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Original Article

Newly discovered fossil remains of *Selenoportax vexillarius* from Hasnot, locality of Siwaliks of Pakistan

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Abstract
Five dental specimens are investigated as the member of Boselaphini (Bovidae) which belong to an extinct genus *Selenoportax*. All the samples are collected from well exposed strata of Late Miocene of Hasnot, district Jehlum, Pakistan. All The specimens are identified and characterized on the basis of morphometric comparison and morphological similarities and described as *Selenoportax vexillarius*. The molars have divergent styles and moderately developed median basal pillars while the crown in all specimens is slightly narrow at the bottom and broader at the apex.
Keyword: Bovidae, Late Miocene, Boselaphini, DhokPathan Formation, mammals.

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INTRODUCTION

The fossil history of Bovid from the Middle Siwaliks of Pakistan is good and exclusive with reference to other fossiliferous areas of world while in the Dhok Pathan Formation which is Late Miocene in age has produced the biggest boselaphine fauna (Pilgrim, 1937, 1939; Akhtar, 1992). True Bovids appeared about 19.5 Ma ago in Pakistan, and this family was clearly existed at 18.5 Main Siwaliks (Barry *et al*., 2005). Boselaphini is one of the major Bovid found in Middle Siwaliks (Gentry, 1970; Khan, 2009a). It has just two living species *i.e.,Tetracerus quadricornis* and *Boselaphus tragocamelus* (Khan, 2008). Dhok Pathan Formation is situated in peripheries of District Chakwal and it is widely exposed in Potwar Plateau. The age of this formation is to early Pliocene from late Miocene (Barry *et. al.,* 2002). It is mainly composed of siltstone, clay stone and sandstone which are present in alternate fashion. Sandstone is dark grey to light grey, greenish brown to reddish brown and moderately cemented. Clay is brown, orange, sometime dull orange, sandy and calcareous. Interactions of minor siltstone having brownish color are common. A very rich vertebrate fauna is present in DhokPathan Formation (Shah, 1977). The village Hasnot (Long. 73°18′ E:Lat. 32° 49′ N) is located in 70 kilometers west of the main city of Jehlum in northern regions of Pakistan around the Potwar Plateau representing an exclusive fauna of Dhok Pathan Formation. Neogene freshwater sedimentary rocks are extensively exposed in the peripheries of the Hasnot village. The thickness of this sequence is about 180m at the altitude of 326m. The characteristic fauna of Hasnot mainly consist of Artiodactyla which include Bovidae, Cervidae, Tragulidae, Giraffidae, Suidae, Perissodactyla, Proboscides and Primates (Cercopethicoids) (Ghaffar *et al*., 2003; Iqbal *et al*., 2009). However, Bovids are the most common ones. Lithostratigraphically, the sediments of Hasnot are characterized by sand, silt and clay having rich collection of fossils (Khan *et al.,* 2008). The fluvial deposits of Hasnot are developed in a wetland environment composed mainly of a landscape of mosaic pattern with waters, marshes, woodlands and forests (Barry *et al*., 2002). The fossiliferous area around Hasnot village includes 27 localities as described by Colbert (1935). Extensive Neogene freshwater sedimentary rocks present around the village and have an average

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thickness of about 180m. The successions of rocks around the village have similar lithology as in the DhokPathan Formation. The sand is light colored containing igneous minerals particularly feldspar, forming a huge fossiliferous horizon comprising the typical Middle Siwalik fauna (Colbert, 1935). It is suggested by Pilbeam*et al.* (1977) that Hasnot age was about 7 Ma, anyhow, presence of thebovids, cervids, giraffids, and the suids suggests a late Miocene to early Pliocene age for Hasnot.

