

## NEW FOSSIL REMAINS OF *BRACHYPOTHERIUM PERIMENSE* FROM THE CHINJI AND NAGRI FORMATIONS OF PAKISTAN

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### ABSTRACT

*Brachypotherium perimense* is a well known extinct species of family Rhinocerotidae from the Siwaliks of Pakistan. The specimens described in this paper were collected during field work from the Late Miocene localities of the Chinji and Nagri formations in district Chakwal, Punjab, Pakistan. Based upon the morphological and metric similarities the specimens are assigned to *Brachypotherium perimense* (Falconer and Cautley, 1847).

**Key words:** Teleoceratini, Rhinocerotidae, Mammals, Siwaliks, Miocene.

### INTRODUCTION

The Siwalik group is a range of southern Himalayan Mountains extending from southwest Kashmir through India into southern Nepal. The extensive fossil remains are found in widely separated areas along the foothills of Himalayas. The Siwaliks in Himalayan foreland form a continuous belt ranging from Pakistan to Eastern India. It has an average elevation of 1000 m and width of 20 km. It is associated to the most active thrust across Himalayas, which is the main frontal thrust (Dubille and Lave, 2007). The name Siwalik was introduced by Medlicott (1864) for the sub-Himalayan rocks. This term derived from the Siwalik Hills in Deharadun, India. The term is commonly used for the Neogene sediments found in foothills of Himalayas. The most fossiliferous layers of the Siwaliks found in Pakistan are in Potwar Plateau (Khan *et al.*, 2006).

The Chinji Formation is a characteristic phase of about 2,300 feet of bright red clays, carrying beds of what Pilgrim has termed "pseudo-conglomerates." This zone contains the typical Lower Siwalik fauna. Pilgrim originally recognized two divisions of the Chinji, namely a lower and an upper division. Later work would seem to show that the fossils range pretty well throughout the thickness of the Chinji deposits, and that the upper and lower horizons recognized by Pilgrim (1910) really represent levels of unusual abundance of fossils, rather than zones of faunal differences. An unconformity, the only definite break in the Siwalik series, separates the Chinji from the lowest of the Siwalik zones (Colbert, 1935). The age of Formation is considered to be Late Miocene (Fatmi, 1973). Lewis (1937) established the term Chinji Formation. At the type locality, near the Chinji village, the lower contact of the Chinji Formation with the Kamli Formation is gradational, while the upper contact is conformable with the Nagri Formation. It

contains typical Lower Siwalik fauna (Colbert, 1935), and rhinocerotids from this formation include *Caementodon oettingenae*, *Chilotherium intermedium*, *Chilotherium blanfordi*, *Aprotodon fatehjangense*, *Brachypotherium perimense*, *Didermoceros* aff. *sumatrensis*, *Didermoceros* aff. *abeli*, *Aceratherium* sp., *Eurhinoceros* sp., *Gaindatherium browni*, and *Gaindatherium vidali* (Matthew, 1929; Colbert, 1935; Heissig, 1972).

The Nagri Formation consists of sandstone with secondary shale and conglomerate beds. The sandstone is grayish to greenish gray, fine to medium-grained, coarse-grained texture observed in lower part. The sandstone is cross-bedded, thick bedded to massive. Occasionally the sandstone is bluish to reddish gray, calcareous and weakly cemented. The shale observed unevenly proportioned from section to section is sandy or silty, dark brown or reddish brown and light orange. The percentage of conglomerates has extremely diverse in thickness and composition in different areas. The conglomerate beds composed of particles of hard rocks and Eocene sedimentary rocks particularly of limestone.

Transitional contact has been marked with upper Dhok Pathan formation. The contact can be easily positioned because it is noticeable by color alteration from greenish gray to light red or shiny white and also by typical inter bedding of shale and sandstone of overlying Dhok Pathan Formation. The age assigned to the Formation in Kohat-Potwar province is early Pliocene on the basis of the fossils such as crocodylians, chelonians, perissodactyls, rhinoceros, carnivores, proboscideans, primates and artiodactyls have been reported by Pascoe (1963). Rhinocerotids in the Nagri include *Caementodon oettingenae*, *Aprotodon fatehjangense*, *Gaindatherium vidali*, *Chilotherium intermedium*, *Brachypotherium perimense*, and *Eurhinoceros* aff. *sondaicus* (Matthew, 1929; Colbert, 1935; Heissig, 1972).

