

Short Communication

NEW FOSSILS OF SUIDAE (MAMMALIA) FROM DHOK PATHAN FORMATION OF SIWALIKS, PUNJAB, PAKISTAN

F. Y. Dar¹, K. Aftab², M. A. Babar¹, M. A. Khan¹, S. G. Abbas¹, R. Shahid¹ and M. Asim¹

¹Dr. Abu Bakr Fossil Display and Research Centre, Department of Zoology, University of the Punjab (Quid-e-Azam Campus) Lahore, Punjab, Pakistan; ²Department of Zoology, University of Gujrat, Gujrat, Punjab, Pakistan

*Corresponding author e-mail: dr.kiran@uog.edu.pk

ABSTRACT

New suid remains are recovered from the Siwalik Hills of northern Pakistan. The type locality Dhok Pathan, aged to Late Miocene, is located in Chakwal district, Punjab, Pakistan. The new material comprises incisors, mandibular fragments, upper and lower premolars and lower molars. The specimens are assigned to three genera *Tetraconodon*, *Hippopotamodon* and *Propotamochoerus*. The fossils provide evidences about anatomical features of the Siwalik suids.

Keywords: Artiodactyla, Suiformes, Suidae, Miocene, Siwaliks.

INTRODUCTION

Suids have been classified as even toed ungulates and are abundant in the Siwaliks of Indian Subcontinent. These are diverse in number and species and have been studied by the various researchers from the beginning of paleontological studies in this area (Falconer, 1868; Lydekker, 1883; Pilgrim, 1926; Colbert, 1935; Pickford, 1988; Made, 1996, 1999; Batool *et al.*, 2015). In the past, this family was widespread both in Africa and Eurasia with several genera (Kostopoulos and Sen, 2016., Pickford and Obada, 2016., Spassov *et al.*, 2018., Mors *et al.*, 2019). Some of the species are well-represented in these studies based on their abundant fossils and others have been represented by only a few specimens. Every new specimen of these species is extremely important and valued much because of the information's it provides.

Such a rare species is *Tetraconodon magnus*, a large sized tetraconodont species, found from the late Miocene of the Siwaliks (Pilgrim, 1926; Pickford, 1988; Made, 1999; Khan *et al.*, 2013). Only 15 specimens are found and some of these are un-described (Made, 1999; Khan *et al.*, 2013). Other species like *Hippopotamodon sivalense* and *Propotamochoerus hysudricus* are well-documented with handful fossils record. However, *Hippopotamodon sivalense* has a close affinity with the European species *Microstonyx major* and there remains a

whether later species arrived in the Siwaliks or both can be synonymized or not (Made and Hussain, 1989., Pickford, 2015).

The samples described in this article include the *Tetraconodon cf. magnus*, *Hippopotamodon cf. sivalense* and *Propotamochoerus hysudricus*. Among these the newly recovered specimen of *T. cf. magnus* adds the new insights in the morphology of the tooth and jaw of this species and that of *Hippopotamodon cf. sivalense* confirms the point of view of Pickford (1988) that only a single species is present in the Siwaliks contrary to Made and Hussain (1989). Hence, the new addition in the Siwalik suids is the objective of the article.

The present specimens are recovered from the Late Miocene type locality Dhok Pathan (Lat. 33° 07'N; Long. 72° 14'E), Chakwal, Pakistan (Fig. 1). The thickness of these deposits varies from 950 - 1200 m (Barry *et al.*, 2002). The type locality comprises alternate sandstone, claystone/siltstone and rarely with conglomerates (Shah, 1977, 1980; Barry *et al.*, 2002; Bhatti *et al.*, 2012a, b). Magnetic polarity and stratigraphic dating indicate that the age of Dhok Pathan Formation is between 10.1–ca.3.5 Ma. The lower part of the Dhok Pathan Formation is dated between 10.1-9.0 Ma and the upper part is dated at ca. 9.0-5.5 Ma (Cande and Kent, 1995; Barry *et al.*, 2002).

