



REVISED MAMMALIAN BIOSTRATIGRAPHY OF THE LOWER SIWALIK SEDIMENTS OF RAMNAGAR (J. & K.), INDIA AND ITS FAUNAL CORRELATION

R. K. SEHGAL

WADIA INSTITUTE OF HIMALAYAN GEOLOGY
33, GENERAL MAHADEO SINGH ROAD
DEHRA DUN- 248 001, INDIA
Email: rksehg@wihg.res.in

ABSTRACT

A revision of the mammalian biostratigraphy of the Lower Siwalik sediments of Ramnagar (J.&K.) has been attempted, in view of the recent fossil findings, especially micro-mammals. This locality is famous for primate fossils, and has yielded a rich and diversified mammalian assemblage. In all, 46 mammalian species are recorded from the area and, among these 12 species have been reported for the first time from this area during the present research. Bulk of the fauna depicts a Lower Siwalik age for the sediments, and there are at least 11 taxa in the assemblage which are found to be restricted within the Chinji Formation of the type section in Potwar Plateau, Pakistan. No fauna belonging to the Kamli Formation (older part of the Lower Siwalik) has yet been reported from India. Therefore, the Ramnagar locality can be safely regarded as the oldest fossil yielding locality for The Siwalik sediments in India.

The faunal assemblage from Ramnagar has been compared to various other Lower Siwalik localities including the Chinji Type Section and Daud Khel (both in Pakistan), Kalagarh (India) and Dang Valley (Nepal). It shows a very close faunal resemblance with the Chinji Type Section, Daud Khel and Dang Valley. However, the Kalagarh assemblage is comparatively younger and represents Lower/ Middle Siwalik transition.

Keywords: Siwalik Group, Chinji Formation, Potwar Plateau, Ramnagar, faunal assemblage, type section

INTRODUCTION

The Siwalik Group forming an extensive belt of fresh water molassic deposits along the southern foothills of the Himalaya ranges in age from 18.3 to .22 Ma (Johnson *et al.*, 1985; Ranga Rao *et al.*, 1988). It preserves a gradational succession of continental sediments of more than 6000 m thickness. One of the most significant characters of the Siwalik Group is its richness in vertebrate fossils, especially mammals, for which it is well known all over the world. Pilgrim (1910, 1913) divided the Siwalik Group into three subgroups - Lower, Middle and Upper. He further subdivided the three subgroups into various formations. The Lower Siwalik Subgroup is classified into the Kamli and Chinji Formations, which have yielded a rich vertebrate fauna, and the type sections of both the formations lie in The Potwar Plateau, Pakistan.

In India, the Siwalik succession of Ramnagar is one of the most promising localities for the Lower Siwalik Subgroup. It is a small town in Udhampur District (J. & K.) and lies 38 km. northeast of Jammu. It provides a central link between the type sections located in The Potwar Plateau to its northwest, and the Siwaliks of India and Nepal to its southeast. A number of workers have contributed towards the geology and vertebrate palaeontology of The Ramnagar area. Sehgal (1998) described fossil carnivores from Ramnagar, and Sehgal and Nanda (2002) discussed the palaeoecology of the region. Parmar and Prasad (2006) reported fossil rhizomyid rodent *Kanisamys potwarensis* from Ramnagar. Very recently Sehgal and Patnaik (2012) described two

short ranging rodents *Antemus chinjiensis* and *Megacricetodon cf. sivalensis* from this region.

The Lower Siwalik succession of Ramnagar occurs in the form of a plunging syncline, the axis of which runs NW- SE. Geographically the Lower Siwalik succession around Ramnagar is spread over an area of 20 sq. km. This succession conformably overlies the Murree Group and is gradationally overlain by the Middle Siwalik (Karunakaran and Ranga Rao, 1979, Sheet A). The exposures, at Ramnagar, are present in the form of low to medium hills, dip slopes, cusetas, scarps and hogbacks. The dip of the beds is very low; averaging around 12° towards northwest. Lithologically the succession is dominantly characterized by red to reddish brown, purplish and dark chocolate mudstones with alternations of grey and

