PACHYPORTAX (BOVIDAE: RUMINANTIA) FROM DHOK PATHAN FORMATION OF SIWALIKS

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ABSTRACT

Some new molars of *Pachyportax* are recovered from the Late Miocene-Early Pliocene of the Middle Siwalik Subgroup. The material allowed the identification of two species of *Pachyportax*: *P. latidens* and *P. nagrii. Pachyportax nagrii* is known with a rare fossil record. These findings enhance our knowledge on the anatomical characters of the described species.

Key words: Antelopes, Boselaphini, Hasnot, Miocene, Pliocene, Siwaliks.

INTRODUCTION

Boselaphines were abundant during the Eurasian and African Late Miocene (Thomas, 1984; Bibi, 2007; Khan *et al*., 2009, 2010). The evolutionary lineage of early boselaphines can be seen in the Siwalik deposits. The earliest member of boselaphines has been recorded from the Kamlial Formation (ca 16 Ma) of the Northern Pakistan (Solounias *et al*., 1995). The Chinji Formation (14.2-11.2 Ma) of the Siwaliks is represented by more than three species (*Sivaceros gradiens, Miotragocerus gluten, Helicoportax tragelaphoides*) of Boselaphini (Pilgrim, 1937, 1939; Thomas, 1984; Khan *et al*., 2011). The Nagri Formation (11.2-10 Ma) represents typically *Sivoreas eremita, Elachistoceras khauristanensis*, *Selenoportax vexillarius* (Thomas, 1977; Akhtar, 1992; Made and Hussain, 1994) and the Dhok Pathan Formation (10-3.4 Ma) represents *Tragoportax punjabicus, Selenoportax vexillarius* and *Pachyportax latidens* (Pilgrim, 1937, 1939; Akhtar, 1992; Khan *et al*., 2009).

The Siwalik Boselaphini have been studied by several researchers identifying many number of species (Pilgrim 1937, 1939; Thomas, 1977; Akhtar, 1992; Solounias *et al*., 1995; Khan *et al*., 2009, 2010, 2012). The boselaphines appear to decline in the Soan Formation (3.4-0.6 Ma) and only one extinct species *Boselaphus namadicus* is recorded. They probably became extinct in Africa at the end of the Miocene (Bibi, 2007) and today they are only restricted to Asia with two living species: large *Boselaphus tragocamelus* and small *Tetracerus quadricornis*.

The Siwalik outcrops are represented by two species of *Pachyportax, P. latidens* and *P. nagrii. Pachyportax latidens* is a gigantic species and restricted to the Late Miocene-Early Pliocene of the Siwaliks. *Pachyportax nagrii* is smaller than *P. latidens* (Akhtar *et al.,* 2003). Gentry (1974) considered that *P. nagrii* was an invalid species, but later, Akhtar *et al*. (2003) ascribed *P. nagrii* from the Nagri type locality in Chakwal, Pakistan. Prior to this study, *P. nagrii* was only known from the outcrops belonging to the Nagri Formation of the Siwaliks (e.g. see Pilgrim, 1937, 1939; Akhtar, 1992; Akhtar *et al*., 2003).

The new findings of *P. nagrii* from the Dhok Pathan Formation of the Pakistani Siwaliks reconfirm the validity of this species and extend the stratigraphic range from the Nagri Formation to the Dhok Pathan Formation of the Siwaliks. Thus, the present paper deals with a taxonomic investigation of *Pachyportax* from the sediments of the Middle Siwalik Subgroup having age 10.2-3.4 Ma.

Geography and geology: The material comes from the fossil sites of the Dhok Pathan (Lat. 33° 07' N: Long. 72° 14' E), type locality in district Chakwal and the Hasnot (Lat. 32° 49' N: Long. 73° 18' E), village in district Jhelum northern Pakistan (Figure 1). The studied sites are rich in fossil remains (Barry *et al*., 2002; Khan *et al*., 2009, 2010, 2012, 2013). The outcrops consist of orange shale with less compacted gray sandstone bodies and red-brown mudstone with a few thin conglomerate interbeds (Quade and Cerling, 1995).

