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NEW FOSSILS OF SUIDAE (MAMMALIA, ARTIODACTYLA) FROM THE HASNOT LATE MIOCENE, NORTHERN PAKISTAN

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ABSTRACT

A variety of suids from the Dhok Pathan Formation of the Middle Siwaliks are identified, described and discussed in this paper. The new remains were recovered from the Late Miocene continental deposits, located in the vicinity of the Hasnot village, Jhelum district, Punjab province, Pakistan. A three suid species namely *Propotamochoerus hysudricus,* cf. *Hippohyus sivalensis* and *Hippopotamodon sivalense* have been identified. A documentation of the new remains is the objective of this paper.

Key words: Suids, Artiodactyla, Vertebrates, Late Miocene, Hasnot, Siwaliks.

INTRODUCTION

The family Suidae (Artiodactyla, Mammalia), generally known as boars, hogs, pigs or suids, is part of the superfamily Suoidea along with Tayassuidae (peccaries) (Gongora *et al*., 2011). India was considered a vast center for the adaptive radiation of the Suidae in middle and later parts of the Tertiary period (Pickford, 1993). The Siwalik deposits of the northern Punjab exhibit numerous fossil remains of pigs and they correspond to a diversity of types indicative of the phylogenetic plasticity of the suid group. In Siwaliks, one locality, in a series of deposits ranging in age from Upper Miocene to Lower Pleistocene, may be found almost the complete phylogenetic history of Suidae, from the most primitive, undifferentiated types to the very advanced, highly specialized genera (Pickford, 1993). Made and Hussain (1989) concluded that the Indian and Eurasian suid fauna had many species and genera in common. The Late Miocene suids are generally represented in Eurasia by the large-sized *Hippopotamodon* (the Siwaliks) and *Microstonyx* (Western Eurasia).

The Hasnot village (Lat. 32° 49′ N: Long. 73°18′ E) is located at about 70 km west of the Jhelum city in the Potwar Plateau of the northern Pakistan (Khan *et al*., 2009). The Hasnot outcrops represented most complete sequence of the Siwalik group yield a diversified assemblage of the Dhok Pathan Formation in Pakistan (Janis and Scott, 1987a, b; Gentry and Hooker, 1988; Akhtar, 1992; Gentry, 1994; Khan, 2007; Farooq *et al*., 2007a, b, c, d, 2008; Khan *et al*., 2006, 2007, 2008, 2009, 2010). The average thickness of the sequence around this area is about 180 m at an altitude of almost 326 m. The fauna mainly consists of Artiodactyla (Cervidae, Tragulidae, Giraffidae, Suidae), Perissodactyla (Equidae, Rhinocerotidae), Proboscidea and Primates (Khan *et al*., 2013). Recently, abundant suid fossils were unearthed from the Hasnot area (Fig. 1), Potwar Plateau northern Pakistan ranging in age from the Late Miocene - Early Pliocene.

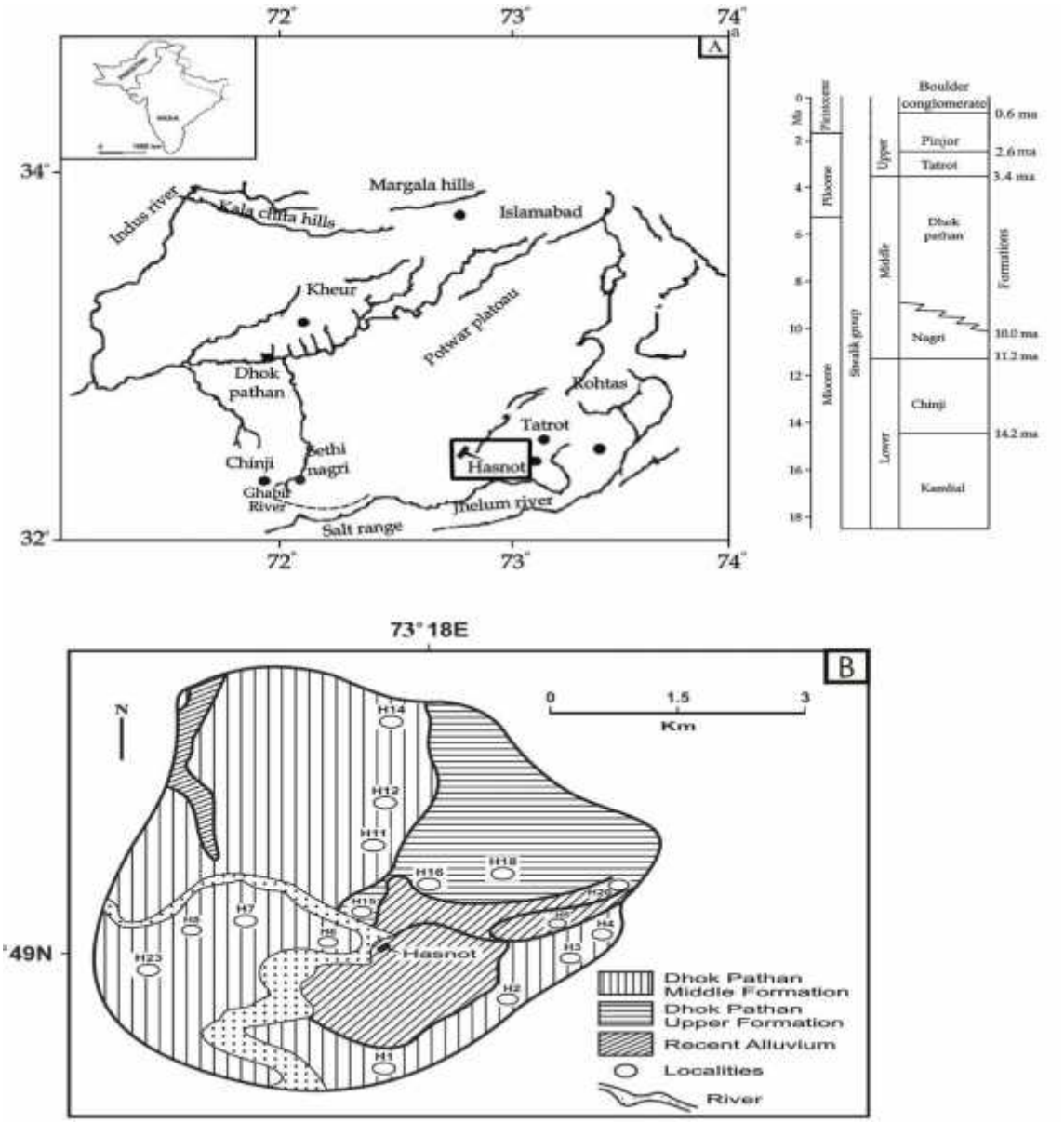

Fig. 1: A – Map of the Potwar Plateau in northern Pakistan; reference locality of the Siwaliks encircled. Chronological text modified from Behrensmeyer and Barry (2005); Dennell (2008) and Nanda (2008). B – Simplified geologic map of the Hasnot area with indicated localities around the village Hasnot (H = Hasnot) from where the studied material is recovered (modified from Colbert, 1935).

