

New Mammalian Remains from the Middle Miocene of Bhilomar Punjab, Pakistan

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Abstract. Fossil remains of *Gazella* sp., *Dorcatherium majus* and *Gaiotherium browni* are recovered from the middle Miocene (14.2-11.2 Ma) of Bhilomar, Chakwal, Punjab, Pakistan. The sample comprises upper and lower dentitions. Presence of above fossil families in the Chinji formation depicts more faunal elements in this zone and their abundance. The Siwalik group has yielded an abundant vertebrate fauna which consists of almost all type of mammalian groups.

Keywords: fossil, faunal elements, mammalian

Introduction

New odontological material recovered from the middle Miocene of a small village Bhilomar (originally Bhil Maar), lies in the Talagang boundaries of district Chakwal, Punjab, Pakistan (Fig. 1). The fossiliferous site (Lat 32° 43' N; Long 72° 27' E) is located at 1.5 Km east of the village. These rocks correspond to the upper part of the Chinji Formation and exposed by erosion of rock material after the removing of the upper layer by rainfall. The Chinji Formation comprises bright red clays with light gray sandstone (Khan *et al.*, 2012).

The fossils which were collected various field campaigns consists of isolated teeth and mandible fragments. The fossils are housed in the collections of the Palaeontology Laboratory, Institute of Zoology, University of Punjab, Lahore, Pakistan. The specimens have been washed and clean thoroughly in the laboratory identification. After preparation the specimens are cataloged with inventory numbers. Cataloging is done by showing the year of collection and specimen number of that year in the laboratory, like Punjab University Palaeontological Collection (PUPC)18/145, here the numerator is depicting collection year and denominator is showing ongoing number of that year in the same laboratory. Uppercase letter corresponds to upper dentition and lowercase letters lower dentition.

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The specimens are measured in millimeters (mm) with Vernier Caliper Tooth measurements are taken from occlusal side, length is represented by 'L' and width is represented by 'W', tooth height and width are taken at their maximum value, shown in Table 1 and it is formulated for comparison. The described specimens are photographed with a Canon Camera using additional lens.

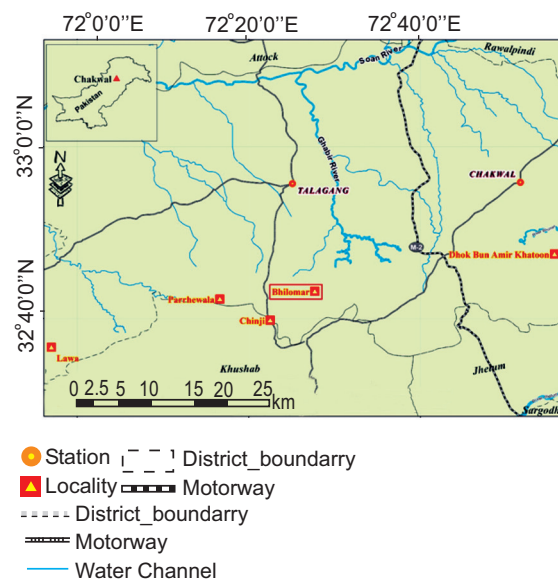


Fig. 1. Map showing the exposed area (Bhilomar) from Siwaliks of northern Pakistan.

Table 1. The comparative measurements (mm) of the cheek teeth of *Gazella* sp., *Dorcatherium majus*, *Gaindatherium browni*. *the studied specimens. Referred data are from (Khan *et al.*, 2013; 2009; Farooq *et al.*, 2008; 2007a; Akhtar, 1992; Heissing, 1972)

| Taxa | Number | Nature/ position | L | W | W/L |
|-----------------------------|-------------------|---------------------|-------|-------|------|
| <i>Gazella</i> sp. | PUPC 17/138* | lm1 | 11.07 | 4.88 | 0.44 |
| | | lm2 | 10.38 | 5.23 | 0.50 |
| | PUPC 17/139* | rp3 | 12.22 | 6.79 | 0.55 |
| | PUPC 17/140* | rp4 | 10.22 | 6.27 | 0.61 |
| | PUPC 17/141* | IP4 | 9.44 | 11.4 | 1.21 |
| | PUPC 98/101 | rP4 | 9.60 | 9.70 | 1.01 |
| PUPC 83/67 | rP4 | 9.00 | 9.00 | 1.00 | |
| <i>Dorcatherium majus</i> | PUPC 17/142* | rp3 | 13.23 | 6.52 | 0.49 |
| | PUPC 17/143* | IM2 | 16.09 | 16.30 | 1.01 |
| | PUPC 67/191 | IM2 | 13.3 | 14.5 | 1.00 |
| | PUPC 68/33 | IM2 | 13.3 | 14.5 | 1.00 |
| | PUPC 85/21 | IM2 | 18.0 | 22.0 | 1.20 |
| | PUPC 68/250 | IM2 | 15.7 | 16.4 | 1.00 |
| | PUPC 85/15 | IM2 | 19.0 | 20.0 | 1.00 |
| | PUPC 87/328 | IM2 | 17.7 | 19.0 | 1.00 |
| | AMNH 19302 | IM2 | 18.5 | 21.5 | 1.10 |
| | GSIB197 | IM2 | 19.6 | 19.6 | 1.00 |
| <i>Gaindatherium browni</i> | PUPC 17/146* | dp1 | 26.07 | 32.57 | 0.80 |
| | PUPC 17/145* | p4 | 53.47 | 29.11 | 0.54 |
| | 1956 II 247 & 249 | p4 | 34.0 | 25.0 | 0.69 |

