

## ***Chilotherium intermedium* (Rhinocerotidae: Mammalia) From the Siwaliks of Pakistan: Systematic Implications**

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**Abstract.-** New dental material attributed to *Chilotherium intermedium* from the Chinji and the Nagri formations of the Siwaliks is presented. *Chilotherium intermedium* is the most abundant rhinocerotid species in the Lower and the Middle Siwaliks of the subcontinent. However the generic allocation of the species has been changed several times in the past. A careful comparison of the newly discovered remains with previously described dental remains of *Chilotherium intermedium* and *Subchilotherium intermedium* by several workers has led the authors to consider *Chilotherium* as a valid generic name for the species *Chilotherium intermedium* and the synonymy of the genus *Subchilotherium* is proposed.

**Key words:** *Chilotherium*, *Subchilotherium*, Aceratheriini, Miocene, Siwaliks, Pakistan.

### INTRODUCTION

Ringström (1924) established the genus *Chilotherium* Ringström and referred two species from the Siwalik to this genus, i.e., *C. blanfordi* (Lydekker, 1884) and *C. fatehjangense* (Pilgrim, 1910), but Heissig (1975) attributed them to the genus *Aprotodon*. Lydekker (1881, 1884) described *Rhinoceros sivalensis* var. *intermedius* from the Siwaliks of Sindh, Pakistan on the basis of a right M2. This molar was characterized by a slight constriction on the protocone and a well-developed parastyle and consequently Pilgrim (1910) revised it as *Aceratherium gajense intermedium*. Later Matthew (1929) referred *Aceratherium gajense intermedium* Pilgrim, 1910 to the genus *Chilotherium* Ringström 1924, whose author considered the large and strongly projected parastyle, the absent or weak parastyle fold, and an almost flat ectoloph as diagnostic characteristics of *Chilotherium*. Years later, Colbert (1935) ascribed to *Chilotherium intermedium* (Lydekker, 1884) many fossil remains from the Siwaliks of Pakistan stored in the American Museum of Natural History (New York, USA), considering the well-developed

parastyle fold and the slightly constricted protocone as the prominent diagnostic features of *Chilotherium intermedium*.

The systematics of the Siwalik *Chilotherium* has been discussed by Ringström (1924), Matthew (1929), Colbert (1935), Heissig (1972, 1975, 1989) and Deng (2006b), and it is, however, little understood mainly because of the limited samples. For example, the status of *Chilotherium intermedium complanatum* described by Heissig (1972) from the Dhok Pathan Formation has been revised already by Antoine (2003) on the basis of cladistic analysis and this species is now placed in the genus *Alicornops* and the species *Alicornops complanatum*. The contribution of this study is to shed a new light on the systematic implication of the Siwalik *Chilotherium*.

The rhinoceros fossils to be described in this paper come from the continental Miocene deposits of the Chinji and the Nagri formations. A characteristic phase of about 701.04 meters of bright red clays, carrying beds of what Pilgrim termed "pseudo-conglomerates", contains the typical Lower Siwalik fauna, and 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

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from this formation include *Caementodon oettingenae* Heissig, 1972, *Chilotherium intermedium* (Lydekker, 1884), *Chilotherium blanfordi* (Pilgrim, 1910), *Aprotodon fatehjangense* (Pilgrim, 1910), *Brachypotherium perimense* (Falconer and Cautley, 1847), *Didermoceros* aff. *sumatrensis* (Fischer, 1814), *Didermoceros* aff. *abeli*, *Aceratherium* sp., *Eurhinoceros* sp., *Gaindatherium browni* (Colbert, 1934), and *Gaindatherium vidali* Heissig, 1972 (Matthew, 1929; Colbert, 1935; Heissig, 1972).

The Nagri Formation type locality is located at the north of Ghabir River, and its name is after the Sethi Nagri village. Much of the vertebrate fossil record comprises fragmentary specimens that are widely dispersed across eroding outcrops and typified by forerunners of the Dhok Pathan fauna and by numerous holdovers from the Chinji fauna. Rhinocerotids in the Nagri include *Caementodon oettingenae*, *Aprotodon fatehjangense*, *Gaindatherium vidali*, *Chilotherium intermedium*, *Brachypotherium perimense* and *Eurhinoceros* aff. *sondaicus* (Desmarest, 1822) (Matthew, 1929; Colbert, 1935; Heissig, 1972).

PUPC 97/84 and PUPC 08/01 were collected from the Chinji Formation of the Chinji type locality, Chakwal district, Punjab, Pakistan (Fig. 1). The outcrop of the Chinji type locality is located about 3 km south of the Chinji village and is characterized by bright red clay, interbedded with grey, soft sandstone. PUPC 07/93, PUPC 07/94 and PUPC 08/02 have been unearthed from the Nagri Formation outcropping nearby the Bhilomar village, Chakwal district, Punjab, Pakistan. Regionally the area is situated in the north of the Ghabir River (Fig. 1). The section from which the remains were excavated represents a typical sequence of fluvial sedimentation and consists of bluish grey, massive and coarse sandstone with purple and orange clay and thick brown sandstone.

## MATERIALS AND METHODS

The available material of *Chilotherium* from the Chinji and the Nagri formations comprises a part of the right maxilla with P3-M3, and right and left mandibular ramii with p2-m3. Determination at species level can be attempted for the teeth, based

on extensive and reliably determined material from the Middle Siwalik localities. The specimens were found partly exposed and excavated during the various field works by the authors (AMK, MAK, MA and MA).

The fossils are housed in the Dr. Abu Bakr Fossil Display and Research Center of the Department of Zoology, University of the Punjab, Lahore, Pakistan. The specimens catalogue in two series *i.e.* the yearly catalogue number and the serial catalogue number. The upper figure denotes the collection year, while the lower one denotes the serial number of the respective specimen. Uppercase letter stands for upper dentition and lowercase for lower dentition. Measurements of the specimens are given in millimeters (mm), and taken with the help of metric Vernier Calipers. Tooth cusp nomenclature follows Heissig (1972). Tooth length and breadth were measured at occlusal level.

