



Middle Miocene Suids from Chinji Formation of Chabbar Syedan, Punjab, Pakistan

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ABSTRACT

Listriodon pentapotamiae, *Conohyus sindiensis* and *Propotamchoerus* sp. described in this article, have been recovered from a long neglected Middle Miocene locality of Chabbar Syedan, Jhelum district, Punjab, Pakistan. The lower deciduous incisor (di1) of *L. pentapotamiae* has been described for the first time from the Siwalik Group. The newly discovered remains are fruitful to understand the fauna of this Middle Miocene locality and excavated material expands our anatomical knowledge about the recorded species.

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Authors' Contribution

MAK and MA conceived and designed the study. MKN, SGA and MAB acquired and analyzed the data. MA, SGA, MAB and RS drafted the article.

Key words

Listriodon, Siwaliks, Miocene, Suidae, Chinji.

INTRODUCTION

The fossil record of the family Suidae from the Siwaliks is generally very good in comparison with that of other parts of the world, and many Indian taxa are represented by more or less complete skulls or mandibles (Lydekker, 1884; Pilgrim, 1926; Colbert, 1935a; Pickford, 1988; van der Made, 1996; Khan *et al.*, 2010, 2012, 2013; Batool *et al.*, 2015). The most primitive suids *Listriodon*, *Conohyus* and *Hyotherium* are found in the lower portions of the Siwaliks, and *Hyotherium* is a survivor of the central stem from which developed the more specialized kinds of pigs (Pickford, 1988; Van der Made, 1996).

Listriodon was first described from Switzerland by von Meyer (1846) as *L. splendens*. An upper second molar (M2) from the Siwaliks was described by Falconer (1868) as *Tapirus pentapotamiae* which was later referred as *Listriodon pentapotamiae* by Lydekker (1876, 1884). Some new remains including maxillary and mandibular fragments were described by Pilgrim (1926) and Colbert (1935). According to some authors (Pilgrim, 1926; Colbert, 1935a; Chen, 1986; Van der Made, 1996; Orliac *et al.*, 2009, 2010), the genus *Listriodon* is known by three species from the Siwaliks: *L. pentapotamiae*, *L. theobaldi* and *L. guptai*. *Listriodon theobaldi* is much smaller than *L. pentapotamiae* (Pilgrim, 1926; Colbert, 1935a). Pickford (1988) was of the opinion that only a single species *L. pentapotamiae* is present in the Siwaliks.

Van der Made (1996) was of view that there are two subspecies of genus *Listriodon* and interpreted that *L. pentapotamiae theobaldi* is a somewhat smaller subspecies with higher and better formed lophs on the molars, which evolved from *L. p. pentapotamiae*. *Conohyus* is a tetraconodont genus of Suidae and is represented by the two species *C. sindiensis* and *C. indicus* in the Siwaliks (Pickford, 1988). Biometrically these species are more similar to *Sivachoerus* than to *Conohyus simorreensis* and were placed in that genus (Van der Made, 1999), but this transfer was not followed by others. Its first occurrence is in the early Miocene (Kamlial Formation) and it is abundant in the Middle Miocene (Pilgrim, 1926; Colbert, 1935a, b; Pickford, 1988; Van der Made, 1999; Pickford and Gupta, 2001).

Institutional abbreviations

PUPC, Punjab University Palaeontological Collection, University of the Punjab, Lahore, Pakistan; UZ, Department of Zoology, University of the Punjab, Lahore, Pakistan; GSI-B, Geological Survey of India, Burma; GSI K, Geological Survey of India, Calcutta; GSP, Geological Survey of Pakistan; HGSP, Howard Geological Survey of Pakistan; BSHPGM, Bayerische Staatssammlung für Palaeontologie und historische Geologie (München); IVAU CHC, Instituut voor Aardwetenschappen (Utrecht) Chinji; FISFCHA, Forschungsinstitut Senckenberg (Frankfurt am Main) Chaske Wala; Instituut voor Aardwetenschappen (Utrecht); IVAU CHB, Instituut voor Aardwetenschappen (Utrecht) Burri Wala; AMNH, American Museum of Natural History (AM); BMNH, British Museum of Natural History (M).

Anatomical abbreviations

I, upper incisor; DP, upper deciduous premolar, P, upper premolar; M, upper molar; i, lower incisor, di, lower deciduous incisor, c, lower canine, p, lower premolar, m, lower molar; L, length; W1,2,3, width of the first, second and third loph/lophid.

