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ACERATHERIUM FROM THE DHOK PATHAN FORMATION OF THE MIDDLE SIWALIKS, PAKISTAN

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ABSTRACT

Dental remains of the rhinoceroses comprising right and left fragmentary maxillae bear first, second and third molars are recovered from the Dhok Pathan Formation of the Middle Siwaliks. The remains are identified and assigned to *Aceratherium* sp. as well as these are compared with the other late Miocene rhinoceroses *Aceratherium perimense, A. abeli, A. incisivum and Chilotherium intermedium.* The findings allow discussion on the diversity of the late Miocene rhinoceroses.

Key words: Rhinoceroses, Dhok Pathan, *Aceratherium*, Middle Siwaliks, Miocene.

INTRODUCTION

The Siwalik acerathere are a group of rhinoceroses evolved from the European *Aceratherium*, but the Siwalik acerathere has considerably more advancement in hypsodonty. The genus *Aceratherium* is widespread in Europe; up to Samos and Maragheh, but probably not much further eastward, since the Siwalik hornless rhinoceroses are certainly different. Gentry (1987) has considered the *Aceratherium abeli* from basal Miocene of Dera Bugti, Pakistan as an offshoot of European Oligocene *Aceratherium.* Larger and smaller sized *Aceratherium* continued in to the upper Miocene. The aim of the paper is to document the acerathere diversity in the Siwaliks, Pakistan.

The Dhok Pathan rhinoceros fauna mainly belongs to genera *Aceratherium*, *Rhinoceros*, *Subchilotherium* (Matthew, 1929; Colbert, 1935; Pilbeam *et al*., 1979; Heissig, 1999; Barry *et al*., 2002 and Khan *et al*., 2005, 2008). The Siwalik acerathere can be distinguished from the *Chilotherium* on the basis of dentition size (Matthew, 1929). *Aceratherium* has been found from the Middle Siwaliks of the Perim Island, India and from the Chinji formation of the Lower Siwaliks, Pakistan (Matthew, 1929). Lydekker (1884) described *Aceratherium perimense* from Hasnot, Punjab Pakistan. *A. bugtiense, A. abeli, A. blanfordi* have been described from Bugti beds of Pakistan (Pilgrim, 1910; Cooper, 1934; Osborn, 1900; Lydekker, 1884).

Kaya and Heissig (2001) have described *A. incisivum* Kaup, 1832 from Thrace, Turkey. *Aceratherium incisivum* is very common in the Vallesian and Trolian mammal assemblages of Romania (Heissig, 1989); in MN9-MN13 in Europe (Guerin, 1980). Spassov *et al.* (2006) described *Aceratherium* (sit) sp. from the late Neogene deposits of Southwest Bulgaria (Struma river valley). *Aceratherium tetradactylum* has been recorded from Sansan and Simorre France (Osborn, 1900); Vallesian of Nombrevilla (Daroca, Teruel) (Santafe-Llopis, 1992). The presence of the genus *Aceratherium* has also often been mentioned from Africa, but Gentry (1987) has recently questioned these determinations. Geraads *et al*. (2005) have described *Aceratherium* sp. from the middle Miocene locality of Candir (Turkey) and *Aceratherium kiliasi* from the upper Miocene of Macedonia, Greece.

MATERIALS AND METHODS

Terminology and taxonomy follow Heissig (1969, 1989). Dental morphology and measurements are according to Heissig (1975). Measurements are given in mm. The upper case letter denotes upper dentition and lower case letter is for lower dentition. The catalogue number of the specimens consists of series i.e., yearly catalogued number and serial catalogued number, so figures of the specimen represent the collection year (numerator) and serial number (denominator) of that year (e.g. 08/01). The material is housed in the Abu Bakr Fossil Display and Research Center, Zoology Department, University of the Punjab, Lahore, Pakistan.

Abbreviation: PUPC – Punjab University Paleontological Collection, AMNH – American Museum of Natural History, MN – European Mammalian Neogene Zone, Ma- Million years ago, M – molar, L – length, W – width, H – height.

Systematic Palaeontology

Order	PERISSODACTYLA Owen, (1848)
Family	RHINOCEROTIDAE Gill, (1872)
Subfamily	ACERATHERIINAE Dollo, (1885)

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Tribe ACERATHERINI Dollo, (1885)
Genus *ACERATHERIUM* Kaup, (1832)

Aceratherium sp.
(Plate 1, figs. 1-2; Table 1)

PUPC 68/843a and PUPC 68/843b, left and right maxillary fragments having M1-M3 recovered from Dhok Pathan type locality of the Dhok Pathan Formation, Middle Siwaliks.