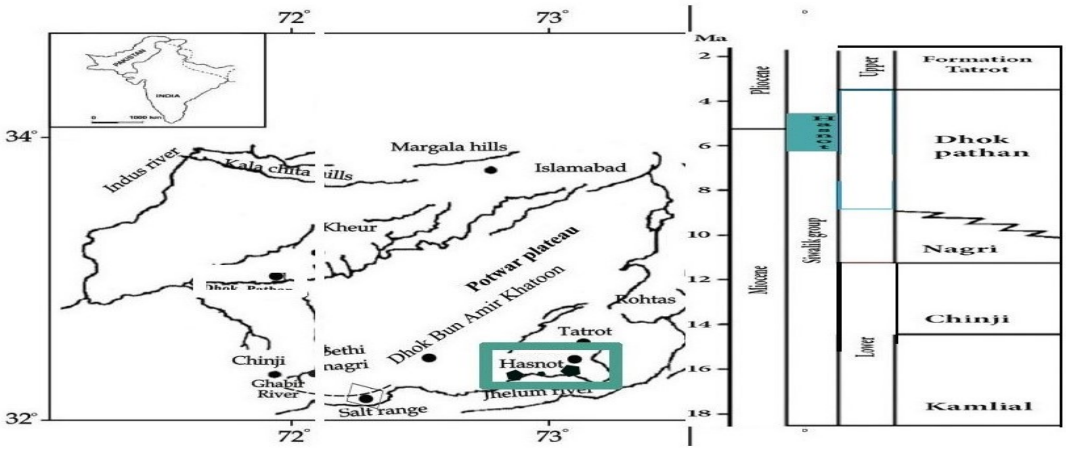

Figure 1: Geographic locations of Localities of Hasnotfrom the Late Miocene of DhokPathan Fm. in northern regions of Pakistan.

Boselaphine can be divided into medium to large sized group viz. *Tragoportax* and *Selenoportax* and gigantic sized group *Pachyportax* (Moya-Solà, 1983; Gentry, 1999). The following investigation deals with *Selenoportax* remains from four localities of Hasnot which contribute to the taxonomic studies of Boselaphine. *Selenoportax* is found from the Middle Siwalik strata as suggested by Khan (2009a).

Originally Pilgrim (1937) discovered and described the *Selenoportax*on the basis of teeth and horn core measurements from the Middle Siwaliks. The fossils of *Selenoportax* are described from Nagri, DhokPathan and Tatrotformations (Khan *et al*., 2007). Pilgrim (1937) classified this genus on the basis of collection of fossils from various localities of India and Pakistan and further added two species, *Selenoportax vexillarius* and *Selenoportax lydekkeri* to this genus. The present investigation deals with the morphological and morphometric comparison of *Selenoportax* from Hasnot localities and contributes to the taxonomic as well as climatic studies of this region of the Siwaliks.

Material and Methods

Material:

PUPC 85/01 left mandibular ramus containing D_4 (L=26, W=13, W/L= 50) and M_1 (L=21.5, W=14, W/L= 65.11); PUPC 15/23 left M_2 (L=26, W=15, W/L= 57.69); PUPC 15/24 left M_3 (L=28, W=16, W/L=57.14); PUPC 15/25 left M_3 (L=30, W=14, W/L=46.4); PUPC 15/26 left M_3 (L=26, W=16, W/L=61.5).

Method

The studies material was collected by using surface collection technique from different outcrops of Hasnot area. The fossils were cleaned properly by using needles and brushes and then cataloged. The species level identification was carried out on the basis of morphological diagnosis and its comparison with reported data of this species.

Abbreviations

PUPC, Punjab University Palaeontological Collection; Ma, million years ago; D, deciduous; L, length;M, molar; W, width, W/L, width to length ratio; mm, millimeters; Fm., formation.

Systematic Palaeontology

Family BOVIDAE Gray 1821
Subfamily BOVINAE Gray 1821
Tribe BOSELAPHINI Knottnerus-Meyer 1907
Genus *SELENOPORTAX* Pilgrim 1937
Type Species: *Selenoportaxvexillarius* Pilgrim 1937
Included Species: *Selenoportax vexillarius* Pilgrim, 1937.

Generic Distribution

This genus, *Selenoportax,* has been described from the Dhok Pathan and Nagri formations from the Middle Siwaliks (Pilgrim 1937). Solounias (1981) indicated a specimen of horn core which is studied by Gaudry (1865) as *Selenoportax*.

Generic Diagnosis

Medium to large sized bovid; with hypsodont dentition, upper molars clearly quadrate with divergent styles, median ribs are fully developed, ectostylid moderately developed while entostyle strongly developed, highly rugose enamel (Pilgrim, 1937).

SELENOPORTAX VEXILLARIUS Pilgrim 1937

Type Locality

Hasnot, district Jehlum, Punjab, Pakistan.