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The studied outcrops are present nearby the Chabbar Syedan village (33° 00' 16.1" N; 73° 13' 29.0" E) which is situated at the base of Bakralla ridge, district Jhelum, Punjab, Pakistan (Fig. 1). The Chinji Formation is relatively exposed in the outcrops nearby the Chabbar Syedan village. The Formation is dominant in this area as the red claystones placed on subordinate hard grey sandstone with interbedding narrow beds of siliceous nodules. The majority of fossils are found in claystones, in the middle and upper part of the Chinji Formation (Aftab *et al.*, 2015; Abbas *et al.*, 2016; Babar *et al.*, 2018). The outcrops are exposed in the surroundings of the village, and yielded the mammalian remains that belong to Middle Miocene age (Table I).

The outcrops are rarely visited by the earlier

researchers. Among them, Sarwar (1977) recorded UZ 70/26 as the holotype of the newly erected species *Gomphotherium chabbariensis* (*Protanancus chinjiensis*). Pickford (1988) has reported one specimen of *Conohyus sindiensis* (K23/121), mentioning the site "2 miles south east of Paridarwaza" which corresponds to the location of Chabbar Syedan. More recently, from this locality Aftab *et al.* (2015) has reported one specimen of *Giraffokeryx punjabiensis* and from this locality; and a year later, Abbas *et al.* (2016), described two specimens of *Protanancus chinjiensis*. The specimens contribute to recent work of Middle Miocene Suidae from the Lower Siwalik subgroup of Pakistan. We emphasize new morphological information represented by the recovered material.

Table I.- Faunal list of recently recovered species from the Chabbar Syedan.

Order	Family	Species
Artiodactyla	Bovidae	<i>Gazella</i> sp.; <i>Sivoreas eremita</i> ; <i>Sivaceros gradiens</i> ; <i>Miotragocerus gluten</i> ; <i>Miotragocerus</i> sp.; <i>Helicopotax praecox</i> ; <i>Helicopotax tragelaphoids</i>
	Tragulidae	<i>Dorcatherium nagrii</i> ; <i>Dorcatherium minus</i> ; <i>D. majus</i>
	Suidae	<i>Listriodon pentapotamiae</i> ; <i>Conohyus sindiensis</i> ; <i>Propotamochoerus</i> sp.
	Giraffidae	<i>Giraffokeryx punjabiensis</i> ; <i>Giraffa priscilla</i> ; <i>Progiraffa</i> sp.
Perissodactyla	Rhinocertidae	<i>Gaindatherium browni</i> ; <i>Brachypotherium</i> sp.
	Chalicotheriidae	<i>Anisodon salinus</i>
Carnivora		<i>Sivaonyx bathygnathus</i> ; Carnivora indet.
Proboscidea	Deinotheriidae	<i>Deinotherium pentapotamiae</i> ; <i>D. indicum</i>
	Amebelodontidae	<i>Protanancus chinjiensis</i> ; <i>Konobelodon</i> sp.
	Gomphotheriidae	<i>Gomphotherium browni</i>

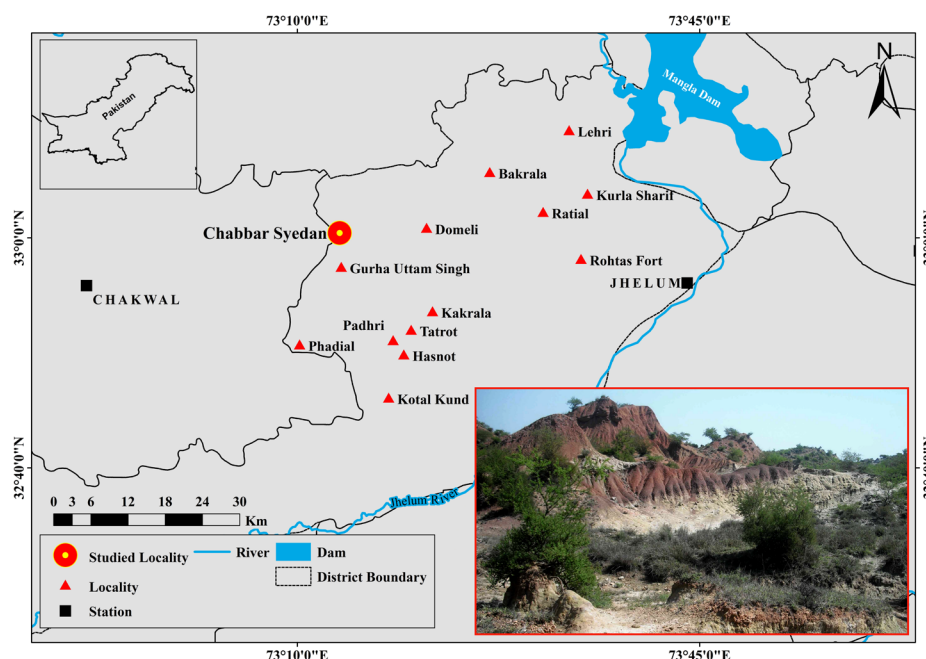


Fig. 1. Location of the studied locality "Chabbar Syedan" in Jhelum district and outcrops exposed near the village in inset.

