

Original Article**Additional Fossils of *Sivalhippus perimensis* (Mammalia, Equidae) from the Late Miocene Siwaliks of Pakistan**Tasneem Ikram¹, Asmat Salamat², Muhammad Akbar Khan², Muhammad Adeeb Babar^{*2}, Khalid Mahmood², Rabia Shahid², Muhammad Akhtar²¹Government College for Woman, Farooq Colony, Sargodha, Pakistan²Dr. Abu Bakr Fossil Display and Research Centre, Department of Zoology, Quaid-e-Azam Campus, University of the Punjab, Lahore, Pakistan**(Article history:** Received: May 4, 2016; Revised: June 22, 2016)**Abstract**

Fossil remains discussed in the present paper have been recovered from the Dhok Pathan Formation of the Middle Siwaliks in the Chakwal district, Punjab, Pakistan. The material was observed, compared with referred material and identified as *Sivalhippus perimensis*. The material consists of isolated molars and premolars, which reflects all the morphological features of *Sivalhippus perimensis*.

Keywords: Perissodactyla, Hipparionine, Miocene, Pliocene, Siwaliks

To cite this article: IKRAM, T., SALAMAT, A., KHAN, M.A., BABAR, M.A., MAHMOOD, K., SHAHID, R. AND AKHTAR, M., 2016. Additional Fossils of *Sivalhippus perimensis* (Mammalia, Equidae) from the Late Miocene Siwaliks of Pakistan. *Punjab Univ. J. Zool.*, **31**(2): 137-141.

INTRODUCTION

The Dhok Pathan is located 65 km North East of Chakwal city and known as a very fossiliferous site (Barry *et al.*, 2002). Pilgrim (1913) suggested the name "Dhok Pathan" which was later reformed by Cotter (1933) as "Dhok Pathan Formation". The Stratigraphic Committee of Pakistan accepted and applied the name to the Kohat-Potwar Province. This Formation spans from 10.1 to 3.5 Ma with prominent presence of sandstone and clay stone. Shale and conglomerate can be found too. Sandstone is light grey in color with a mixture of gleaming white and reddish brown, fine to medium grained, particles. Shale color can varies, in large extent, from bright orange to brown greenish and chocolate. Mostly hard compact claystone color ranges from orange red to chocolate brown. Formation thickness ranges from 500 to 825 meters. The Soan Formation superimposes the Dhok Pathan Formation conformably (Sheikh *et al.*, 2008). This Formation is rich in *Hipparion* and artiodactyl remains (Matthew, 1929; Colbert, 1935; Pilgrim, 1937, 1939; Pascoe, 1963; Pilbeam *et al.*, 1977; Akhtar, 1996; Khan *et al.*, 2007, 2009, 2010,

2014, 2015). This fauna is distributed from Late Miocene age to Early Pliocene age (Barry *et al.*, 2002).

The studied material was recovered from the Dhok Pathan (Long. 72° 14' E: Lat. 33° 07' N), type locality of the Middle Siwalik subgroup (Fig. 1). Collection of the material was done through surface collection method, prepared by washing, cleaning with help of fine needles and dental probes. Broken parts were rejoined with elfy glue. Finally, specimens were catalogued with PUPC Number and studied for identification and comparison. The material is housed in Dr. Abu Bakr Fossil Display and Research Centre, Zoology Department, University of the Punjab, Lahore, Pakistan. The main purpose is to describe the additional dental elements of the Siwalik *Sivalhippus*.

Abbreviations

PUPC, Punjab University
Palaeontological Collection, GSI, Geological
Survey of India.

SYSTEMATIC PALAEOLOGY***Sivalhippus perimensis* (Pilgrim, 1910)**

New material Upper dentition: PUPC 09/10, right P4; PUPC 07/168, right M1; PUPC 07/169, left

M3. Lower dentition: PUPC 09/103, left p2; PUPC 07/175, left p4; PUPC 07/171, left m1.

Description

Upper dentition: The principle cones are well developed and clearly visible in the premolar (Fig. 2). The protocone is somewhat rounded and isolated. The hypocone is elongated. The paracone is equivalent to the metacone in antero-posterior length. The anterior side is

broader than the posterior one. The styles are well developed, so are prominent. The parastyle and mesostyle are rounded and pillar like in shape. The metastyle is comparatively weak. The hypoconal groove is present postero-lingually. The plications in prefossette and postfossette are not clearly visible. The premolar represents single plicaballin. The metaloph and ectoloph are in crescent shaped.