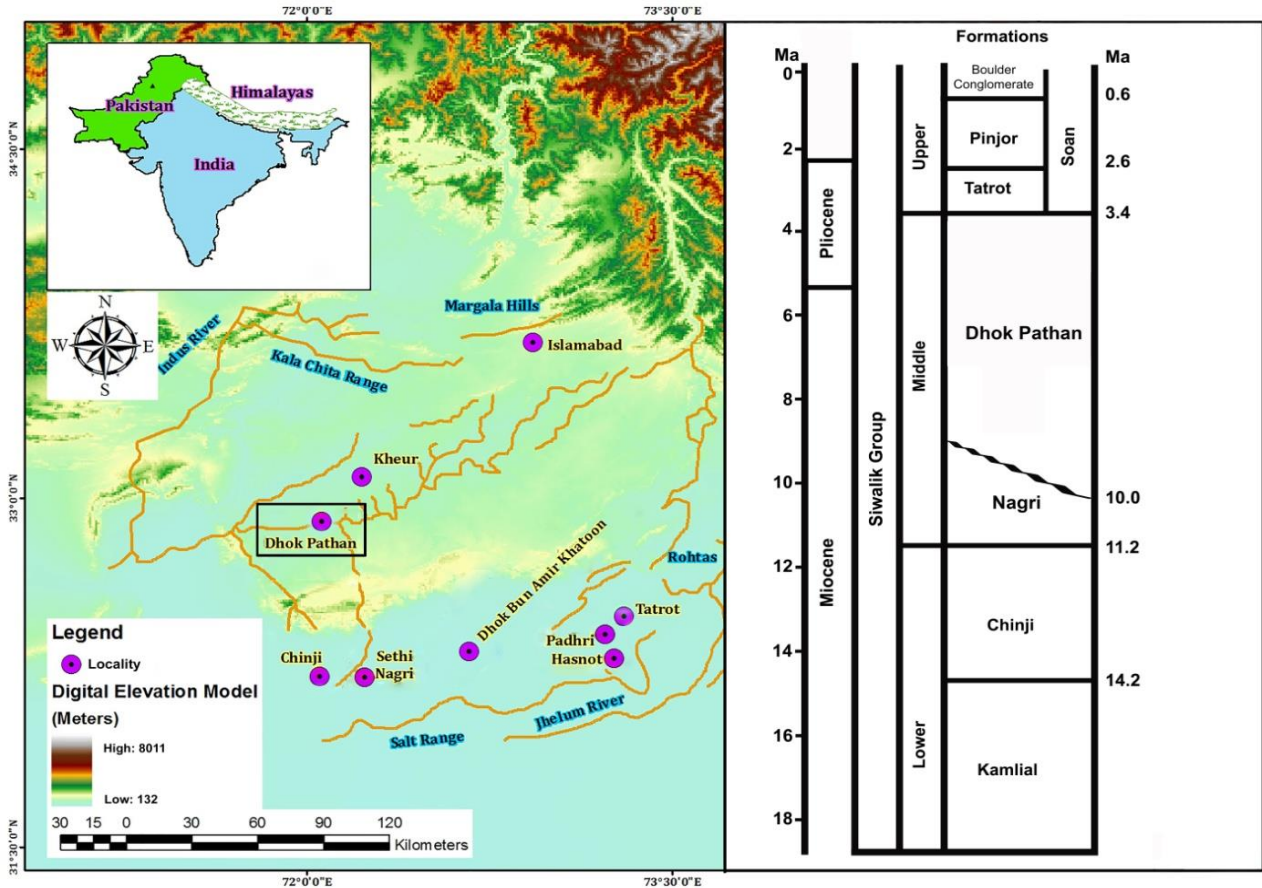


Fig.1. Location map of Potwar Plateau in Pakistan showing the Dhok Pathan type locality (data from Barry *et al.*, 2002; Dennell *et al.*, 2008, and Cohen and Gibbard, 2008).

MATERIALS AND METHODS

Specimens being described in article have been collected from the Dhok Pathan Formation's type locality (Fig. 1). From the gross collection i.e. all the collected specimens, we have selected the suid fossils for this study and removed the sediments with fine needles and brushes. Some of the specimens were partly broken (like 13/370 and 13/63), these were carefully glued with the adhesives after washing them. The specimens were catalogued (e.g. PUPC 16/117) and are kept in Dr. Abu Bakr Fossil Display & Research Centre, Zoology Department, University of the Punjab, Lahore, Pakistan. The catalogue numerator symbolizes the collection year and denominator denotes serial number of that year. Digital Vernier caliper was used for measuring the specimens.