DESCRIPTION AND DISCUSSION

Description: The right and left first upper molars are partially broken and in middle wear. The enamel is rugose and present all over the crown surface. The cingulum is well developed along the protoloph-metaloph but absent in the ectoloph. The protocone is somewhat constricted and extends backwardly to form antecrochet, the para- and the meta-cones are broken in the left second molar but part of the metacone is present in the right molar. The cingulum along the metaloph is raised to form postfossette. The metaloph is well developed, and a weaker crochet is present in the median valley, which extends from the metaloph. The hypocone is also constricted. The entrance of the median valley is open but it is narrow posteriorly owing to the presence of the crochet. There is neither crista nor cristella. The postfossette is very shallow and short sagitally. The protocone is flat at its lingual margin. The anterior cingulum is well developed.

The right and left second upper molars in both the maxillary fragments are well preserved and in middle wear. The tooth is broad and hypsodont. The parastyle fold is well developed along the parastyle. The enamel is rugose and the rugosity is prominent on the posterior side of the tooth. The protocone is well developed and excellently preserved. The paracone as well as parastyle are also well developed, however the apex of the paracone and the metacone are damaged. The vertical cracks are also present along the outer side of the ectoloph, which seem to appear owing to surface exposure of the specimen for a long time. The cingulum is present anteriorly along the base of the crown and look like shelf. A weaker antecrochet extends toward the median valley from the protoloph. The median valley is open anteriorly. The crochet is strong and likely to enclose a medifossette in the left and right second upper molars. The cingulum is also well developed posteriorly and raised along the metaloph to form postfossette. The median valley and posterior valley are isolated from the margin of the crown and possess a thick enamel investment. There is a rudimentary crista present in the median valley extending from ectoloph. The crochet is not bifid in the specimen. The ectoloph is slightly convex behind the wide paracone fold, which is the characteristic of *Aceratherium*. The protocone is well separated from the hypocone pillar due to the presence of deep vertical median valley. The mesostyle is absent in this molar. The ectoloph is higher than the metaloph and the protoloph. The protoloph and metaloph are roughly parallel.

The right and left third upper molars are broken due to long surface exposure and in middle wear. The molars are triangular shaped due to the bending back of the ectoloph and its fusion with the metaloph. The parastyle is marked forming an obtuse angle with the ectometaloph. The protoloph is continuous, sigmoid with strong anterior constriction and antecrochet at the base of the crown. Lingual side of the protocone is very long and flat without any groove. The medisinus is wide open lingually. The ectometaloph is convex without any constriction. In the both third molars spur like enamel projection is present in the medisinus and extends along its vertical height seem to be the early stage of growth of the crochet, which is evidently proved. The enamel is moderate in thickness. The protocone is conical and buccolingually compressed. The protoloph is narrow at the preprotocrista producing a constricted protocone condition. The antecrochet is moderate in size and extends beyond the distal limit of the protocone. There is a broad cingulum originating low on the base of the anterior side of the protocone and extend along the protoloph and join the parastyle but the posterior one is weak and low; lingual cingulum is absent. The lingual valley is open and crochet is somewhat developed.

Discussion: Morphological and metrical features of the specimens clearly indicate the large sized late Miocene rhinoceroses (Table 1). The large sized Siwalik rhinoceroses include *Aceratherium*, *Rhinoceros* and *Chilotherium*. The presence of a strong parastyle fold, hypsodonty, moderately elongated ectoloph, protocone somewhat pinched off, moderately developed crochet, strongly developed antecrochet and no crista are characters that correspond to the genus *Aceratherium* (Colbert, 1935; Geraads and Sarak, 2003) but more material is needed for precise species identification.

Comparison: *Aceratherium* is distinguished from the other Siwalik rhinoceroses by its great size. Lydekker (1881) in his detailed description of the species (AMNH 19470) in the American Museum collection is quite indicative of the large proportions of the skull that are characteristics of *Aceratherium perimense*. Owing to the massiveness of the skull of the *Aceratherium perimense* it gives the impression of being extraordinarily great in size (Colbert, 1935).

Compared with the European Miocene faunas, both the acerathere and the "dicerorhinine" groups have their corresponding representatives through the Middle to Late Miocene: the former with *Alicornops*, *Hoploaceratherium*, and *Aceratherium*, and the later with *Lartetotherium*. On the contrary, *Hispanotherium* disappeared from the European record by the late

Aragonian. Its extinction has been correlated with environmental changes when dry and warm conditions became wetter and cooler in the central Spanish basins (Cerdeno and Nieto, 1995). Both *Aceratherium* and *Dicerorhinus* have been recorded at different sites of Caspian Sea area, through the Miocene (Gabunia, 1981). The faunal turnover between the Middle and the Late Miocene Chinese faunal assemblage implies an increase of browsing mammal taxa, with rhinos as main elements among them. This is interpreted to indicate an important change in the vegetation. The lesser representation of the iranotherines during the Late Miocene, in contrast to the presence of *Acerorhinus* and "dicerorhinines", supports a decrease of the grasslands (Cerdeno, 1996). Geraads and Sarac (2003) have considered the *Aceratherium* sp. from Turkey as more primitive than *A. tetradactylum* and *A. simorrensis* in which the crochet is better developed.