MATERIALS AND METHODS

The new dental remains described in this article include upper and lower dentitions, collected from Chabbar Syedan by the first author (MKN) during the field campaign 2013-18. The specimens have been placed in the Dr. Abu Bakr Fossil Display and Research Centre, Department of Zoology, University of the Punjab, Lahore, Punjab, Pakistan.

The comparison has been done with the material described by Lydekker (1884), Pilgrim (1926), Colbert (1933, 1935a, b), Pickford (1988), Van der Made (1996) and Aslam *et al.* (2015).

The specimens have been measured with error free digital Vernier calipers with a precision of 0.1 mm. Length corresponds to antero-posterior measurement and width corresponds to labio-lingual measurement, both length and width are taken occlusally.

The dental nomenclature and measurements follow Van der Made (1996). Upper letters (I, P, M) represents the maxillary teeth and lower letters (i, c, p, m) are used for the mandibular teeth.

SYSTEMATIC PALAEOONTOLOGY

Family Suidae Gray, 1821

Subfamily Listriodontinae Gervais, 1859

Genus *Listriodon* von Meyer, 1846

***Listriodon pentapotamiae* Falconer, 1868**

Type specimen

GSI B107, a complete right M2 and fragment of right M3; right and left P4 (Falconer, 1868).

Type locality

Khushalghar, Attock, Punjab, Pakistan (Colbert, 1935a).

Stratigraphic range

Chinji and Nagri formations of the Siwaliks (Colbert, 1935a, b; Khan *et al.*, 2012).

Studied specimens

PUPC 16/202, serially arranged right P2-3; PUPC 18/57, left P3; PUPC 16/305, right P4; PUPC 18/56, left P4; PUPC 16/304, left M2; PUPC 16/303, right M2; PUPC 16/204, left M3; PUPC 16/205 left M3; PUPC 18/59, left di1 (first deciduous incisor); PUPC 17/184, small basal fragment of right lower canine; PUPC 16/210, right p4; PUPC 16/206, right p4; PUPC 16/207, left mandible fragment with m3.

Description and comparison

Upper premolars

The P2 and P3 are triangular in shape (Fig. 2A). The P2 is smaller in size and more triangular than P3. The cusps are obliquely oriented. The cingulum covers the entire base of each tooth and it is thick labially. The valleys are wide and open. The median fossette is broad and shallow in P4s (Fig. 2B-D). The protocone is well developed and surrounded by well-developed cingulum. The metacone is reduced and can be easily distinguished from the paracone.

Upper molars

The anterior cingulum is thick and heavy, covering the base of the tooth in M2-3 (Fig. 2E-G). The posterior cingulum is relatively less heavy, starting from the posthypocrista and joining the anterior cingulum in the center of the median valley. The median valley is blocked by the union of the anterior and posterior lobes centrally (Fig. 2F-G). A small tubercle is present at the base of the median valley labially. The talon is small. The median valley is broad in M3 (Fig. 2H).

Lower deciduous incisor

The deciduous incisor is small, enamel is smooth and thin (Fig. 2H). It is well worn. Lingually, it is partially divided into grooves due to the presence of an incipient crest. The dentine is visible in the dentinal cup. A small part of the root is also preserved.

Lower canine

It is triangular in shape, enamel present at the pre- and ectocristae whereas the endocrista is devoid of enamel (Fig. 2I).

Lower premolar

PUPC 16/210 is a bilophodont and extremely worn p4 (Fig. 2J). The dentine is well visible in the first loph of the tooth owing to the heavy wear. The anterior cingulum is present at the base of protoloph whereas the posterior cingulum is absent. In PUPC 16/206, the anterior cingulum is present at the base of the first lophid (Fig. 2K). The protoconid, metaconid and hypoconid are well developed, having elongate cristids. The posterior cingulum is strong and heavy. The median valley is small.

Mandible fragment

PUPC 16/207 represents a robust jaw fragment, preserving length 38.70 mm (Fig. 2L). The m3 is well preserved, slightly worn and gradually becomes narrow. Posteriorly, the hypopreconulid is more developed than the hypopostconulid. The anterior cingulum is thin. The talonid is well developed, forming the pentaconid.

