
AMNH 19475	P^2	22.00	19.00	0.86
PC-GCUF 86/2018*	lP^3	21.42	21.40	0.99
PC-GCUF 04/18	lP^3	22.86	19.81	0.84
PC-GCUF 01/14	lP^3	18.50	19.50	1.05
UOGPC 17/10	lP^3	21.10	20.30	0.96
AMNH 19475	lP^3	20.50	20.00	0.97
AMNH 19930	lP^3	22.00	20.00	0.91
PC-GCUF 88/2018*	lM^1	28.02	28.04	0.98
UOGPC 17/07	lM^1	22.00	23.00	1.04

UOGPC 17/04	lM¹	23.70	24.60	1.03
GCUPC 706/05	lM¹	26.20	27.10	1.03
GCUPC 1185/12	lM¹	27.50	28.00	1.02
AMNH 19475	lM¹	22.00	24.00	1.09
AMNH 19334	lM¹	25.50	25.00	0.98
AMNH 19311	lM¹	23.00	22.00	0.95
AMNH 19593	lM¹	23.00	22.00	0.95
PC-GCUF 89/2018*	lM²	28.51	28.00	0.98
PUPC 08/18	lM²	28.50	27.00	0.95
PUPC 69/137	lM²	29.00	29.00	1.00
UOGPC 17/07	lM²	26.80	25.70	0.95
AMNH 19472	lM²	27.00	25.00	0.93
AMNH 19611	lM²	26.00	27.00	0.96
AMNH 19320	lM²	29.00	28.50	0.98
PC-GCUF 90/2018*	lM³	31.94	30.19	0.94
PUPC 95/23	lM³	31.00	23.00	0.74
PUPC 66/95	lM³	26.00	28.00	1.07
UOGPC 17/07	lM³	27.20	27.90	1.02
GSI B182	lM³	29.00	31.00	0.94
AMNH 19475	lM³	24.00	26.00	1.08

*The studied fossil specimens. Referred data is taken from Pilgrim (1911), Matthew (1929), Colbert (1935), Bhatti (2005), Samiullah (2011); Bhatti *et al.,* (2012); Khan *et al.,* (2012).

PC-GCUF 83/2018 is an upper right third molar and is almost similar to PC-GCUF 02/14, PC-GCUF 03/14, AMNH 19325, AMNH 19327 and AMNH 19475. PC-GCUF 82/2018 and PC-GCUF 83/2018 are right upper second molars respectively, and when they are compared with AMNH 19475, it is clear that they are similar with PUPC 08/18, PUPC 08/28.

They are narrow crowned like GCUPC 1184/12, PUPC 07/133 AMNH 19472. All the major cusps are well preserved with a groove on lingual side.

The anterio- posterior length of the teeth is more prominent than the transverse width as compared to type specimens (Table 1). PC-GCUF 84/2018 is upper left second premolar and it is compared positively with AMNH 19475, PUPC 08/35 and PUPC 08/97. PC-GCUF 86/2018 is an upper left third premolar with small size. When the described study material examined on the basis of tooth size, enamel formation and structure of crown, the specimens resembles with the type specimens of *Giraffokeryx punjabiensis* given by Colbert, 1935 and are also comparable with PC-GCUF 04/18, PC-GCUF 01/14, UOGPC 17/10, AMNH 19475 and AMNH 19930.

PC-GCUF 88/2018) is upper left first molar and resembles with the previously collected specimens of the genus *G. punjabiensis* when compared with UOGPC 17/07, UOGPC 17/04, GCUPC 706/05, GCUPC 1185/12, AMNH 19475, AMNH 19334, AMNH 19311 and AMNH 19593. PC-GCUF 89/2018 is an upper left second molar and is compare able with PUPC 08/18, PUPC 69/137, UOGPC 17/07, AMNH 19472, AMNH 19611 and AMNH 19320. PC-GCUF 90/2018 is upper left third molar and is similar to PUPC 95/23, PUPC 66/95, UOGPC 17/07, GSI B182 and AMNH 19475. As all the specimens under study show all the morphological features of the cheek teeth described by Matthew (1929); Colbert (1935); Sarwar (1990); Khan *et al.* (2010a); Samiullah (2011); Bhatti *et al.* (2012a), therefore, we confirm their inclusion in *Giraffokeryx punjabiensis*.

