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DENTAL REMAINS AND PALAEOECOLOGY OF *GIRAFFOKERYX PUNJABIENSIS* FROM HOMINOID BEARING LOWER SIWALIKS OF RAMNAGAR BASIN (J&K), INDIA

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ABSTRACT

Ramnagar basin of Jammu and Kashmir area of India is known world over for its fossil primate remains. Several fossil prosimians and hominoids, such as Sivapithecus and Sivaladapis, have been reported from this region. In addition, a plethora of fossil mammals have also been reported from the Ramnagar Basin. The present paper describes fossilized dental remains (lower premolars and molar) of Giraffokeryx punjabiensis collected from the Chinji Formation of Lower Siwalik deposits at Ramnagar (J & K), India. All the specimens are isolated. The dental remains indicate that Girafokeryx punjabiensis was herbivorous browser. The present paper deals with the systematic description of the fossil material of Giraffokeryx. A brief account of the palaeoecological conditions prevalent during Chinji times has also been provided.

***Keywords**: Palaeocology, Giraffokeryx, Chinji Formation, Lower Siwaliks, Dental Remains*

INTRODUCTION

Ramnagar basin of Jammu and Kashmir region of India is known the world over for its fossil primate remains. Several fossil prosimians and hominoids, such as *Sivapithecus, Sivaladapis, Ramadapis, and Kapi*, have been reported from this region (Vasishat *et al.*, 1978; Gaur and Chopra, 1983; Sehgal and Patnaik, 2012; Gilbert *et al.*, 2017; Gilbert *et al.*, 2020). In addition, a plethora of fossil mammals have also been reported from the Ramnagar basin (Vasishat *et al.*, 1978; Gaur, 2016). The fossiliferous Lower Siwalik deposits of Ramnagar basin display very close faunal and lithological resemblances to those of the Chinji Type locality in the Potwar Plateau of Pakistan and are therefore attributable to Chinji Formation of Lower Siwaliks (Vasishat *et al.*, 1978; Gaur

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and Chopra, 1983; Basu, 2004, Gaur, 2016). In the Ramnagar Basin, the Lower Siwalik Chinji rocks are better exposed than even at the famous Haritalyangar area (Gaur, 2016). The geological age of these deposits varies from 11 to 13 million years (Vasishat *et al.*, 1978, 1979; Basu, 2004). In a recent study, Sehgal and Patnaik (2012) increased the age of Ramnagar faunal assemblages to between at the least ~13.2 MY and 13.8 million years, on the basis of fossil rodent faunal remains. At Ramnagar the Chinji deposits are characterized by alternating sequences of medium to fine grained grey, reddish and reddish-brown sandstones and dominant variegated clays (Vasishat *et al.*, 1979). In this communication we report dental remains of 11 to 13-million-year-old giraffid taxon, *Giraffokeryx punjabiensis,* from the Chinji Formation of Ramnagar Basin (J & K), India. A brief account of the palaeoecological conditions prevailing during Chinji times has also been presented.