METHODOLOGY

The material, which is a part of the Ph. D. research work of the first author, comes from the Hasnot outcrops during 2010 to 2013. The surface collection has been remained the primary way of collecting the suid fossils. The embedded material was cautiously excavated with the help of instruments such as chisels, geological hammers, fine needles, pen knifes, hand lances and brushes. During excavation careful measures were taken to avoid any damage to fossil specimen. Each sample, after collection was wrapped in separate cotton piece to avoid any damage during transportation from collecting site to laboratory. The material was carefully washed and cleaned in "Palaeontology Laboratory of the Zoology, Wildlife & Fisheries Department, GC University Faisalabad" for their taxonomic and morphological determination.

Hand lens was used for a keen observation of small fossils with indefinite morphological features. The specimens were catalogued, consisting of 2 series i.e., yearly catalogue number and serial catalogue number, so figures on the specimen (PC-GCUF 11/186; PC-GCUF –

an institutional abbreviation 'Palaeontological Collection of Government College University Faisalabad) represents the collection year (nominator) and serial number of that year (denominator).

Measurements of the specimens were taken with the help of metric vernier caliper and expressed in millimeters (mm). The metric and morphological characteristics of the fossil samples are determined and the systematic determination is discussed. Uppercase letter represents the upper dentition (e.g. M1) and lowercase letter with number indicates the lower dentition (e.g. m1).

Tooth Morphology. Terminology and taxonomy follows Pickford (1988). An entostyle can be found in the center of the lingual side of the upper molar and ectostylid is found in the buccal side of the lower molar. Measurements were taken occlusally at maximum level and expressed in millimeters.

***Comparison*.** Comparison is made with fossils housed in the British Natural History Museum (BMNH), London, the American Museum of Natural History (AMNH), the Geological Survey of Pakistan (GSP), the Geological Survey of India (GSI) and the specimens of the Palaeontology laboratory of the Zoology department of the Punjab University, Lahore, Pakistan (PUPC).

SYSTEMATIC PALAEONTOLOGY

Order ARTIODACTYLA Owen, 1848
Suborder SUIFORMES Jaeckal, 1911
Infraorder SUINA Gray, 1868
Superfamily SUOIDEA Gray, 1821
Family SUIDAE Gray, 1821
Subfamily Suinae Zittel, 1893

Genus *Propotamochoerus* Pilgrim, 1925

Type species: *Propotamochoerus hysudricus* (Stehlin), 1899-1900.

Generic diagnosis: As in Pickford (1988).

Geographic distribution: *Propotamochoerus* occurs in the Late Miocene sediments of the Middle Siwaliks of Pakistan (Hasnot, Kotal Kund, Lehri, Kundrali, Gandakas, Utran, Dhok Mila, Jabi, Nagri, Khushalghar, Khaur, Kaulial, Mari, Ava, Bandar) and India (Perim Island, Haritalyangar) (Colbert, 1935; Matthew, 1929; Pickford, 1988; Pilgrim, 1926).

Time range: The age range is from about 10 to 6 million years, a range that is comparable to the European *Korynochoerus* (Pickford, 1988).

Propotamochoerus hysudricus (Stehlin), 1899-1900

Type specimen: Right mandible fragment with p3-m3 in worn condition: GSI B30.

Type locality: Potwar Plateau, Pakistan.

Stratigraphic range: Middle Siwaliks.

Specific diagnosis: No diastemata in upper or lower cheek tooth rows; orbits open over talon of M3; zygomatic arches leave face at midline of M1; lower premolars compressed with a long and complex third molar (Colbert, 1935; Pickford, 1988).

New material: Upper dentition: PC-GCUF 12/08, left I3; PC-GCUF 11/182, right P3; PC-GCUF 12/03, right P4; PC-GCUF 11/162, right maxillar fragment with P3-4; PC-GCUF 11/156, right M2; PC-GCUF 10/78, left M2; PC-GCUF 12/24, left M3; PC-GCUF 12/34, right maxillar fragment with M2-3. Lower dentition: PC-GCUF 11/186, lp3; PC-GCUF 11/181, lp4; PC-GCUF 10/83, partial m3; PC-GCUF 12/17, left mandible fragment with m3.

Description

Upper dentition: The incisor is a well-preserved complete unworn tooth (Fig. 2(1)). The tooth is comparatively small and has a premolariform appearance, which places it in number third position in the upper incisor series. The incisor consists of a principal cusp and anterior and posterior accessory cusplets. The incisor has a small lingual cingulum on the postero-lingual border. It is somewhat modified as a trenchant blade with narrow root.

The third premolars have prominent main cusps and smaller lingual posterior cusps (Figs. 2(2), 3). A valley separates the posterior cusp. The antero-postero-lingual cingula are present. The principal cusp has twisted so that the anterior ridge lies over the most lingual portion of the anterior root. The fourth premolar has more breadth than length (Fig. 2(3); Table 1). It is much more molarised tooth than third premolar. The premolar consists of two labial cusps and one lingual cusp that are somewhat equal in suture. The accessory cusplets and weak antero-posterior cingula are present. PC-GCUF 12/03 represents two sagital cusplets arising from the lingual aspects of the two labial cusps (Fig. 2(3)). PC-GCUF 11/162 is in middle wear. There are no labio-lingual cingula on the premolar.

The square shaped second upper molar represents four main cusps with accessory cusps (Fig. 3(5-6)). There are three accessory cusps: anterior, median and posterior. The cingulum is present antero-posteriorly. The enamel is thin and shiny. The furchen are moderately well developed. The median basal pillars look like tubercles are present in the median valleys. There is moderate lingual flare in the molars. The third molar differs from the second one by the presence of talon posteriorly (Fig. 3(7)). The talon is actually an expanded posterior accessory cusp with cingulum. The border of the cingulum is characterized by accessory cusps. The talon looks closer to the lingual side of the tooth.