The studied outcrops belong to the Late Miocene-Early Pliocene (10.2-3.4 Ma) of the Siwaliks (Barry *et al*., 2002). The age of the Hasnot out croups spans 7-3.5 Ma with youngest layers in Bhandar bed in North-East of the Hasnot (Pilbeam *et al*., 1977; Johnson, *et al.*, 1982; Barry *et al*., 1982, 2002; Khan *et al*., 2009, 2010). The Dhok Pathan type locality outcrops are older than the Hasnot localities and ranging in age 10.2-8.4 Ma (Pilbeam *et al.*, 1977; Barry *et al*., 2002; Khan *et al*., 2010).

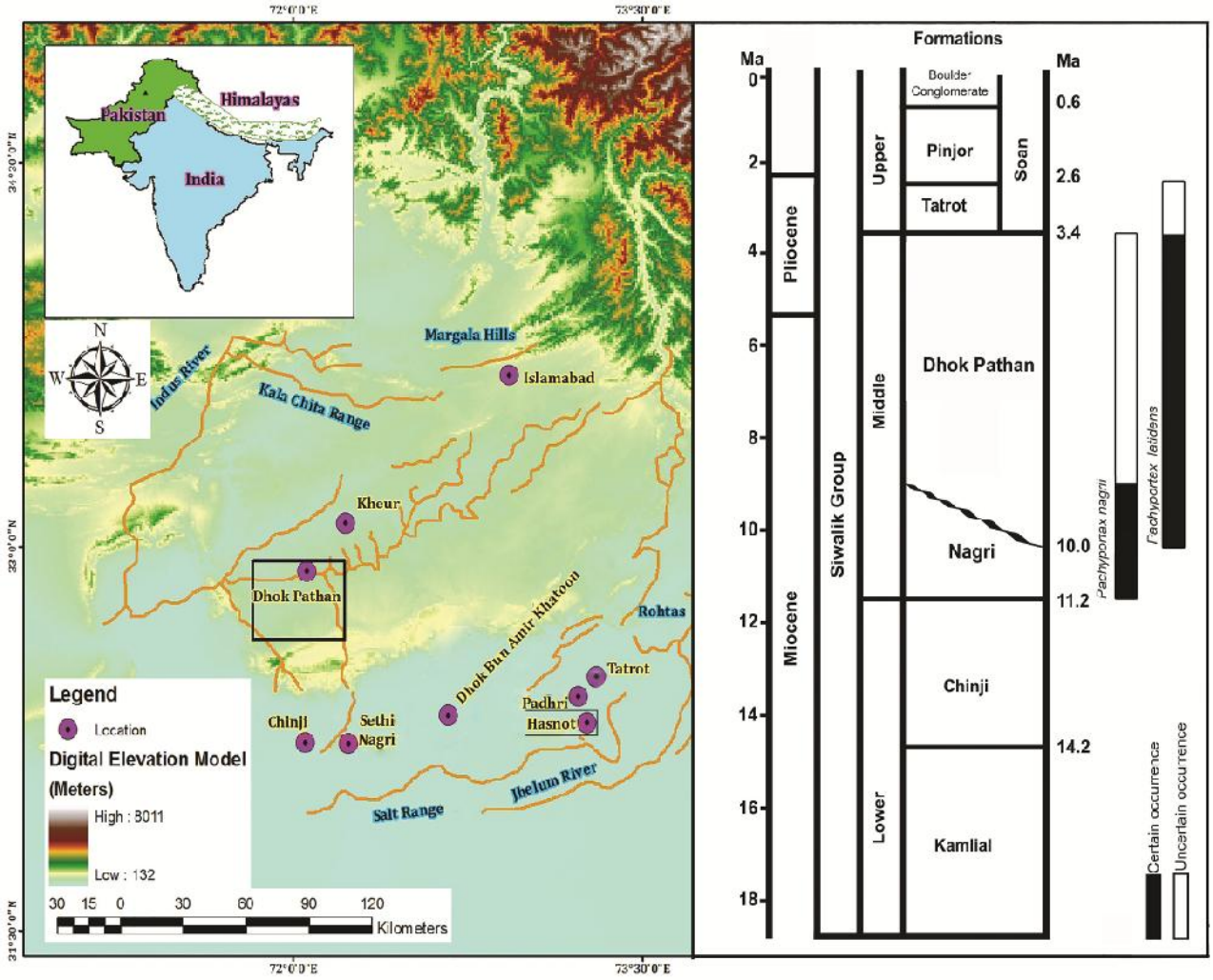

Fig. 1. Map of the Potwar Plateau in northern Pakistan; reference localities of the Siwaliks encircled. Bars represent chronological distribution of the Siwalik *Pachyportax* (modified from Behrensmeyer and Barry 2005 and the boundary dates are from Dennell 2008 and Nanda 2008).