## Abbreviations

PUPC, Punjab University Palaeontological Collection; AMNH, American Museum of Natural History; Fm, Formation; M, upper molar; m, lower molar; P, upper premolar; p, lower premolar; L, length; W, width; l, left; r, right; Ma, million years ago.

## SYSTEMATIC PALAEOLOGY

Family Rhinocerotidae Owen, 1845

Tribe Aceratheriini Dollo, 1885

Genus *CHILOTHERIUM* Ringström, 1924

*Chilotherium intermedium* (Lydekker, 1884)

## Synonymy

*Rhinoceros sivalensis intermedius* Lydekker, 1884

*Aceratherium gajense intermedium* Pilgrim, 1910

*Chilotherium intermedium intermedium* (Lydekker, 1884)

*Subchilotherium intermedium* (Lydekker, 1884)

*Species presently included in Chilotherium* (Deng 2006c)

*C. intermedium* (Lydekker, 1884), Sindh,

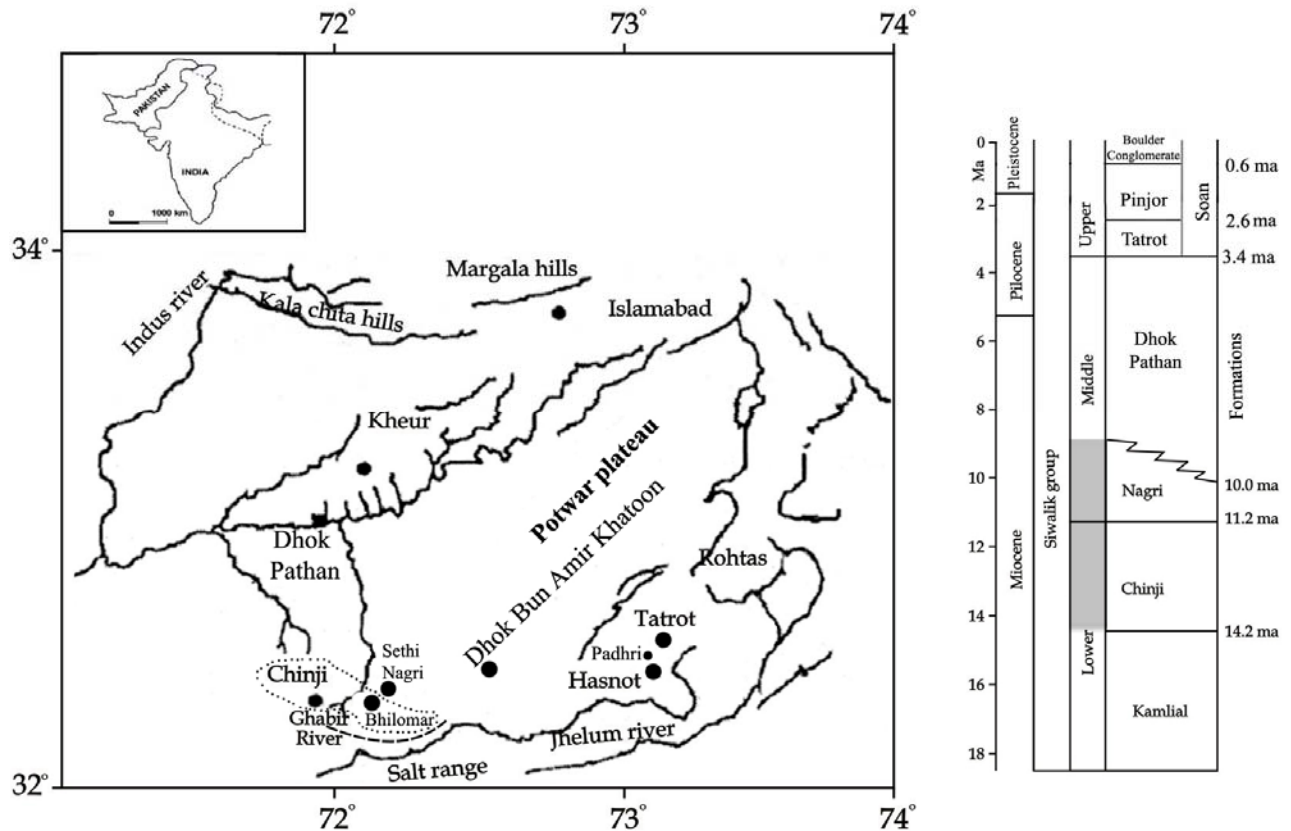


Fig. 1. Map of the Potwar plateau in northern Pakistan, encircling the studied areas (Boundary dates are from Barry *et al.*, 2002).

Pakistan; *C. samium* (Weber, 1905), Samos, Greece; *C. schlosseri* (Weber, 1905), Odessa, Ukraine; *C. kowalevskii* (Pavlov, 1913), Samos, Greece; *C. kiliasi* (Geraads and Koufos, 1990), Pentalophos, Greece; *C. anderssoni* Ringström, 1924, China; *C. habereri* (Schlosser, 1903), China; *C. wimani* Ringström, 1924, China; *C. xizangensis* Ji *et al.*, 1980, China; *C. persiae* (Pohlig, 1885) Maragha, Iran.

#### Holotype

rM2 (GSI C34).

#### Type locality

Sindh, Pakistan.

#### Stratigraphic distribution

Lower to Middle Siwaliks (Middle Miocene to Early Pliocene).