Materials and Methods

Systematic Palaeontology. Family: **Bovidae Gray (1821); Genus: *Gazella* Blainville (1816).** New material: PUPC 17/141, IP4; PUPC 17/139, rp3; PUPC 17/140, rp4; PUPC 17/138, left mandibular fragment with mL-2.

Description: PUPC 17/141 is a fourth upper premolar P4 and is well-preserved Fig. 2(1a-c). The tooth is triangular in occlusal outline. Styles are clear on the labial side. Both parastyle and metastyle are present. A median rib runs from apex to base. Fossette and the four cones are clear. The pre-protocrista is shorter than the postprotocrista.

PUPC 17/139 is p3 asymmetrical and uneven Fig. 2(3a-c). Anterior lingual valley is much wider. The medial and posterior lingual valleys are not clear. The protoconid is pointed and hypoconid is rounded. The metaconid and entoconid are adjacent to one another.

PUPC 17/140 is a p4, it has three valleys that are present on the lingual side *i.e.* anterior lingual valley, medial lingual valley and posterior lingual valley Fig. 2(2a-c). The valley present on anterior side is more developed and wider. The protoconid and hypoconid are separated by a depression. The entoconid is placed beside the metaconid.

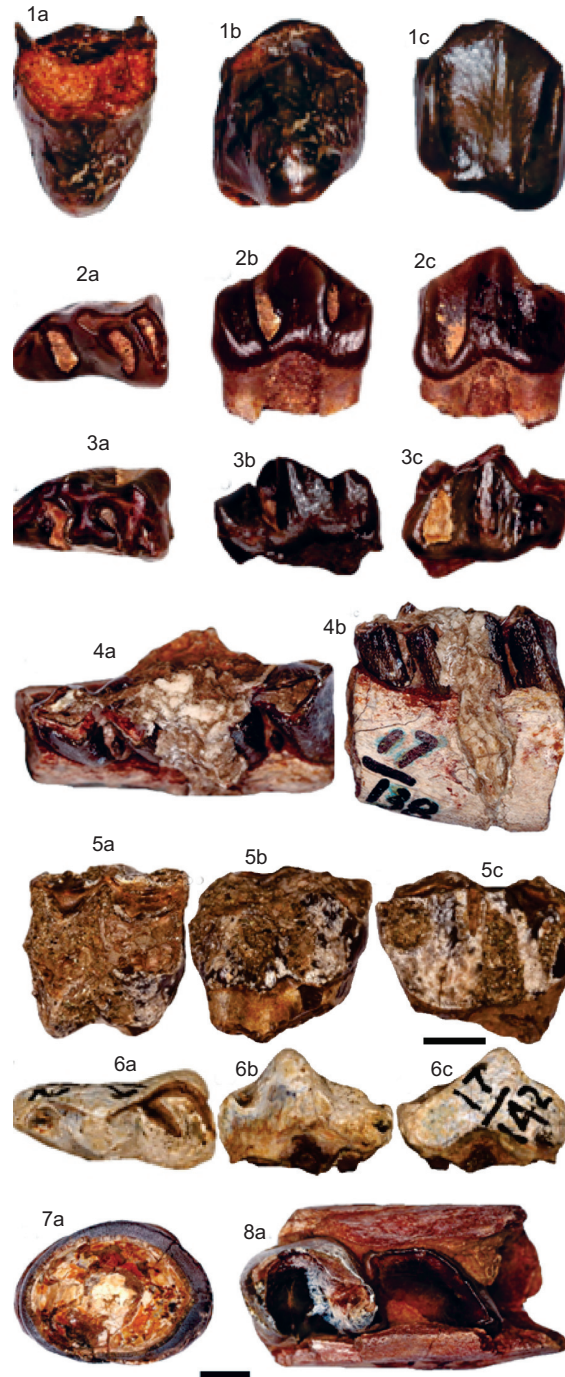


Fig. 2. *Gazella* sp. 1. PUPC 17/141, IP4; 2. PUPC 17/140, rp4; 3. PUPC 17/139, rp3; 4. PUPC 17/138, left mandibular fragment with m1-2; *Dorcatherium majus*: 5. PUPC 17/143, IM2; 6. PUPC 17/142, rp3; *Gaindatherium browni*: 7. PUPC 17/146, dp1; 8. PUPC 17/145, left mandible ramus with partially erupted p4. Views: a. occlusal, b. lingual, c. labial. Scale bar equals to 10mm.