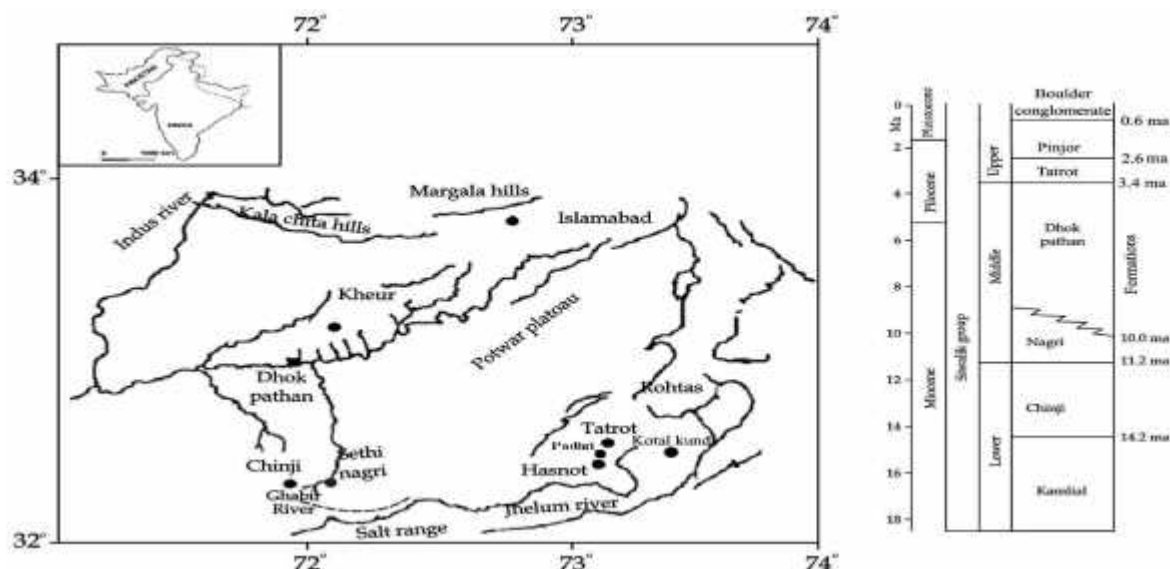


Fig. 1. Map of the Siwalik sequence of Pakistan indicating chronostratigraphy of the Chinji and Nagri formations. Boundary dates adopted from Barry *et al.* (2002).

## METHODOLOGY

The specimens described in this paper are the property of Dr. Abu Bakr Fossil Display and Research Center, department of Zoology, university of the Punjab, Lahore. The specimens were collected by the authors (AMK and MA). Some of the specimens are well preserved while others are partly broken due to long-term exposure to weathering. The specimens were washed, cleaned and prepared before study. Various types of adhesive material were used such as peligom, Epoxy steel, Magic and Elfi during the preparation of the material in the laboratory. Photographs were taken with the help of "Canon EOS 353D" camera. Vernier Caliper was used for the measurements of the specimens in order to record the data. For the description of the specimens, dental morphological terminology for rhinoceros in this paper follows that of Heissig (1972). The specimens are catalogued in two series, e.g., 169/07, the upper figure denotes the serial number of the specimen while the lower one denotes the collection year of that particular specimen.

### Systematics

Family Rhinocerotidae GRAY, 1825  
 Tribe Teleoceratini HAY, 1885  
 Genus *Brachypotherium* ROGER, 1904

### *Brachypotherium perimense* (FALCONER AND CAUTLEY, 1847)

(Fig. 1A-4C; Table 1)

*Rhinoceros* (*Acerotherium*?) *perimensis* - Falconer and Cautley 1847: pl. 75, fig. 13-16; pl. 46, fig. 14-16

*Rhinoceros perimensis* - Falconer 1868: p 157, 171, 517-519

*Aceratherium perimense* Falconer- Lydekker 1876: p. 51, pl. 6, fig. 2, 5

*Rhinoceros iravaticus* Lydekker 1876: p. 36, pl. 5, fig. 1-4

*Rhinoceros planidens* Lydekker 1876: p. 40, pl. 4, fig. 7, 9

*Rhinoceros iravaticus* Lydekker - Medlicott and Blanford 1879: p. 574, pl. 19, fig. 2

*Acerotherium perimensis* Falconer and Cautley- Lydekker 1881: p. 9, pl. 1-4, fig. 1

*Acerotherium perimensis* Falconer and Cautley- Lydekker 1884: p. 132, pl. 1, fig. 5