The terminology and measurements followed Pickford (1988). Comparisons were made with specimens present in American Museum of Natural History (AMNH), British Museum of Natural History London (BMNH), the Geological Survey of India (GSI) and the Geological Survey of Pakistan (GSP).

SYSTEMATIC PALAEOLOGY

Order ARTIODACTYLA Owen, 1848

Family SUIDAE Gray, 1821

Sub-family TETRACONODONTINAE Lydekker, 1876

Genus *TETRACONODON* Falconer, 1868

Tetraconodon cf. magnus (Falconer, 1868)

New material: PUPC 13/37, left mandible fragment with a lower third molar (m3).

Description and comparison: PUPC 13/37 is an elongated molar, narrower distally than mesially (Fig. 2(1)). All four cuspids are well differentiated. The protoconid, metaconid, hypoconid and entoconid are organized into two distinct lobes with rounded corners separated from each other by a well-developed median valley. The furrows are indistinct. The protoconid is larger than other cuspids. The third lobe or talonid is present. It is relatively simple and has a length of 26 mm. The pentaconid is very distinct in the molar. The protoendoconulid, hypoproconulid and pentapreconulid are well developed. The tooth shows mesodonty and its enamel is very thick, with visible scratches.

The molar has inflated conids with hypoproconulid and pentapreconulid. These features can

be recognized in the generous sized Siwalik suid *Tetraconodon*. Two species were erected by the Siwalik: *T. magnus* and *T. minor* (Pickford, 1988; Made, 1999). Although, morphometrically (Tab. 1), the specimen resembles *Tetraconodon magnus*, however, being a single specimen collection and is partially broken it has been assigned to *T. cf. magnus* (Pickford, 1988; Made, 1999; Khan *et al.*, 2013).

Subfamily SUINAE Zittel, 1893

Genus *HIPPOPOTAMODON* Lydekker, 1877

***Hippopotamodon cf. sivalense* Lydekker, 1877**

New material: PUPC 11/40, right upper first incisor (I1); PUPC 13/374, left upper second premolar (P2).

Description and comparison: PUPC 11/40 is a large spade like tooth with raised labiolingual borders, surrounding a central lingual fossa (Fig.2(2)). A small central rib is not visible at the tip of the central lingual fossa because of wearing. The mesiodistal borders are raised lingually. The occlusal surface of the tooth is beaded and there are light bifurcations near the mesial edge. The parapreconule is clearly visible at the anterior side of the paracone. The basal fossa is present at the base of the protocone. At the mesiolingual border of the tooth a crest is present i.e. preanticle and next to it there is trough i.e. presyncline. Similarly, at the distal lingual border of the tooth there is a crest i.e. endoanticle and next to it is a trough which is endosyncline. Metapostcrista is clearly visible. At the lingual side of the tooth, two pillar-like ridges prestyle at mesial end and poststyle at distal end are present. The anteroposterior diameter (DAP) of the tooth is 25.7 mm and transverse diameter (DT) is 10.7 mm.

The premolar PUPC 13/374 is an elongated tooth with inflated main cusp (protocone) (Fig.2(3)). The premolar is bordered by a complete cingulum lingually, labial cingulum is lightly formed. The posterolingual cusplet is prominent. The paracone is present mesially. A large fossa is visible on the entire occlusal surface. The parastyle and cingulum is present anteriorly. There is a contact depression posteriorly. The new studied specimens are morphometrically (Tab. 1; Fig. 2(2,3)) associated with *Hippopotamodon cf. sivalense*.

Genus *PROPOTAMOCHOERUS* Pilgrim, 1925

***Propotamochoerus hysudricus* (Stehlin) 1899-1900**

New material: PUPC 13/63, right mandible fragment with third premolar (p3) and partial fourth premolar (p4); PUPC 09/95, left mandible fragment with fourth premolar (p4).

Description and comparison: The paraconid is present mesially and entoconid distally in the third premolar (Fig. 2(4)). The protoconid and hypoconid are visible labially while the metaconid is prominent lingually. The anteroposterior cusplets are absent. The 3rd cusp is found distinctively. The parastylid, protostylid, metastylid and entostylid are clearly visible with their respective conids. The distal edge of the premolar is slightly broken lingually. The antero-posterior grooves are present labiolingually.