MATERIALS AND METHODS

The studied material consists of upper and lower dental elements and part of the PhD thesis of the first author. The specimens were sampled by various means during campaign which took place in the 2004-2013 time range. A few already collected specimens are included in this study as well. The sampled material was transported to the Dr. Abu Bakr Fossil Display and Research Centre. The fossils were arranged for the morphometric studies. The inventory number consists of yearly catalogue number (nominator) and the serial number of the respective year (denominator) (e.g. 07/166, the upper figure denotes the collection year and the lower one the serial number of the respective year). The capital letter is used for upper dentition and the lower one for lower dentition. The measurements of the specimens were taken with the help of a metric Vernier caliper and mentioned in millimeters.

Depository: The studied specimens are housed in the Fossil Display and Research Centre, Zoology Department, University of the Punjab, Lahore, Pakistan.

Terminology: The terminology (Fig. 2) and protocol of measurements follow Gentry *et al.* (1999).

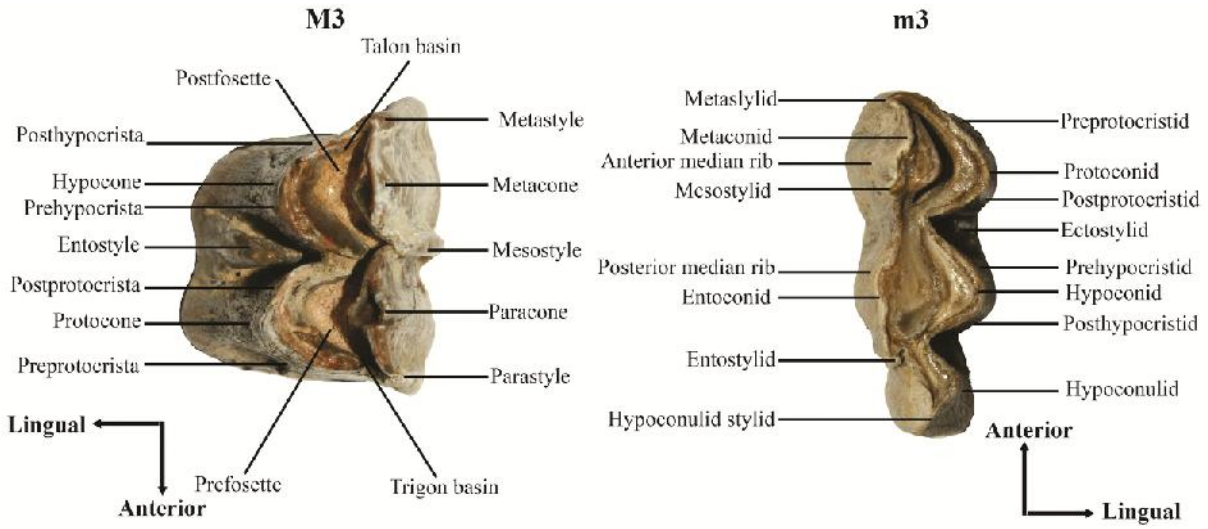

Fig. 2. The terminology of upper (M3) and lower (m3) third molar of *Pachyportax*.

SYSTEMATIC PALAEONTOLOGY:

Family Bovidae Gray, 1821

Subfamily Bovinae Gill, 1872

Tribe Boselaphini Knottnerus-Meyer, 1907

Genus *Pachyportax* Pilgrim, 1937

***Pachyportax latidens* (Lydekker) Pilgrim, 1937**

[Fig.3 (1-3)]

Localities: Dhok Pathan, district Chakwal and Hasnot, district Jhelum, northern Pakistan.

Studied Material: PUPC 04/22, lM1; PUPC 04/31, lM2; PUPC 07/166, part of maxilla bearing M2-3; PUPC 13/304, rM3; PUPC 13/234, rm3; PUPC 13/233, partial lm3.