#### Diagnosis

A *Chilotherium* of medium size. Upper incisor absent; cheek teeth hypsodont; parastyle fold indistinct or lacking; protocone constricted; ectoloph greatly elongated; mandibular symphysis transversely expanded. The trigonid is angularly V-shaped. On the lower molars the lingual and labial cingula are absent, the hypolophid reclines backward, and the entoconid have a flat lingual margin (Matthew, 1929; Colbert, 1935; Heissig, 1972).

Material referred from the Chinji Formation of the Lower Siwaliks: IP2 (PUPC 97/84, Chinji), right broken mandibular ramus with p4-m3 (PUPC 08/01, Chinji).

Material referred from the Nagri Formation of the Middle Siwaliks: a right maxillary fragment with P3-M3 (PUPC 07/93, Bhilomar), a left mandibular ramus with p3-m2 (PUPC 07/94,

Bhilomar), a right partially broken mandibular ramus with p2-m3 (PUPC 08/02, Bhilomar), rm3 (PUPC 07/95, Bhilomar).

### DESCRIPTION

Left P2 (PUPC 97/84; Fig. 2A) is a poorly preserved specimen with an advanced wear degree. The premolar is rather upright and considerably broader than long. The protoloph and the metaloph are parallel. The parastyle is well developed and has a vertical groove. The ectoloph is flat in appearance and there is no median rib or mesostyle. The crista is absent in the premolar, however the crochet is slightly developed. The posterior cingulum is present and projects upward to close a postfossette. The median valley is narrow and presently closed as a fossette due to a narrow fusion of the protoloph and the metaloph. Slight traces of cement are present posteriorly along the metaloph.

In the right mandibular ramus with p4-m3 (PUPC 08/01; Fig. 2B-D), the horizontal ramus is higher and has greater depth laterally on the anterior region than the posterior one. The buccal profile of the horizontal ramus is slightly concave at the level of p4-m1. The tooth crowns are relatively high. The teeth are in the middle stage of wear, less accentuated on m3. In p4 the anterior cingulum is present and continues lingually as a cingular rim to the base of the anterior valley. The paralophid is short; the trigonid is V-shaped and the posterior valley is U-shaped; the labial cingulum is absent; the hypolophid reclines backwardly; the entoconid is lingually flat; the talonid is better developed than the trigonid; the labial groove is shallow and U-shaped in both premolar and molars. The m1 has a damaged paralophid. The labial groove is shallow. The anterior cingulum is present. A cingular rim is present at the base of the anterior valley. The posterior valley is widely V-shaped lingually. An enamel tubercle is present at the base of the posterior valley. The lingual margin of the entoconid is flat. The occlusal outline of m2 is rectangular, longer than broad. The anterior and the posterior valleys are widely V-shaped lingually. The metalophid and the hypolophid are oblique and the paralophid is short. The trigonid of m3 is angularly V-shaped with the narrow and short paralophid and

a right-angled metalophid with a slightly constricted metaconid. The entoconid has a posterior groove. No trace of cement is present. There is no labial cingulum. Metalophid and hypolophid are oblique. The measurements of the mandibular ramii are provided in Table I.

**Table I.- Comparative measurements of the studied mandibular ramii of *Chilotherium intermedium* (PUPC 08/01 and PUPC 08/02) and the referred *Chilotherium blanfordi* (AMNH 19469).**

Specimen	Position	mm
PUPC 08/01	Height of horizontal ramus at m1	118.0
	Height of horizontal ramus at m2	112.0
	Width of horizontal ramus at m3	61.0
	Height of horizontal ramus at m3	123.0
	Length of the molar series m1-m3	179.0
PUPC 08/02	Max. width of ascending ramus	56.0
	Height of horizontal ramus at m1	101.0
	Height of horizontal ramus at m2	116.0
	Height of horizontal ramus at m3	121.0
	Width of horizontal ramus at m3	61.0
	Length of the premolar series p2-p4	131.0
AMNH 19469	Length of the molar series m1-m3	187.0
	Length of the premolar series	83.0
	Length of the molar series	143.0
	Height of horizontal ramus at m1	77.0

The right maxillary fragment with P3-M3 (PUPC 07/93; Fig. 3A-C) is excellently preserved and the teeth are in middle wear. The molars are large and wide. The last upper molar is triangular in shape. The enamel is thick. In premolars the lingual cingula are discontinuous and the labial cingula are absent in the P3 and the P4, the ectoloph is greatly elongated and the medisinus is opened lingually except in the P3. There is a well-developed paracone rib. The parastyle fold is relatively weak. The protocone is somewhat constricted whereas the hypocone is bulbous. The protoloph and the metaloph are of different width. The crochet and the crista are absent except in the P3. The protoloph is longer than the metaloph. The P3 is small, about half the width of the P4 and has well-developed anterior cingulum. The P4 has a larger protocone than the hypocone. The anterior fold of the protocone is large and deep in the P4, which together with the anterior cingulum unites to form an accessory fossette.