PUPC 17/138, is a left mandibular ramus with lower m1-2. Goat fold is present on the anterior side of the lower molar Fig. 2(4a-b). Selenodont pattern exists, while the conids are narrow. The conids are conical at the apex. The hypoconid is directed forward. The anterior rib is more elaborated than the posterior rib. The pre-fossitid and post-fossitid are present. It has more pronounced metaconid and hypoconid.

Comparison. Specimens described here are small in size and possess finally rugose enamel. These characters are shown by most of the medium sized bovids from the Siwaliks (Khan *et al.*, 2009; Pilgrim, 1939). The small sized bovids from the Siwalik Middle Miocene include *Gazella*, *Palaeohypsodontus*, *Eotragus*, *Sivoreas* and *Elachistoceras* (Khan *et al.*, 2013, 2008; Pilgrim, 1939, 1937). Presence of a small ectostylid, narrow external folds and styles and lower molars with goat folds excludes the attribution of these specimens to all the above mentioned species other than *Gazella* (Khan *et al.*, 2013; Pilgrim, 1939, 1937). The premolars are best represented by the valleys with anterior median valley being wide. Three reported gazelle species from the Siwalik Group are; *Gazella* sp., *G. lydekkeri* and *G. superba*. First being reported from the lower Siwaliks and later two from the middle Siwaliks. A fourth species, *Gazella padriensis*, erected by Akhtar (1992) is synonymized here with *G. lydekkeri*. The recovered specimens from the Chinji Formation are morphometrically in accordance with *Gazella* sp. and hence allocated to *Gazella* sp.

Family: Tragulidae Milne-Edwards, 1864. Genus: Dorcatherium Kaup and Scholl (1834); Dorcatherium majus Lydekker (1876). New material: PUPC 17/143, IM2; PUPC 17/142, rp3.

Description and comparison: PUPC 17/143, is the left upper second molar Fig. 2(5a-c). It is quadrate in its outline and displays a selenodont pattern. The cones are damaged and the metacone is somewhat visible. The protocone is extended outward. The parastyle is damaged while the metastyle and mesostyle are present.

PUPC 17/142 is right third lower premolar Fig. 2 (6a-c). The p3 comprising two roots is a long tooth which is a tragulid feature. The anterior valley is prominent. The protoconid is pointed and the hypoconid is present far from the protoconid. The metaconid is present posterior to the thin entoconid. The stylids are also present and the teeth dimensions are close morphometrically to those of the Siwalik *Dorcatherium majus*.

The Siwalik *Dorcatherium* species are mainly differentiated by their size (Khan *et al.*, 2017; 2012; 2011; Batool *et al.*, 2014; Farooq, 2008; Gauv, 1983; Sankhyan, 1982). *D. minimus*, *D. minus* and *D. nagrii* have smaller teeth, while *D. majus* have larger teeth.

Family: Rhinocerotidae Owen (1845); Genus: Gaiндatherium Colbert (1934); Gaiндatherium browni Colbert (1934). New material: PUPC 17/146, partial lower deciduous p1; PUPC 17/145, left mandible ramus with partially erupted p4.

Description and comparison: PUPC 17/146 is a deciduous p1 Fig. 2(7a). The p4 is partially broken. There is a trace of cement deposition in the lower premolars. The dental material is in a middle wear stage. A deeper buccal groove is near to crown base. PUPC 17/145 has V shaped anterior valley while U-shaped posterior valley Fig. 2(8a). According to the recorded measurements, the studied specimens shows good matching with the cheek teeth of genus *Gaiндatherium* and the species *Gaiндatherium browni*. At the same time, they show marked morphological and metrical differences with respect to other rhinocerotids recognized in the Chinji Formation and its equivalents in other areas, such as the Manchar Formation, Sindh (Khan *et al.*, 2013; Cerdeño and Hussain, 1997). The genus revised by Heissig (1972) *Gaiндatherium* to sub generic rank under *Rhinoceros*. Colbert (1934) describes that the genus *Gaiндatherium* mainly belongs to Chinji Formation and that it is consider as an immediate ancestor of living *Rhinoceros*. Addition material adds new information concerning the presence of *Gaiндatherium* in the Chinji Formation of the Siwaliks of Pakistan.

