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SIVALHIPPUS NAGRIENSIS (EQUIDAE, MAMMALIA) FROM DHOK PATHAN FORMATION OF SIWALIKS, PAKISTAN

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ABSTRACT

The described specimens have been collected from the Dhok Pathan Formation of the Siwaliks, northern Pakistan. The new material consists of the isolated dentition and reflects morphological features of *Sivalhippus nagriensis*. The specimens were observed and compared with the previous data. The new discovered material found from the Dhok Pathan type locality identifies the species *Sivalhippus nagriensis*. The new sample contributes additional information about the species *Sivalhippus nagriensis*.

Key words: Mammalia, Perissodactyla, Fossils, Miocene, Pliocene, Pleistocene, Siwaliks.

INTRODUCTION

The described specimens are recovered from the outcrops nearby the Dhok Pathan village (Lat. 33° 07' N: Long. 72° 14' E), which is the type locality of the Dhok Pathan Formation of the Middle Siwaliks (Fig. 1). The Dhok Pathan fossil site is located at 65 km NE from the Chakwal city and is extremely rich in fossils (Barry *et al*., 2002). The sediments those are present in the Dhok Pathan Formation grade down through a considerable thickness of unfossiliferous beds into the Nagri beds (Khan *et al*., 2014). It contains light colored sand and considerable amount of unweathered igneous minerals notably fledspar (Colbert, 1935). The clay is orange, brown, dull red or reddish brown and sometimes rusty orange, yellowish grey, chocolate colored, greenish yellow, calcareous and sandy.

The sandstone is grey, light grey, reddish brown, soft and cross-bedded. Yellowish brown siltstone is common. Layer of conglomerate is found in the upper part. One sandstone-clay cycle varies in thickness from 6 to 60 m (Cheema *et al*., 1977). The measured thickness is about 500-825 m. The unit is overlain conformably by the Soan Formation (Sheikh *et al*., 2008). The Dhok Pathan Formation that is present in the Kohat Potwar Province is rich in vertebrate fauna whereas, it is less fossiliferous in the Lower Indus Basin and the Quetta region (Pascoe, 1963). Rich number of *Hipparion* and artiodactyls are present in this Formation. The fauna indicates an age ranging from Late Miocene to Middle Pliocene.

The measurements of the specimens were taken in millimeters (mm) with the help of metric vernier caliper. The morphological and metrical characters of the specimens are described and their systematic determination is discussed. The catalogue number of the specimens consists of series i.e., yearly catalogue number and serial catalogue number, so figures of the specimens represent the collection year (numerator) and serial number (denominator) of that year (e.g. 09/12). Upper case letters with number stands for upper dentition (e.g. M1) and lower case letters with number stands for lower dentition (e.g.m1). The studied material is the property of the Palaeontology laboratory of the Zoology Department of the Punjab University, Lahore, Pakistan. The terminology follows Wolf *et al.* (2013).