The studied specimens are lophodont. The specimens resemble the previously described specimens of *L. pentapotamia*, especially the holotype figured by Lydekker (1876, pl. 8, Fig. 8). The metrical values (Table II) of the specimens favor their allocation to *L. pentapotamia*.

Discussion

The Siwalik *Listriodon* was reported by Falconer

(1868), Lydekker (1876), Pilgrim (1926), Colbert (1935a, b), Pickford (1988), Van der Made (1996) and Khan *et al.* (2010). According to Pilgrim (1926), this genus is very abundant in the Chinji Formation of the Siwaliks and rare in the Nagri Formation (Pickford, 1988). *Listriodon pentapotamia* is a most common suid in the Middle Miocene of the Siwaliks (Pickford, 1988; Van der Made, 1996).

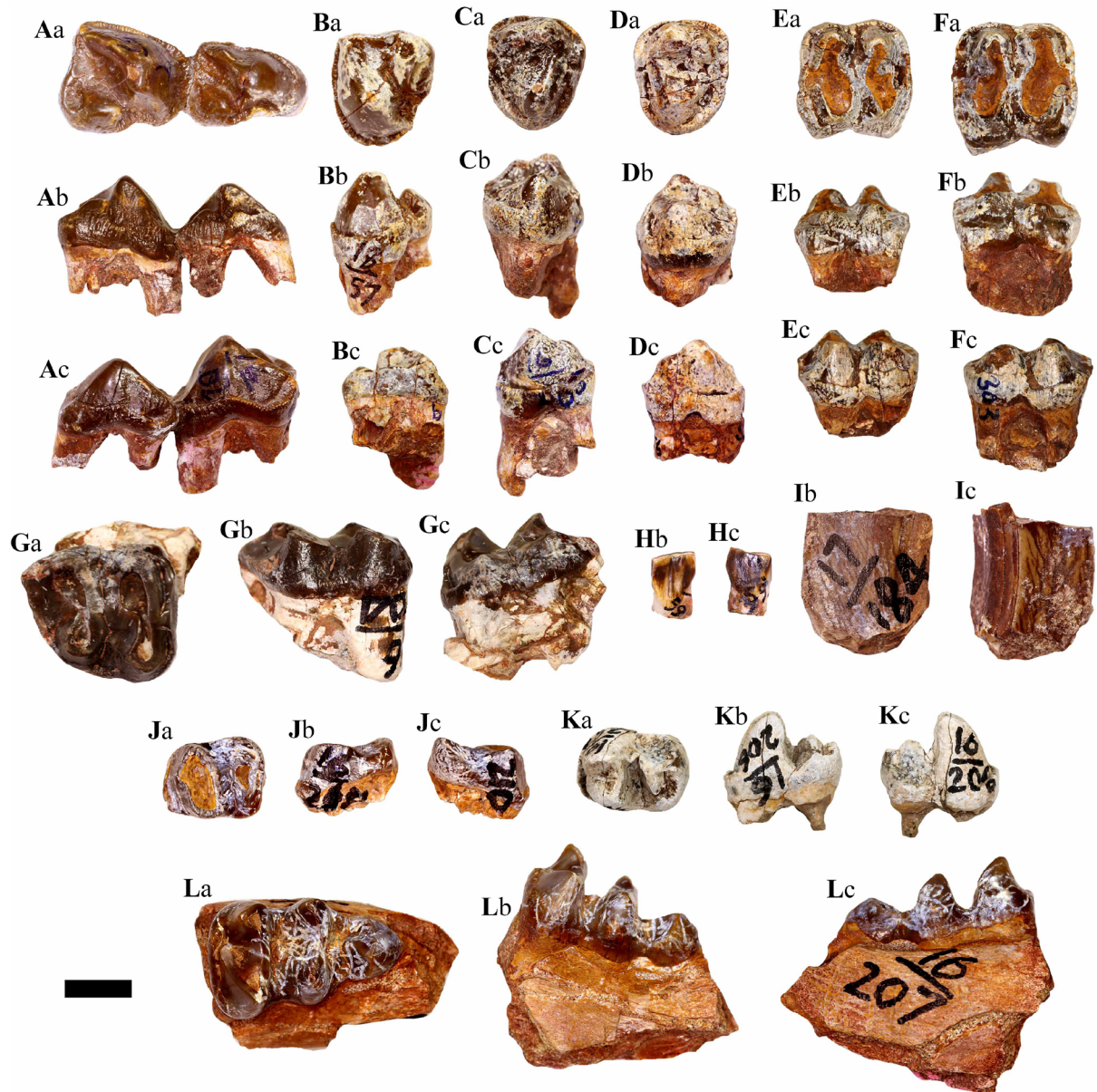


Fig. 2. *Listriodon pentapotamia*: **A**, PUPC 16/202, serially arranged right P2-3; **B**, PUPC 18/57, left P3; **C**, PUPC 16/305, right P4; **D**, PUPC 18/56, left P3; **E**, PUPC 16/304, left M2; **F**, PUPC 16/303, right M2; **G**, PUPC 16/204, left M3; **H**, PUPC 18/59, left di1 (first deciduous incisor); **I**, PUPC 17/184, small basal fragment of right lower canine; **J**, PUPC 16/210, right p4; **K**, PUPC 16/206, right p4; **L**, PUPC 16/207, left mandible fragment with m3. Views: a, occlusal view; b, lingual view; c, labial view. Scale bar = 10 mm.

Table II.- Comparative measurements (in mm) of studied specimens of *Listriodon pentapotamiae*. Comparative measurements are from Pickford (1988) and Van der Made (1996).

Number	Position	Length	W1	W2	W3	Number	Position	Length	W1	W2	W3
PUPC 16/202*	rP2	15.02	11.03			K 22/ 435	M3	26.7	24		
	rP3	15.86	14.48			K13/ 808	M3	23.0	19.0		
PUPC 18/57*	lP3	16.84	15.08			K13/ 803	M3	22.9	20		
PUPC 16/305*	rP4	14.30	17.07			M13257	M3	21.0	20.3		
PUPC 18/56*	lP4	11.40	17.31			M13586	M3	23.4	20.4		
PUPC 16/304*	lM2	17.57	18.49	18.06		M31869	M3	23.5	20.3		
PUPC 16/303*	rM2	17.77	18.97	17.63		M13584	M3	23.7	22.6		
PUPC 16/204*	lM3	24.12	21.72	19.43		M13594	M3	25.6	23.3		
PUPC 16/205*	lM3	25.90	13.30**	19.59		M13598	M3	27.5	23.7		
