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Tetraconodon (Mammalia: Artiodactyla: Suidae) From the Late Miocene Dhok Pathan Formation of Pakistan

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Abstract. – We describe here a suid molar originating from the Late Miocene Dhok Pathan type locality (Chakwal, Punjab, Pakistan) of Dhok Pathan Formation, Middle Siwaliks, Northern Pakistan. The molar belongs to the large sized Pliocene suid *Tetraconodon.* The specimen, which is attributed to a tetraconodon, reliably matches with *T. magnus*, a rare taxon previously found in the Pliocene of the Siwaliks. The presence of this species in the Late Miocene of the Dhok Pathan type locality represents the oldest record in the Siwaliks.

Keywords: Mammalia, vertebrates, Tetraconodontinae, suid, Late Miocene, Siwaliks.

INTRODUCTION

The studied specimen has been collected from the outcrops nearby the Dhok Pathan type locality. The village Dhok Pathan (Lat. 33° 07 N, Long. 72° 14 E) is situated in the Chakwal district and the outcrops nearby are of Late Miocene in age (Fig. 1). The thickness of the outcrops is from 950-1200 m. The Dhok Pathan village is designated the type locality of the Dhok Pathan Formation. The Dhok Pathan Formation is widely exposed in Potwar area of Pakistan (Shah, 1977, 1980) and it is composed of alternate sandstone, claystone/siltstone beds with occasional lenses of gravels. Sandstone is hard, well cemented to very soft and poorly cemented having thickness from few meters to more than 90 meters. While clay stones are hard dark grey, greenish grey brown over consolidated silty clays, laminated at places containing some calcium carbonate. The clays are orange brown in color (Barry *et al*., 2002; Khan *et al*., 2006; Bhatti *et al*., 2012a, b).

The Dhok Pathan Formation was deposited in semi to sub tropical climatic conditions and it contains plant fragments and vanadium rich minerals. In some areas, the Formation contains considerable amount of humic acid pyrite, formed during diagnoses and these served as important reductants from uranium deposits. A few places, crevasse-splay sheets, around 30 cm thick, clast-supported conglomerates occur (Behrensmeyer and Barry, 2005). Sandstone beds gradually thicker as well as multistoried. These substantially thicker, vertically stacked and laterally extensive individual grey sandstone units from a finning-upward sequence with thinner dull red or brown siltstone on the top (Sheikh *et al*., 2008).

Overall, the Dhok Pathan Formation of the Middle Siwaliks in the Potwar Plateau shows two contemporaneous, interfingering fluvial systems, namely the Blue-grey system and the Buff system. The Blue-grey system is characterized by widespread sheet with low sand/mud ratio, and was deposited by a large braided system while the Buff System is characterized by shoe-string sand bodies, and was attributed to frequent avulsion in a 10-20 km wide floodplain. The difference in the Blue-grey system and the Buff-grey system was explained on the basis of difference in source area analogous to mountain-fed rivers in fan areas and foothill-fed river systems in interfan areas (Shah, 1977; Barry *et al*., 2002).

Our new discovery of *T. magnus* from a Late Miocene site in Dhok Pathan enables us to extend the stratigraphical range of this species. Previous researchers were unable to conclusively date of this species in having a poor idea on provenance

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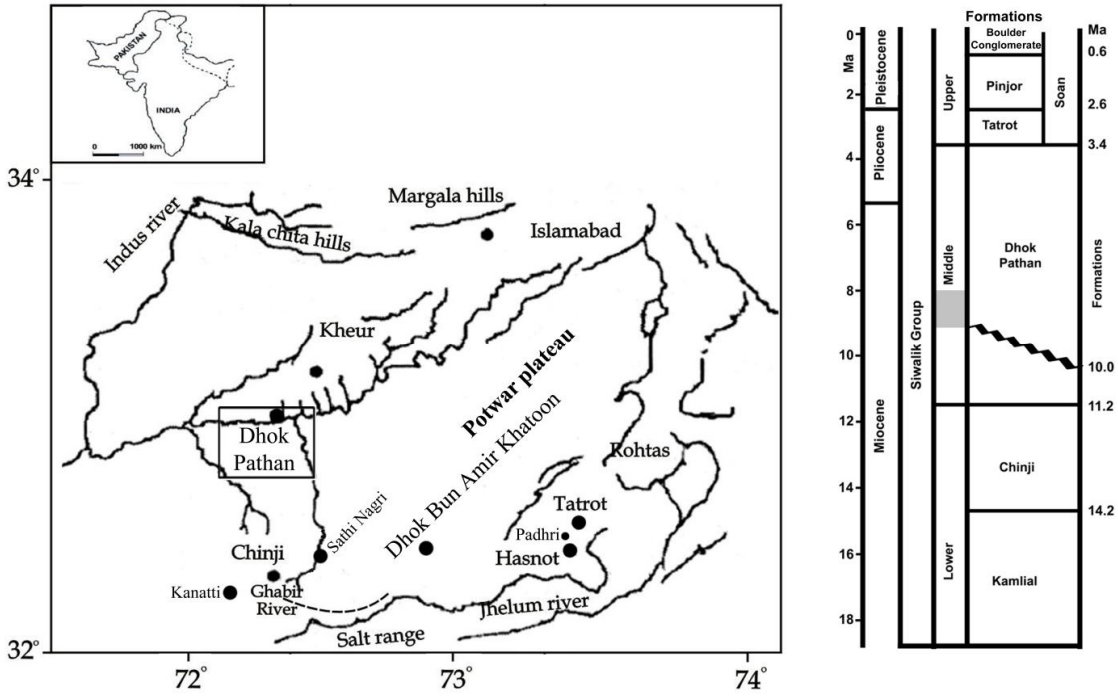