Description

Upper dentition: The enamel is wrinkled (Fig. 3). The wrinkling is equally evident labio-lingually. The labial cusps are higher than the inner lingual cusps. The protocone is slightly extended forward than the hypocone, so anterior side of the tooth is wider than the posterior one. The protocone is crescent with praeprotocrista and postprotocrista. The postprotocrista is united with the praehypocrista. The praeprotocrista is united with the praeparacrista. The posthypocrista is united with the postmetacrista. The paracone and metacone are sharp with their cristae running antero-posteriorly namely praeparacrista, postparacrista, praemetacrista and postmetacrista respectively. The anterior and posterior central cavities are well developed. The anterior one is broader than the posterior one. The parastyle, mesostyle and metastyles are present labially. The mesostyle is more developed than the other two styles. The median ribs are prominent. The entostyle is transversely extended in upper molars.

Lower dentition: The lower dentition includes third molars (Fig. 3). The crown is high and narrow. The ectostylid lies towards the hypoconid. The hypoconid covers more area than the protoconid. The anterior transverse flange is present. The metastylid and entostylid are highly developed. The median ribs are bulky near the neck of the crown. The prefossette is shorter than postfossette.

Comparison: The cheek teeth differ from a giraffid in having fairly low rugosity (Pilgrim, 1911; Khan *et al*., 2009; Bhatti *et al*., 2012). The studied specimens seem to belong to boselaphine bovids and they are too large to be accommodated in *Miotragocerus* and *Tragoportax* (Gentry, 1990; Khan *et al*., 2009, 2010). The upper molars represent heavy entostyle. However, it is variable in some teeth. The studied specimens show all the basic features of *Pachyportax* that the upper molars are strongly hypsodont, quadrate, having entostyle extended transversely, relatively strong styles and ribs. The morphometric of the specimens are similar to that of *P. latidens* (Figs. 3, 4; Table 1).

***Pachyportax nagrii* Pilgrim, 1939**

[Fig.3 (4-6)]

Locality: Hasnot, Jhelum district, the Punjab province, Pakistan.

Studied Material: PUPC 04/4, lM1; PUPC 04/3, lM2; PUPC 13/287, lM2; PUPC 69/206, rM2; PUPC 13/373, lM3; PUPC 67/187, rM3.

Description: The studied material includes only upper dental elements (Fig. 3). The labial cusps are higher vertically than the lingual ones. The postprotocrista is joining with the praehypocrista. The paracone and metacone with their sloping cristae are well preserved. The antero-posterior cavities are well developed and deep. The anterior cavity is wider than the posterior one. The parastyle is more strongly developed than the metastyle. Nevertheless, the metastyle is heavy in the M3. The transverse width slightly exceeds than the

anteroposterior length in some molars (Table 1). The anteroposterior median ribs are strong.

Comparison: The studied specimens reflect the morphology of the genus *Pachyportax.* However, they are of appropriate size to match that of *P. nagrii* (Figs. 3, 4; Table 1). The material represents autapomorphic characters of *P. nagrii*: small size, strong styles and median ribs, no constricted crown neck that is common in *Selenoportax* and *Tragoportax* and transversely extended entostyle. *Pachyportax latidens* is a large sized *Pachyportax* whereas *P. nagrii* is a small one (Table 1).