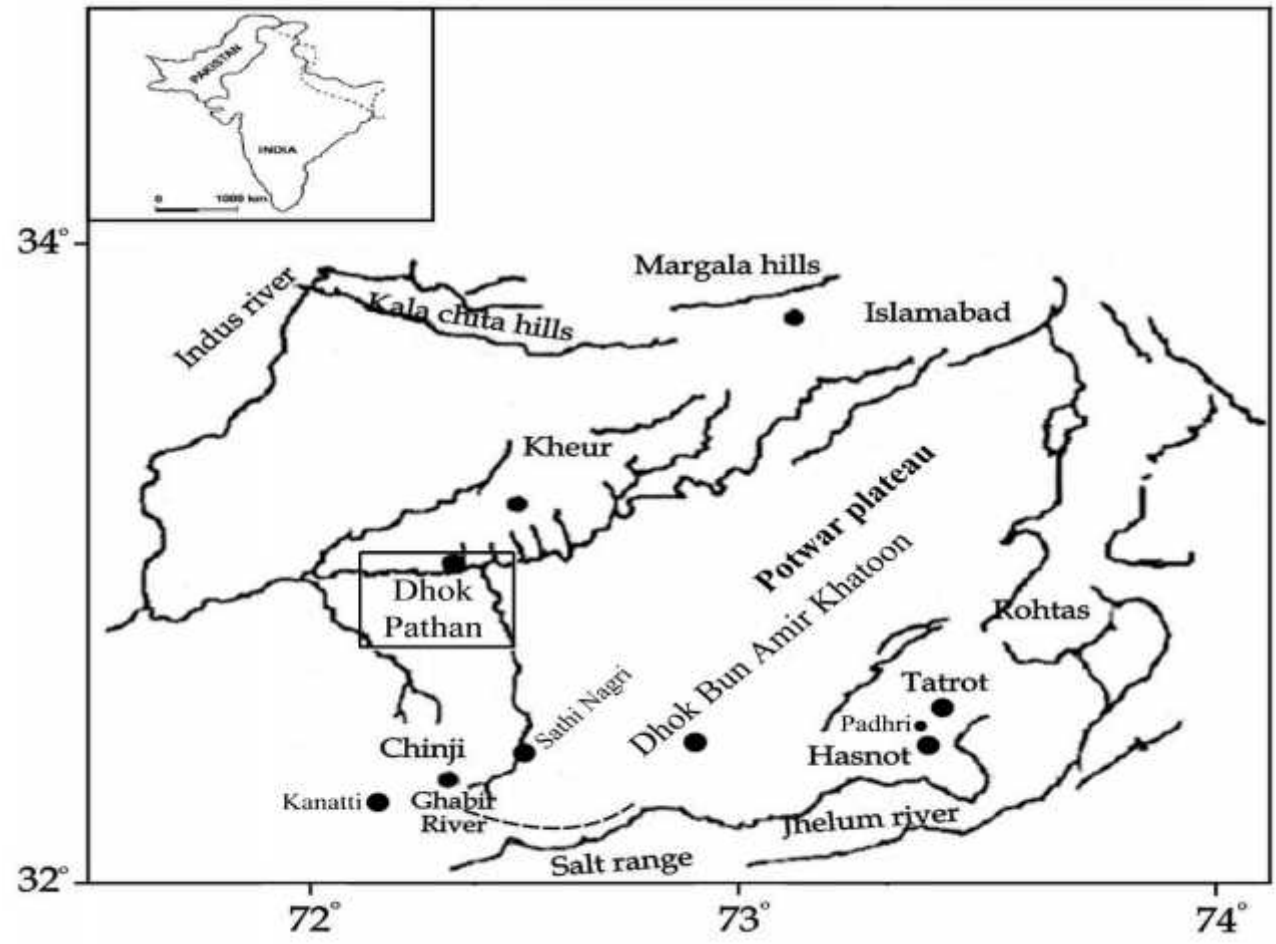

Fig. 1. Location map of Potwar Plateau in northern Pakistan showing the type locality Dhok Pathan, northern Pakistan from where the hipporionine material is collected.

SYSTEMIC PALAEONTOLOGY

Family Equidae Gray, 1821

Subfamily Equinae Steinmann and Doderlein, 1890

Genus *Sivalhippus* (Lydekker 1877)

Sivalhippus nagriensis (Hussain, 1971)

Synonymy

Hipparion nagriensis Hussain, 1971

Hipparion theobaldi nagriensis Zhegallo, 1978

Cormohipparion cf. *nagriensis* Macfadden & Woodburne, 1982

"Cormohipparion" (Sivalhippus) sp. (in part), Bernor & Hussain, 1985

Holotype. BSPG 1956 II H 15 (Text-fig. II), rt. Ml-2,from the Nagri faunal zone, Nagri Gorge (near the village of Nagri), Potwar Plateau, Pakistan (modified after Macfadden & Woodbrune 1982).