The fossil giraffids were widespread both in Asia, Europe and Africa and included several genera (Colbert, 1935; Churcher, 1978; West, 1981; Geraads, *et al.*, 1995; Kostopoulos and Sarac, 2005; Iliopoulos and Roussiakis, 2022). Giraffidae first appeared in the Early Miocene of Africa by the presence of *Zaraffa* and *Prolybitherium* (Churcher, 1978; Geraads, 1986). The genus *Giraffokeryx* was created by Pilgrim (1910). *Giraffokeryx punjabiensis* has been recorded from the Siwaliks (Matthew, 1929; Colbert, 1933, 1935; Gaur *et al.*, 1985; Bhatti *et al.*, 2007) and Greco-Irano-Afganian province (Geraads *et al.*, 1995). Pilgrim (1911) made the first comprehensive study on "The Fossil Giraffidae of India". Akhtar and Sarwar (1991) divided the Siwalik giraffids into large forms (*Bramatherium*, *Hydaspitherium*, *Sivatherium*, *Helladotherium* and *Vishnutherium*) and small forms (*Giraffokeryx* and *Giraffa*). The Siwalik giraffids were studied by several workers namely, Falconer and Cautley (1836), Falconer (1845), Forsyth-Major (1891), Pilgrim (1911), Bohlin (1927), Colbert (1933, 1935), Lewis (1939), Churcher (1978), Gaur (1987), Gaur *et al.* (1985), Akhtar *et al.* (1991), De Bonis *et al.* (1997), Franz-Odendaal and Solounias (2004), Samiullah (2011), etc. The giraffid history is not clearly deciphered in the Siwaliks (Gentry, 1999). Though, the giraffids made their appearance in the Kamlial Formation of the Siwaliks (Raza *et al.*, 1984), nevertheless, they remain poor in quality but relatively abundant in quantity in the lower part of the Chinji Formation. The Chinji Formation contains the fossils of a mixture of arboreal, burrowing, and terrestrial micro- and macromammals with the dominance of terrestrial herbivores (Badgley *et al.* 2008). *Giraffokeryx* occurs in the middle Miocene fresh water deposits of Eurasia (Colbert, 1935; Geraads and Aslan, 2003; Geraads *et al.*, 1995). *Giraffokeryx punjabiensis* disappeared from the Nagri Formation about 10 million years ago, and only large giraffes were present for the rest of Miocene (Barry *et al.*, 1982). At present, *Giraffokeryx punjabiensis* is the only valid species of genus *Giraffokeryx* known from Siwaliks.

MATERIALS AND METHODS

The present research paper is based on the fossil specimens of *Giraffokeryx* collected from the Chinji sediments of the Ramnagar Basin of Jammu and Kashmir, India. The dental specimens reported here are part of a UGC major project awarded to Professor Rajan Gaur under Grant, number F. No. 39-76/ 2010 (SR). The data collection was carried out during several field expeditions spread over the field seasons from 2011 to 2014 by the authors.

Ramnagar is a small hilly town of Udhampur District of Jammu and Kashmir, located approximately 38 kilometers from Udhampur Town of Jammu District. The town is famous for Ramnagar Fort, which is believed to have been built by Raja Suchet Singh. The fort is now a protected monument under the care of Archaeological Survey of India, since 1972.

The systematic palaeontology and related aspects are detailed as follows:

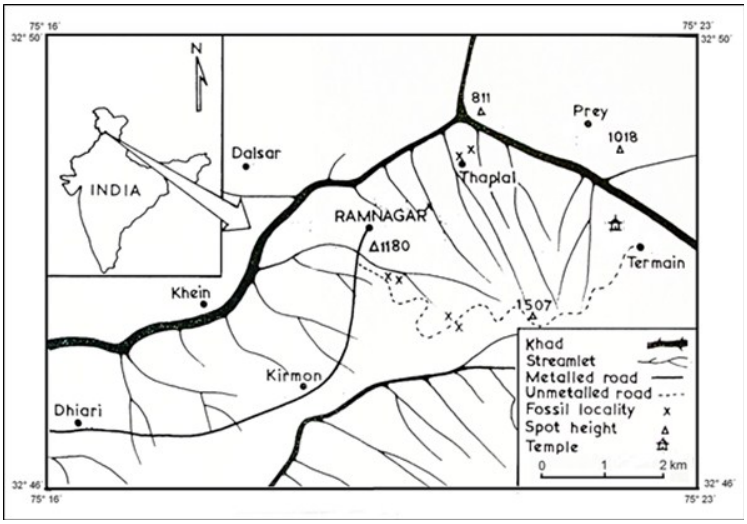

Figure-1: Locality map of the Ramnagar area (Modified after Vasishat *et al.*, 1978)

Systematic Palaeontology

Order	Artiodactyla	Owen, 1848
Suborder	Rumantia	Scopoli, 1777
Superfamily	Giraffoidea	Gray, 1821
Family	Giraffidae	Gray, 1821
Subfamily	Giraffinae	Zittel, 1893
Genus	*Giraffokeryx*	Pilgrim, 1910

Type Species: *Giraffokeryx punjabiensis* Pilgrim, 1910

Species *Giraffokeryx punjabiensis* Pilgrim, 1910

Type specimen: Lectotype GSI 502, a third molar (M^3) of the right maxilla.