Lower dentition: The third premolar is characterized by the anterior and posterior cusplets (Fig. 5(9)). The cusplets are well preserved and strongly developed. The central cusp is well distinct but it is not migrated lingually to form innenhugel as it is in the fourth premolar. The posterior cingulum is expanded labio-lingually. The fourth premolar represents innenhugel and is molarised (Fig. 5(10)). The 2-3 cusp of the premolar has migrated lingually to form the innenhugel and it appears subsymmetrical in lateral view. The 2-3 cusp is large and strongly offset in the premolar. The protoconid is strong whereas the metaconid is weak. The posterior accessory cusplet is enlarged and is bordered by an inflated cingulum. The accessory cusp and cingulum are moderately high anteriorly, forming accessory cusplet.

The third molar is bunodont with the usual suid layout of four main conids arranged in two lophs with characteristic talonid (Fig. 5(11)). The three cusplets (anterior, median and posterior) are present in the midline of the crown. The posterior accessory cusplet is prominent supported by the bifurcated cingulum. The median basal pillar is present in the median valley buccally. The talonid appears complex owing to the bifurcated cingulum. The buccal flare is moderate whereas the lingual flare is minimal. The lingual cusps are slightly higher than the labial ones. The enamel is moderately thick and wrinkled.

Table 1: Comparative cheek teeth measurements (mm) of *Propotamochoerus hysudricus.* *The studied specimens. Referred data are taken from Colbert (1935), Pickford (1988), Geraads *et al.* (2008) and Khan *et al.* (2010).

Taxa	Number	Nature/Position	Length	Width	W/L ratio
P. hysudricus	PC-GCUF 12/08*	lI3	13.2	06.5	0.49
	PC-GCUF 11/182*	rP3	15.0	11.2	0.74
	PC-GCUF 11/162*	rP3	13.2	11.4	0.86
		rP4	12.7	14.4	1.13
	PC-GCUF 12/03*	rP4	12.3	14.5	1.16
	PC-GCUF 10/78*	rM2	19.5	20.0	1.17
	PC-GCUF 11/156*	rM2	21.5	29.1	1.35
	PC-GCUF 12/34*	rM2	23.4	18.8	0.80
		rM3	29.5	19.0	0.64
	PC-GCUF 12/24*	lM3	26.8	17.2	0.64
	PC-GCUF 11/186*	lp3	13.7	07.7	0.56
	PC-GCUF 11/181*	lP4	15.3	09.5	0.62
	PC-GCUF 10/83*	m3	21.0	15.3	0.72
	PC-GCUF 12/17*	lm3	29.4	14.1	0.47
	Vozarci-271	P3	14.5	13.1	0.90
		P4	13.2	16.6	1.25
		M2	22.3	21.3	0.95
		M3	29.5	21.1	0.71
	Kalnitsa	p3	15.5	09.7	0.62
	Vozarci-n N	p3	16.5	10.0	0.60
	PUPC 99/02	lp4	14.5	11.0	0.75
	PUPC 94/65	rp4	15.0	09.5	0.63
	GSP 17	p4	15.6	12.6	0.80
	GSP2503	p4	13.6	11.6	0.85
	GSP 10998	p4	15.5	11.6	0.74
	GSP 12343	p4	16.7	09.2	0.55
	GSP 5823	p4	14.4	11.3	0.78
	GSP 9355	p4	16.6	11.4	0.68
	GSP 12732	p4	16.0	9.40	0.58
	PUPC 07/32	lp4	14.4	10.5	0.72
	GSP 10998	m1	17.6	13.0	0.74
	GSP 2807	m1	16.0	12.0	0.75
	GSP 457	m1	16.8	11.5	0.68
	GSP 6226	m1	16.7	12.0	0.71
	GSP 7017	m1	14.6	13.0	0.89
	GSP 6727	m1	16.3	11.4	0.69
	GSP 4773	m1	16.6	12.5	0.75
	GSP 5112	m1	18.4	11.7	0.63
	GSP 7384	m1	17.5	12.4	0.70

GSP B742	m3	31.0	16.0	0.51
GSP B39	m3	30.0	15.0	0.50
GSP 9145	m3	31.3	17.0	0.54
GSP 9405	m3	34.0	19.0	0.55
GSP 9403	m3	35.5	18.0	0.53
GSP 11684	m3	32.5	18.0	0.55
GSP 9355	m3	34.5	18.5	0.53
GSP 10224	m3	34	17.9	0.51
GSP 10225	m3	34.7	18.8	0.54
GSP 6944	m3	32.5	17.6	0.54
GSP 10231	m3	31.4	18.5	0.58
GSP 7318	m3	35.0	18.5	0.52
GSP 2807	m3	28.5	15.8	0.55
GSP 6226	m3	31.7	16.0	0.50
GSP 9145	m3	31.3	17.0	0.54
GSP 9405	m3	34.0	19.0	0.55
Kalnitsa	m3	32.0	18.1	0.56
Vozarci-563	m3	33.8	18.8	0.55
Vozarci-564	m3	34.5	18.7	0.54

Comparison: The teeth are large enough to belong to *Tetraconodon, Sivachoerus* and *Propotamochoerus,* the genera of the Late Miocene suids from the Siwaliks. *Tetraconodon* and *Sivachoerus* are characterized by having inflated p3-4 (Pickford, 1988). The cheek teeth of the genus *Hippopotamodon* are extremely large. The material is associated with *Propotamochoerus* in having 2 cusplets in sagital valley of P4 without labio-lingual cingula, moderate enamel thickness in molars, shallow furchen, no cingula on molars, presence of basal pillars in ends of median valleys; simple talon/talonid of M3/m3 relatively, no extra cusp pairs, anterior and posterior cusps of premolars variable, but never reach the same height as the main cusps (Pickford, 1988). The teeth match, metrically (Table, 1), with the species *Propotamochoerus hysudricus* (Fig. 6), a species found abundantly in the sequence of Hasnot with *Hippopotamodon sivalense* (e.g. see Pickford, 1988).