PUPC 18/59*	di1	6.53	3.92			GSP 1606	M3	21.7	20.5		
PUPC 17/184*	rc	17.38	11.70			K 16/ 425	M3	18.9	14.0		
PUPC 16/210*	rp4	14.84	11.64	10.84		GSP 4527	M3	17.4	12.5		
PUPC 16/206*	lp4	17.22	11.21	11.79		GSP 4412	M3	17.6	13.5		
PUPC 16/207*	lm3	28.11	16.76	15.10	9.19	GSP 4422	M3	18	13		
K14/ 432	P2	17.2	13			GSP 4528	M3	17	12.1		
GSP 4529	P2	16.9	13			K13/808	p4	15.3	12.3		
GSP 4531	P2	15.5	-			K13/436	p4	17.4	11.3		
M13597	P2	20	16.7			K23/721	p4	16.1	12.5		
GSP 4415	P2	16.5	13.5			K13/808	p4	19.2	12.3		
M31870	P3	14	13.7			K13/847	p4	18.4	13		
M13585	P3	13.5	13.2			K14/492	p4	16.5	11.8		
M13596	P3	16.7	15.7			K 16/ 425	p4	18.9	14.0		
M13257	P3	14.8	13.			GSP 4527	p4	17.4	12.5		
M31871	P3	14.2	13.7			GSP 4412	p4	17.6	13.5		
K13/ 431	P3	17	15.9			GSP 4422	lp4	17.8	12.5	12.6	
K 13/798	P3	12.4	11.3			GSP 4528	rp4	16.6	11.3	12.1	
K 12/811	P3	15	12.5			GSP 14163	lp4	13.6	10.5	10.4	
K16/ 293	P3	15.8	13.5			IVAU K 83	lp4	17.2	11.5	12.5	
K 16/ 293	P3	15.3	13.7			IVAU K 86	rp4	14.6	10.4	10.7	
K 13/798	P3	15.2	15			IVAU CHB 21	lp4	15.5	9.7	10.2	
M13585	P4	11.6	14.6			FISF CHA F6132	lp4	16.9	12.1	14.1	
M31871	P4	12.3	15			IVAU CHO 126	rm3	32.2	17.9	16.7	9.3
M13257	P4	12.5	14.8			IVAU CHO 123	lm3	27.8	16.5	13.6	9.9
M13596	P4	14	16.8			HGSP 8304/1333	rm3	32.2	18.0	17.4	13.3
K13/798	P4	13	16.3			BSHPGM 1956II48	lm3	28.5	17.7	15.8	12.0
K 13/793	P4	12.8	15.4			GSP 1360	rm3	31.6	17.7	16.4	-
K 13/ 832	P4	13.1	15.7			K 15/520	m3	-	20.5		
K 15/ 529	P4	14.1	16.9			K 41 /858	m3	29.5	16.0		
K14/ 434	P4	13.0	15.2			K 41 /862	m3	29.5	18.0		
K 13/ 810	P4	14.0	17			K 41 /870	m3	30.7	26.7		
K 15/ 813	P4	13.7	16.0			K 41 /841	m3	25	16.4		
K 25/123	P4	16.1	17.8			K19/138	m3	33	19		
K13 /798	P4	12.5	15.7			K 13/ 206	m3	29.4	17.7		
K 13/798	P4	13.7	14.8			K 13/806	m3	30.7	17.2		
K12/811	P4	15	12.5			K23/512	m3	33.7	19.7		
M13257	M2	18.3	18.3			GSP 4527	m3	36.5	20		
M13586	M2	19.7	19.5			GSP 4413	m3	35.3	18.7		
M13590	M2	17.9	16			GSP 4412	m3	32.5	18.8		
M31869	M2	20.1	19.7			M31873	m3	29.5	16.8		
K 15/813	M2	19.6	20			M13592	m3	30.6	19.0		
K 15/ 813	M3	23.0	21								