The anterior, lingual and posterior cingula are

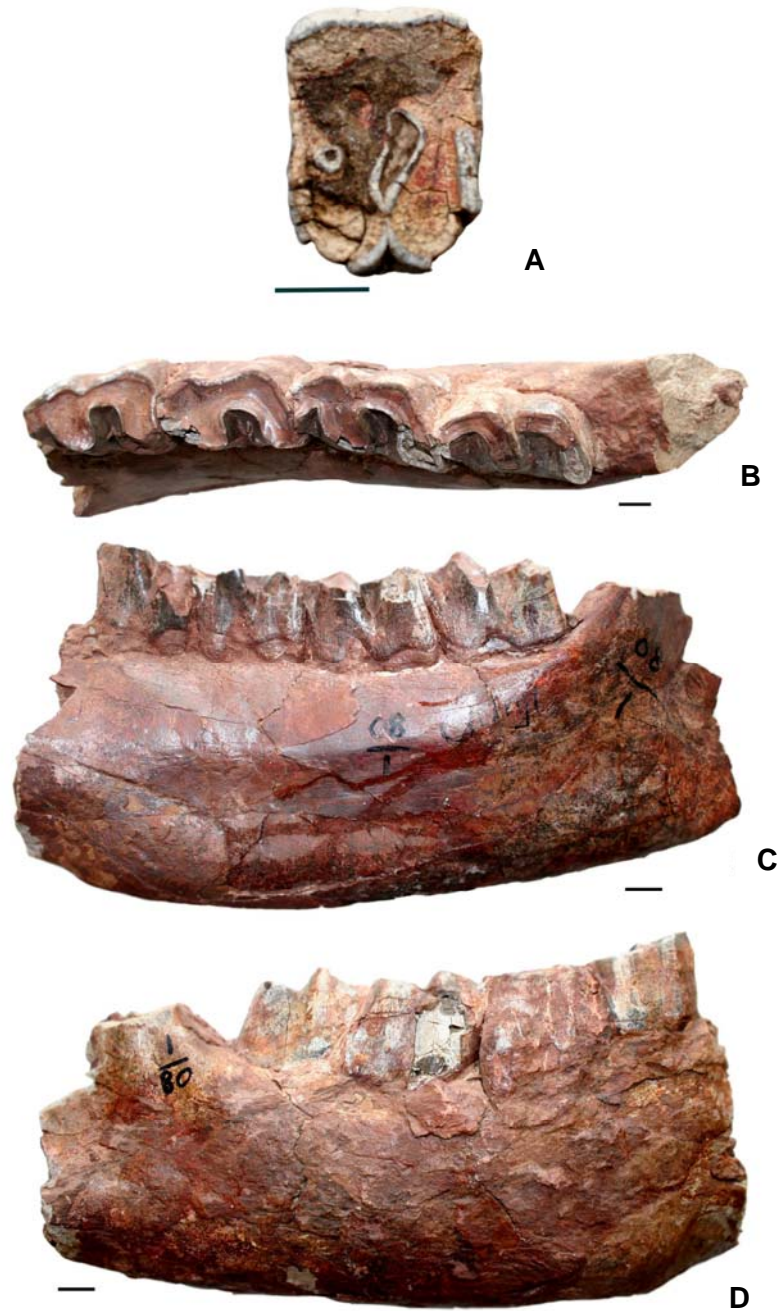


Fig. 2. *Chilotherium intermedium* from the Chinji Formation. A, occlusal view, PUPC 97/84 – IP3; B-D, a right mandible with p4-m3, PUPC 08/01. B, occlusal view, C, lingual view, D, buccal view. Scale bar 30 mm.

present in the upper molars; however, the cingulum is discontinuous in the M2 and the M3 at the lingual face of the protocone and the hypocone. The M1 and the M2 have slightly constricted protocone, the

parastyle fold is weak, and the crochet and the antecrochet are short and thick. The protoloph is longer than the metaloph both being at equivalent levels and perpendicular to the ectoloph. The M2 is

similar to the M1; the protocone of the M2 has a vertical crack; the parastyle, the paracone rib and the hypocone flange are damaged. The M3 is triangular in shape with a slightly convex ectometaloph. The crochet of the M3 is strong, very extended and in contact with the protoloph to enclose a fossette. Within the fossette are inflections of varying degree. The crista is prominent and does not connect with the crochet. Measurements of the upper dentition from the Chinji and the Nagri formations are provided in Table II.

PUPC 08/02 (Fig. 4A-C) is a partially broken mandibular ramus. The horizontal ramus is high and it is broken anteriorly just beneath the p2. The ascending ramus has a shallow horizontal depression on the lateral surface. Measurements of the mandibular ramus as well as other specimens belonging to the lower dentition are provided in the Table II.

The p2 is comparatively smaller in length than the other lower cheek teeth of the series and the paralophid is very short and weak. The posterior valley is narrow and U-shaped. A weak labial cingulum is present in the p2. The anterior and posterior cingula are weak. The p3 paralophid is short. The posterior valley is U-shaped. The labial cingulum is absent; the anterior and posterior cingula are weak. The hypolophid reclines backward slightly and the lingual margin of the entoconid is flat. The labial groove is shallow and widely U-shaped. The anterior cingulum is present in the p4. A lingual cingular rim is present at the base of the anterior valley. The paralophid is short; the trigonid is V-shaped and the posterior valley is U-shaped; the labial cingulum is absent; the hypolophid is backwardly reclining, and the entoconid is lingually flat. The labial groove is shallow and U-shaped. The talonid is better developed than the trigonid.

The m1 has a partly damaged paralophid. The labial groove is shallow and wide. The anterior cingulum is present. A cingular rim is present at the base of the anterior valley. The posterior valley is widely V-shaped. An enamel tubercle is present at the base of the posterior valley. The lingual margin of the entoconid is flat. The occlusal outline of the m2 is rectangular and it is longer. The metalophid and the hypolophid are oblique and the paralophid is

short. In the m3 the trigonid is angularly V-shaped, with narrow and short paralophid and a right angled metalophid with a slightly constricted metaconid. The talonid is also V-shaped; the entoconid has a posterior groove. No trace of cement is present. There is no labial cingulum. The ectolophid groove is shallow and not marked to the base of the crown. The metalophid and the hypolophid are oblique.