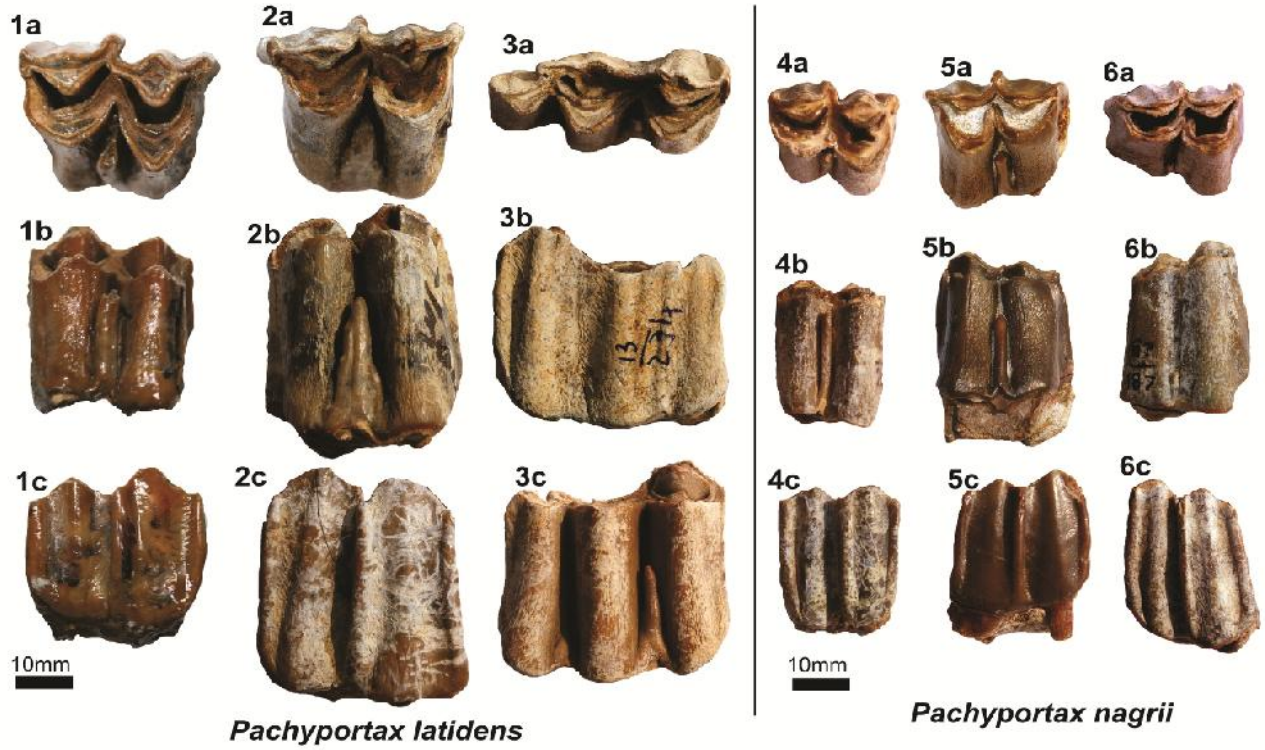

Fig. 3. Representative cheek teeth of *Pachyportax*: 1. PUPC 04/31, lM2. 2. PUPC 13/304 rM3. 3. PUPC 13/234, rm3. 4. PUPC 69/206, rM2. 5. PUPC 13/287, lM2. 6. PUPC 67/187, rM3. a = occlusal view, b = lingual view, c = labial view. Scale bar 10 mm.

Table 1.– Comparative measurements (in mm) of the cheek teeth of the Dhok Pathan Formation *Pachyportax*. *the studied specimens. Referred data are taken from Pilgrim (1937), Akhtar (1992) and Khan *et al*. (2009).

Taxa	Number	Nature/Position	L	W	W/L
Pachyportax latidens	PUPC 04/22*	lM1	24.0	20.0	0.83
	PUPC 04/31*	lM2	26.0	26.0	1.00
	PUPC 07/166*	rM2	28.0	26.0	0.93
		rM3	28.0	21.0	0.75
	PUPC 13/304 *	rM3	32.0	28.4	0.89
	PUPC 13/234*	rm3	40.0	19.0	0.48
	PUPC 13/233*	lm3		18.0	
	PUPC 83/718	rM2	27.4	26.0	0.95
	PUPC 86/36	rM2	30.0	23.0	0.77
	AMNH 19730	rM3	29.5	27.0	0.92
	PUPC 00/87	rM3	25.9	17.6	0.68
	PUPC 04/15	rM3	28.0	21.2	0.76
	PUPC 83/840	rM3	31.9	23.0	0.72
	PMNH 86/215	lM2	26.0	28.0	1.08