The p4 is more moralized tooth than the p3 (Fig. 2(5)). The central cusp has migrated lingually to form an inner cusp. The anteroposterior accessory cusps are present. The posterior accessory cusp is enlarged having a border of inflated cingulum. The anterior cingulum, as well as accessory cusp, are moderately high, forming an ac-1 cusp. The p4 is attached with a small portion of broken m1 posteriorly. The socket of a lower canine is also visible. A short, curved symphysis is visible at buccal side of mandibular fragment. A broken incisor is also present at the tip of the symphysis. A mandibular pit can be seen labially. Morphometrically (Tab. 1; Fig. 2 (4,5)), the sample belongs to *Propotamochoerus hysudricus*.

Suoid indet: *New Material:* PUPC 13/62, right mandible fragment with roots of second and third molars (m2& m3).

Description and comparison: The molars are in late wear, disappearing the crown (Fig. 2(6)). The length of the fragment is 49.7 mm. Morphologically, the molar features are visible. Therefore, its taxonomy cannot be determined.

DISCUSSION

The Siwalik suids form an important assemblage whose ties with the other regions of the world are prominent. Pilgrim (1926) was the first one who discovered vast divergence in the Siwalik Suidae. The Siwalik suids are represented by some endemic genera like *Lophochoerus*, *Tetraconodon*, *Hippopotamodon*, *Sivahyus* and *Hippohyus*, whereas some genera are common in Siwaliks and Europe and other parts of the world like *Bunolistriodon*, *Listriodon*, *Propotamochoerus*, *Conohyus* and *Sus* (Pilgrim 1926, Colbert, 1935; Pickford, 1988, Made, 1996). The Siwalik suids are also important in that a few genera which evolved in subcontinent, but later migrated to Europe, Africa and other parts of the world like *Conohyus*, *Propotamochoerus*, *Sivachoerus* and *Sus* (Matthew, 1929; Colbert, 1935; Pickford, 1988; Made 1999).