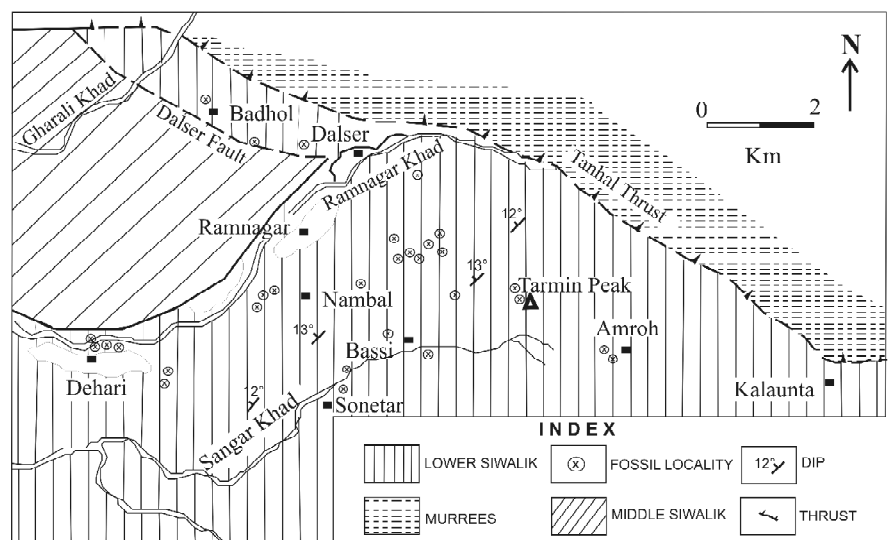


Fig. 1: Location and Geological map of the Ramnagar area (modified after Basu, 2004).

brown, fine to medium grained sandstones and intraformational clay conglomerate beds. The mudstone beds are multistoried in nature, as individual mudstone bed between two sandstone beds consists of several identifiable units differing in colour, grain size and texture.

The vertebrate fossils occur in pockets. The upper interval of the Lower Siwalik succession is more promising. The fossiliferous localities are concentrated around Nambal, Dehari, Sonetar, Amroh and Tarmin villages. The primate locality lies in village Dalser, where the Lower Siwalik exposures occur between Dalser Fault and Tanhal Thrust (Fig.1). The red mudstones and intraformational clay conglomerate beds are comparatively more fossiliferous. Only the Lower Siwalik sediments yielded fossils, and the Murrees and the Middle Siwalik, though well exposed in the area, are devoid of fossils. In Potwar Plateau, both the Kamliyal and Chinji Formations are well established, but in India, there is yet no report of the Kamliyal Formation and the Lower Siwalik Subgroup is represented only by the Chinji Formation. A location and geological map of the Ramnagar area is reproduced in Figure 1.

A revised mammalian biostratigraphy and a correlation of the Ramnagar assemblage with its equivalent fossiliferous localities within the Siwalik basin have been discussed in this communication.

FAUNAL ASSEMBLAGE AND AGE OF THE FAUNA

As said above the Ramnagar locality lying in Jammu sub-Himalaya is well known for primate fossils. A number of workers have contributed towards understanding the biostratigraphy, palaeoenvironment and palaeoecology of the Ramnagar area (Brown *et al.*, 1924; Lewis, 1934; Colbert, 1935; Dutta *et al.*, 1976; Vasishat *et al.*, 1978; Thomas and Verma, 1979; Gaur and Chopra, 1983; Nanda and Sehgal, 1993, 2005; Sehgal, 1998; Sehgal and Nanda, 2002; Basu, 2004; Parmar and Prasad, 2006; Sehgal and Patnaik, 2012). Singh *et al.*, (2011) performed stable isotope analyses of pedogenic carbonates of the region. All the workers considered the Ramnagar fauna as equivalent to the Chinji Formation of the type section. In view of the recent faunal discoveries from Ramnagar by Parmar and Prasad (2006) and Sehgal and Patnaik (2012), the faunal assemblage from Ramnagar has been critically re-examined, in the light of recent applied work carried out in Potwar Plateau (Barry *et al.*, 2002;

Badgley, 2008). No magnetostratigraphic data is available for the Ramnagar sediments; therefore faunal correlation with the type localities is the only viable method to derive an exact stratigraphic nature of the Ramnagar assemblage. The mammalian assemblage encountered from Ramnagar is compiled in Table 1.