Type locality. Y0311 of the YGSP excavations, Potwar Plateau,Pakistan(cf.Bernor & Hussain, 1985).

Diagnosis. A medium-sized hipparion. POF is placed low on the face close to the facial maxillary crest, with presumably a great dorsoventral height; fossa has a well-defined, continuous peripheral border including the anterior rim and is deeply pocketed posteriorly, medially deep, and long. P2 anterostyle is somewhat elongate; maxillary cheek tooth crown height does not exceed 60 mm in early populations but can later reach more than 65 mm; maxillary cheek teeth are complexly ornamented with multiple plications on the distal border of the prefossette and the mesial border of the postfossette; mesial border of the prefossette and distal border of the postfossette are less complex in their plications; bifid to, especially in premolars, trifidplicaballins are present; protocones are oval, somewhat flattened lingually, and rounded buccally; hypoglyphs are broad and moderately deeply incised (Wolf *et al*., 2013).

New Material. PUPC 09/104-right P2; PUPC 12/46-left M1; PUPC 14/48-left m1; PUPC 09/99-left m2; PUPC 14/47-left m3.

Description and comparison: The 2nd upper premolar is in early-middle wear having anterostyle and triangular in general appearance (Fig. 2). The 1st upper molar is in early wear and quadrate shaped (Fig. 2).The protocone is

oval in shape, flattened lingually and isolated from rest of the crown. The hypocone is elongated with well-developed hypoconal groove. The paracone and metacone similar in appearance. The parastyle and mesostyle are similar in appearance. The styles are intact and prominent. Trifid palicaballine is present. Complex plications are present in prefossette and postfosette. The protoloph, metaloph and ectoloph are crescent shaped and prominent.

The lower molars are narrow crowned (Fig. 2). The metaconid and entoconid are rounded. The hypoconid is broader than the protoconid. The metastylid is pointed outwardly. The molars are slightly higher lingually. The ectoflexid is deeply incised. The linguaflexid is moderately deep. The preflexid and postflexid is clearly visible in this tooth and have simple margins. A well-developed hypoconulid is present posteriorly. Morphometrically, the teeth match to the hipparionine species *Sivalhippus nagriensis* (Fig. 2, 3; Table I).