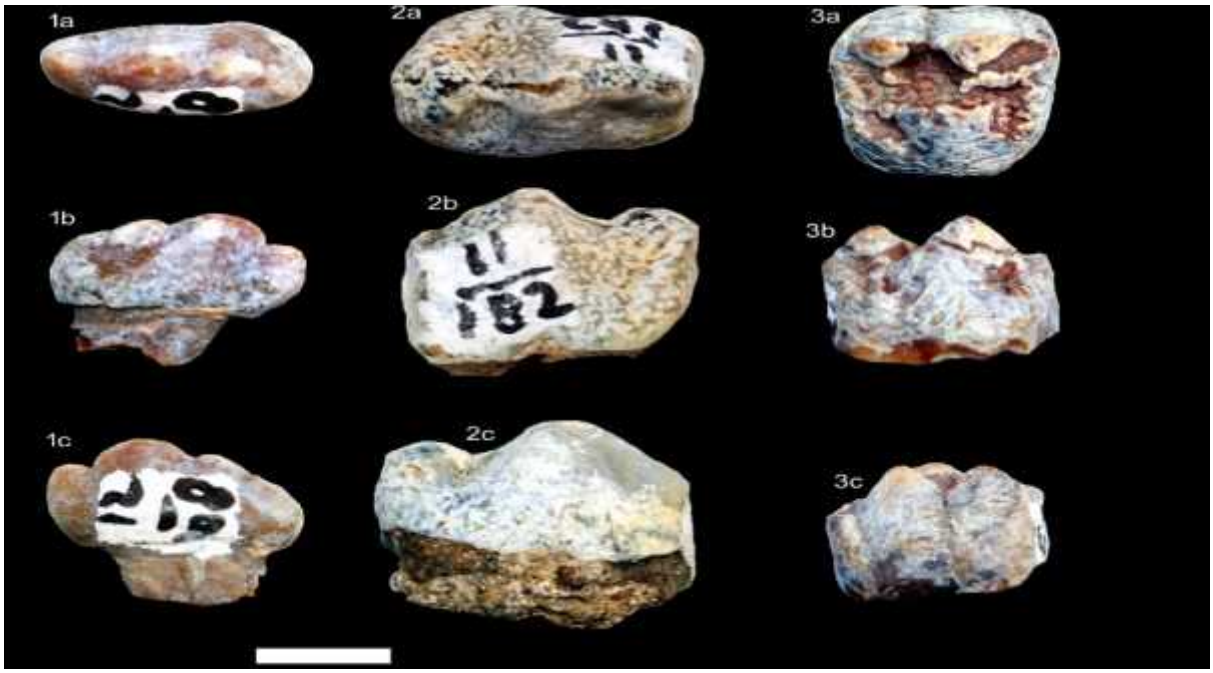

Fig. 2: ***Propotamochoerus hysudricus*****. 1. PC-GCUF 12/08, lI3. 2. PC-GCUF 11/182, rP3. 3. PC-GCUF 12/03, rP4. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.**

Fig. 3: ***Propotamochoerus hysudricus*****. 4. PC-GCUF 11/162, right maxillar fragment with P3- 4. 5. PC-GCUF 11/156, rM2. 6. PC-GCUF 10/78, lM2. 7. PC-GCUF 12/24, lM3. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.**

Fig. 4: ***Propotamochoerus hysudricus*****. 8. PC-GCUF 12/34, right maxillar fragment with M2-3. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.**

Fig. 5. ***Propotamochoerus hysudricus*. 9. PC-GCUF 11/186, lp3. 10. PC-GCUF 11/181, lp4. 11. PC-GCUF 10/83, partial m3. 12. PC-GCUF 12/17, left mandible fragment with m3. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.**

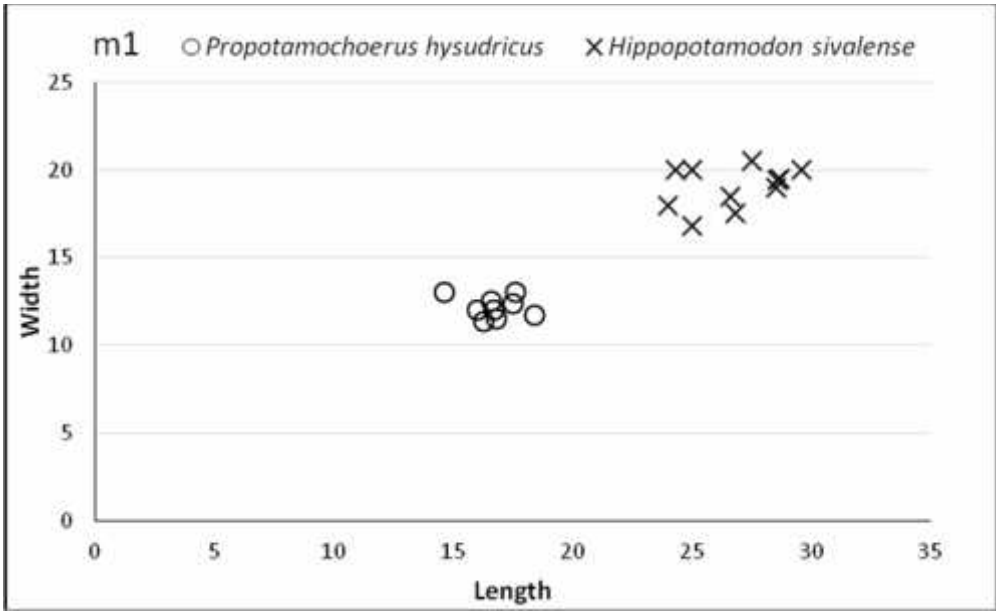

Fig. 6. Scatter diagram showing dental proportions of Hasnot *Propotamochoerus hysudricus*. Referred data are taken from Colbert (1935), Pickford (1988), Geraads *et al.* (2008) and Khan *et al*. (2010).

Genus cf. *Hippohyus* Falconer and Cautley, in Owen 1840-45

Type species: *Hippohyus sivalensis* Falconer and Cautley, in Owen 1840-45.

Generic diagnosis: As in Pickford (1988).

Geographic distribution: *Hippohyus* has only been recorded from Pakistan (Tatrot, Hasnot, Kotal Kund, Pohta, Kolsa, Darapur, Jabi, Kakrala) and India (Pinjor) (Pickford, 1988) in a very late Miocene to Pliocene sediments (ca. 5 – 2 Ma).

cf. *Hippohyus sivalensis* Falconer and Cautley, in Owen (1840-45)

Type specimen: Specimen illustrated in Owen (1840-45) Pl. CXL, fig. 7.

Type locality: Siwalik Hills, India.

Stratigraphic range: Late Middle Siwaliks to Upper Siwaliks.

Diagnosis: A species of *Hippohyus* of large size with upper molar row longer than 65 mm (Pickford, 1988).

New material: PC-GCUF 12/43, left M2; PC-GCUF 12/22, left M3.