All the cheek teeth are excellently preserved and show characteristic morphological features in PUPC 07/94 (Fig. 3F). Most of the lower teeth are covered with thin and irregular cement on their labial walls, especially in the labial grooves. The enamel is uniformly thick. All the teeth are strongly worn. The lingual and the labial cingula are absent and the V-shaped labial groove is wide and shallow. The hypolophid is oblique in direction, but it is transverse in occlusal view. The ectolophid fold is sharp and reclines backward. The protoconid of the p2 and the p4 are partially damaged; the p2 is longer, triangular in outline and the anterior end of the paralophid is sharp and projecting forward. In the p3 occlusal cracks are present, and the metaconid is partially damaged. The paraconid is well preserved and rounded. The trigonid is well developed, the paralophid is weak and the metalophid is acute. Its hypolophid is partially damaged. The m1 has a partially damaged paralophid. The entoconid has a clearly flat lingual margin. The labial groove is narrow and deep, projecting towards the base; the trigonid is angularly V-shaped with narrow and short paralophid and a right-angled metalophid. The m1 has oblique hypolophid but transverse in occlusal view, the ectolophid fold is sharp but reclines backward.

The right m3 (PUPC 07/95, Fig. 4D-F) is isolated, complete, and in middle wear. The trigonid is angularly V-shaped with narrow and short paralophid and a right angled metalophid with a slightly constricted metaconid. The entoconid has a clearly flat lingual margin. The labial groove is narrow and deep down to the base. The hypolophid is oblique but transverse in occlusal view. A vertical crack is present on the crown. The enamel is thick and thinly wrinkled vertically. There is a poorly developed antero-lingual cingulum. Comparative measurements of the lower cheek teeth of *Chilotherium intermedium* from the Chinji and



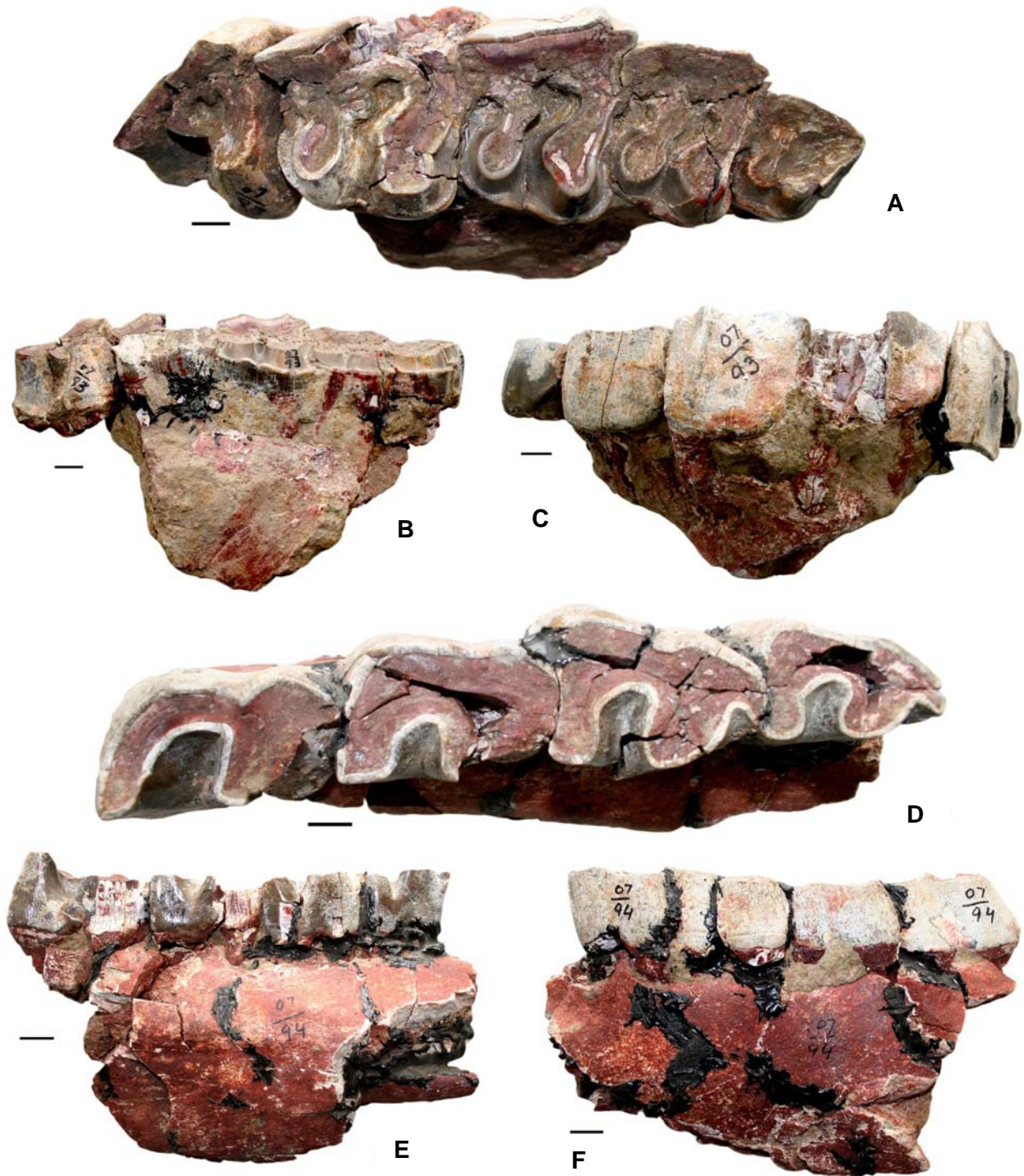


Fig. 3. *Chilotherium intermedium* from the Nagri Formation. Occlusal view (A), lingual view (B) and buccal view (C) of PUPC 07/93 – a right maxillary fragment with P3-M3. Occlusal view (D), lingual view (E) and buccal view (F) of PUPC 07/94 – a left mandibular ramus with p3-m2. Scale bar 30 mm.