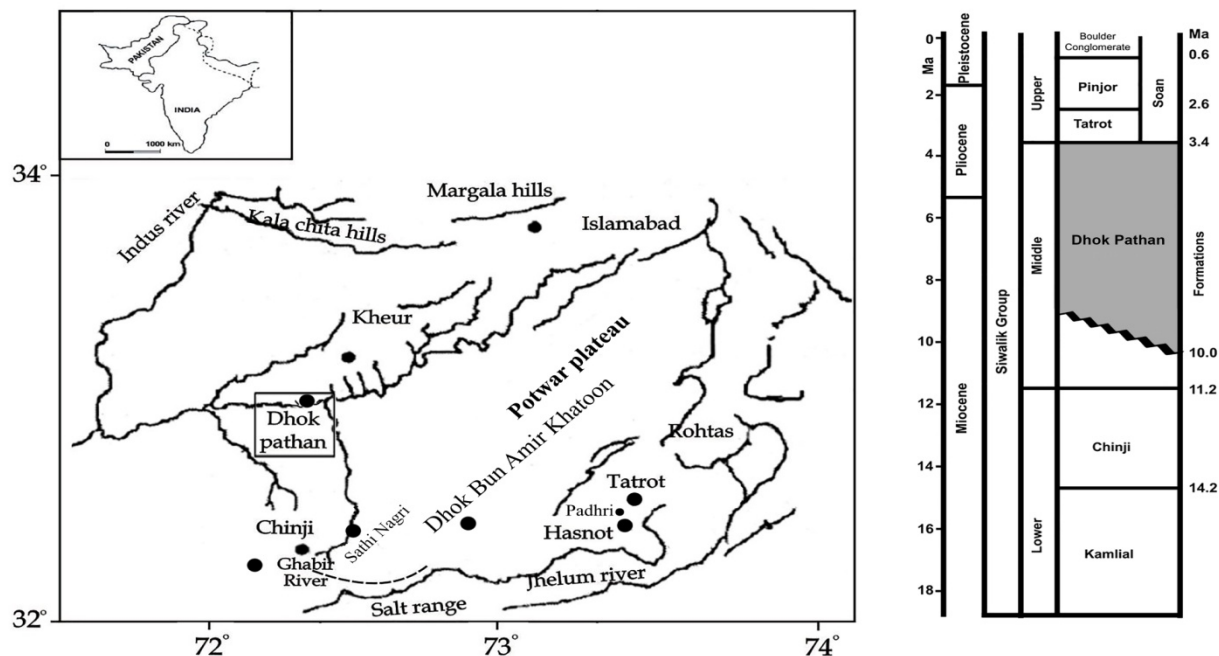


Figure 1 Map of Potwar Plateau in Pakistan, showing the encircled studied area.

Molars are broad crown and hypsodont with well-developed cusps. M1 is quadrate and M3 is triangular in general appearance (Fig. 2). The extended and ovoid protocone isolated from rest of the crown. It is flattened lingually and circular labially. Elongated hypocone bears deep hypoconal groove. Paracone and metacone are similar both in size and appearance. All the styles are intact and prominent. Rich plication can be observed between prefossette and post fossette with maximum enamel folding posterior to prefossette and anterior to post fossette. The prefossette is larger and more plicated than the post fossette. The plicaballin is trifid. Highly plicated crown shows crescentic protoloph, metaloph and ectoloph.

Lower dentition: Premolars are almost rectangular in shape (Fig. 2). The p2 has anterostylid characteristic. The occlusal surface is narrow. Protoconid and hypoconid are present

labially whereas metaconid and entoconid are lingual in position. V-shaped metaconid is distinguished from the entoconid which instead is triangular in shape. Protostylid and parastylid appearance is pillar like. Metastylid is pointed and have a wavy outline. The lingual side of tooth is slightly higher than the labial side. Lingual flexid is deep, U-shaped, and the ectoflexid is deeply incised. Posteriorly, well-developed and prominent hypoconulid is present. The metastylid is placed anteriorly in the molar (Fig. 2). The mesostylid and entostylid is present lingually. The hypoconid is present posteriorly. Lingually, two prominent invaginations can be observed in the metaflexid anteriorly and in the entoflexid posteriorly. The metaflexid is slender centrally, but broad antero-posteriorly. The entoflexid is extended, curved anteriorly, but broad posteriorly. The ectoflexid is elongated, broad anteriorly and curved posteriorly.