Description and comparison: Only two isolated molars belonging to upper dentition are recorded (Fig. 7). The second upper molar (PC-GCUF 12/48) is hypsodont with deepened furchen (Fig. 7(1)). The enamel is thin with complex infolding occlusally. The molar represents four main cusps, anterior, median and posterior accessory cusps, and anterior and posterior cingula. The principal cusps are characterized by three furchen: anterior, median and posterior. The anterior and posterior furchen are deeper than the median one. The median valley is deep having median basal pillar. The third molar (PC-GCUF 12/22) is unworn and looks to be a juvenile animal. The molar have four main cusps in addition to talon on postero-lingual corner of the molar, bordered laterally by hypsodont cingular cusplets.

The molars show the basic pattern of *Propotamochoerus.* Nevertheless, they differ from *Propotamochoerus* in thin enamel; deep furchen and forming complex infolding of enamel surfaces and match with *Hippohyus* (Colbert, 1935; Pickford, 1988). *Hippohyus* is recorded by two species *H. sivalensis* Falconer and Cautley, in Owen (1840-45) and *H. lydekkeri* Pilgrim, 1910 from the Siwaliks. The sample resembles with *H. sivalensis*, morphometrically (Figs. 7-8; Table 2). However, the sample is insufficient and can be assigned to cf. *H. sivalensis*.

Genus *Hippopotamodon* Lydekker, 1877

Type species: *Hippopotamodon sivalense* Lydekker, 1877.

Generic diagnosis: As in Pickford (1988).

Geographic distribution: *Hippopotamodon* is found in the late Miocene of the Siwaliks and its range is very similar to that of *Propotamochoerushysudricus* and *Microstonyx* (Pickford, 1988).

***Hippopotamodon sivalense* Lydekker, 1877**

Type specimen: GSI B7, left maxilla with fragment of P4 broken M1 and M2.

Type locality: Hasnot, Potwar Plateau, Pakistan.

Stratigraphic range: Middle Siwaliks.

Diagnosis: A gigantic species of *Hippopotamodon* in which the upper molar row exceeds 110 mm in length (Pickford, 1988).

Table 2: Comparative cheek teeth measurements (mm) of cf. *Hippohyus sivalensis.* *The studied specimen. Referred data are taken from Pickford (1988).

Taxa	Number	Nature/Position	Length	Width	W/L ratio
cf. *H. sivalensis*	PC-GCUF 12/48*	lM2	23.4	19.0	0.81
	PC-GCUF 12/22*	lM3	32.1	20.4	0.63
	B722	M2	28.0	21.5	0.76
	K15/914	M2	24.6	19.8	0.80
	K13/922	M2	24.3	21.0	0.86
	B720	M2	22.4	23.2	1.03
	B722	M3	42.0	22.0	0.52
	B66	M3	35.0	22.7	0.64
	B720	M3	38.0	24.5	0.64
	K15/914	M3	33.5	21.4	0.63

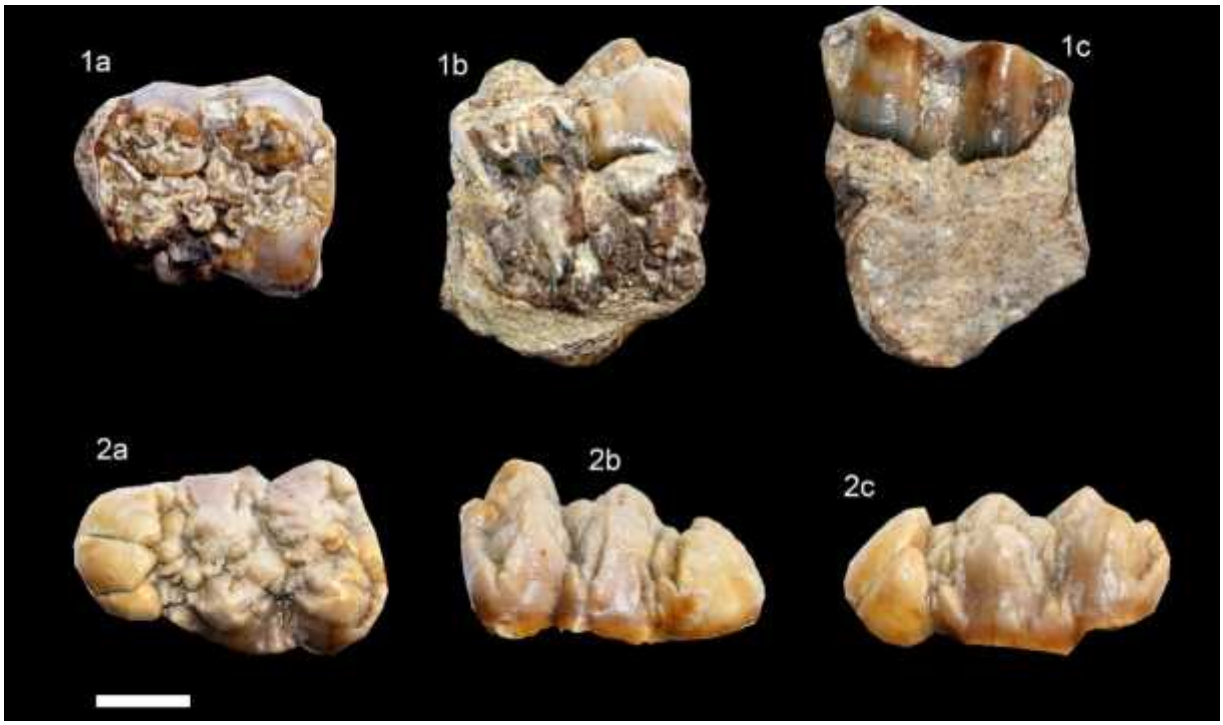

Fig. 7. cf. *Hippohyus sivalensis*. 1. PC-GCUF 12/48, lM2. 2. PC-GCUF 12/22, lM3. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.