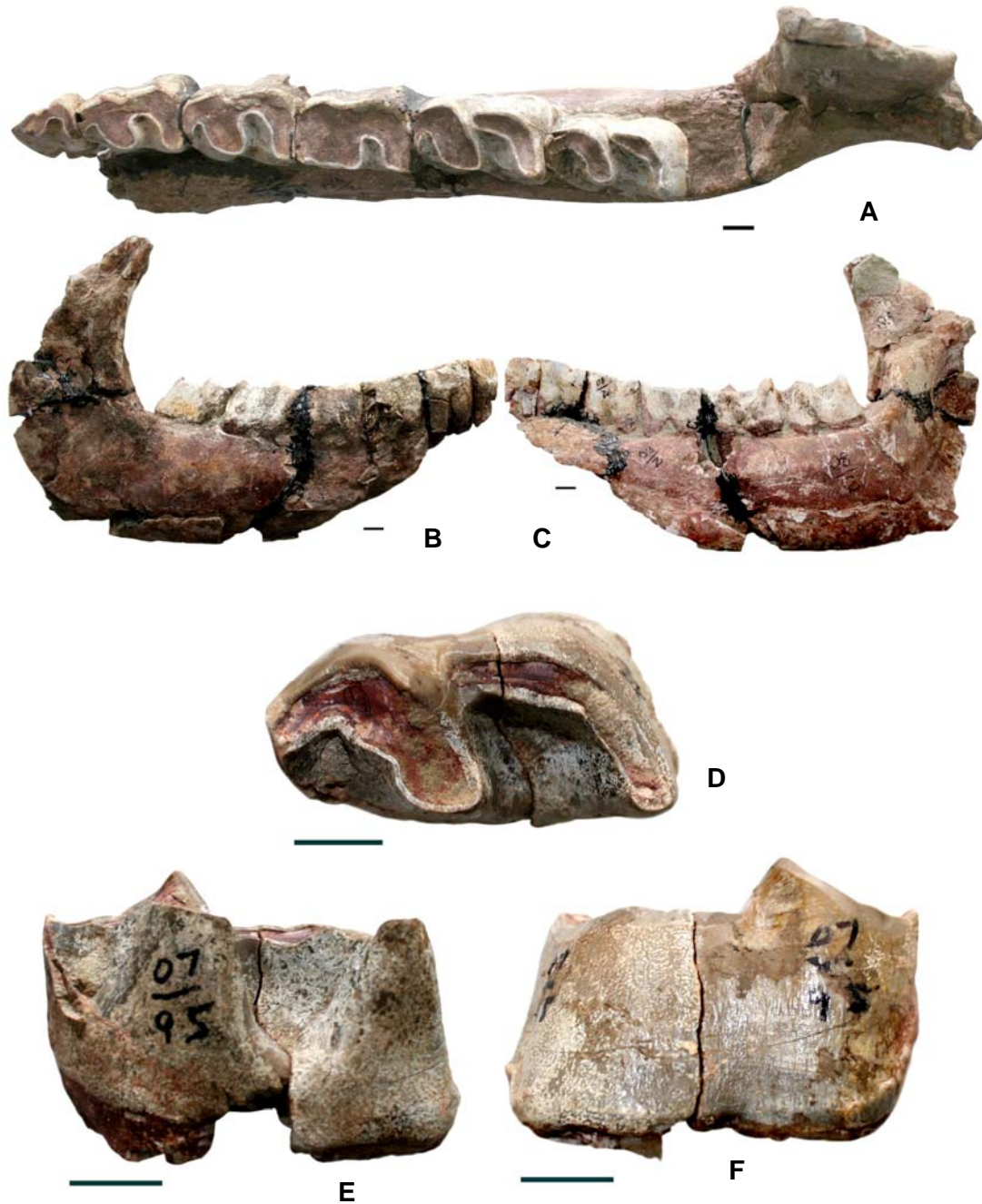


Fig. 4. *Chilotherium intermedium* from the Nagri Formation. Occlusal view (A, D), lingual view (B, E) and buccal view (C, F) of PUPC 08/02 – a right partially broken mandibular ramus with p2-m3 (A-C) and PUPC 07/ 95 – m3 (D-F).. Scale bar 30 mm.

Nagri formations are provided in Table II.

#### Comparison

The studied sample is comparable to that

described as *C. intermedium* by Colbert (1935) and to those figured by Matthew (1929) from the Middle Siwaliks of Pakistan in having a broad and flat ectoloph with a strong and well-developed parastyle



**Table II.- Comparative dental measurements of the cheek teeth of *Chilotherium intermedium* from the Nagri and the Chinji formations in mm. \* The studied specimens. Referred data are taken from Heissig, 1972, (*Subchilotherium intermedium intermedium* and *Subchilotherium intermedium complanatum*); Colbert, 1935 (*Chilotherium blanfordi*); Deng Tao and Gao Feng, 2006 (*Subchilotherium intermedium*)**

Taxa	Formations	Number	Nature	Length	Width	
<i>C. intermedium</i>	Chinji	PUPC 97/84*	P2	31.0	42.0	
			Nagri	PUPC 07/93*	P3	41.0
	P4	52.0			64.0	
	M1	60.0			71.0	
	M2	64.2			72.0	
	M3	65.2	70.0			
<i>Subchilotherium int. intermedium</i>	Chinji	1956 II 395	P4	34.0	44.0	
		1956 II 390	M3	45.0	46.0	
<i>Subchilotherium int. complanatum</i>	Dhok Pathan	1956 II 392	P2	26.0	34.0	
			P3	29.0	46.0	
			P4	34.0	47.0	
			M1	38.0	45.0	
			M2	45.0	42.0	
			M3	45.0	53.0	
<i>C. blanfordi</i>	Lower Chinji	AMNH 19408	M1	52.0	64.0	
			M2	64.0	66.0	
			M3	56.0	61.0	
<i>C. intermedium</i>	Chinji	PUPC 08/01*	p4	53.3	38.4	
			m1	52.4	35.0	
			m2	58.0	40.3	
			m3	66.0	34.0	
<i>C. intermedium</i>	Nagri	PUPC 07/94*	p3	45.5	32.0	
			p4	48.3	42.0	
			m1	52.0	39.0	
			m2	61.0	41.0	
			PUPC 07/95*	m3	69.0	37.0
				PUPC 08/02*	p2	35.0
		p3			46.5	37.5
		p4			52.0	38.5
		m1			56.0	42.5
		m2			62.0	45.0
		m3	65.0		42.5	
		<i>Subchilotherium int. complanatum</i>	Dhok Pathan	1956 II 392	p2	20.0
p3	30.0				24.0	
p4	33.0				25.0	
m1	35.0				24.0	
m2	37.0				25.0	
m3	38.0				25.0	
<i>Subchilotherium intermedium</i>	Upper Nagri level (Yuanmou, China)		m1	46.6	-	
			m1	43	24.5	