L, length; W1, width of 1stloph/lophid; W2, width of 2ndloph/lophid; W3, width of 3rdlophid. *indicates the studied specimen, **indicates the length of preserved segment.

In the Siwaliks, three listriodon species are traditionally identified: *Listriodon pentapotamiae* (Falconer, 1868), *Listriodon affinis* (Pilgrim, 1908) and *Listriodon guptai* (Pilgrim, 1926). The stratigraphic range of *L. pentapotamiae* is upper Kamlial to basal Nagri Formation (Barry *et al.*, 2002) and it is widely accepted as a valid species. *Listriodon affinis* is known only by two specimens from Bugti Hills, Baluchistan, Pakistan (Pilgrim, 1908, 1926; Pickford, 1988; Van der Made, 1996) and is the earliest Miocene in age (Welcomme *et al.*, 2001;

Métais *et al.*, 2009). Pickford (1988) placed *L. affinis* to the genus *Libycochoerus*. Van der Made (1996) observed that it is the earliest known listriodont and assigned it as *Bunolistriodon affinis*. *Listriodon guptai* was erected by Pilgrim (1926). The species has been recorded from the basal Manchar Formation (Sind), Bugti Hills (Balochistan) and basal Kamlial Formation (Punjab), aging from late early Miocene to early Middle Miocene (Van der Made, 1996; Raza *et al.*, 2002). Van der Made (1996) placed *Listriodon guptai* in the genus as *B. guptai*.



Fig. 3. *Conohyus sindiensis*: A, PUPC 18/58, left M3; B, PUPC 18/12, right p3; C, PUPC 18/10, left mandible fragment with m3; D, PUPC 18/62, anterior lobe of left lower molar; *Propotamochoerus* sp.: E, PUPC 16/203, An isolated left I1; F, PUPC 18/55, right lower third molar; G, PUPC 16/306, left mandible fragment with m2. Views: a, occlusal view; b, lingual view; c, labial view. Scale bar = 10 mm.

Subfamily Tetraconodontinae Lydekker, 1876**Genus *Conohyus* Pilgrim, 1925*****Conohyus sindiensis* (Lydekker, 1884)***Holotype*

GSI B102, left maxilla fragment with M1-2 (Lydekker, 1884).

Type locality

The Laki Hills, Sind, Pakistan (Lydekker, 1884).

Stratigraphic range

Kamlial and Chinji formations of the Lower Siwaliks and basal Nagri Formation of the Middle Siwaliks (Lydekker, 1884; Pilgrim, 1926; Colbert, 1935a; Pickford, 1988).

Studied specimens

PUPC 18/58, left M3; PUPC 18/12, right p3; PUPC 18/62, anterior lobe of left lower molar; PUPC 18/10, left mandible fragment with m3.

*Description**Upper molar*

PUPC 18/58 is a small, underdeveloped and unworn M3 (Fig. 3A). The anterior cingulum is small. The protopreconule and hypopreconule are well-developed. The furchen are small and frequent. The hypo- and metacone are not fully developed. The median valley is curved due to the presence of the large hypopreconule.

Lower premolar

The p3 is a monocuspid tooth (Fig. 3B). The precristid is unworn and posteristid is well-worn. The anterior cingulum is moderately thick whereas the posterior cingulum is confluent with the hypoconid. The Hunter-Schreger bands can easily be seen.