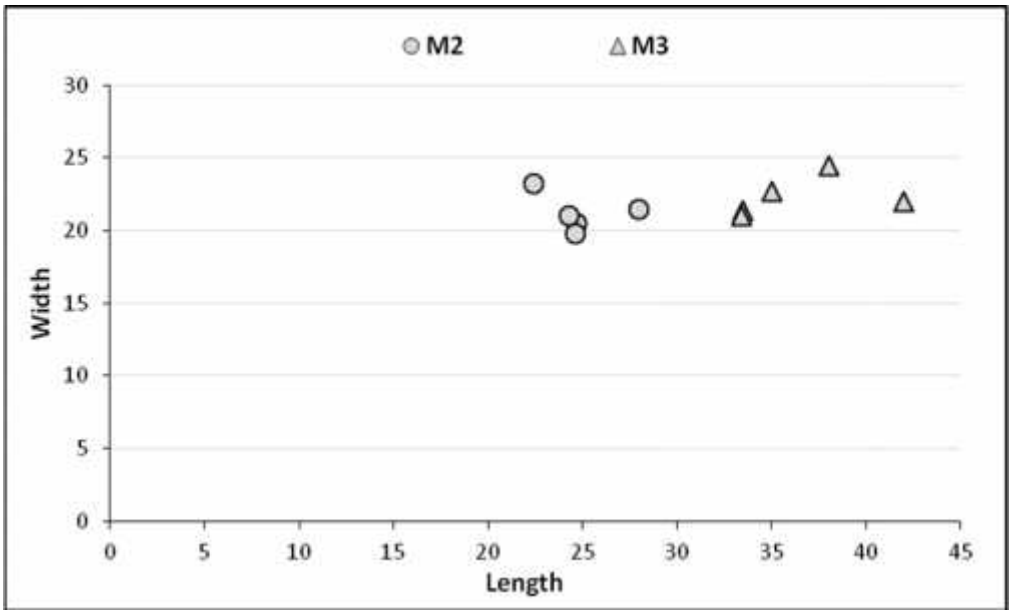

Fig. 8. Scatter diagram showing dental proportions of the studied cf. *Hippohyus sivalensis*. Referred data are taken from Colbert (1935), Pickford (1988) Geraads *et al.* (2008) and Khan *et al.* (2010).

New material: PC-GCUF 12/14, right I1; PC-GCUF 11/163, left M1; PC-GCUF 10/87, right p1; PC-GCUF 10/81, right p3; PC-GCUF 12/27, left p4.

Description and comparison: *Upper dentition:* The first upper incisor is damaged labially (Fig. 9(1)). The tooth is large and recurved with raised lingual border surrounding a central lingual fossa, which has a small central rib near its tip. The occlusal surface of the tooth is beaded, and there are bifurcations near the mesial edge. The first molar is in late middle wear (Fig. 9(2)). The molar is relatively simple and it is not furnished with any marked accessory cusps. There are four main cusps with anterior, median and posteriory accessory cusps. The small basal

pillar is present in the median valley. The furchen are moderately expressed. The antero-posterior cingula are missing. The enamel is thin and the labial cones are higher than the lingual ones.

Lower dentition: The first premolar (PC-GCUF 10/87) is long single rooted tooth (Fig. 9(3)). The lingual rib is prominent in the tooth. The lingual and distal margins are raised lingually. The first premolar displays a short and weakly developed posterior part, which confers a globular aspect to the tooth. The third premolar is smarter than the fourth one (Fig. 9(4-5). The premolar has had an offset innenhugel. The anterior accessory cusp is high. The accessory-1 cusp is large while 2-3-4 cusp is moderately high. The premolar is furnished with 2 vertical grooves labially. The fourth premolar is a large version of the third premolar. The accessory-1 cusp and 2-3-4 cusp are very prominent and large. The antero-posterior cingula are about same the height of the main cusps.

The morpho-metrical features of the specimens resemble with *Hippopotamodon sivalense*, a species recorded from the Middle Siwaliks and abundantly found in the Hasnot's sediments (Pickford, 1988). The metrical values of the sample match than those of the already described material of the species (Table, 3). Therefore, the material can be assigned to *Hippopotamodon sivalense* based on the morphometric features (Figs. 9-10; Table 3).

Table 3: Comparative cheek teeth measurements (mm) of *Hippopotamodon sivalense.* *The studied specimens. Referred data are taken from Colbert (1935) and Pickford (1988).

Taxa	Number	Nature/Position	Length	Width	W/L ratio
H. sivalense	PC-GCUF 12/14*	rI1	22.3	13.1	0.58
	PC-GCUF 10/87*	rp1	54.7	13.6	0.24
	PC-GCUF 10/81*	rp3	22.0	12.0	0.54
	PC-GCUF 12/27*	lp4	24.0	19.3	0.80
	PC-GCUF 11/163*	lm1	24.3	20.3	0.83
	K14/394	I1	23.0	18.0	0.78
	K13/328	I1	25.0	15.0	0.60
	K13 345	I1	19.0	19.0	1.00
	K15/3660	I1	22.0	17.0	0.77
	GSP 122	i1	13.0	20.0	1.53
	Cmu10-101	p3	20.7	11.8	0.57
	Cmu10-101	p4	19.1	14.3	0.74
	GSP 330	m1	28.6	19.4	0.67
	GSP 4086	m1	28.7	19.5	0.67
	K47/798	m1	28.5	19.0	0.66
	B435	m1	27.5	20.5	0.74
	B2	m1	26.6	18.5	0.69
	B358	m1	24.0	18.0	0.70
	B25	m1	29.6	20.0	0.67
	B3539	m1	25.0	20.0	0.80
	GSP 4673	m1	26.8	17.5	0.65
	B714	m1	25.0	16.8	0.67