Horizon

Middle Siwaliks

Distribution

The species *Selenoportax vexillarius* is well known from Middle Siwaliks at Dhok Pathan Fm.

Diagnosis

Size is medium to large, skull wide at frontal sides and also at occipital sides, face is down slightly at the cranium sides, frontal sides are medially bent around the regions of horn-cores and form a little uplifted surface in middle of the horn-cores, with hypsodont dentition, rugosity of enamel is high, upper molars quadrate, with strong and contrasting styles while middle ribs highly advanced, basal pillars of median valley are highly developed on apical side and less developed on the lower dentition.

Description

Lower Dentition

PUPC 85/01(Figure 1a,b,c) is a fragment of lower left jaw having D_4 and M_1. It is well preserved. D_4 is well developed in the maxilla. The molar is in early phase of wear and showing a W-shaped structure with the arms of W towards the inner side. The enamel is poorly wrinkled. The wrinkles are more at outside. This dissimilarity I san effect of weathering on the internal side. It is almost uniform in thickness. The D_4 consists of three lobes which are perfectly preserved. It is low crowned than the permanent first molar and correspondingly to the lower molar the lingual wall of each lobe is curved inwardly. The enamel is thin and the protoconid is prominent. The lingual part of the tooth is highly advanced. The tooth is expanded well labially and has minor folds in the anterior and posterior wings of the protoconid. The valley between the anterior and medial labial lobes possesses a fold whereas the posterior valley is open posterolabially.

The crown and roots of M_1 are well preserved within the mandible. It is in advanced stage of wear. Basal pillar of median valley is present and properly developed. It is elongated, slender and high crowned withwell-preserved 4 main cusps. A prominent feature of molar is its rugosity. The wrinkles are more prominent outside. In general appearance, the protoconid is somehow V shaped. Strongly developed median ribs are present. The mesostylid is closer to the median rib. Median basal pillar is slightly worn. It is high, selender and closer to the posterior side of protoconid.

PUPC 15/23, is a second molar of left mandible. It is showing late stage of wearing. The enamel is rugose. The median basal pillar is very strong but partially broken from apex. The well-developed entoconid which is wedge shaped in the middle having two distinct cristae. The rugosity of enamel is prominent and it is mildly thick. On the buccal sides, rugosity is prominent than the lingual side. The entostylid is not so prominent in the areas of transverse valley,between the protoconid and hypoconid while remaining stylids are highly developed. The parastylid is highly developed and prominent. The mesostylid and the entostylid are developed moderately and the posterior median rib is slightly less advanced than the anterior rib. The fossettes are well defined and wide. The central cavities are showing late level of wear. The posterior cavity is wider and broader than the anterior cavity.PUPC 15/24, 15/25 and 15/26 are all third lower molars. PUPC 15/24 is well preserved and in slightlylate phase of wear. The crown is clearly high and slender. The transverse valley is clear in above mentioned third molars. Median basal pillar is clear and moderately developed in the studied third molars. The specimen 15/26 is partially damaged around the margins of entoconid.