Lower molars

The m3 (PUPC 18/10) is pentacuspid and larger than the m2 (Fig. 3C). The molars are bunodonts. The anterior cingulum is confluent with the protopreconulid. The furchen are small and the valleys are extremely narrow. Valleys are blocked by thick tubercles lingually and labially. Hypopre- and hypopostconules are well-developed. The pentaconid is confluent with the posterior cingulum. PUPC 18/62 represents the anterior lobe of last molar (Fig. 3D). It is unworn, anterior cingulum is extremely thin and covers the lobe antero-transversely and protoprecristid. Furchen are small and less in number. Hypopreconulid is also preserved.

Comparison and discussion

Tetraconodontine differs from other subfamilies, most strikingly, in having two anterior premolars more bunodont (Pickford, 1988; Van der Made, 1999; Thaung-Htike *et al.*, 2005). The representative characters as simple conical shape and large size of the premolars and simple cusps with less conules, thicker enamel, slight anterior and posterior cingula, presence of median conules, less complex talon in molars; are helpful to place the studied specimens in the genus *Conohyus*, proposed by Pilgrim (1926). The genus is reported from the Siwaliks by two species *Conohyus sindiensis* and *Conohyus indicus*. The former is smaller than the latter and has a good fossil record (Pilgrim, 1926; Colbert, 1935b; Pickford, 1988; Pickford and Gupta, 2001). The studied specimens are smaller than *Conohyus indicus* and morphometrically resembles *Conohyus sindiensis* (Pilgrim, 1926; Colbert, 1935a; Pickford, 1988; Pickford and Gupta, 2001). *Conohyus sindiensis* has its oldest occurrence in the Potwar Plateau of 14.5 Ma, and it occurs earlier at Sehwan locality HGSP-8114 in Sind, which has been correlated with 16 Ma level of the Potwar Plateau (Pickford, 1988). *Conohyus sindiensis* is a moderate sized member of the genus *Conohyus* (Pickford, 1988).

The genus *Conohyus* represents a slightly archaic form of Suidae and is very close to the genus *Hyotherium* (Colbert, 1935a; Pickford, 1988). *Conohyus* is especially different from *Hyotherium* in the enlargement of the third and fourth premolars and certain characters like deeply expanded zygomatic arch, which projects below the occlusal line of the cheek teeth, and the rather elongated preorbital portion (Colbert, 1935b; Pickford, 1988). An analysis of *Conohyus* shows that it is trending away from the typical *Hyotherium* group, with an undoubted orthogenetic trend towards the specialized genus *Tetraconodon*.

Tetraconodon is essentially a large edition of *Conohyus*, the proportional indices remaining remarkably similar in these two genera. Pickford (1988) evaluated the biochronologic significance of *Conohyus sindiensis* and suggested age range of 15-11 Ma. It is important to note that *Conohyus sindiensis* was considered by Pilgrim (1926) to have given rise to *Tetraconodon* in the early Middle Miocene. The morphometric gap that used to exist between *C. sindiensis* and the next smallest known Tetraconodontine taxon, *T. minor* (Pickford, 1988; Van der Made, 1999) is filled by the recently described *T. malensis* (Thaung-Htike *et al.*, 2005).

Propotamochoerus* sp.New material*

PUPC 16/203, left I1; PUPC 18/55, right M3; PUPC

16/306, left m2.

Description

Upper incisor

PUPC 16/203 is extremely weathered and corroded tooth (Fig. 3E). It is elongated and flattened, concave lingually and convex labially. Lingually, it is divided into two grooves due to presence of crest. The distal cusp (metacone) is large.

Upper molar

The PUPC 18/55 (Fig. 3F) is partially broken lingually resulting in loss of much of the metaconid. It is extremely bunodont and anterior cingulum is confluent with the protoconule. Furchen are small, valleys are extremely narrow and tooth is slightly weathered. Base of the metacone and pentacone are partially broken resulting in exposure of contact between dentine thick enamel.

Mandible fragment

PUPC 16/306 is a mandible fragment having length 27.26 mm (Fig. 3G). The corpus is robust, broken at the base and filled with mudstone. The preserved m2 is slightly worn with partial posterior cingulum. The anterior cingulum covers the base of the protoconid and metaconid transversely. The furchen are less in number but deep and prominent. A small hypopreconulid blocks the median valley. The hypopostconulid is smaller but higher than the hypopreconulid.