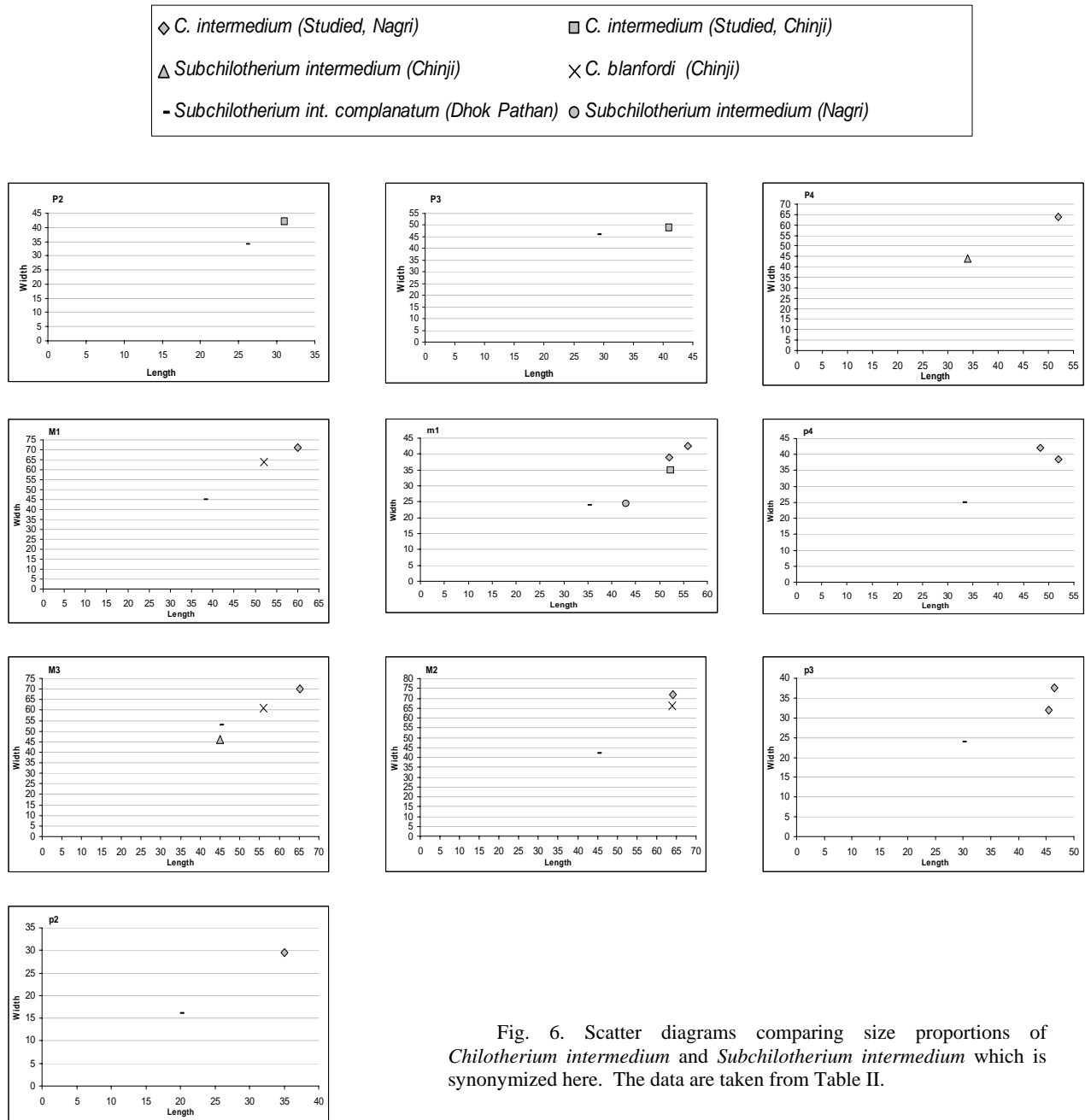


Fig. 6. Scatter diagrams comparing size proportions of *Chilotherium intermedium* and *Subchilotherium intermedium* which is synonymized here. The data are taken from Table II.

in upper dentition, somewhat oblique protoloph and metaloph; metaloph longer than protoloph; strong crochet; absence of internal cingulum and moderate constriction of protocone (Figs. 2-4). In *C. intermedium* the protocone is much less constricted off from the protoloph than that of *C. blanfordi*. The

lower dentition has also very close resemblance in morphology to the dental material of *C. intermedium* described by Colbert (1935) from the Middle Siwaliks in the presence of V-shaped trigonid, absence of lingual and labial cingula, backwardly reclining hypolophid, and flat lingual

margin of the entoconid. The studied dental sample fit in pretty well with that of the remains described by Colbert (1935) as *C. intermedium*, Deng (2006b) and Heissig (1972, 1975) as *C. intermedium intermedium* and *Subchilotherium intermedium* (Fig. 5, Table II).