Fig. 1. Location map of Potwar Plateau in northern Pakistan showing the type locality of the Dhok Pathan Formation in Chakwal district, Northern Pakistan (data from Johnson *et al*., 1982, Barry *et al.,* 2002; Behrensmeyer and Barry, 2005; Dennell, 2008 and Nanda, 2008 and, Cohen and Gibbard, 2008).

(Pilgrim, 1926; Pickford, 1988; Made, 1999). Thus, the significance of this study is to shed new light on the age of *T. magnus*.

Institutional abbreviations

GCS, Government College of Science, Wahdat road, Lahore, Pakistan; NMMP-KU-IR, National Museum, Myanmar, Paleontology–Kyoto University–Irrawaddy (stored in the National Museum, Yangon); GSI, Geological Survey of India, Kolkata, India; AMNH, American Museum of Natural History, New York, USA.

MATERIAL AND METHODS

The recovered sample comes from the site nearby Dhera Kundrali (Lat. 33° 11° 039° N, Long. 72° 33□ 540□ E) of the Dhok Pathan type locality, Chakwal, Northern Pakistan (Fig. 1). The site was visited several times for the collection of the fossils. The recovered specimen is a surface find. The collected material represents only one suid tooth. The sample was carefully washed and cleaned in the Paleontology Laboratory of the Zoology Department, University of the Punjab, Lahore.

The specimen is catalogued with a catalogue code consisting of two parts, a serial catalogue and a yearly one. So number on the specimens represents the collection year and the serial number. The collection year was written in denominator and the serial number of that respective year was written in numerator (*e.g.*, GCS 11/02). The tooth length and width were measured at occlusal level. The measurements were taken with the help of metric vernier caliper and expressed in millimeters (mm). The upper case letter denotes upper dentition and lower case for lower dentition. The terminology follows Pickford (1988) and Made (1999), and measurements method follows Thaung-Htike (2005).

SYSTEMATIC PALAEONTOLOGY

Suborder Suiformes Jaeckal, 1911
Infraorder Suina Gray, 1868
Family Suidae Gray, 1821
Subfamily Tetraconodontinae Lydekker, 1876

Diagnosis

Tetraconodontinae with extremely enlarged P3 and P4 and relatively small M3. DAP' x DT' of the p3 and p4: about 160 x 150 and about 140 x 150, respectively (Pickford, 1988; Made, 1999).

Tribe Tetraconodontini Lydekker, 1876
Genus *TETRACONODON* Falconer, 1868

Type species

Tetraconodon magnus Falconer, 1868.

Tetraconodon cf. *magnus* (Falconer, 1868)

Type

The holotype is a maxilla with M2-M3, figured by Falconer (1868, fig. 5). Colbert (1935) supposed the holotype to be lost and indicated as a neotype GSI B 71, a right mandible with p2-m3. He also made it the lectotype of *T. mirabilis* Pilgrim, 1926, thus synonymising both species. The specimen was figured by Lydekker (1876, pl. 10, figs a-c).

Distribution

The species is known from the Siwaliks subcontinent (Pilgrim, 1926; Pickford, 1988).

Diagnosis

A large species of *Tetraconodon* in which the upper molar series exceeds 95 mm in length, and in which p3-4 are together longer than 75 mm. Large *Tetraconodon*, M1 length about 33 mm.

Type locality

'Between the Murkunda Pass and Pinjor' for the holotype. Hasnot for the neotype.

New material

GCS 11/02, an isolated right upper M2 (Fig.2).

Locality for the new material

Dhok Pathan village near Dhera Kundrali, Chakwal district (Middle Siwaliks), Punjab province, Pakistan.