	PUPC 83/646	rM2	30.0	18.0	0.60
	PUPC 83/744	rM2	30.2	21.9	0.73
	PUPC 97/103	rM2	24.5	17.7	0.72
	PUPC 86/203	rM2	26.4	17.9	0.68
	AMNH 29964	rM2	28.0	25.0	0.89
	AMNH 19730	rM2	28.5	28.5	1.00
	AMNH 19730	M2	28.5	28.5	1.00
	GSI B808	M3	21.0	17.2	0.82
	PUPC 96/38	M3	34.4	29.0	0.84
	GSI B219	M3	34.5	28.0	0.81
	AMNH 19730	M3	29.5	27.0	0.92
	PUPC 83/840	M3	31.9	23.0	0.72
	PUPC 00/87	M3	28.0	21.2	0.76
	AMNH 19730	M3	29.5	27.0	0.92
	PUPC 99/21	m2	26.0	13.9	0.53
	PUPC 86/24	m2	25.3	13.4	0.53
	GSI B268	m2	29.0	18.0	0.62
	PUPC 04/16	m3	34.0	17.3	0.51
	PUPC 96/41	m3	38.0	16.3	0.43
	PUPC 96/43	m3	25.5	14.0	0.55
	AUH 266	m2	28.1	18.7	0.67
		m3	37.5	16.5	0.44
	AMNH 229964	m3	28.0	25.0	0.89
	AMNH 19730	m3	28.5	28.5	1.00
Pachyportax nagrii	PUPC 04/4*	lM1	22.0	20.0	0.91
	PUPC 04/3*	lM2	23.0	23.0	1.00
	PUPC 13/287*	lM2	24.4	21.8	0.89
	PUPC 69/206*	rM2	18.5	16.0	0.86
	PUPC 13/373*	lM3	23.5	18.8	0.80
	PUPC 67/187*	rM3	22.0	16.7	0.76
	GSI B 808	lM1	13.0	11.0	0.85
		lM2	19.0	14.0	0.74
	PUPC 86/77	lM1	15.0	21.0	1.40
		lM2	21.0	21.4	1.02
	GSI B808	M3	21.0	17.2	0.82

DISCUSSION

Many species of the tribe Boselaphini are recorded from the Siwalik Group. The species are known with variation in size (Gentry,1994; Vrba and Schaller, 2000; Khan *et al*., 2014). The Siwalik Boselaphini ranges from small-medium to large size (Akhtar, 1992; Khan *et al*., 2009). Most of the species are endemic to the Siwalik (Lydekker, 1876, 1884; Gentry, 1999). *Pachyportax* have been continuously present during the Late Miocene-Early Pliocene of the Siwaliks (Fig. 1), representing abundance in Hasnot (Lydekker 1876, 1884; Pilgrim, 1937, 1939; Akhtar, 1992, 1995, 1996; Khan *et al.*, 2009, 2010).

Pachyportax nagrii is recovered here for the first time from the Hasnot outcrops (7-5 Ma) of the Middle Siwaliks (Fig. 1). The Hasnot succession has been dated 7 to 5 Ma (Pilbeam *et al*., 1977; Barry *et al*., 2002; Khan *et al*., 2009). The new findings of *P. nagrii* extend the stratigraphic range of *P. nagrii* from the Nagri Formation (11.2-10.2 Ma) to the Dhok Pathan Formation of the Middle Siwaliks (10.2 to 5.0 Ma). This documents the uncertain occurrence in the Pliocene of the Siwalik Group (Fig. 1), and more best preserved material (e.g. skull, horn-cores) is needed to establish the certain occurrence of the species.

Pachyportax nagrii suggests that the species may have confined in the isolated pockets of the Siwaliks during the Late Miocene, in competition with the large sized boselaphines i.e. *P. latidens, Selenoportax vexillarius, S. lydekkeri*. It is already noted that the shift to a drier and more seasonal climate in the Siwaliks caused the extinction of a number of medium-sized boselaphine species, and induced the establishment of high crowned large boselaphines such as *Selenoportax* and *Pachyportax* (Bibi, 2007; Bibi *et al.*, 2009). *Pachyportax* has been restricted to Pliocene of the subcontinent owing to Himalayan Mountains (Barry *et al*., 1982; Bernor, 1984).

Conclusions: *Pachyportax latidens* and *P. nagrii* were recorded from the Late Miocene-Early Pliocene deposits of Pakistan. *Pachyportax latidens* is larger than that of *P. nagrii*. *Pachyportax* confines to the Late Miocene-Early Pliocene of the Siwaliks. The recovered *P. nagrii* demonstrates that the chronological age of the species is the Late Miocene-Early Pliocene (Nagri to Dhok Pathan formations), contrary to the previous findings that belong to the Nagri Formation (early Late Miocene).

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