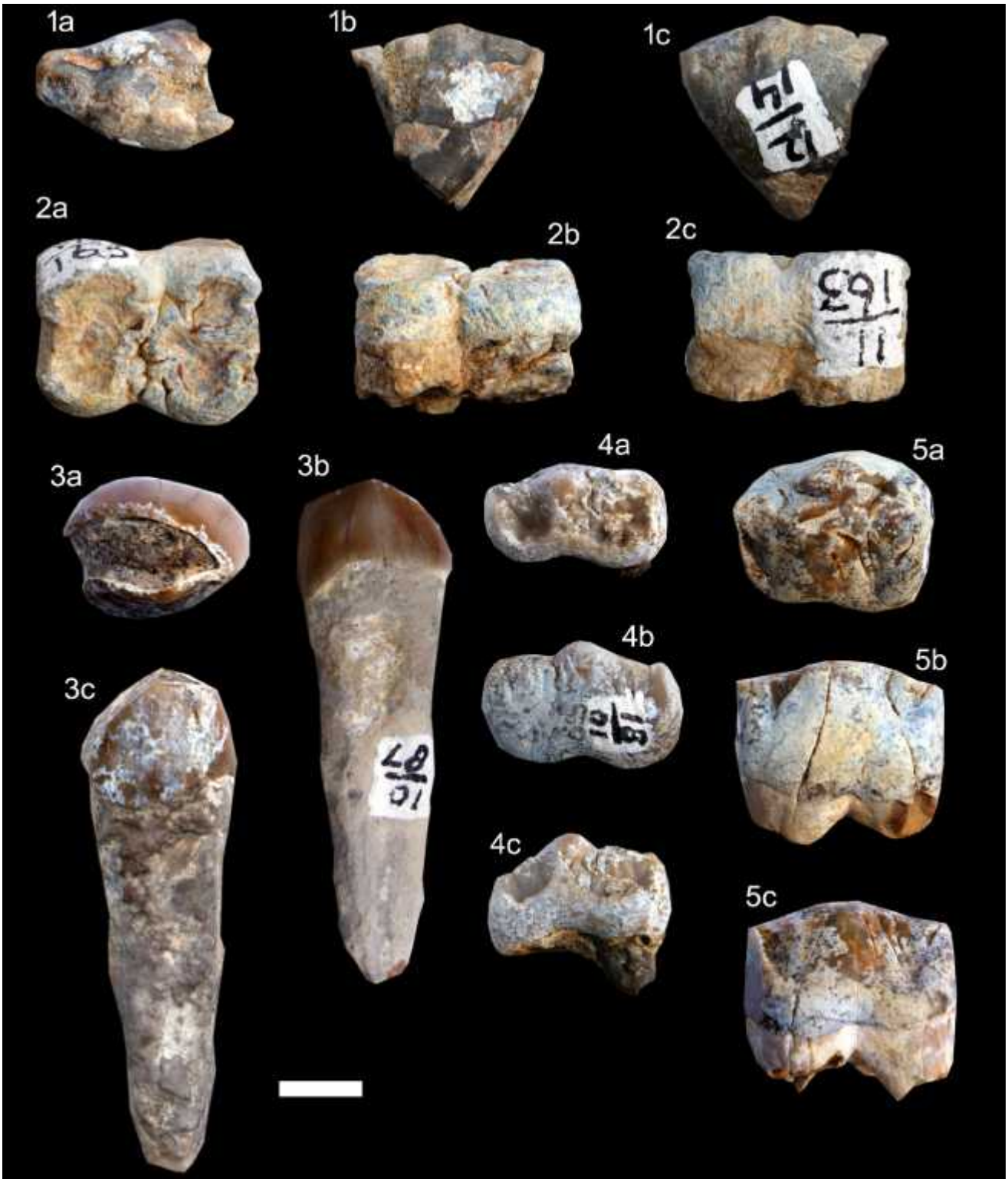

Fig. 9. ***Hippopotamodon sivalense*****. 1. PC-GCUF 12/14, rI1. 2. PC-GCUF 11/163, lM1. 3. PC-GCUF 10/87, rp1. 4. PC-GCUF 10/81, rp3. 5. PC-GCUF 12/27, lp4. a, occlusal view; b, lingual view; c, labial view. Scale bar 10 mm.**

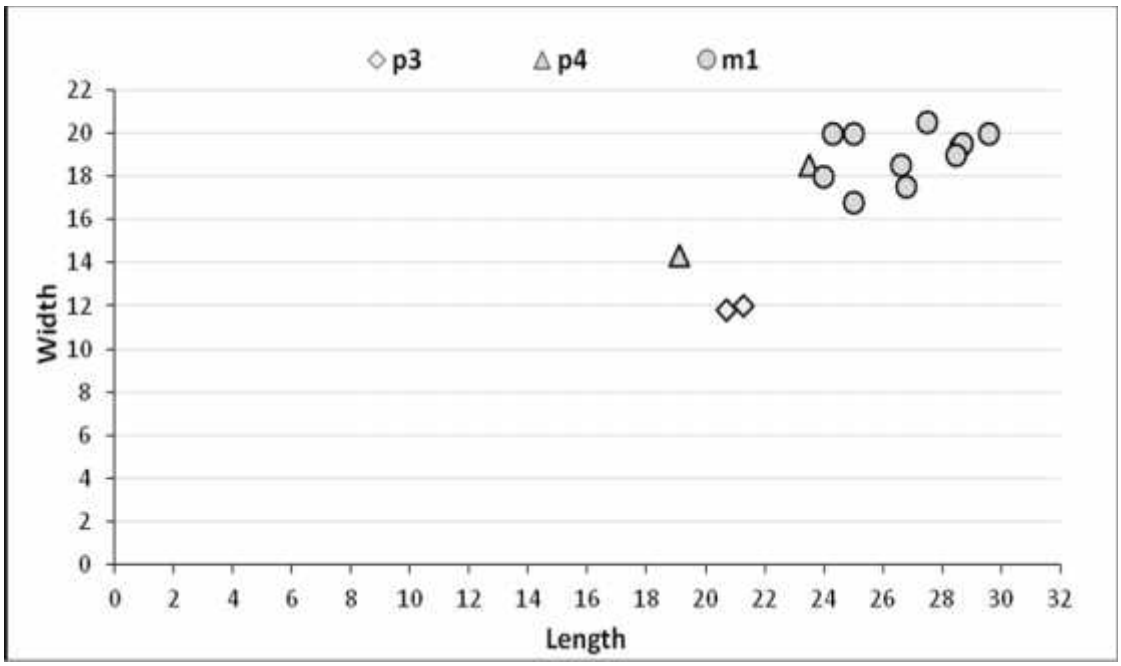

Fig. 10. Scatter diagram showing dental proportions of the Hasnot *Hippopotamodon sivalense.* Referred data are taken from Colbert (1935), Pickford (1988) Geraads *et al.* (2008) and Khan *et al.* (2010).

DISCUSSION AND CONCLUSIONS

The Hasnot Late Miocene is one of the richest Siwalik sites representing many species of Suidae. *Propotamochoerus hysudricus* and *Hippopotamodon sivalense, Tetraconodon magnus, Conohyus indicus* and *Lophochoerus nagrii* are recorded from the lower portion of the Late Miocene while *Propotamochoerus hysudricus* and *Hippopotamodon sivalense* persist up to the upper portion of the Late Miocene (Pickford, 1988). These suid species are inhabitant in northern Pakistan with other artiodactyls like *Selenoportax, Pachyportax, Tragoportax, Gazella, Bramatherium* and *Dorcatherium* during the Late Miocene-Early Pliocene epochs.

Propotamochoerus hysudricus and *H. sivalense* are typically found in the Siwalik Late Miocene and their presence may therefore be taken as good evidence of a Late Miocene age (Pickford, 1988). In Hasnot, the species *Hippohyus sivalensis, Hippohyus lydekkeri, Sivahyus punjabiensis* and *Sivachoerus prior* make their appearance, while both *P. hysudricus* and *H. sivalense* persist beside them. Nevertheless, the species *P. hysudricus* and *H. sivalense* occur from at least the middle part of the Nagri Formation, upwards to the top of the Dhok Pathan Formation, and into younger deposits where *Sivahyus* and *Hippohyus* are found.