Results and Discussion

Occurrence of the genus *Gazella* has been reported from the Libya, Africa and Eurasia. The horn cores of the oldest gazelles described from Algeria and Turkey are conical horns (Kostopoulos, 2006). It is assumed that the ancestors of the *Gazella* were much like the African antelope and these have been reported from the middle Miocene of Ngorora (Kenya) (Gentry *et al.*, 1999). This genus is also present in the middle Miocene sediments of Fort Ternan, Kenya (Gentry, 1970) and from the Langebaanweg and Manonga valley belonging to Late Miocene age (Thomas, 1984; Gentry, 1978). In the Siwaliks, the genus *Gazella* has been reported from the lower and middle Siwaliks subgroups (Khan *et al.*, 2014; Pilgrim, 1939; 1937). It is probable that the

bushlands were absent in the upper Siwaliks because of the absence of gazelles in this subgroup. The palaeoecological studies on the gazelles indicate the shrub land to woodland biomes were the habitats of the animals living during the lower and Middle Siwalik subgroups. Based on the record of C₃/C₄ transition, it is estimated that the communities depending on the C₄ plants probably arose in the early Miocene and significant reduction in the C₃ plants was observed after 7 Ma Barry *et al.* (2005, 2002). Most of the Siwalik gazelles and boselaphines became less in number by the late Pliocene and went extinct at the beginning of the Pleistocene (Kostopoulos, 2009; Bibi and Güleç, 2008; Bibi, 2007; Khan, 2007). The two surviving endemic species in the Indian peninsula are *Boselaphus tragocamelus* and *Gazella bennettii*.

Both frequently encountered species of genus *Dorcatherium*, *D. majus* and *D. minus* characterizes the classical browsing structure of other Siwalik genera like *Dorcabune*, *Tragoportax*, *Eotragus*, *Miotragocerus*, *Elachistoceras*, *Pachyportax* and *Selenoportax* (Khan *et al.*, 2017; Khan and Akhtar, 2013; Khan *et al.*, 2012, 2010; Barry *et al.*, 2002; Solounias *et al.*, 1995; Thomas, 1984). All these species were herbivorous consuming shoots, various types of highly proteinaceous buds and leaves, along with on minor quantities of grass (Khan *et al.*, 2009; Bouvrain, 1994) and preferred the ecotones corresponding to open areas and lowland forests (Geist, 1998; Stuart and Stuart, 1997). Both *Dorcatherium* species seems to have used a wide range of browsing diet which included mostly water plants and sometime grass. Utilization of different feeding methods in *Dorcatherium* and *Hyemoschus* suggests the use of different ecological niches (Stuart and Stuart, 1997; Dubost, 1978). The home range of *Dorcatherium* was limited, it lived in the closed low canopy.

Giraffa priscilla and *Giraffokeryx punjabiensis* are two middle Miocene giraffids present in the lower Siwaliks. In the Siwaliks *Giraffokeryx* is represented by only a single species *Giraffokeryx punjabiensis* which ranges from the middle–early late Miocene. It was previously thought that the diet of fossil Giraffidae is similar to that of extant giraffes, however, such notion changed when an extinct Miocene giraffid species “*Samotherium boissieri*” from the Miocene of Samos (Greece) was determined as mixed a feeder-grazer in the analysis of Solounias (1988).

In comparison with the *Rhinoceros sondaicus*, members of the genus *Gaindatherium* have been regarded

belonging to a small genus (Colbert, 1942). Two Siwalik species, *G. browni* and *G. vidali*, have been reported from middle and early late Miocene of this area (Sehgal and Nanda, 2002; Heissig, 1972). Both these species are markedly morphometrically different from the other rhinocerotids found from the same formations (Chinji and Nagri formations) or the areas like Manchar formation (Sindh) having age equivalent to these formations (Khan *et al.*, 2013; Cerdano and Hussain, 1997). For a long time, it was considered that *G. browni* from the Chinji Formation was a direct ancestor of the extant *Rhinoceros*. This was the view of Colbert (1934) when he determined the phylogenetic relationship of the family Rhinocerotidae. However, after this view was changed by Heissig (1972) after 38 years later with the description of a second species from the Nagri Formation as *Rhinoceros (Gaindatherium) vidali*. Also, for a long time, it has been considered that both species are successive in stratigraphic sense (Sehgal and Nanda, 2002; Heissig, 1972) but recent report of *G. vidali* remains from Chinji Formation by Khan *et al.* (2013) proved it wrong.

Conclusion

New dental material of *Gazella* sp., *Dorcatherium majus* and *Gaindatherium browni* has been collected from the outcrops dated to middle Miocene of village Bhilomar, Chakwal, Pakistan. These fossiliferous beds are attributed to Chinji Formation of the lower Siwalik Subgroup. The faunal assemblage is of mixed type and the fauna on the whole suggests a warm climate and humid conditions. The deposits suggest a riverine system with broad flood plains.

Conflict of Interest. The authors declare they have no conflict of interest.

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