Locality: The Chinji zone and vicinity, Salt Range Punjab.

Horizon: Lower Siwaliks, Chinji Formation and the lower section of the Middle Siwaliks.

Present material:

1. UGC-RG/13/22-TP- Lower premolar (P_2), 2. UGC-RG/13/23-TP- Lower premolar, (P_3), 3. UGC-RG/13/29-NJ- Lower premolar (P_4), 4. UGC-RG/13/30-NJ- Lower half molar (M_1).

Localities: UGC-RG/13/22-TP and UGC-RG/13/23-TP- 100 meters EEN of Degree College along the road at Thaplal; UGC-RG/13/29-NJ and UGC-RG/13/30-NJ- about 400 mts NE of Nagrii Village along the Ramnagar -Tarmain Road (Figure-1).

Horizon: Lower Siwaliks, Chinji Formation.

Description

Table-1 shows the comparative measurements of present specimens of *Giraffokeryx* with others. Figure-2 presents the occlusal, buccal and lingual views of the specimens under description.

P_2: The present specimen (UGC-RG-13/22-TP) is a lower second premolar. The paraconid is not distinct from the parastylid. There is very slight wear on hypoconid and the paraconid. The hypoconid is more prominent than the other conids. The enamel is thick and rugose. The colour of enamel is greyish brown.

P_3: The present specimen (UGC-RG-13/23-TP) is a lower third premolar. The paraconid is separated from the parastylid. The anterior valley is open. The metaconid extends forwards meeting the base of the paraconid. The crest joining the protoconid to the metaconid is oblique backwards. The dentine can be seen on all the conids. The enamel is thick and rugose and rugosity is seen more on the buccal surface. The enamel on inner surface of tooth is smooth. The colour of enamel is greyish brown.

P_4: The present specimen (UGC-RG-13/29-NJ) is a lower fourth premolar. It is slightly larger than third premolar. It is a well preserved tooth. Dentine can be seen on all conids. They are hypsodont and narrow crowned. The enamel is thick and rugose; the rugosity is more prominent on the buccal side. The paraconid is fairly distinct and separated from the parastylid by a wide furrow. The paraconid and the metaconid are not fused and a deep valley is present between them. The metaconid is higher than the paraconid which is growing backward, enclosing an elongated and transverse valley together with the entoconid. The protoconid is connected to the hypoconid. The metaconid extend forwards meeting the base of the paraconid. The crest joins to the metaconid and incorporates the entoconid. The metaconid is expanded into the lingual valley, blocking the anterior valley. The protoconid is connected to the hypoconid. A well-developed furrow separates the hypoconid from the strong. The conids are filled with dentine. The dentine is light pinkish in colour. The entostylid is

weakly developed. The hypoconid is projected latterly with a deep valley in front of it.

M_1: The present specimen UGC-RG-13/29-NJ is a lower left isolated half first molar. The enamel is moderately thick and very rugose. The rugosity is more prominent on the buccal side, as compared to that of the lingual side. The only posterior half is present and it shows two conids, the metaconid and hypoconid. The conids are filled with dentine. The posterior cavity in between metaconid and hypoconid is very narrow.