General Discussion

The study specimens comprise ten fossil remains of giraffids from the area of Dhok Bun Ameer Khatoon of Lower Siwaliks of Punjab, northern Pakistan. The teeth are in tetra tuberculated structure having crescentic cups and strongly rugose enamel which show the characteristics of herbivorous mammalian

fauna so they can be placed in the sub order ruminantia, order artiodactyla and family giraffidae (Romer, 1974; Zittle, 1925). The giraffid teeth are brachydonts with low crown, moderately thick enamel, absence of median basal pillar, outer cups of teeth slightly higher than inner, posterior and anterior fossettes, crescentic outline; median ribs may or may not be prominent. The dentition described here show similar above mention characters of family Giraffidae.

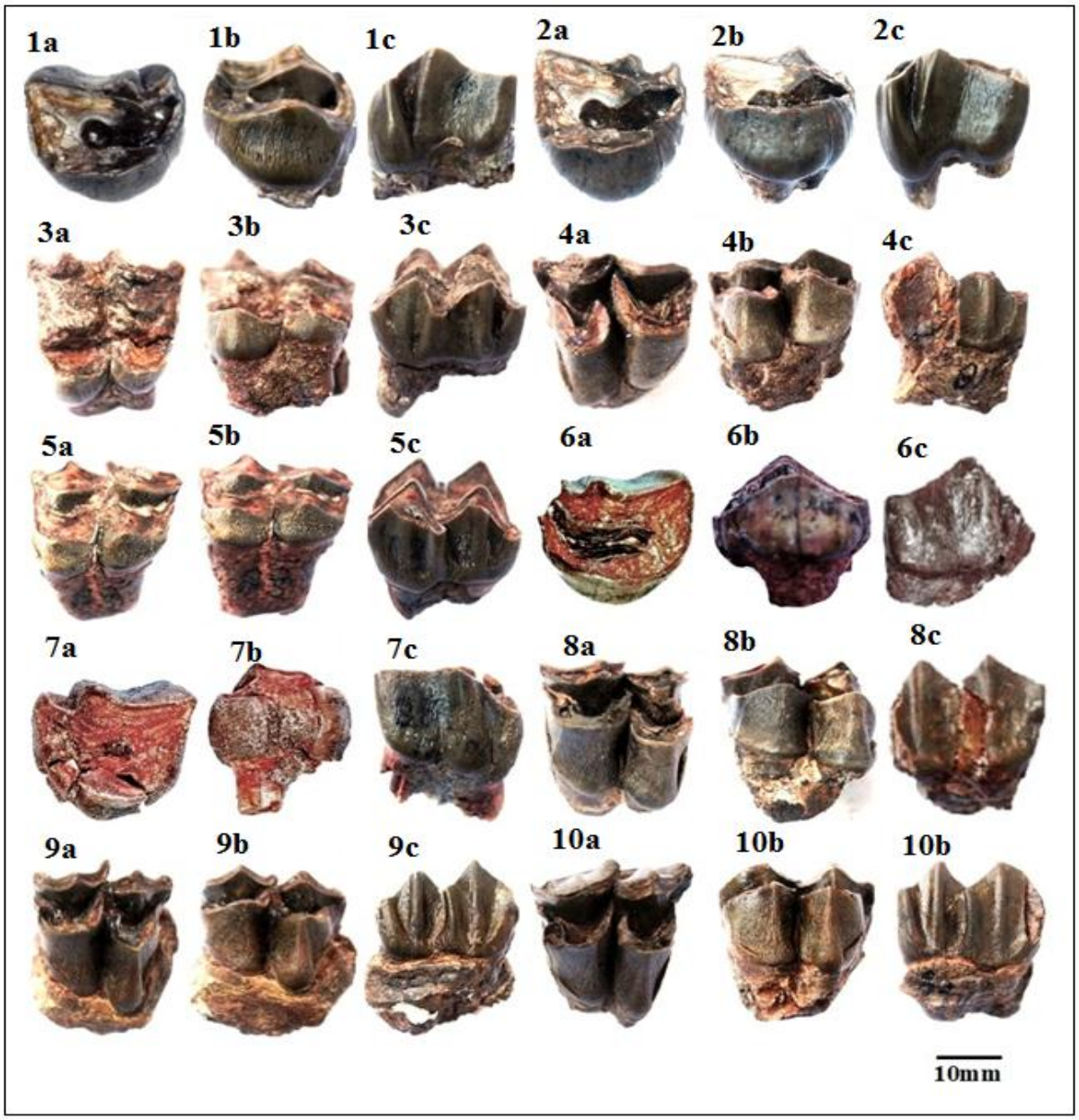

Fig. 2. *Giraffokeryx punjabiensis*: 1- rP^2 (PC-GCUF 77/2018); 2- rP^3 (PC-GCUF 78/2018); 3- rM^1 (PC- GCUF 81/2018); 4, 5- rM^{2}s (PC-GCUF 82/2018 and PC-GCUF 83/2018); 6- lP^2 (PC-GCUF 84/2018); 7- lP^3 (PC-GCUF 86/2018); 8- lM^1 (PC-GCUF 88/2018); 9- lM^2 (PC-GCUF 89/2018); 10- lM^3 (PC-GCUF 90/2018).

The Chinji Formation, Lower Siwalik is Middle Miocene in age (Barry *et al.,* 2002). The age of the Artiodactyla well evolved from the Lower Siwaliks is obviously later than the early Miocene and appeared being sooner than the Pliocene. Indeed, artiodactyl mammals in the Lower Siwaliks belong to the families Bovidae, Anthracothridae, Tragulidae, Suidae and Giraffidae. Thus, the recovered data from Lower Siwaliks give an indication of this age. Giraffids are present extremely very common in Lower Siwaliks.

In the current work, the collected specimens of giraffes show proceeding with size increments after 10 Ma. The study areas are located in the Potwar Plateau of northern Pakistan, belong to the Lower Siwaliks and have yielded fossils of Middle to late Miocene in the current study.

Progiraffa, Giraffa priscilla and *Giraffokeryx punjabiensis* have been recorded from the Chinji Formation of the Lower Siwaliks. *Giraffa priscilla* is only present in the Chinji Formation of the Siwaliks while it is not reported outside of this region. These species have been recovered from the Middle Miocene locality Ramnagar, Uttarakhand, India (Basu, 2004). The *Giraffokeryx* in this study reveals that the Chinji Formation has seasonal forest along with