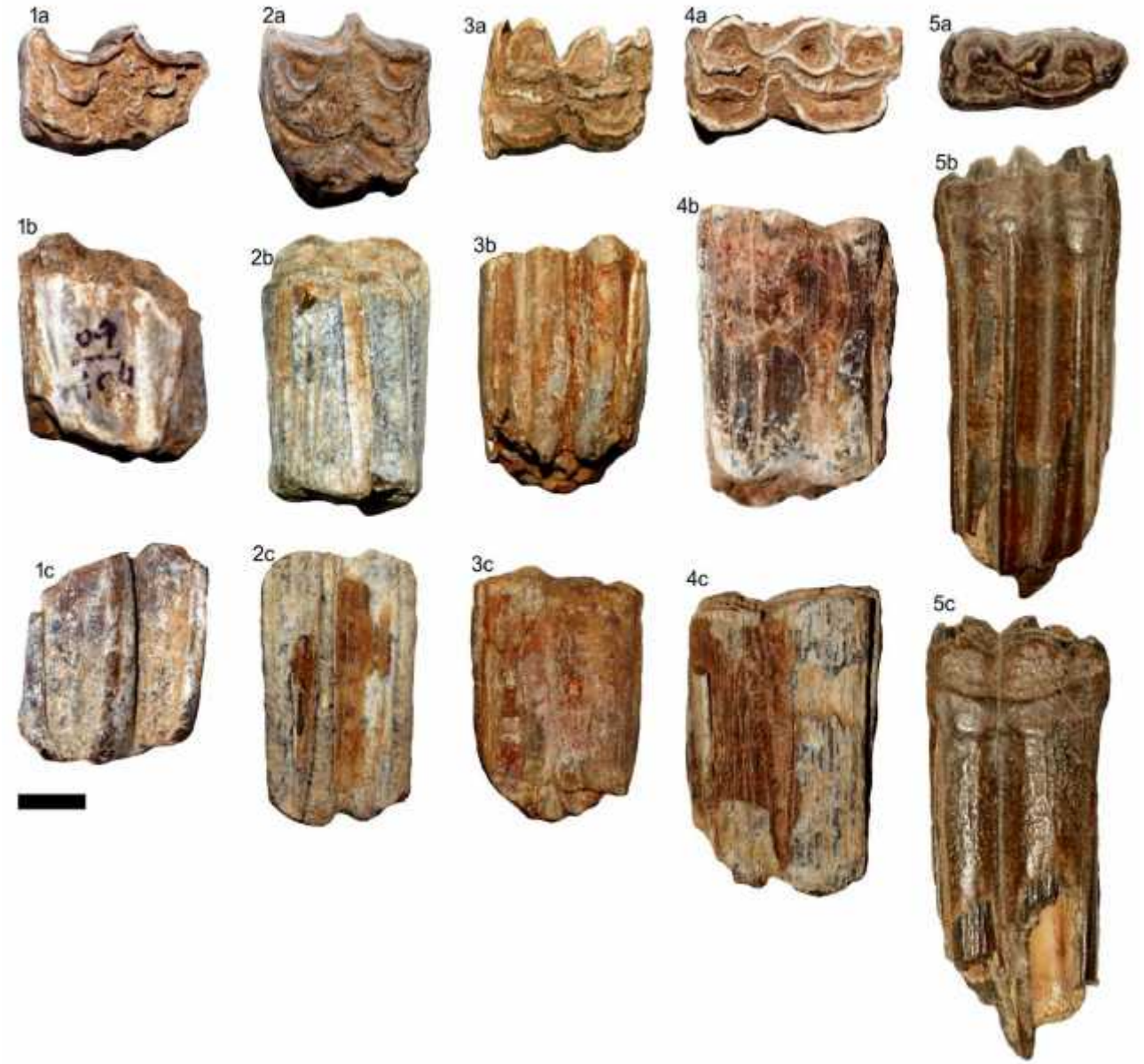

Fig. 2. *Sivalhippus nagriensis*: 1. PUPC 09/104 –rP2. 2. PUPC 12/46 – lM1. 3. PUPC 14/48 –lm1. 4. PUPC 09/99 – lm2. 5. PUPC 14/47 –lm3. Views: a, occlusal; b, lingual; c, labial. Scale bar 10 mm.

Table I. Comparative measurements of *S. nagriensis*. * the studied specimens. Referred data are taken from Bernor and Hussain (1985), Iqbal *et al.* (2009), Naseem *et al.* (2009) and Khan *et al.* (2011, 2014, 2015)