The Ramnagar fossil assemblage is comprised of charophytes, fossil wood, invertebrates, reptiles and mammals. Mammals are the most dominant group and better preserved, being represented by primates, rodents, carnivores, proboscideans, perissodactyls and artiodactyles. In all 46 mammalian taxa have been reported from the area. Twelve mammalian species have been reported for the first time, by the author. These include: *Antemus chinjiensis*, *Megacricetodon cf. sivalensis*, *Eomellivora necrophila*, *Vishnuonyx chinjiensis*, *Percrocuta carnifex*, *Gaindatherium browni*, *Hippopotamodon haydeni*, *Hemimeryx pusillus*, *Dorcabune nagrii*, *Progiraffa sp.*, *Giraffa priscilla* and *Miotragocerus gradiens*. To provide a better resolution of the data; the faunal characterization of the Ramnagar assemblage (with reference to the Chinji stratotype), has been worked out, and presented in Table 2. The stratigraphic comparison of the fauna with the Chinji stratotype has been done after the classical work of Pilbeam *et al.*, 1977; Raza *et al.*, 1997; Barry *et al.*, 1982, 2002; and Badgley *et al.*, 2008.

It can be noticed from Table 2 that there are a large number of mammalian species, which show their first appearance in the Ramnagar assemblage. All of these species are also known from the Chinji stratotype in Potwar Plateau. Further, it is observed that there are 11 mammalian species in the Ramnagar assemblage which are found restricted within the Chinji Formation of the type section. These species are neither reported from the older Kamliyal Formation nor from the younger Nagri Formation and, thus are marker for the Chinji Formation. These include: *Antemus chinjiensis*, *Megacricetodon cf. sivalensis*, *Kanisamys cf. potwarensis*, *Eomellivora necrophila*, *Vishnuonyx chinjiensis*, *Viverra chinjiensis*, *Hippopotamodon haydeni*, *Conohyus chinjiensis*, *Anthracotherium punjabiense*, *Dorcabune anthracotherioides*, *Giraffa priscilla*. There are a few taxa in the Ramnagar assemblage which are survivals from the Kamliyal Formation. Among these *Deinotherium pentapotamiae*,

Table 1: Mammalian fauna from the Lower Siwalik deposits of Ramnagar area (J. & K.) (Compiled after Vasishat *et al.*, 1978; Gaur and Chopra, 1983; Nanda and Sehgal, 1993; Sehgal, 1998; Basu, 2004; Parmar and Prasad, 2006; Sehgal and Patnaik, 2012)

RODENTIA	* <i>Antemus chinjiensis</i> , * <i>Megacricetodon cf. sivalensis</i> , <i>Sivacanthion complicates</i> , <i>Kanisamys cf. potwarensis</i>
PRIMATES	<i>Sivaladapis palaeindicus</i> , <i>Sivapithecus sivalensis</i> , <i>S. indicus</i> , <i>S. simonsi</i>
CREODONTA	* <i>Dissopsalis carnifex</i>
CARNIVORA	* <i>Eomellivora necrophila</i> , <i>Amphicyon sp.</i> , * <i>Vishnuonyx chinjiensis</i> , * <i>Percrocuta carnifex</i> , <i>Viverra chinjiensis</i> , <i>Vishnufelis sp.</i>
PROBOSCIDEA	<i>Deinotherium pentapotamiae</i> , <i>Prodeinotherium sp.</i> , <i>Gomphotherium sp.</i> , <i>Tetralophodon sp.</i>
PERISSODACTYLA	<i>Aceratherium perimense</i> , * <i>Gaindatherium browni</i> , <i>Brachypotherium sp.</i> , <i>Chilotherium? intermedium</i> , <i>Chalicotherium sp.</i>
ARTIODACTYLA	* <i>Hippopotamodon (=Dicoryphochoerus) haydeni</i> , <i>Conohyus chinjiensis</i> , <i>C. sindiense</i> , <i>Listriodon pentapotamiae</i> , <i>Propotamochoerus sp.</i> , <i>Sus sp.</i> , <i>Anthracotherium punjabiense</i> , * <i>Hemimeryx pusillus</i> , <i>Dorcabune anthracotherioides</i> , <i>D. nagrii</i> , <i>Dorcatherium majus</i> , <i>D. minus</i> , <i>D. nagrii</i> , * <i>Giraffa priscilla</i> , <i>Giraffokeryx punjabiensis</i> , * <i>Progiraffa sp.</i> , <i>Helicopotax tragelaphoides</i> , <i>H. praecox</i> , <i>Protragocerus gluten</i> , * <i>Miotragocerus gradiens</i> , <i>Gazella sp.</i> , <i>Kubanotragus sokolovi</i>