riparian areas of woods which testifies the compositional change of the Siwaliks from seasonal forest to tree savannas. *Giraffokeryx punjabiensis* adjusted them in savannas and were mixed feeders (Solounias and Moelleken, 1993; Solounias *et al.,* 2000; Franz Odendaal and Solounias, 2012). The recognized giraffid species from the lower Siwalik are associated with *Microbunodon*, *Gazella*, *Listriodon*, *Elachistoceras*, *Dorcatherium*, *Merycopotamus*, *Conohyus*, *Dorcabune* and *Gaindatherium*. However, the bovids are recorded abundantly from the Siwalik deposits of Miocene (Lydekker, 1876, 1883, 1884; Pilgrim, 1910, 1937, 1939; Colbert, 1935; Thomas, 1984; Badgley *et al.,* 2008; Khan and Akhtar, 2013; Samiullah *et al.,* 2015 a, b, c).

The mammalian diversity of Lower Siwalik determines a mixture of habitats from wet lands and dense forested pockets to the forest ecosystem. The fossil localities of Lower Siwaliks of Pakistan can be associated with the late Miocene diversity of adjacent continental provinces.

Making comparisons of Lower Siwaliks mammals show slight resemblance with the rich Turolian faunal assemblage. Boselaphini, Bovini, and Antilopini are reported from Turolian of the Graeco-Iranianprovince besides their presence in the Lower Siwaliks while Tragulidae are rare in Turolian. Moreover, species abundant here show primitive characters and are differentiated from the species of South and East South Africa. Gentry (1999) identified several species of Artiodactyla from the Late Miocene localities of Baynunah Formation in Abu Dhabi. Several descriptive phases occurred for the Late Miocene (Turolian and Vallesian) faunas that are reported from Greece, via Turkey to Iran, recognized as the Graeco-Iranian province (Iliopoulos, 2003). Information's of these faunas were initiated from the study of the several localities of Maragheh (Iran), Pikermi and Samos (Greece) which was known from the nineteenth century (Solounias, 1982a; Gentry, 1999).

Conclusions

Giraffokeryx punjabiensis is reported from the Late Miocene locality of the Lower Siwalik Subgroup. The new materials of giraffid specimens have been recorded from the DBAK locality of the Chinji Formation. The small sized giraffids were the most successful giraffids in the Late Miocene localities of the Siwaliks, inhabiting forests and woodlands.

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