Taxa	Number	Nature/Position	L	W	W/L ratio
Sivalhippus. nagriensis	PUPC 12/46*	M1	23.22	22.72	0.98
	PUPC 09/104*	P2	23.26	13.34	0.57
	PUPC 14/48*	m1	22.50	18.01	0.80
	PUPC 09/99*	m2	27.75	14.66	0.53
	PUPC 14/47*	m3	25.56	11.90	0.47
S. perimense	PUPC 86/178	P2	24.50	36.00	1.47
	GSI C349	P2	27.00	33.20	1.23
	GSI C349	M1	22.20	-	-
	GSI C277	M1	26.90	24.50	0.91
	GSI C 275	M1	21.30	26.50	1.24
	AMNH 19761	M1	23.10	27.40	1.18
	AMNH 19466	M1	26.70	26.80	1.00
	AMNH 19676	M1	22.50	24.60	1.07
	GSI C151	M1	24.90	26.70	0.89
	PUPC 13/73	rM1	24.60	25.40	1.03
	GSI K 13/123	M1	20.00	24.20	1.21
	GSI C349	M2	22.80	23.70	1.04
	GSI C277	M2	26.20	21.40	0.85
	GSI C275	M2	19.90	24.40	1.23
	AMNH 19761	M2	23.70	24.80	1.05
	AMNH 19466	M2	28.80	25.10	0.87
	AMNH 19676	M2	22.10	22.10	1.00
	GSI C151	M2	26.30	25.50	0.96
	GSI K 13/123	M2	20.70	23.60	1.14
	PUPC 13/70	rM2	26.00	22.90	0.88
	PUPC 13/66	rM2	26.60	23.80	0.89
	GSI C349	M3	24.40	19.60	0.80
	GSI C275	M3	23.90	20.50	0.86
	AMNH 19761	M3	23.30	21.00	0.90
	AMNH 19466	M3	23.80	20.50	0.86
	AMNH 19676	M3	21.10	28.80	1.36
	GSI K 13/123	M3	20.80	21.60	1.04
	PUPC 13/71	rM3	25.30	22.60	0.89
	PUPC 13/64	rM3	23.30	20.30	0.87
	PUPC 13/65	rM3	27.80	21.40	0.77
S. theobaldi	AMNH 19466	M1	26.00	26.00	1.00
	AMNH 19857	M1	25.00	21.00	0.84
	PC-GCUF 10/34	P1	11.50	7.00	0.61
		P2	40.00	22.00	0.55
	PC-GCUF 10/41	P2	35.00	21.00	0.60
	PC-GCUF 09/39	P2	32.00	25.00	0.78
	PC-GCUF 07/02	P2	37.00	22.00	0.59
	PC-GCUF 07/29	M1	29.00	20.00	0.69
	PC-GCUF 10/35	M2	30.00	24.00	0.80
	PC-GCUF 10/38	M2	24.00	24.00	1.00
	PC-GCUF 10/44	m3	31.00	12.00	0.39
	PUPC 83/284	P2	39.50	21.50	0.54
	AMNH 19857	P2	32.00	26.50	0.83
	GSI C153	P2	38.50	26.00	0.68
	PUPC 83/498	P2	40.00	22.00	0.55
	AMNH 19466	M1	26.00	26.00	1.00
	AMNH 19857	M1	25.00	21.00	0.84

PC-GCUF 09/37	M1	26.00	22.00	0.85
PUPC 00/99	M1	26.00	23.00	0.88
AMNH 19723	M1	23.00	23.00	1.00
AMNH 19752	M1	23.00	23.50	1.02
AMNH 19676	M1	24.00	23.00	0.96
AMNH 19492	M1	22.00	20.00	0.91
PC-GCUF 09/38	M2	25.40	22.30	0.88
PC-GCUF 09/40	M2	24.00	24.00	1.00
PC-GCUF 09/41	M2	23.00	22.00	0.96
PUPC 00/99	M2	26.00	24.00	0.92
AMNH 19723	M2	22.50	22.50	1.00
AMNH 19752	M2	23.00	22.00	0.96
AMNH 19676	M2	22.00	21.00	0.95
AMNH 19492	M2	21.50	20.00	0.93