Comparison and discussion

The characteristics of the studied specimens corresponds well with the suid genus *Propotamochoerus*. The incisor has a large distal cusp (metacone) which is absent in *Conohyus sindiensis*. Such a cusp occurs in various species of *Propotamochoerus*. In general, in the earlier species of the genus. The upper molar is longer than any species of *Conohyus* and the lobes or crests between them are better developed. This is a feature that points to *Propotamochoerus* (more than *Hyotherium* or *Conohyus*). In lower molar, the talon cusp (pentaconid) is large and points to *Propotamochoerus*, rather than *Hyotherium* or *C. sindiensis*. Based on the characteristics, it is obvious that the studied specimens belong to genus *Propotamochoerus* but the material is not sufficient enough to elevate it to species level hence, designated as *Propotamochoerus* sp.

Pilgrim (1926) has reported several species in the genus *Propotamochoerus* from the Indian subcontinent, but Pickford (1988) emphasized that all these belong to *P. hysudricus* except *Propotamochoerus ingens*. However, he noted the size variation, complexity and hypsodonty in molars. According to Pickford (1988), the age range of the species is from about 10 million to about 6 million years but Van der Made and Defen (1994) have stated that some material from the Chinji Formation resembles with *P. hysudricus* but differs in having a small M3. Pickford (1988) named a species *Hyotherium pilgrimi*. However, according to his own criteria, this should be placed in *Propotamochoerus* (Van der Made, personal commun.).

Table III.- Comparative measurements (in mm) of the studied specimens of *Conohyus sindiensis* and *Propotamochoerus* sp. Comparative measurements are from Colbert (1933) and Pickford (1988).

Taxa	Number	Position	L	W1	W2	W3
<i>Conohyus sindiensis</i>	PUPC 18/58*	IM3	15.93	15.32	11.94	
	PUPC 18/12*	rp3	17.61	12.46		
	PUPC 18/10*	lm3	23.58	13.57	12.73	9.84
	PUPC 18/62*	1 st lobe	11.33**	15.23	-	-
	GSP 1375	M3	19.0	16.2		
	GSP 5399	M3	24.0	20.0		
	GSP 757	M3	20.4	16.1		
	AM 19594	M3	20	17		
	B336	M3	21.4	16.1		
	B671	M3	19.0	16.5		
	K41/827	M3	20.5	16		
	K19/60	M3	22.3	15		
	856	M3	21.2	13		
	K42/189	M3	17.5	14		
	K15/499	M3	17.1	14.4		
	K13/815	M3	19.8	14.4		
	K19/60	M3	17.5	15.4		

Taxa	Number	Position	L	W1	W2	W3
<i>Conohyus sindiensis</i>	K13/834	p3	17.8	12.2		
	K21/435	p3	17.7	11.5		
	GSP 12588	p3	18.2	12		
	K13/831	p3	19	13.7		
	K13/834	p3	18.2	12.5		
	K13 /831	p3	19	13.8		
	K13/825	m3	23	13.5		
	K41/836	m3	21.5	12.2		
	K13/820	m3	24.9	13.6		
	K13/815	m3	25	14.6		
	K19/59	m3	21.3	13.2		
	B99	m3	19.7	10.5		
	B98	m3	22.5	12.7		
	GSP 12587	m3	28	15.3		
	GSP 9729	m3	25.3	12.5		
<i>Propotamochoerus</i> sp.	PUPC 16/203*	II1	13.3	7.3		
	PUPC 18/55*	rM3	19.66	9.60**	10.51**	7.99**
	PUPC 16/306*	Im2	16	11.18	11.14	
<i>P. hysudricus</i>	5509	I1	13.6	7.5		
	440	I1	12.7	6.7		
	11207	I1	13.2	8.5		
	6046	I1	13.5	7.4		
	12661	I1	15	7.5		
	11204	M3	29.9	22.6		
	7017	M3	26.5	18.7		
	6753	M3	28.7			
	4591	M3	27.3	20.0		
	2807	m3	28.5	15.9		
	9145	m3	31.3	17		
	10231	m3	31.4	18.5		
	6226	m3	31.7	16.0		
	12787	m3	32.7	17.8		

L, length; W1, width of 1st loph/lophid; W2, width of 2nd loph/lophid; W3, width of 3rd lophid. *indicates the studied specimen, **indicates the length of preserved segment.

CONCLUSIONS

The archaic suids *Listriodon pentapotamiae*, *Conohyus sindiensis* and *Propotamochoerus* sp. are reported from the Middle Miocene of Chabbar Syedan, Punjab, Pakistan. The listriodont specimens are homogenous and can be referred to a single species, *Listriodon pentapotamiae*, in which the molars are truly lophodont. *Conohyus sindiensis* is a typical basal and earliest tetraconodont, characterized by the enlarged premolars. *Propotamochoerus* sp. described here verified the presence of this genus in the Chinji Formation of the

Lower Siwaliks.

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Statement of conflict of interest

The authors declare no conflict of interest.

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