*Rhinoceros perimensis* - Falconer and Cautley- Lydekker 1886: p. 155

*Brachypotherium perimense* - Schlosser 1903: p. 72

*Teleoceras? perimense* Lydekker sp. - Schlosser 1903: p. 206

*Aceratherium lydekkeri* Pilgrim 1910: p. 65

*Aceratherium gajense* Pilgrim pp- Pilgrim 1912: p. 28, pl. 11, fig. 1, 2

*Aceratherium perimense* Falconer and Cautley, 1868 - Matthew, 1929: p. 461, 507

*Teleoceras fatehjangense* (Pilgrim) - Forster-Cooper, 1934: p. 601, fig. 14

*incretae sedis*- Forster-Cooper, 1934: p. 599, fig. 13c

*Aceratherium perimense* (Falconer and Cautley) - Colbert, 1935: p. 191, fig. 86-89

*Chilotherium blanfordi* (Lydekker) - Colbert, 1935: fig. 94

*Aceratherium perimense* Falconer et Cautley - Hooijer, 1946: p. 114, pl. 9, fig. 1

**Cotypes:** The specimens figured by Falconer and Cautley, (1847: pl. LXXV, figs. 13-16, and LXXVI, figs. 14-17).

**Type locality:** Perim Island in India.

**Geographic distribution:** Siwalik region.

**Stratigraphic range:** Lower to Middle Siwaliks.

**Diagnosis:** A very large species of the genus *Brachypotherium* with relatively high cheek teeth. All generic features are extremely developed. Nasals are shortened and hornless. The upper molars have weak constrictions of the inner cusp; reduced antecrochet usually present. Upper Premolars are molariform, usually with highly convex exterior. Lower molars almost without buccal fold; cingula usually reduced and short (Heissig, 1972).

**Material referred from the Chinji Formation:** PUPC 07/126, rP2, an isolated upper premolar; PUPC 08/121, IP2, an isolated upper premolar.

**Material referred from the Nagri Formation:** PUPC 07/169, rP4, an isolated upper premolar; PUPC 08/122, lp1, an isolated lower premolar (East of Sethi Nagri village, Nagri Formation, Middle Siwaliks).

**Locality:** Chinji and Nagri formation for the present material.

**Stratigraphic range:** Lower to Middle Siwaliks.

**Table: 1-** Comparative dental measurements of the cheek teeth of *Brachypotherium perimense* from the Chinji and Nagri formations in mm. \*the studied specimens. Referred data for *Brachypotherium perimense* are taken from Colbert, 1935; Heissig, 1972 and Cerdeño and Hussain, 1995.

Taxa	Formations	Number	Nature	Length	Width
<i>B. perimense</i> *	Chinji	PUPC 07/126	P2	36.5	46.5
		PUPC 08/121	P2	32.5	X
		PUPC 07/169	P4	61.5	60.0
		PUPC 08/122	p1	30.1	22.0
<i>B. perimense</i>	Chinji	AMNH 19454	P2	38.0	46.0
			P4	51.0	74.0
			P2	35.0	46.0
<i>B. perimense</i>	Chinji	1956 II 439	P2	35.0	46.0
		1956 II 456	P4	47.0	67.0
		CHC 8	p1	26.0	20.0
<i>B. perimense</i>	Manchar		P2	32.5	40.8



**Figs. 1- 4.** *Brachypotherium perimense*. PUPC 08/122, lp1 in occlusal (1A), lingual (1B) and buccal (1C) views. PUPC 07/126, rP2 in occlusal (2A) and lingual (2B) views. PUPC 08/121, IP2 in occlusal (3A) view. PUPC 07/169, rP4 in occlusal (4A), lingual (4B) and buccal (4C) views. Scale bar 20 mm.

## DESCRIPTION

**PUPC 07/126** is an isolated second premolar. It is well preserved and at the middle stage of wear. The dentine is visible. It is roughly rectangular in outline. The Protocone show forward extension with constriction. Ectoloph is flat with no style folds. The anterior and lingual cingula are well developed while posterior cingulum is not visible due to wear. The lingual cingulum is continuous with the anterior one and forms a shelf at the lingual opening of the median valley. The buccal cingulum is weakly developed and the anterior cingulum forms a rib like structure at the buccal end of protoloph. Antecrochet is absent while a rudimentary crochet is present. A rudimentary crista is also present which looks like an undulation due to wear. Parastyle is well developed with a forward projection. Ectoloph is well developed and broad. Metaloph is also well developed. Metaloph is longer and wider than the protoloph. Postfossette is oval in shape.

**PUPC 08/121** is an isolated second left upper premolar. Ectoloph is broken, therefore metacone, paracone and styles cannot be observed. It is at middle stage of wear and dentine is visible. It is roughly quadrate. Protocone show forward extension with constriction. Lingual cingulum is well developed and continues with posterior one. It is absent at the base of protocone. Anterior cingulum is also well developed. Cingulum is present high above the base of both the cones. The median valley is closed towards the lingual base due to the fusion of protocone and paracone, but it is open above the level of cingulum. Postfossette is deep and oval shape. Median valley is very deep behind the protocone and paracone fusion. A rudimentary crochet is also developed.