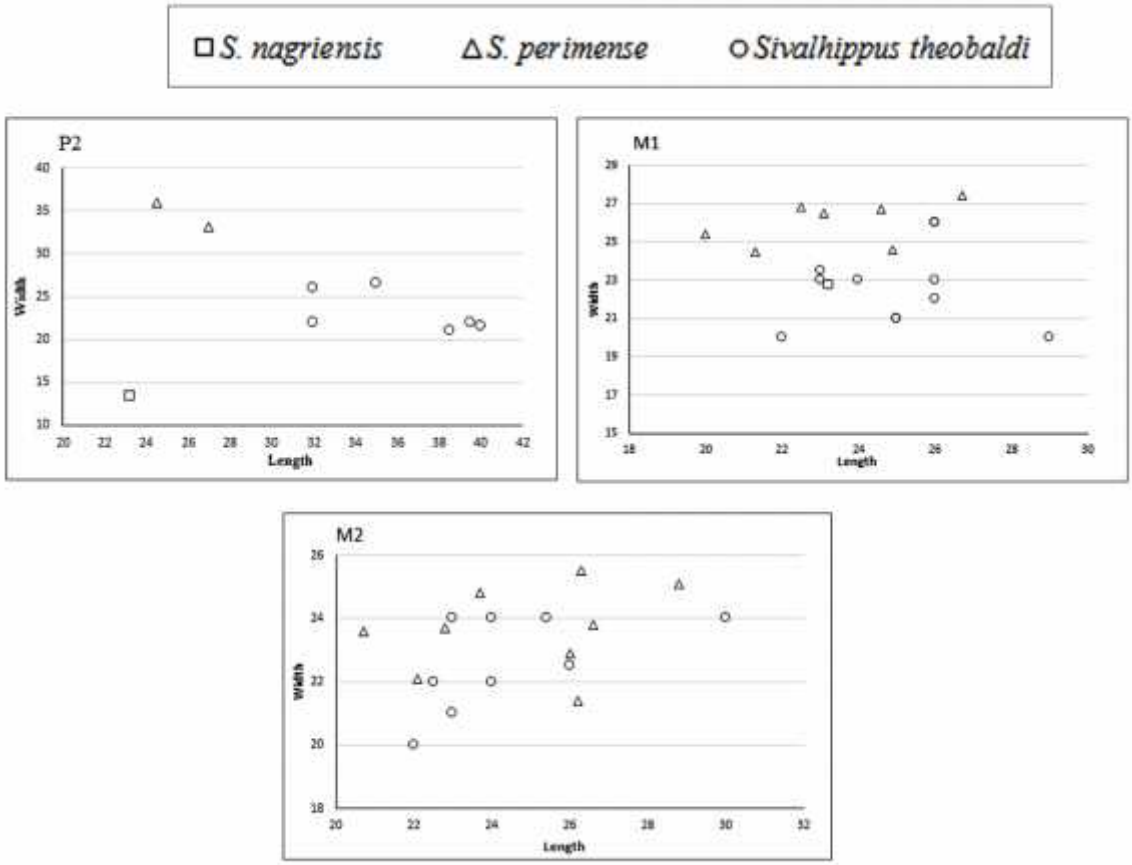

Fig. 4: Scatter diagram of the Siwalik hipparionines showing size variation.

DISCUSSION

A comprehensive revision was made by Hussain (1971), and noted that a single migration of a *Hipparion* primitive species, *Hipparion nagriensis* during Lower Nagri time led to the local diversity of two *Hipparion* taxa in the Middle Siwalik horizons: *Hipparion antelopinum*, a small form with slender elongate third metapodials and more hypsodont teeth, and *Hipparion theobaldi*, a large form with more massive metapodials and more hypsodont teeth than *Hipparion nagriensis.*

Hussain (1971) recognized three Siwalik *Hipparion* species *i.e., H. nagriensis, H. antilopinum* and *H. theobaldi*. Hussain (1971) has created *H. nagriensis*, which was the ancestor of *Hipparion antilopium* and *Hipparion theobaldi* according to him. The most recent systematic of Siwalik hipparionines was made by Wolf *et al*. (2013) and recognized four distinct species: *Sivalhippus nagriensis, S. theobaldi*, *S. perimensis* and

Cremohipparion antelopinum. They synonymized *H. nagriensis* (*Cormohipparion* cf. *nagriensis* of MacFadden and Woodburne, 1982) with a more derived taxon *Sivalhippus nagriensis* and noted that the species was dominated between ca. 10.7 and 9.3 Ma.

Conclusions: The Late Miocene-Early Pliocene outcrops of the Siwaliks have rich history of the hipparionine fossils. *Sivalhippus nagriensis* fossils, described in detail in this study, were excavated from the Dhok Pathan type locality, Chakwal district of northern Pakistan which was dated to the Late Miocene-Early Pliocene.

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