Description and comparison

The molar is in late wear, rectangular in occlusal view and slightly damaged antero-lingually (Fig. 2). The tooth is bunodont and brachydont with a thick enamel. The molar has four main inflated cusps, the paracone, the protocone, the metacone and the hypocone. The hypo-pre-conule and penta-pre-conule are distinct. The proto-pre-conule is prominent. The pentacone is absent. The enamel is thick and rugose. The cingulum is present antero-posteriorly. The median valley is deep, so that the mesial and distal cusp pairs do not unite. Small cusplets at either end of the median valley is present.

The molar is characterized by large size, thick enamel and inflated cones with hypo-pre-conule and penta-pre-conule. These features associate the sample to the large sized Siwalik suid *Tetraconodon*. The genus *Tetraconodon* is represented in the Siwaliks (Pickford, 1988; Made, 1999) by two species namely *T. magnus* (Falconer, 1868) and *T. minor* (Pilgrim, 1926) from the Siwaliks. *Tetraconodon magnus* is a large sized suid which is characterized by exceedingly large upper molar series, about 95 mm in length and p3-4 are longer than 75 mm. Morphometrically (Table I; Figs. 2-3), the specimen matches with *Tetraconodon magnus,* as the specimen is single and can be assigned to species *T.* cf. *magnus* (Pickford, 1988; Made, 1999).

DISCUSSION

Tetraconodon is represented by 5 species namely *T. magnus, T. intermedius, T. minor, T. thailandicus, T. malensis*. *Tetraconodon magnus* is the largest one and *T. malensis*, reported recently, is the smallest one (Made, 1999; Thaung-Htike *et al.*, 2005). Previously, *T. minor* was considered the smallest species and chronologically oldest species of the genus (Pilgrim, 1926; Colbert, 1935; Made, 1999). However, newly discovered species *T. malensis* is equal to the size of *T. sindiensis* and it

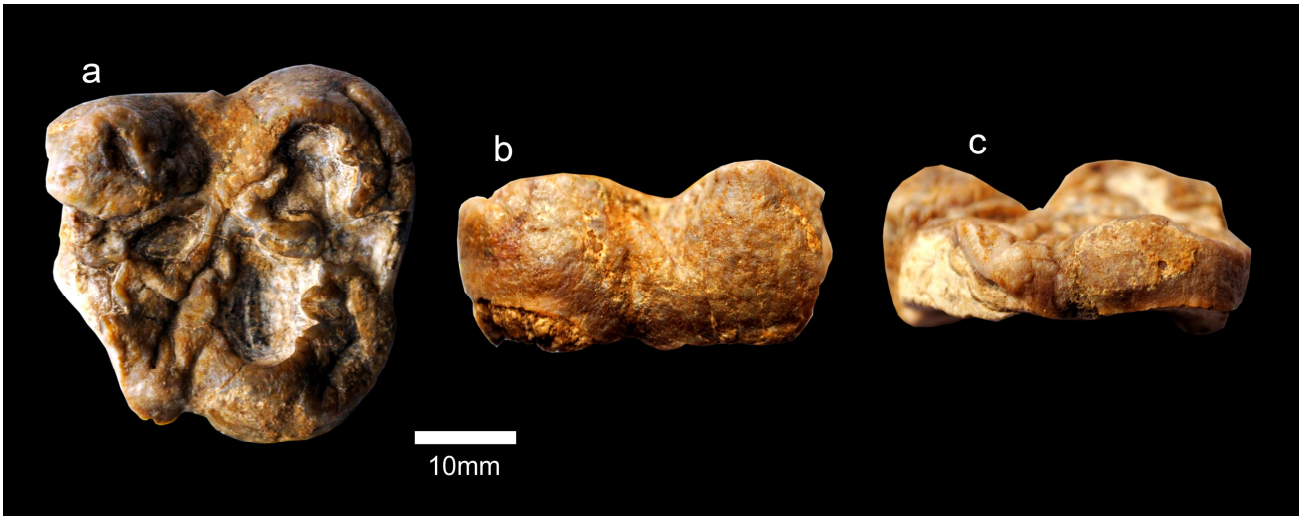

Fig. 2. *Tetraconodon magnus*, GCS 11/02, right M2; a. occlusal view, b. labial view, c. lingual view.

Table I.- Comparative measurements (mm) of M2 of *Tetraconodon magnus* in mm.

Taxa	Number	Nature	L	W1	W2	W1/L
*T.*cf. *magnus*	GCS 11/02*	rM2	38.0	39.0	33.0	1.02
T. magnus	AMNH 93868	M2	37.3	43.5	-	1.16
	GSI B675	M1	31.1	35.8	-	1.15
*T.*cf. *intermedius*	NMMP-KU-IR 0225	M2	30.6	32.6	29.1	1.06

Abbreviations: L, mesiodistal length; W1, labiolingual first lobe width; W2, labiolingual second lobe width.
*The studied specimen. Referred data is taken from Pickford (1988) and Thaung-Htike *et al*. (2005).