*reported by the author for the first time from this area

Table 2: Faunal characterizations of Ramnagar fauna (with reference to the Chinji type section)

First Appearance:	<i>Antemus chinjiensis</i> , <i>Megacricetodon</i> cf. <i>sivalensis</i> , <i>Sivacanthion complicates</i> , <i>Kanisamys</i> cf. <i>potwarensis</i> , <i>Sivapithecus sivalensis</i> , <i>S. indicus</i> , <i>S. simonsi</i> , <i>Eomellivora necrophila</i> , <i>Vishnuonyx chinjiensis</i> , <i>Percrocuta carnifex</i> , <i>Viverra chinjiensis</i> , <i>Vishnufelis</i> sp., <i>Prodeinotherium</i> sp., <i>Gomphotherium</i> sp., <i>Tetralophodon</i> sp., <i>Aceratherium perimense</i> , <i>Gaiotherium browni</i> , <i>Brachypotherium</i> sp., <i>Chalicotherium</i> sp., <i>Hippopotamodon haydeni</i> , <i>Conohyus chinjiensis</i> , <i>C. sindiense</i> , <i>Propotamochoerus</i> sp., <i>Sus</i> sp., <i>Anthracotheium punjabiense</i> , <i>Hemimeryx pusillus</i> , <i>Dorcabune anthracotherioides</i> , <i>D. nagrii</i> , <i>Dorcatherium majus</i> , <i>D. minus</i> , <i>D. nagrii</i> , <i>Giraffa priscilla</i> , <i>Giraffokeryx punjabiensis</i> , <i>Helicopotax tragelaphoides</i> , <i>H. praecox</i> , <i>Protragocerus gluten</i> , <i>Miotragocerus gradiens</i> , <i>Gazella</i> sp., <i>Kubanostragus sokolovi</i>
Restricted Species: (within Chinji Formation)	<i>Antemus chinjiensis</i> , <i>Megacricetodon</i> cf. <i>sivalensis</i> , <i>Kanisamys</i> cf. <i>potwarensis</i> , <i>Eomellivora necrophila</i> , <i>Vishnuonyx chinjiensis</i> , <i>Viverra chinjiensis</i> , <i>Hippopotamodon haydeni</i> , <i>Conohyus chinjiensis</i> , <i>Anthracotheium punjabiense</i> , <i>Dorcabune anthracotherioides</i> , <i>Giraffa priscilla</i>
Survivor species: (from older horizons)	<i>Sivaladapis palaeindicus</i> , <i>Dissopsalis carnifex</i> , <i>Amphicyon</i> sp., <i>Deinoitherium pentapotamiae</i> , <i>Chilotherium? intermedium</i> , <i>Listriodon pentapotamiae</i> , <i>Progiraffa</i> sp.

Amphicyon sp., *Chilotherium intermedium* and *Listriodon pentapotamiae* are cosmopolitan forms having stratigraphic range from the Kamlial to Dhok Pathan Formation (Colbert, 1935; Raza, 1997; Barry *et al.*, 2002). *Progiraffa* sp. is reported for the first time from the Siwalik, earlier it was known from the Bugti Beds of Lower Miocene age (Pilgrim, 1911).

The above discussed faunal characterization (especially

the first appearance and restriction of large number of species in the Chinji type section) clearly indicates that the mammalian assemblage from Ramnagar is almost identical to those of the Chinji Formation of the type section. Vasishat *et al.* (1978), on the basis of close faunal similarity between Ramnagar and Chinji type area, assigned an age of 11 to 13 Ma to Ramnagar sediments. Gaur and Chopra (1983), Sehgal and Nanda (1993, 2005) and Basu (2004) followed the same age assessment. However, Parmar and Prasad (2006) on the basis of new finding of *Kanisamys potwarensis* (14.3 to 13.3 Ma) opined that Ramnagar sediments could be older than that suggested by earlier workers. Recently, Sehgal and Patnaik (2012) described two short ranging rodents *Antemus chinjiensis* and *Megacricetodon* cf. *sivalensis* from Ramnagar, and using high resolution Siwalik rodent biochronology they constrained the Ramnagar assemblage between 13.2 to 13.8 Ma.