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REFERENCES

Akhtar, M. (1992). Taxonomy and distribution of the Siwalik bovids. Ph.D. Diss., University of the Punjab, Lahore, Pakistan.

Behrensmeyer, A.K. and J. Barry (2005). Biostratigraphic surveys in the Siwaliks of Pakistan. A method for standardized surface sampling of the vertebrate fossil record. Palaeont. Electro., 8(1): 1-24.

Colbert, E.H. (1935). Siwalik mammals in the American Museum of Natural History. Trans. Amer. Philos. Soc., N. S. 26, 1- 401.

Dennell, R.W. (2008). The taphonomic record of Upper Siwalik (Pinjor stage) landscapes in the Pabbi Hills, northern Pakistan, with consideration regarding the preservation of Hominin remains. Quat. Int., 192: 62-77.

Farooq, U., M.A. Khan, M. Akhtar and A.M. Khan (2007a). *Dorcatherium minus* from the Siwaliks, Pakistan. J. Anim. Plant Sci., 17: 86–89

Farooq, U., M.A. Khan, M. Akhtar and A.M. Khan (2007b). *Dorcatherium majus*, a study of Upper dentition from the Lower and Middle Siwaliks of Pakistan. J. Appl. Sci., 7(9): 1299-1303.

Farooq, U., M.A. Khan, M. Akhtar and A.M. Khan (2007c). *Dorcabune anthracotherioides* (Artiodactyla, Ruminantia, Tragulidae) from Hasnot, the Middle Siwaliks, Pakistan. Pakistan J. Zool., 39(6): 353-360.

Farooq, U., M.A. Khan and M. Akhtar (2007d). *Dorcabune nagrii* (Ruminantia, Tragulidae) from the Upper part of the Middle Siwaliks. J. Appl. Sci., 7(10): 1428-1431.

Farooq, U., M.A. Khan, M. Akhtar and A.M. Khan (2008). Lower Dentition of *Dorcatherium majus* (Tragulidae, Mammalia) in the Lower and Middle Siwaliks (Miocene) of Pakistan. Turk. J. Zool., 32: 91-98.

Gentry, A.W. and J.J. Hooker (1988). The phylogeny of Artiodactyla. In M. J. Benton (Ed.), The Phylogeny and Classification of the Tetrapods, (2 pp. 235-272). Mamm. Syst. Asso. Special No. 35B. Clarendon, Oxford.

Geraads, D., N. Spassov and R. Garevski (2008). New specimens of *Propotamochoerus* from the Miocene of Balkans. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 248: 103-113.

Gongora, J., R.E. Cuddahee, F.F.D. Nascimento, C.J. Palgrave, S. Lowden, S. Y. W. Ho, D. Simond, C. S. Damayanti, D. J. White, W. T. Tay, E. Randi, H, Klingel, C.J. Rodrigues-zarate, K. Allen, C. Moran and G. Larson (2011). Rethinking the evolution of extant sub-Saharan African suids (Suidae, Artiodactyla). Zool. Scrip., 40: pp 327– 335.

Janis, C.M. and K.M. Scott (1987a). Grades and clades in hornless ruminant evolution: the reality of gelocidae and the systematic position of *Lophiomeryx and Bachitherium.* J. Vert. Paleont., 7: 200- 216.

Janis, C.M. and K.M. Scott (1987b). The interrelationship of higher ruminant families with special emphasis on the members of the Cervoidea. Amer. Mus. Novi. 2893: 1-85.

Khan, M.A., A. Ghaffar, U. Farooq and M. Akhtar (2006). Ruminant fauna from the Tertiary Hills (Neogene) of the Siwaliks of Pakistan. J. Appl. Sci., 6 (1): 131-137.

Khan, M.A. (2007). Description of *Selenoportax vexillarius* molars from Dhok Pathan village (Middle Siwaliks), Pakistan. Pakistan J. Bio. Sci., 10(18): 3166-3169.

Khan, M. A., A. Ghaffar, U. Farooq and M. Akhtar (2007). New fossil remains of *Selenoportax vexillarius* from the Late Miocene of Hasnot. Pakistan J. Zool., 39(5): 333-338.

Khan, M. A., M. Iqbal, A. Ghaffar, Khan, A.M. and Akhtar, M. (2008). Collection of *Selenoportax* from the Kundi Wala Kas, Hasnot, Pakistan. Pakistan J. Zool., 40: 303-307.

Khan, M.A., G. Iliopoulos and M. Akhtar (2009). Boselaphines (Artiodactyla, Ruminantia, Bovidae) from the Middle Siwaliks of Hasnot. Pakistan. Geob. 42: 739-753.

Khan, M.A., M. Akhtar and M. Iqbal (2010). The Late Miocene Artiodactyls in the Dhok Pathan type locality of the Dhok Pathan Formation, the Middle Siwaliks, Pakistan. Pakistan. J. Zool., Suppl. Ser. 10: 1-90.

Khan, M.A., A. Batool, A.Q. Nayyer and M. Akhtar (2013). *Gazella lydekkeri* (Cetartiodactyla: Ruminantia: Bovidae) from the Middle Siwaliks of Hasnot (Late Miocene), northern Pakistan. Pakistan J. Zool., 45(4): 981-988.

Made, J. Van der and Hussain S.T. (1989). "*Microstonyx*" *major* (Suidae, Artiodactyla) from the type area of the Nagri Formation, Siwalik Group, Pakistan. Estud. Geol., 45: 409-416.

Matthew, W.D. (1929). Critical observations upon Siwalik mammals (exclusive of Proboscidea). Bull. Amer. Mus. of Nat. Hist. 56: 437-560.

Nanda, A.C. (2008). Comments on the Pinjor mammalian fauna of the Siwalik Group in relation to the post-Siwalik faunas of Peninsular India and Indo-Gangetic plain. Quat. Int., 192: 6-13.

Pickford, M. (1988). Revision of the Miocene Suidae of the Indian Subcontinent. Münchner Geowissenschaften Abhandlungen, 12: 1-91.

Pickford, M. (1993). Old world Suoid systematics, phylogeny, biogeography and biostratigraphy. Paleontologia Evolucio, 26– 27: 237–269.

Pilgrim, G.E. (1926b). The fossil Suidae of India. Memoir. Geol. Sur. India., N. S. 8: 1-65.