The present collection of *Chilotherium intermedium* when compared to the large bodied *Brachypotherium fatehjangense* (Pilgrim, 1910), which is abundantly found in the Siwaliks and described by Heissig (1972), reveals significant differences. The upper dentition in *B. fatehjangense* is morphologically different from *C. intermedium* in having brachydont teeth, a wide and evenly flat or slightly concave ectoloph surface behind the rather insignificant paracone rib; the crista and the lingual cingulum are absent in the upper premolars and molars of *B. fatehjangense*. The labial groove in the lower dentition of *B. fatehjangense* is more conspicuous and deeper than in *C. intermedium*.

The studied specimens show some affinities with *C. wimani* described by Deng (2001) from Fugu, Shanxi and Linxia basins, China, in the presence of weakly constricted protocone and unconstricted hypoconid, well-developed parastyle fold and paracone ribs, weaker development of crochet, small antecrochet, and wide mandibular symphysis. However, *C. wimani* differ greatly from *C. intermedium* due to the low cheek tooth crowns and the wavy labial walls in the upper cheek teeth.

The Nagri specimens are comparable to *C. anderssoni* from China in having a flat labial wall and the absence of the medifossette; however, the parastyle fold in the present material is more prominent than in *C. anderssoni*, whose paracone rib and parastyle folds are almost absent (Deng, 2006b). In the upper premolars of *C. anderssoni*, the lingual cingulum is weak and discontinuous, while in the studied specimens it is well developed and continuous. In the upper molars of *C. anderssoni*, the lingual cingulum and the crista are completely absent, and the antecrochet is large enough to fill the whole median valley (Deng, 2006b); in contrast, the lingual cingulum is well developed and continuous in the M1 of the studied material, although in M2 and M3 the lingual cingulum is present only in the median valley, being absent on lingual faces of the protocone and the hypocone. The presence of a

prominent crista, a well-developed crochet, a moderate antecrochet, and a lingual bridge between protoloph and ectometaloph of M3 in the Nagri specimens distinguish them very well from *C. anderssoni*.

## DISCUSSION

According to Ringström (1924) the peculiar characters of *Chilotherium* include large and strongly projected parastyle, little constricted protocone and almost flat ectoloph in upper cheek-teeth. Since the establishment of the genus *Chilotherium* by Ringström (1924), twelve species have been described, and nineteen other species have been referred to this genus by various authors (Deng, 2006b). Colbert (1935) described *C. intermedium* from the Lower and the Middle Siwaliks with the diagnosis of a well-developed parastyle fold and slightly constricted protocone. The general pattern of the present material matches those of the material of Ringström (1924), Matthew (1929), Colbert (1935) and Heissig (1972), in strongly projected parastyle, little constricted protocone and almost flat ectoloph.

Heissig (1972) described *C. intermedium intermedium* from the Chinji and the Nagri formations, and *C. intermedium complanatum* from the Dhok Pathan Formation of the Siwaliks of Pakistan. Heissig (1975) placed the Siwalik *C. intermedium* in the new subgenus *Subchilotherium*, which later rose to the generic rank (Heissig, 1989). *Subchilotherium intermedium* has a well developed antecrochet on all upper cheek teeth; a strong posterior groove of protocone on upper molars and a wide posterior cingulum in M3. Deng (2006b) proposed a revised diagnosis of *Subchilotherium intermedium* Heissig 1975, and characterized it by the presence of a narrow mandibular symphysis; subhypsodont cheek teeth with strongly projected paracone and parastyle, parastyle fold sharp, the lingual cingulum weak; premolars with marked molarization, and the P2/p2 comparatively small.

The present upper dentition from the Nagri Formation resembles the Heissig's sample of *Subchilotherium intermedium* in having a posterior groove of protocone; however it differs in having a weak antecrochet in M2 and M3, a weak posterior

cingulum in M3 and larger size (Figs. 3, 5). The recovered upper dentition also shows similarities to *Subchilotherium intermedium* described by Deng (2006b) from Leilao and Xiaohu, China, in the presence of a medifossette and well developed crista arising from ectometaloph in M3. A lingual cingulum is present in the M3 of Chinese specimens as well as in the Nagri specimens. However, the lingual cingulum in Chinese specimens is a strong pillar according to Deng (2006b), which is quite different from the lingual cingulum of the M3 in the Nagri specimens (Figs. 3-4).

Morphological and metrical characters (Figs. 2-4, Table II) of the dental specimens of *C. intermedium* clearly indicate that the differences among the specimens do occur. The differences might occur due to sexual dimorphism, subject to interaspecific variability in *C. intermedium*. Comparing the holotypes of *C. intermedium* and *Subchilotherium intermedium* (Colbert, 1935; Heissig, 1972) with the new findings, it is clear that the size variation is within the range of intraspecific variability (Fig. 5). The general features of *Chilotherium*: strongly projected parastyle, little constricted protocone, almost flat ectoloph, cingula and antecrochet are variable. All these variations can be observed in the recovered remains from the Chinji and Nagri formations and the differences can be considered merely the individual variations (Fig. 5). Therefore, *Subchilotherium* is considered a junior synonym of *Chilotherium*. The common stratigraphic level of both genera strengthens such a decision.

### CONCLUSIONS

The morpho-metric variation of the dental sample in the present study has urged us for considering *Chilotherium* as a valid taxon for the Siwalik chilothers and synonymizing *Subchilotherium* with *Chilotherium*. The Siwalik *Chilotherium* is still poorly known, leaving a great hiatus in the anatomical features of this rhinoceros group. *Chilotherium intermedium* is known from deposits dated 16.3 Ma to 7.6 Ma (Flynn *et al.*, 1995). The recognition of the new material as this species ranges from the Middle Miocene deposits of the Chinji Formation to the Late Miocene deposits

of the Nagri Formation of the Siwaliks, dated approximately between 14.2-10 My. In this case, the *C. intermedium* record in Pakistan would span from Middle Miocene up to the Late Miocene, agreeing previous concepts.

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