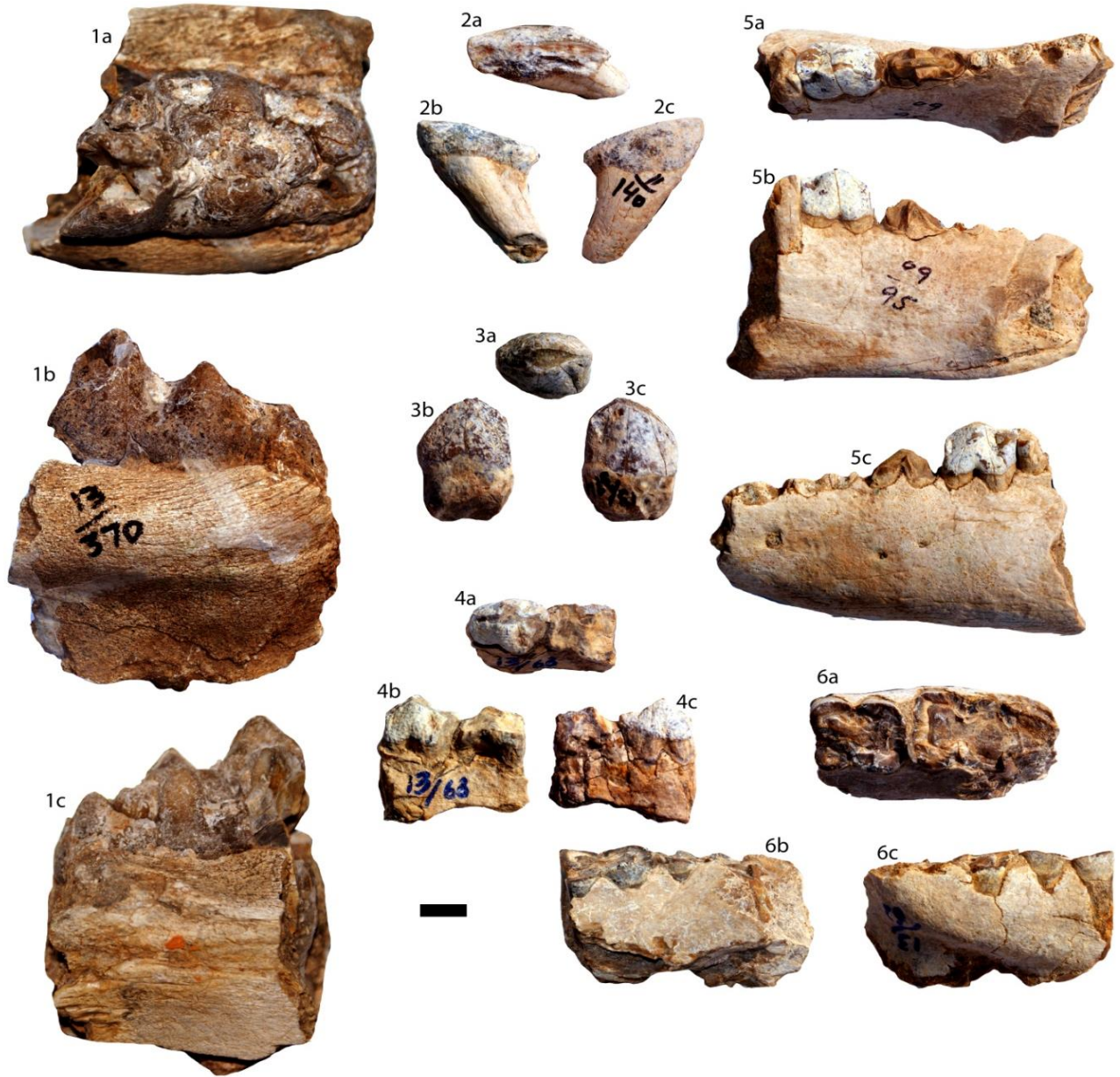


Fig.2. *Tetraconodon cf. magnus*: 1. PUPC 13/37, left mandible fragment with m3. *Hippopotamodon cf. sivalense*: 2. PUPC 11/140, right I1; 3. PUPC 13/374, left P2. *Propotamochoerus hysudricus*: 4. PUPC 13/63, right mandibular ramus with p3-4; 5. PUPC 09/95, left mandible fragment with p4. Suoid indet.: 6. PUPC 13/62, right mandible fragment with roots of m2 & m3. Views: a= occlusal, b= lingual, c= labial. Scale bar 10 mm.

Table. 1. Comparative measurements (in mm) of the teeth of *Tetraconodon magnus*, *Hippopotamodon sivalense* and *Propotamochoerus hysudricus*. *the studied specimens. Referred data are taken from Pickford (1988).

Taxa	Inventory No.	Position/Nature	Width	Length	W/L
<i>Tetraconodon cf. magnus</i>	PUPC 13/37*	lm3	29	55	0.53
	B 71	m3	32.5	50	1.54
	B 828	m3	31.4	48	0.65
<i>Hippopotamodon cf. sivalense</i>	PUPC 11/40*	rI1	10.7	25.7	2.4
	GSP 12508	I1	11.3	19.2	1.7
	GSP 330	I1	12.3	-	-

	K 14/394	I1	18	23	1.28
	K 13/328	I1	15	25	1.67
	K 13/345	I1	19	19	0
	K 15/660	I1	17	22	1.3
	PUPC 13/374*	IP2	13	20	1.54
	K 23/105	P2	11.4	18.1	1.59
	B 396	P2	13.3	19	1.43
	K 12/870	P2	12.3	20	1.63
	B 354	P2	11.5	15.6	1.36
	K 42/172	P2	13.4	20.4	1.52
	B 737	P2	13.6	22.1	1.63
	GSP 3789	P2	12.3	-	-
<i>Propotamochoerus hysudricus</i>	PUPC 13/63*	rp3	10.7	15	1.4
	B 32	p3	10	16.7	1.67
	B 39	p3	8	14.7	1.84
	GSP 2807	p3	9.1	15	1.65
	GSP 11598	p3	7.6	-	-
	GSP 457	p3	8.6	15	1.74
	GSP 2503	p3	8.2	15.1	1.84
	GSP 10998	p3	8.2	15.7	1.91
	PUPC 09/95*	lp4	11.7	15.2	1.3
	GSP12343	p4	9.2	16.7	1.82
	GSP 5823	P4	11.3	14.4	1.27
	GSP 9355	p4	11.4	16.6	1.46
	GSP 12732	p4	9.6	16	1.67
	GSP 457	p4	11.4	15	1.32
	GSP 5230	p4	10.8	16.4	1.52
	GSP 48	p4	10.5	-	-
	GSP 2807	p4	10	14.5	1.45
	GSP 7017	p4	12.6	15.6	1.24
	GSP 2503	p4	11.6	13.6	1.17
	GSP 10998	p4	11.6	15.5	1.34
	B 742	p4	10.7	15.3	1.43
	B 39	p4	9.9	13.9	1.4
	B 32	p4	12	18	1.5
B 715	p4	12.5	17.5	1.4	