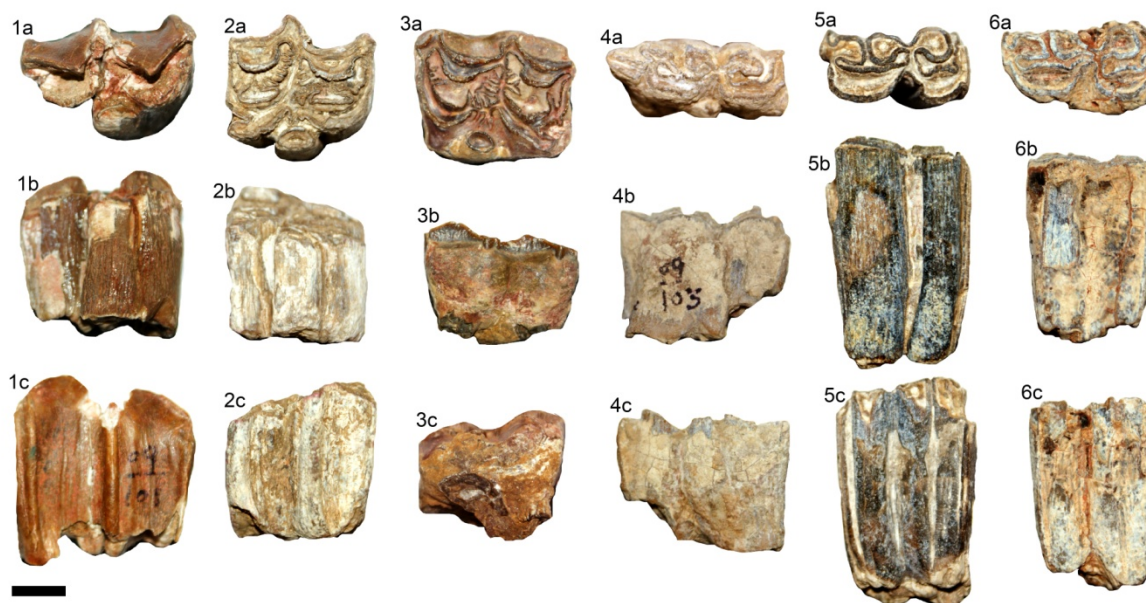


Figure 2. Representative cheek teeth of *Sivalhippus perimensis*. 1. PUPC 09/10, right P4; 2. PUPC 07/168, right M1; 3. PUPC 07/169, left M3; 4. PUPC 09/103, left p2; 5. PUPC 07/175, left p4; 6. PUPC 07/171, left m1. Scale bar is 10mm.

COMPARISON AND DISCUSSION

Sivalhippus is represented by high frequency of plications in fossettes and bifid (in some teeth trifid) plicaballins (Bernor and Hussain, 1985; Bernoret *et al.*, 1996; Khan *et al.*, 2010, 2011; Iqbal *et al.*, 2012; Wolf *et al.*,

2013). Specimen PUPC 09/101 is an upper fourth premolar, 31.4 mm in length and 22.18 mm in width. The length shows conformity with GSI C349 type specimen of *S. perimensis*. The specimen PUPC 07/168 is an upper first molar, 26.93 mm in length and 23.9 mm in width, which is closest to the type specimen of *S. perimensis*.

Table I: The measurements (mm) of the cheek teeth of *Sivalhippus perimensis*. Referred data are from Colbert (1935), Bernor and Hussain (1985), Ghaffar (2005) and Iqbal *et al.* (2009).