FAUNAL CORRELATION OF RAMNAGAR ASSEMBLAGE

The Lower Siwalik sediments are exposed all along the foot-hills, but there are a very few localities which yielded significant faunal assemblages. In the type section in Potwar Plateau, both the formations of the Lower Siwalik (the Kamlial and Chinji) are well identified on the basis of distinguished faunal assemblages (Colbert, 1935; Pilbeam *et al.*, 1977; Raza, 1997). The magnetostratigraphic data of the type localities is also well documented (Keller *et al.*, 1977; Opdyke *et al.*, 1979; Johnson *et al.*, 1982, 1985). Another important locality from where fauna belonging to the Chinji Formation is reported lies in Daud Khel, Pakistan (Hussain *et al.*, 1979). In India, in addition to Ramnagar, the Lower Siwalik assemblage (= the Chinji Formation) is known from Kalagarh, Uttarakhand (Tewari, 1983). Further east, equivalent faunal assemblage is reported from Dang Valley, Nepal (West *et al.*, 1978; 1991).

No magnetostratigraphy data is available for Ramnagar sediments; therefore the correlation of the Ramnagar assemblages with equivalent faunas within the Siwalik Group has been done on the basis of faunal comparisons. The geographical positions of the various Lower Siwalik localities are shown in Figure 2. For correlation the mammalian

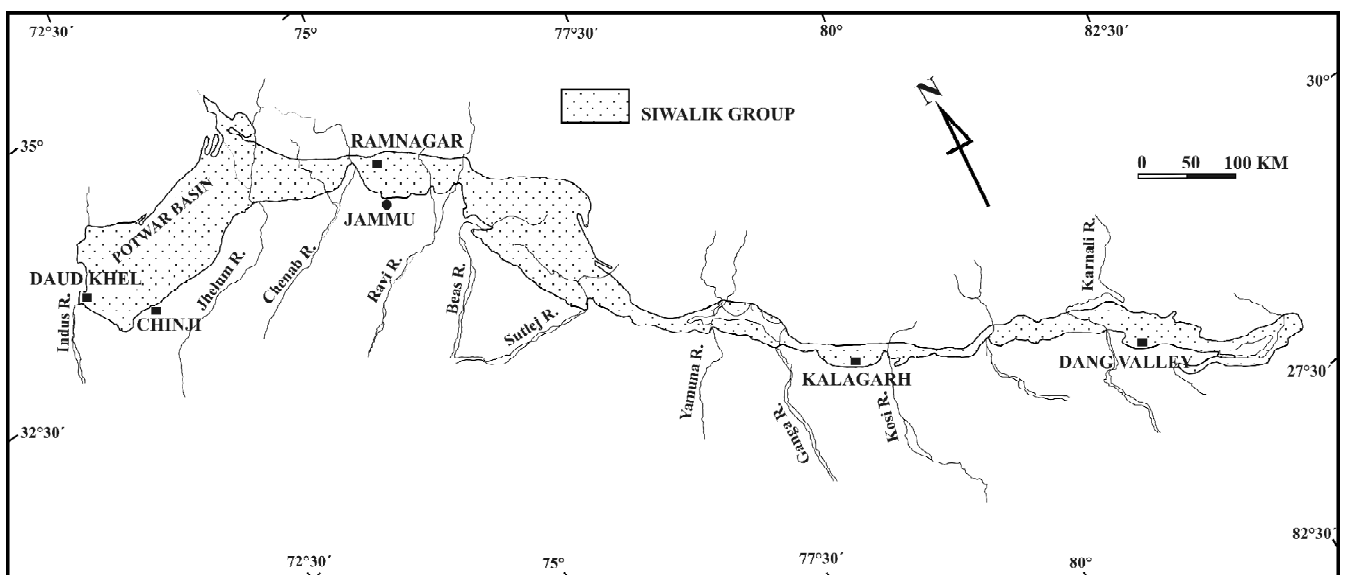


Fig. 2. Siwalik belt showing fossiliferous localities of the Lower Siwalik Subgroup in Pakistan, India and Nepal.

Table 3: Distribution of Ramnagar fauna in other Lower Siwalik localities within the Siwalik basin.