The African suids have been evolved from the primitive Siwalik *Sus* (Pickford, 1988).

Genus *Tetraconodon* is represented by three species *T. magnus*, *T. intermedius*, and *T. minor* (Pilgrim, 1926; Pickford, 1988; Made, 1999). All the species are poorly documented and have been based on the isolated dentition mostly. *T. minor* is considered as the smallest and *T. magnus* has been regarded as the largest (Pickford, 1988; Made, 1999). The status of the two newly erected species *T. malensis* by (Thaung-Htike et al., 2005) is yet uncertain. It may represent a variant *Conohyus indicus*. Pilgrim (1926) and Lydekker (1884) described several specimens of *Hippopotamodon sivalense* from the Late Miocene of the Siwalik Hills but with different names. Older and younger specimens of this genus was present from about 10 to 7 myr. *Hippopotamodon sivalense* range is very similar to that of *Propotamochoerus hysudricus* and apparently *Microstonyx*. Nevertheless, it is Late

Miocene species which disappearing during Pliocene (Pickford, 1988).

According to controlled collection of Yale/Pakistan Expedition, *P. hysudricus* existing in the Nagri and Dhok Pathan formations along with *Sivahyus*, *Hippohyus* and *Hippopotamodon sivalense*, having age about 10 to 6 myr. Another species *Korynochoerus palaeochoerus* has been discovered from Europe in the same range (Pickford, 1988).

Conclusions: The Dhok Pathan type locality displays the three contemporaneous and sympatric genera *Tetraconodon*, *Propotamochoerus* and *Hippopotamodon*. *Tetraconodon magnus*, *Hippopotamodon sivalense* and *Propotamochoerus hysudricus* are Late Miocene species that disappeared at the end of Pliocene. The type locality of the Dhok Pathan Formation provides evidence of diversifying suids in the Late Miocene of the Siwaliks.