Comparisons:

The present dental specimens are smaller in size than *Sivatherium* and *Bramatherium* and come close in size to *Giraffokeryx* and *Giraffa. Giraffokeryx punjabiensis* is very close to *Giraffa priscilla* in size (Colbert, 1935). In genus *Giraffa,* styles and median ribs are strong and well pronounced and crown is slightly broad while in *Giraffokeryx* styles are weak, median ribs are absent and crown is slightly narrow. Furthermore, the crown is narrow in *Giraffokeryx* and it is broad in *Giraffa* (Pilgrim, 1910). Stylids are weakly developed in the specimen under study, which is a major character of the genus *Giraffokeryx*. The specimens have characteristic depth of the central enamel folds, enamel layer rugosity and shape of the major conids. The present specimens are much more similar to *Giraffokeryx punjabiensis* and the teeth show the typical morphology of the species. The teeth stylids and less pronounced median ribs are features that match those of the *Giraffokeryx punjabiensis* holotype (Colbert, 1935). The present specimens, shows distinct morphological and metrical resemblances with *Giraffokeryx punjabiensis*. Hence it is assigned to *Giraffokeryx punjabiensis*.

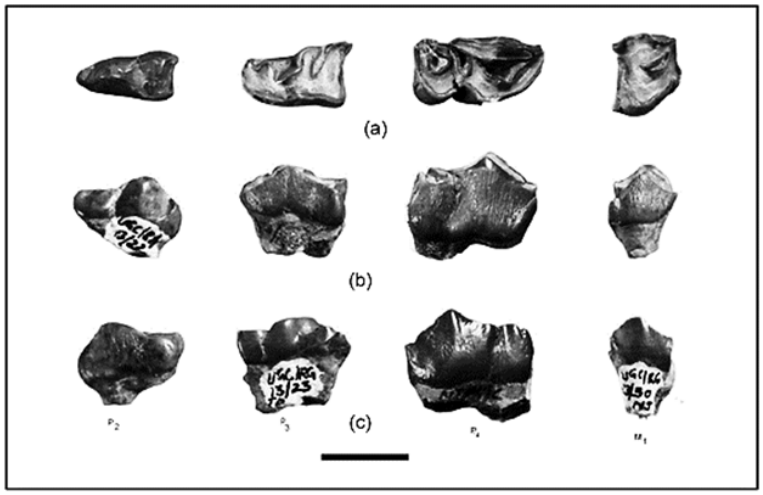

Figure-2: Occlusal, buccal and lingual views of mandibular P_2 (UGC-RG/13/22TP); P_3 (UGC-RG/13/23-TP); P_4 (UGC-RG/13/29-NJ) and half M_1 (UGC-RG/13/30-NJ). (a): Occlusal views, (b): Buccal views, (c): lingual views. Bar represents one centimeter.

DISCUSSION

The review of literature reveals that several fossil giraffid genera such as *Propalaeomeryx, Bramatherium, Hydaspitherium* and *Helladotherium*, *Giraffa, Hanotherium*, *Camelopardalis, Vishnutherium, Sivatherium, Indratherium, Giraffokeryx* have been known from Siwaliks of India and Pakistan (Gaur,1987). The Siwalik giraffids may be divided into two groups: one comprising larger forms, the other, smaller forms. The larger forms are represented by five genera, viz., *Sivatherium, Bramatherium, Hydaspitherium, Helladotherium and Vishnutherium*, while smaller forms of fossil giraffids consist of two genera, namely *Giraffokeryx* and *Giraffa*. The giraffids in India made their first appearance in Chinji stage of the Siwaliks. However, the record is poor and is based on two genera and three species. These are *Giraffokeryx punjabiensis* (Pilgrim, 1910), *Giraffokeryx chinjiensis* (Sarwar, 1990) and *Giraffa priscilla* (Mathew, 1929). *Giraffokeryx punjabiensis* was a widespread species which was known to occur only from Chinji to Nagri Formations of Siwalik deposits. However, for the first time, *Giraffokeryx punjabiensis* was reported from Dhokpathan Formation near Haritalyangar, Bilaspur (H.P.) by Gaur *et al.* (1977). With this discovery, the upper limit of this species was extended to Dhokpathan Formation in the Siwaliks. Many workers on various occasions merged certain genera with other genera to reduce the number of taxa and to remove the confusion in the Siwalik giraffids existing at that time. Consequently, *Propalaeomeryx w*as assigned to *Hydaspatherium* by Mathew (1929) and Colbert (1935); *Indratherium* was synonymisd with *Sivatherium* by Mathew (1929) and Colbert (1935); *Honotherium* and *Orasius* were synonymised under *Giraffa* by Mathew (1929) and Colbert (1935) and *Hydaspatherium* was considered a junior synonym of *Bramatherium* by Lewis (1939) and Hamilton (1978). Subsequently, Gaur *et al.* (1985) published an exhaustive review of the Siwalik fossil giraffids and reduced the number of Siwalik fossil giraffid genera to only four, viz., *Giraffokeryx, Giraffa, Bramatherum* and *Sivatherium*, with six species in all.