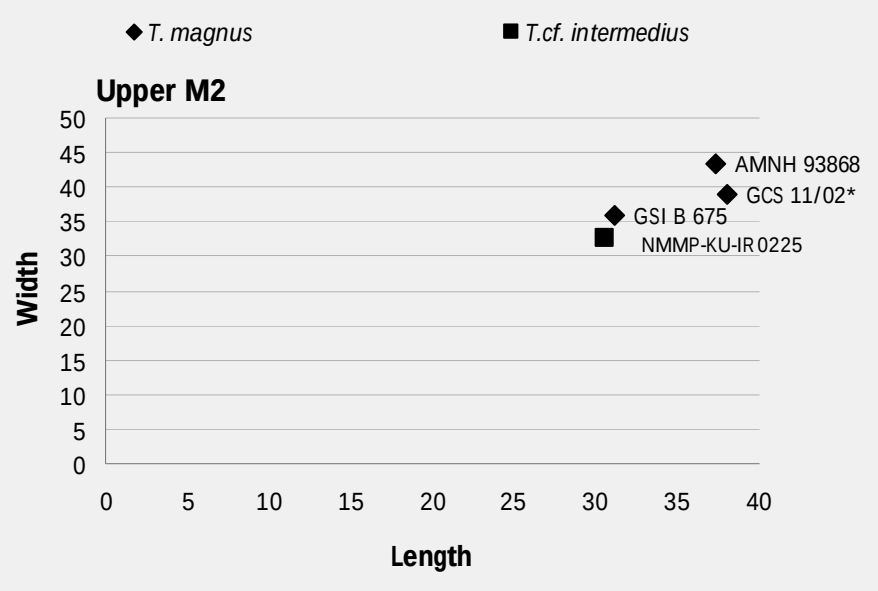

Fig. 3. Bivariate plot (in mm) of the second upper molars of *Tetraconodon*.

is, now, considered the smallest and most primitive species of the genus *Tetraconodon* (Thaung-Htike *et al.*, 2005).

Most of the tetraconodontines have been recovered from the Siwaliks sub-continent (Pilgrim, 1926; Pickford, 1988; Made, 1999; present study). Based on these fossils, the researchers believed that *Tetraconodon* was probably derived from the lower Middle Miocene form *T. sindiensis*, an early species recorded from the Kamlial or lower Chinji Formation of the Siwaliks (Pilgrim, 1926; Pickford, 1988; Made, 1999) as well as from the Middle Miocene of Thailand (Ducroq *et al*., 1994) and Nepal (West *et al*., 1991). The similarity of the size of *T. sindiensis* in Pakistan and *T. malensis* in Myanmar (Burma) reinforces such decision.

The specimen record of *T. magnus* is yet scarce. Previously, only eight specimens had been recovered from the expeditions held during the last centuries (Pilgrim, 1926; Colbert, 1935; Pickford, 1988; Made, 1999). The exact provenance of most specimens is unknown and probably they were recovered from the Hasnot and basal area of the Tatrot Formation (Made, 1999). Earlier researchers (Pilgrim, 1926; Lydekker, 1876) erroneously suggested an Upper Siwalik age for *T. magnus*, which was based on a poor idea of the provenance. Pickford (1988) noted that *T. magnus* was a Middle Siwalik form, the view which was later on criticized by Made in 1999.

Nevertheless, the in situ finding of the new specimen from the Dhok Pathan type locality provides exact information on provenance for *T. magnus*. The specimen comes from the fossiliferous Hilltop Sand bed in the N2, R3, and N3 magnetozones of Barry *et al*. (2002, fig. 4), which was dated to ca. 8 Ma and which consists locally the basal part of the Dhok Pathan Formation. Therefore, it is confirmed that the Pickford's idea (1988) is essentially correct that the species is of Middle Siwalik age (8.0-3.5 Ma) instead of Upper Siwalik age (3.4-0.6 Ma). The finding of *T. magnus* in the Late Miocene of the Siwaliks with other mammalian groups like proboscideans (Sarwar, 1977), ruminants (Pickford, 1988; Khan, 2008; Khan *et al*., 2007, 2008, 2010; Ghaffar *et al*., 2011; Bhatti *et al*., 2012a, b) and perissodactyls (Bernor and Hussain 1985; Khan, 2009) extends its stratigraphical range from the Late Miocene to the Pliocene.

CONCLUSIONS

The studied specimen found at the Dhok Pathan type locality, where *T. magnus* had been previously unknown. The discovery of *T. magnus* from the Dhok Pathan type locality suggests the possibility that the species exists at the base of the Dhok Pathan Formation. The record of *T. magnus* in the Late Miocene sediments of the Dhok Pathan type locality extends the geochronological range of the species and represents the oldest record of the species in Pakistan.

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