REFERENCES

- Barry, J.C., M.E. Morgan, L.J. Flynn, D. Pilbeam, A.K. Behrensmeyer, S.R. Mahmood, I.A. Khan, C. Badgley, J. Hicks, and J. Kelley (2002). Faunal and environmental change in the late Miocene Siwaliks of northern Pakistan. *Paleobiol.* 28 (2): 1-71.
- Batool, A., M.A. Khan, and N.A. Qureshi (2015). New fossils of Suidae (Mammalia: Artiodactyla) from the Hasnot Late Miocene, northern Pakistan. *The J. Anim. Pl. Sci.* 25(2): 578-590.
- Bhatti, Z.H., M.A. Khan, and M. Akhtar (2012a). *Hydaspitherium* (Artiodactyla: Giraffidae) New Collection from the Dhok Pathan Formation of the Middle Siwaliks, Pakistan. *Pakistan J. Zool.* 44: 799-808.
- Bhatti, Z.H., M.A. Khan, M. Akhtar, A.M. Khan, A. Ghaffar, M. Iqbal and M.K. Siddiq (2012b). *Giraffa punjabiensis* (Giraffidae: Mammalia) from Middle Siwaliks of Pakistan. *Pakistan J. Zool.* 44:1689-1695.
- Cande, S.C. and D.V. Kent (1995). Revised calibration of the geomagnetic polarity time scale for the Late Cretaceous and Cenozoic. *J. Geophys. Res.* 100: 6093-6095.
- Cohen, K.M. and P.L. Gibbard (2008). Global chronostratigraphical correlation table for the last 2.7 million years. *Episodes.* 31: 243-247.
- Colbert, E.H. (1935). Siwalik mammals in the American Museum of Natural History. *Trans. Am. Phil. Soc., N. S.* 26: 1-401.
- Dennell, R.W., R. Coard and A. Turner (2008). Predators and Scavengers in Early Pleistocene southern Asia. *Quat. Int.* 192: 78-88.
- Falconer, H. (1868). Description of a fragment or a jaw of an unknown extinct pachydermous animal from the Valley of the Murkunda. *Tetraconodon magnum* vel *Choeritherium*. In Murchinson C. (ed.). *Palaeontological memoirs and notes of the late Hugh Falconer, A.M., M.D. Fauna Antiqua Sivalensis*. Robert Hardwicke, London. 149-156.
- Khan, M.A., M. Iqbal, A.Q. Nayyer, M. Akhtar, M. Shahzadi, and K. Mahmood (2013). *Tetraconodon* (Mammalia, Artiodactyla, Suidae) From the Late Miocene Dhok Pathan Formation of Pakistan. *Pakistan J. Zool.* 45(4):975-980.
- Kostopoulos D.S. and S. Sen (2016). "Suidae, Tragulidae, Giraffidae, and Bovidae, in Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey". *Geodiversitas.* 38(2): 273-298.
- Lydekker, R. (1883). Indian Tertiary and post-Tertiary Vertebrata: Siwalik selenodont Suina, etc. *Mem. Geol. Surv. India Palaeont. Ind.* 5(10): 143-177.
- Lydekker, R. (1884). Additional Siwalik Perissodactyla and Proboscidea. *Mem. Geol. Surv. India. N. S., Pal. Ind.* 3(10): 1-34.
- Made, J.V.D. (1996). Listriodontinae (Suidae, Mammalia), their evolution, systematics and distribution in time and space. *Contrib. Tert. and Quat. Geol.* 33: 3-254.
- Made, J.V.D. (1999). Biometrical trends in the Tetraconodontinae, a subfamily of pigs. *Earth and Environmental Science Trans. Royl. Soc.* 89: 199-225.
- Made, J.V.D. and S.T. Hussain (1989). *Microstonyx major* (Suidae, Artiodactyla) from the type area of Nagri formation, Siwalik group, Pakistan. *Estudios. Geol.* 45: 409-416.
- Matthew, W.D. (1929). Critical observations upon Siwalik mammals (exclusive of Proboscidea). *Am. Mus. Nat. Hist. Bull.* 56: 437-560.
- Mors, T., L. Liu, and J. Hagstrom (2019). A Miocene tetraconodontine (Suidae, Mammalia) from Falkenberg (Halland, Sweden). *GFF* 141(1):77-81.
- Pickford, M. (1988). Revision of the Miocene Suidae of the Indian Subcontinent. *Munch Geowis. Schaf. Abh.* 12: 1-91.
- Pickford, M. (2015). "Late Miocene Suidae from Eurasia: the Hippopotamodon and Microstonyx problem revisited. *Münchner geowissenschaftliche Abhandlungen. Reihe A, Geol. Palaontol.* 42: 1-126.
- Pickford, M. and T. Obada (2016). Pliocene suids from Musaitu and Dermenji, Moldova: implications for understanding the origin of African *Kolpochoerus* Van Hoepen and Van Hoepen, 1932. *Geodiversitas.* 38 (1): 99-134.
- Pilgrim, G.E. (1926). The fossil Suidae of India. *Mem. Geol. Surv. India. N. S.* 8: 1-65.
- Shah, S.M.I. (1977). Stratigraphy of Pakistan. *Mem. Geol. Surv. Pakistan.* 12: 1-138.
- Shah, S.M.I. (1980). Stratigraphy and economic geology of Central Salt Range. *Rec. Geol. Surv. Pakistan.* 52: 1-104.
- Spassov, N., D. Geraads, L. Hristova, G.N. Markov, B. Garevska, and R. Garevski (2018). "The Late Miocene Mammal Faunas of the Republic of Macedonia (FYROM)". *Paleontographica. Abt. A. Paleozoology-Stratigraphy.* 311: 1-85.
- Thaung-Htike, T., M. Tsubamoto, M. Takai, M. Natori, N. Egi, M. Maung, and C. Sein (2005). A revision of *Tetraconodon* (Mammalia, Artiodactyla, Suidae) from the Miocene of Myanmar and description of a new species. *Pal. Res.* 9(3): 243-253.