Palaeoecological Inference

The general, lithology of Ramnagar sediments is suggestive of fluviatile environment and low energy depositional conditions of laterally shifting rivers on a broad flood plain under oxidizing, warm and probably humid climatic conditions (Gaur and Chopra, 1983). In a recent study, Pandita and Bhatt (2012) have also concluded that the Lower Siwalik Chinji sediments at Ramnagar were deposited by a flood flow dominated meandering riverine system. Gaur and Chopra (1983) inferred the presence of localised water bodies on the flood-plain, on the basis of the fossil gastropods, unionids, and crustacean fossils recovered by them. Gaur (2016) provided a list of mammalian taxa known from the Chinji deposits of Ramnagar and concluded that the assemblage was of mixed type but dominated by closed habitat forms, such as *Sivaladapis* and *Sivapithecus*, which suggest a dominant forested ecology. The presence of

Giraffokerys indicates the occurrence of some less forested/ open areas also. A closer examination of the occlusal surfaces of the dental specimens being reported here indicates browsing adaptations for *Giraffokerys punjabiensis,* which probably browsed on the foliage. Gaur (2016) suggested that the occurrence of fauna, such as *Amphicyon, Vishnufelis, Deinotherium, Listriodon,* gomphotherids, etc., supports the occurrence of wooded conditions.

Table-1: Comparative measurements of *Giraffokeryx* with other known giraffidae genera from Lower Siwaliks of India

Measurement	Tooth	Present specimens				*Giraffokeryx punjabiensis* Colbert,1935		*Giraffa punjabiensis* Colbert,1935
		UGC 13/23	UGC 13/24	UGC 13/29	UGC 13/30	AMNH 19587	AMNH 19849	AMNH 19318
Max. mesio-distal diameter (L)	P_2	16.9	--	--	--	18.0	16.0	20
Max. bucco-lingual diameter (B)	P_2	9.05	--	--	--	9.0	9.0	11
Index (B/L X 100)	P_2	54	--	--	--	50	56	55
Max. mesio-distal diameter (L)	P_3	--	20.7	--	--	20.5	22	21
Max. bucco-lingual diameter (B)	P_3	--	12.0	--	--	12.0	11	17
Index (B/L X 100)	P_3	--	58	--	--	59	50	81
Max. mesio-distal diameter (L)	P_4	--	--	23.40	--	24.0	19	24
Max. bucco-lingual diameter (B)	P_4	--	--	12.60	--	15.0	11.5	20
Index (B/L X 100)	P_4	--	--	54	--	62	60	83.3
Max. mesio-distal diameter (L)	M_1	--	--	--	--	24	20	27
Max. bucco-lingual diameter (B)	M_1	--	--	--	14.50	14	14.5	22
Index (B/L X 100)	M_1	--	--	--	---	58.3	72.5	81.4

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