Inventory No.	Nature/Position	Length	Width	L/W
PUPC 09/101	P4	31.4	22.1	1.41
PUPC 07/168	M1	26.9	23.9	1.12
PUPC 07/16	M3	27.8	23.3	1.19
PUPC 09/103	p2	31.9	13.9	2.28
PUPC 07/175	p4	25.8	14.4	1.79
PUPC 07/171	m1	24.6	15.0	1.63

The other described specimens show conformity (Table I; Fig. 2) with the previously studied specimens of *S. perimensis* (Bernor and Hussain, 1985; Iqbal *et al.*, 2009; Naseem *et al.*, 2009; Khan *et al.*, 2011; Wolf *et al.*, 2013). A peculiar variety of the Siwalik hipparionine was reported by many researchers (Lydekker, 1883,

1884; Bernor and Hussain, 1985; Bernor *et al.*, 1996; Iqbal *et al.*, 2009, 2012; Naseem *et al.*, 2009; Khan *et al.*, 2011, 2015). Recently, Wolf *et al.* (2013) revised the taxonomy of the Siwalik hipparionines and documented four distinct species viz., *S. perimensis*, *S. theobaldi*, *S. nagriensis* and *Cremohipparion antilopinum*. A

rare finding of *Hipparion* sp. is also reported from the Middle Siwalik Subgroup (Wolf *et al.*, 2013). *Sivalhippus perimensis* is an endemic species, representing primitive characters with complex cheek teeth, fossette ornamentation, complex plicaballins, deeply incised hypoglyph and elongate P2 anterostyle. The existence of equid along with other mammalian fauna during Late Miocene age predicts diverse range of habitats during the said age. The hipparion have wide ranging habitat adaptations as they are hypsodont browsers to grazers.

Conclusions

The new fossil material of *Sivalhippus perimensis* are recorded from the Dhok Pathan type locality, Chakwal district of Northern Pakistan. *Sivalhippus perimensis* was a Late Miocene Siwalik hipparionine and the Dhok Pathan type locality yielded a rich fossil remains of this equid taxa. The studied material enlarges our knowledge about the Late Miocene hipparionine fossils. The presence of the hipparion in the Pakistani Middle Siwalik Subgroup indicates wooded-grassy savannas and grasslands during the Late Miocene – Early Pliocene.

REFERENCES

- AKHTAR, M., 1996. A new species of the genus *Selenoportax* (Mammalia, Artiodactyla, Bovidae) from Dhok Pathan, district Chakwal, Punjab, Pakistan. *Proc. Pakistan Congr. Zool.*, **16**: 91-96.
- BARRY, J., MORGAN, M., FLYNN, L., PILBEAM, D., BEHRENSMEYER, A.K., RAZA, S., KHAN, I., BADGELY, C., HICKS, J. AND KELLEY, J., 2002. Faunal and Environmental change in the Late Miocene Siwaliks of Northern Pakistan. *Paleobiol. Mem.*, **28**: 1-72.
- BERNOR, R.L. AND HUSSAIN, S.T., 1985. An assessment of the systematics phylogenetic and biogeographic relationships of Siwalik Hipparionine Horses. *J. Vert. Pal.*, **5**(1): 32-87
- BERNOR, R.L., KOUFOS, G.D., WOODBURN, M.O. AND FORTELIUS, M., 1996. The evolutionary history and biochronology of European and Southwestern Asian late Miocene and Pliocene hipparionine horses. In: *The Evolution of western Eurasian Later Neogene Faunas* (Eds. R.L. Bernor, V. Fahlbusch, and H.W. Mittmann), Columbia University Press, New York. pp. 307–338.
- COLBERT, E.H., 1935. Siwalik mammals in the American Museum of natural History. *Trans. Amer. Phil. Soc.*, **26**: 1-401.
- COTTER, G.P., 1933. The geology of the part of the Attock district, West of Longitude 72° 45: *Ind. Geol. Surv. Mem.*, **55**: 63-161.
- GHAFFAR, A., 2005. *Studies on Equids, Cervids and Carnivora from the Siwalik hills of Pakistan*. PhD. Thesis, University of the Punjab, Lahore, Pakistan.
- IQBAL, M., LIAQAT, A., KHAN, M.A. AND AKHTAR, M., 2009. Some New Remains of Hipparion from the Dhok Pathan Type Locality, Pakistan. *J. Anim. Plant Sci.*, **19**(3): 154-157.
- IQBAL, M., ASHRAF, I., KHAN, M.A., BABAR, M.A., MAHMOOD, K. AND AKHTAR, M., 2012. Some new fossils of *Hipparionine* from Dhok Pathan formation of Siwaliks. *Punjab Univ. J. Zool.*, **27**(1): 27-31.
- KHAN, M.A., GHAFFAR, A., FAROOQ, U. AND AKHTAR, M., 2007. New Fossil remains of *Selenoportax vexillarius* from the Late Miocene of Hasnot. *Pakistan J. Zool.*, **39**: 333-338.
- KHAN, M.A., IQBAL, M., AKHTAR, M. AND HASSAN, M., 2009. Chalicotheres in the Siwaliks of Pakistan. *Pakistan J. Zool.*, **41**: 429-435.
- KHAN, M.A., AKHTAR, M. AND IQBAL, M., 2010. The late Miocene artiodactyls in the Dhok Pathan formation, the Middle Siwaliks, Pakistan. *Pakistan J. Zool. Suppl. Ser.*, **10**: 1-87.
- KHAN, M.A., MANZOOR, F., ALI, M., BHATTI, Z.H. AND AKHTAR, M., 2011. A new collection of hipparionine from the type locality of the Dhok Pathan Formation of the Middle Siwaliks. *J. Anim. Plant Sci.*, **21**: 83-89.
- KHAN, M.A., ALI, S., IQBAL, J. AND AKHTAR M., 2014. Some New Remains of Hipparionine (Equidae: Mammalia) from Dhok Pathan Upper Miocene, Northern Pakistan. *Pakistan J. Zool.*, **46**(2): 347-354.
- KHAN, M.A., AZIZ, H., GUL, S., BABAR, M.A., MAHMOOD, K. AND AKHTAR, M., 2015. New Hipparionine (Equidae) Remains from Dhok Pathan Formation of Siwaliks, Pakistan. *Pakistan J. Zool.*, **47**(6):1617-1624.