**PUPC 07/169** is an isolated fourth upper premolar. It is well preserved. The protocone is broken partially at the base lingually. It is roughly quadrate and in early wears. Dentine is visible. Protocone is forwardly directed with moderate constriction. Hypocone, metacone and paracone are well preserved. Parastyle is well developed. Slight convexity corresponding to mesostyle is also present. Metastyle is moderately developed with a backward inclination. Anterior cingulum is well developed and posterior cingulum is divided by V-shaped incision. Lingual cingulum is present at the base of the median valley and absent at the base of protocone and hypocone. Buccal cingulum is present at the posterior half of ectoloph. Ectoloph is elongated with slight concavity. Crochet is present but broken at the top while antecrochet is weakly developed. Crista is rudimentary. There is a wide median valley between protocone and hypocone. The postfossette is triangular and deep.

**PUPC 08/122** is an isolated first lower premolar. It is well preserved and in an early stage of wear. Anterior cingulum is serrated and well developed

and continuous with buccal one. Posterior cingulum is also present and well developed. Lingual cingulum is absent. Many tubercles corresponding to buccal cingulum are present at the base of the buccal groove. Hypolophid and metalophid are well developed. A tubercle is present at the base of the paralophid groove lingually. Ectolophid outline is straight with forwardly projecting paralophid. Paralophid is slightly constricted. A V-shaped posterior valley is present between entoconid and metaconid. The comparative measurements of the specimens are provided in table 1.

## DISCUSSION

*Brachypotherium* is distinguished from the other Siwalik rhinoceroses by its large size. Lydekker (1881) in his detailed description of the species (AMNH 19470) in the American Museum collection is quite indicative of large proportion of skull that is characteristic of *Brachypotherium perimense* (Colbert, 1935). *Brachypotherium* has been found from the Middle Siwaliks of the Perim Island, India and from the Chinji Formation of the Lower Siwaliks, Pakistan (Matthew, 1929). *Brachypotherium* was one of the most widely distributed rhinocerotids during the Late Middle Miocene and Early Late Miocene of the Siwaliks (Barry *et al.*, 2002).

According to Colbert (1935) *Brachypotherium perimense* is a rhinoceros of gigantic size with hypsodont teeth. The skull is rather short and deep with retracted nasals zygomatic arch is heavy and postglenoid separate from posttympanic. Upper incisor is present and well developed. The molars have moderately developed crochet, weaker antecrochet and rudimentary crista. Protocone is constricted. Lower molars are narrow and compressed. Ectoloph is moderately elongated and parastyle is well developed.

The present material collected from the Chinji and Nagri formations include four premolars. Among these one belongs to lower dentition and rest of all belongs to the upper dentition. The specimens in the present collection are similar to *Brachypotherium perimense* described by Colbert (1935) and Heissig (1972) in having constricted protocone, well developed anterior cingulum and paracone fold, moderately developed crochet, weaker antecrochet and rudimentary crista. The well-developed paracone fold is the characteristic feature of *Brachypotherium* (Colbert, 1935). Colbert (1935) recognized *Brachypotherium perimense* in the Chinji, Nagri and Dhok Pathan Formations while Heissig (1972) indicated that this species is also found in rocks of the Kamli Formation. West *et al.*, (1978) described lower dentition of *Brachypotherium perimense* from the Dang valley in Nepal. The lower premolar in the present collection is very much similar to those described by West *et al.*,

(1978) in having well developed anterior cingulum, presence of tubercles corresponding to buccal cingulum, V-shaped valley present between entoconid and metaconid, and well developed metalophid and hypolophid. The specimens in the present study are comparable to *Brachypotherium perimense* described by Cerdeño and Hussain (1997) from the Manchar Formation in Sindh. According to Cerdeño and Hussain (1997) the lower teeth in *Brachypotherium perimense* have smooth external groove in buccal wall.

The diversity of Siwalik rhinoceroses is clearly dependant on climatic conditions. The change in climatic conditions has resulted in shrinkage and growing of dry

and wet areas and their special vegetation (Heissig, 2003). The hypsodonty and brachydonty are also directly related to species environment. The hypsodont species could eat coarse grasses, so lived in open habitat where environmental conditions are intermediate (Lacombat, 2005). The high crowned genera i.e. *Chilotherium* and *Brachypotherium* are abundant in those areas of Chinji, Nagri and Dhok Pathan formations where the climatic conditions are intermediate. In the Nagri Formation, *Brachypotherium perimense* is most common in times of transition and rare during most humid and most arid times (Heissig, 2003).

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