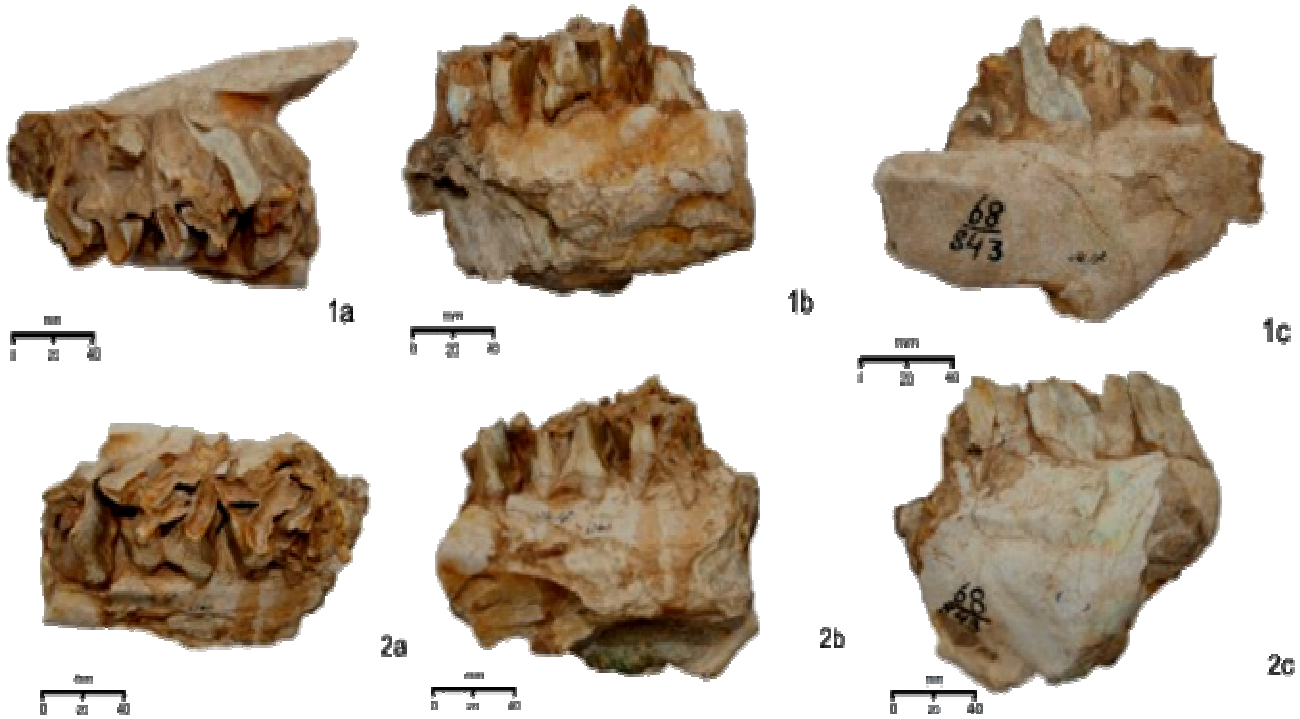

Plate 1; Figs. 1-2. *Aceratherium* sp. **1**. PUPC 68/843a; **2**. PUPC 68/843b. a = occlusal view, b = lingual view, c = labial view.

CONCLUSION: *Aceratherium* was one of the most widely distributed rhinocerotids during the late Middle Miocene and early Late Miocene of the Siwaliks (11-10.2 Ma; see Barry *et al*., 2002). This appears to be abundant in the Dhok Pathan Formation of the Siwaliks and coexists with other Siwalik rhinocerotid species (*Chilotherium*, *Rhinoceros*, *Brachypotherium*), and is usually better represented than these. This is well differentiated by its greater size, showing greater proportions than the other rhinoceroses of this age. At the end of the Middle Miocene, the previously dry and cold climate became wetter, and *Aceratherium* appears as the most abundant rhinoceros during the early Late Miocene (9-7 Ma). During the Middle Miocene the climate of the Siwaliks was warm and dry, tropical or subtropical. This changed in the Late Miocene to temperate and humid conditions, with clear seasonal differences (Barry *et al*., 2002). At the end of the middle Miocene and the beginning of the late Miocene there was a further climatic change towards an increase in temperature and a decrease in humidity (Cerdeño & Nieto, 1995). The environment became more arid, which possibly contributed to the decline of *Aceratherium*.

Table 1. The comparative measurements of the cheek teeth of *Aceratherium* sp.

	Position	*Aceratherium* sp. (this paper)	*A. incisivum* (Kaya and Heissig, 2001)	*A.tetrada-ctylum* (Guerin, 1980)
M^1	L	47.7	40.5	45.5
	W	52.2	54.8	52.0
	H	-	19.0	52.3
M^2	L	46.8	43.5	48.0
	W	55.0	54.2	48.0
	H	-	23.0	-
M^3	L	46.0	49.0	52.0
	W	53.0	47.0	49.0
	H	-	24.0	-

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