- LYDEKKER, R., 1883. Indian Tertiary and post-tertiary Vertebrata: Siwalik selenodont Suina, etc. *Memoirs of the Geological Survey of India, Pal. Indica*, Series 10, **5**: 143-177.
- LYDEKKER, R., 1884. Additional Siwalik Perissodactyla and Proboscidea. *Mem. Geol. Surv. India, Palaeontologica Indica*, 10, **3**: 1-34.
- MATTHEW, W.D., 1929. Critical observations upon Siwalik mammals (exclusive of Proboscidea). *Amer. Mus. Nat. Hist. Bull.*, **56**: 437-560.
- NASEEM, L., KHAN, M.A., AKHTAR, M., IQBAL, M., KHAN, A.M. AND FAROOQ, U., 2009. Hipparion from the Nagri type locality of the Nagri Formation, Middle Siwaliks, Pakistan: Systematics. *J. Natural Sci.*, **7**(1-2): 18-29.
- PASCOE, E.H., 1963. A manual of the geology of India and Burma. *India*, Calcutta, **3**: 1344-2130.
- PILBEAM, D., BARRY, J., MEYER, G. E., SHAH, S.M.I., PICKFORD, M.H.L., BISHOP, W.W., THOMAS, H. AND JACOBS, L.L., 1977. Geology and palaeontology of Neogene strata of Pakistan. *Nature*, London, **270**: 684-689.
- PILGRIM, G.E., 1910. Notices of new Mammalian genera and species from the Tertiaries of India, Calcutta. *Rec. Geol. Surv. India*, **40**: 63-71.
- PILGRIM, G.E., 1913. The correlation of the Siwaliks with the mammalian horizons of Europe. *Geol. Surv. Rec. India*, **43**: 264-326.
- PILGRIM, G.E., 1937. Siwalik antelopes and oxen in the American Museum of Natural History. *Bull. Amer. Mus. Nat. Hist.*, **72**: 729-874.
- PILGRIM, G.E., 1939. The fossil Bovidae of India. *Palaeontologia Indica*, NS, **26**: 1-356.
- SHEIKH, I.M., PASHA, M.K., WILLIAMS V.S., RAZA S.Q. AND KHAN K.S.A., 2008. Environmental Geology of the Islamabad-Rawalpindi Area, Northern Pakistan. In: Regional Studies of the Potwar-Plateau Area, Northern Pakistan. *Bull.*, 2078G.
- WOLF, D., BERNOR, R.L. ANDHUSSAIN, S.T., 2013. A Systematic, Biostratigraphic, and Paleobiogeographic reevaluation of the Siwalik Hipparionine Horse assemblage from the Potwar Plateau, Northern Pakistan. *Palaeontographica Abt. A.*, **300**: 1-115.