Ramnagar Fauna (Vasishat <i>et al.</i> , 1978; Gaur and Chopra, 1983; Nanda and Sehgal, 1993; Basu, 2004; Parmar and Prasad, 2006; Sehgal and Patnaik, 2012)	Potwar Plateau, Pakistan (Colbert, 1935; Pilgrim, 1939; Pilbeam <i>et al.</i> , 1979; Barry <i>et al.</i> , 2002)	Daud Khel, Pakistan (Hussain <i>et al.</i> , 1979)	Kalagarh (U.P.), India (Tewari, 1983)	Dang Valley, Nepal (West <i>et al.</i> , 1978; 1991)
RODENTIA				
<i>Megacricetodon cf. sivalensis</i>	+	-	-	-
<i>Antemus chinjiensis</i>	+	+	-	-
<i>Sivacanthion complicates</i>	+	-	-	-
<i>Kanisamys cf. potwarensis</i>	+	+	-	-
PRIMATES				
<i>Sivaladapis palaeindicus</i>	+	-	-	-
<i>Sivapithecus sivalensis</i>	+	-	+	+
<i>S. indicus</i>	+	-	-	-
<i>S. simonsi</i>	-	-	-	-
CREODONTA				
<i>Dissopsalis carnifex</i>	+	+	-	-
CARNIVORA				
<i>Eomellivora necrophila</i>	+	-	-	-
<i>Amphicyon sp.</i>	+	-	-	+
<i>Vishnuonyx chinjiensis</i>	+	-	-	-
<i>Percrocuta carnifex</i>	+	-	-	-
<i>Viverra chinjiensis</i>	+	-	+	-
<i>Vishnufelis sp.</i>	+	-	-	-
PROBOSCIDEA				
<i>Deinotherium pentapotamiae</i>	+	+	+	+
<i>Prodeinotherium sp.</i>	+	-	-	-
<i>Gomphotherium sp.</i>	+	-	-	+
<i>Tetralophodon sp.</i>	+	-	-	-
PERISSODACTYLA				
<i>Aceratherium perimense</i>	+	+	-	-
<i>Gaiotherium browni</i>	+	+	-	-
<i>Brachypotherium sp.</i>	+	-	-	+
<i>Chilotherium? intermedium</i>	+	+	-	-
<i>Chalicotherium sp.</i>	+	-	-	-
ARTIODACTYLA				
<i>Hippopotamodon haydeni</i>	+	-	-	-
<i>Conohyus chinjiensis</i>	+	-	+	-
<i>C. sindiense</i>	+	-	+	+
<i>Listriodon pentapotamiae</i>	+	+	-	-
<i>Propotamochoerus sp.</i>	+	-	+	-
<i>Sus sp.</i>	+	-	-	-
<i>Anthracotherium punjabiense</i>	+	-	-	-
<i>Hemimeryx pusillus</i>	+	+	-	+
<i>Dorcabune anthracotherioides</i>	+	-	-	+
<i>D. nagrii</i>	+	-	-	-
<i>Dorcatherium majus</i>	+	+	+	+
<i>D. minus</i>	+	+	-	+
<i>D. nagrii</i>	+	+	+	+
<i>Giraffa priscilla</i>	+	-	-	-
<i>Giraffokeryx punjabiensis</i>	+	+	+	+
<i>Progiraffa sp.</i>	-	-	-	-
<i>Helicopotax tragelaphoides</i>	+	-	-	-
<i>H. praecox</i>	+	-	-	-
<i>Protragocerus gluten</i>	+	-	-	+
<i>Miotragocerus gradiens</i>	+	+	-	-
<i>Gazella sp.</i>	+	+	-	-
<i>Kubanotragus sokolovi</i>	+	-	-	-

assemblage from Ramnagar is compiled in Table 3, and the occurrence of individual taxa in the equivalent localities is marked with symbol +. The locality wise correlation is discussed below:

Potwar Plateau, Pakistan

A rich vertebrate assemblage is known from the Chinji type section in Potwar Plateau, Pakistan. A number of workers have compiled the list of the fauna from the Chinji Formation of the type section (Colbert, 1935; Pilgrim, 1939; Pilbeam *et al.*, 1977; Moonen *et al.*, 1978; Savage and Russell, 1983; Barry and Flynn, 1989; Nanda and Sehgal, 1993; Raza, 1997). It is noticed from Table 3 that the Ramnagar assemblage has a very distinct and close resemblance with those of the Chinji type section, which lies 270 km. west of Ramnagar. All the species of Ramnagar assemblage, except *Sivapithecus simonsi* and *Progiraffa* sp., show their presence in the Chinji Formation of the type section. *Progiraffa* sp. is identified on the basis of a single molar from Ramnagar (Nanda and Sehgal, 1993). Thus barring *S. simonsi*, the Ramnagar assemblage shows close affinity with the assemblage from the Chinji Formation of Potwar Plateau, Pakistan.

Daud Khel, Pakistan

Ramnagar fauna can also be correlated to the Chinji equivalents at Daud Khel, Pakistan which lies about 330 km. west of Ramnagar. Hussain *et al.* (1979) provided an exhaustive faunal list of the Lower Siwalik of Daud Khel, and stated that this faunal assemblage is in all respects very similar to the Chinji Formation at its stratotype. It is noticed from Table 3 that there are a large number of species common in Ramnagar assemblage and those from Daud Khel, and these include: *Antemus chinjiensis*, *Kanisamys* sp., *Dissopsalis carnifex*, *Deinotherium pentapotamiae*, *Aceratherium perimense*, *Gaiotherium browni*, *Chilotherium? Intermedium*, *Listriodon pentapotamiae*, *Hemimeryx pusillus*, *Dorcatherium majus*, *D. minus*, *D. nagrii*, *Giraffokeryx punjabiensis*, *Miotragocerus gradiens* and *Gazella* sp. Hussain *et al.* (1979) also reported doubtful presence of *Hipparion* (typical Middle Siwalik taxa) from Chinji equivalents at Daud Khel. However, Bernor and Hussain (1985) accepted the first appearance of *Hipparion* in the Middle Siwalik. Thus, a striking similarity is observed between the faunal assemblages from Ramnagar and Daud Khel.

Kalagarh, India

Tewari (1983) reported a fairly good assemblage from the Kalagarh locality, lying 540 km. southeast of Ramnagar, and referred the Siwalik succession of Kalagarh as equivalent to the Chinji Formation. Critical re-examination of the faunal assemblages of Ramnagar and Kalagarh, show that there is only a slight similarity between the faunas of two areas (Table 3). The common taxa between two areas include: *Sivapithecus sivalensis* (referred as *Ramapithecus punjabicus* in Kalagarh), *Viverra chinjiensis*, *Deinotherium* sp., *Conohyus* sp., *Proptomachoerus* sp., *Dorcatherium majus*, *D. nagrii* and *Giraffokeryx* sp. Among these only *V. chinjiensis* is a characteristic form of the Chinji Formation; whereas the species belonging to suids and tragulids are of cosmopolitan nature (range from the Chinji to Dhok Pathan Formation). In addition, Tewari (1983) also reported some typical Middle Siwalik taxa, such as, *Hipparion antelopinum*, *Hippopotamodon* (= *Dicoryphochoerus*) *robustus* and *Dorcadoxa porrecticornis*. Thus it can be opined that the faunal

assemblage from Kalagarh is younger to that of Ramnagar, and represents a Middle Siwalik age.

Dang Valley, Nepal

Lower Siwalik fauna is also known from Dang Valley, Nepal (West *et al.*, 1978; 1991). The fauna is not well enriched, but the forms present show affinity with Ramnagar fauna (Table 3). It is noticed that several taxa are common to two areas which include: *Sivapithecus sivalensis*, *Amphicyon* sp., *Deinotherium pentapotamiae*, *Gomphotherium* sp., *Brachypotherium* sp., *Conohyus sindiense*, *Hemimeryx pusillus*, *Dorcabune* sp., *Dorcatherium majus*, *D. minus*, *D. nagrii*, *Giraffokeryx punjabiensis* and *Protragocerus gluten*. Moreover like Ramnagar there is yet no report of hipparionines from Dang Valley. Thus a safe correlation can be made between Ramnagar fauna and fauna from Dang Valley, Nepal.

CONCLUSIONS

From the present studies following conclusions may be drawn:

1. The Ramnagar assemblage has a striking similarity with the faunal assemblage from the Chinji Formation of the type section in Potwar Plateau, Pakistan.
2. The Ramnagar assemblage represents the oldest Siwalik fauna in India.
3. The Ramnagar assemblage is equivalent to the Lower Siwalik fauna from Daud Khel, Pakistan and Dang Valley, Nepal.
4. The Kalagarh assemblage is younger than that of Ramnagar, and represents a Middle Siwalik age.

ACKNOWLEDGEMENTS

The author would like to thank Prof. A.K. Gupta, Director, Wadia Institute of Himalayan Geology for providing facilities and necessary permission. Sincere thanks are also due to Dr. A. C. Nanda for useful discussion.

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