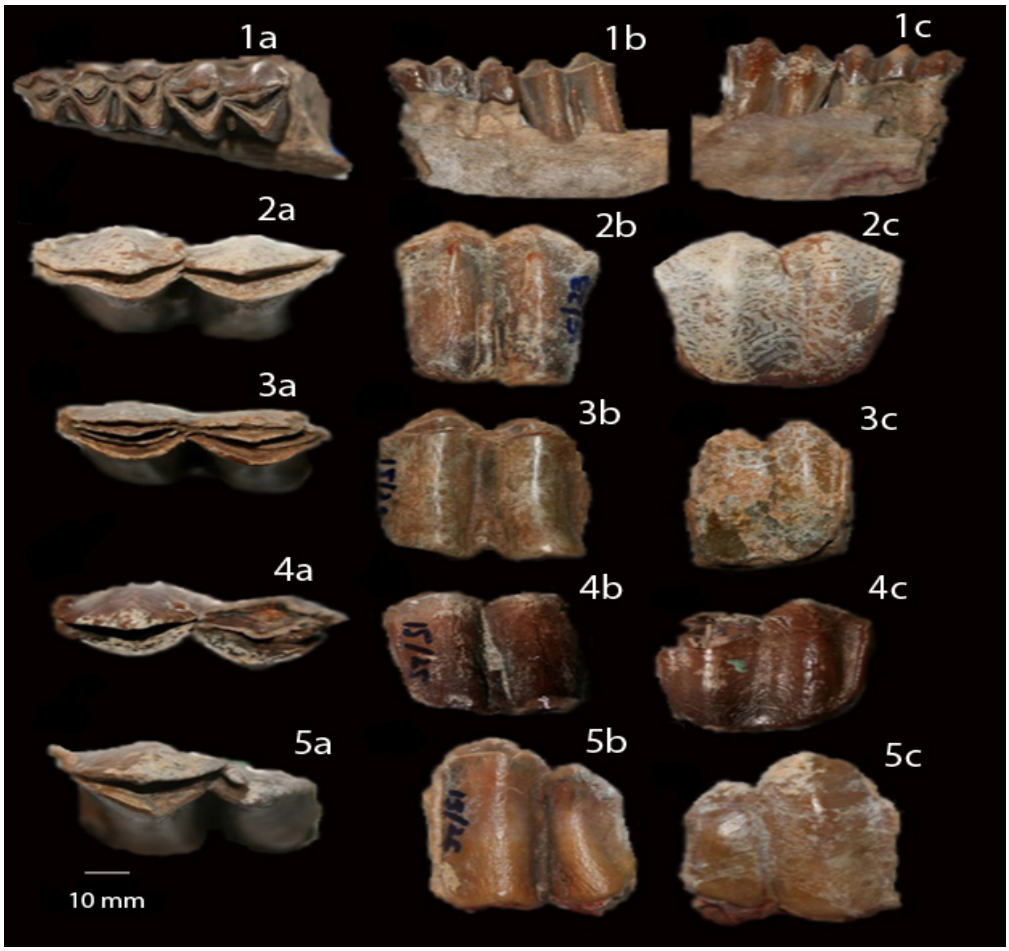

Figure 2: ***Selenoportax vexillarius,*** **1: PUPC 85/01 lower right mandible; 2: PUPC 15/23 M_2; 3: PUPC 15/24 M_3; 4: PUPC 15/25 M_3; 5: PUPC 15/26 M_3. A = occlusal view, B = lingual view C = labial view.**

DISCUSSION

Presently examined samples are well preserved except one third molar of lower dentition, which is broken partially interiorly. Most of the samples are rugouse but all of the presently studied third molars have less rugosity. All of the specimens are in early to middle stage of wear. The samples belonging to genus *Selenoportax* show selenodonty with crescent shaped cusps. The studied specimens are of *Selenoportax vexillarius*. Presently studied D_4 is equal in height and width with respect to Khan's (2009) described specimen. The enamel is thin. Small folds and cristae are present which are more prominent than D_4described by Khan (2009). The M_1in the present sample is high crowned and having a prominent and well developed median basal pillar similar to the specimen described by Khan (2009a). The specimen under study is equal in length and width with reference to Khan's studied sample. It has well preserved root as compared to the specimen studied by Khan (2009). The M_2 studied is equal in length and width with respect to the specimen described by Khan (2007). The studied M_3 is well preserved having prominent and well developed heel. It has a high crown and transverse goat fold is clear as in Khan's specimen. It is equal in length and width in comparison with Khan's studied specimen. The thickness is uniform. The studied specimen has less wrinkles and less rugose with reference to Khan (2007). It is in early phase of wear, that's why the effect of weathering is less prominent. The rugosity of enamel is moderate. The rugosity is very well observed in areas of protoconid as described by Khan (2007). Enamel is damaged internally and dentine can be seen. The enamel shows almost a uniform

thickness. The median basal pillar is closer to protoconid in comparison to Khan's described specimen. Both are almost equal in length and width. The last third lower molar has well developedtalonid which is less prominent in Khan's (2007) described specimen. These placations are more visible on the outer cones than the inner one. The entoconid is clearly higher in middle with an anterior and posterior sloping ridge just as in the molar described by Khan (2007).

Table I: Comparative measurements of Cheek teeth of *Selenoportax vexillarius*.

Specimen No.	Position	Presently Described Fossils measurements (mm)		Khan (2007, 2009a).	
		L	W	L	W
PUPC 15/23	M_2	26	15	26	14
PUPC 15/24	M_3	28	16	25.5	14
PUPC 15/25	M_3	30	14	31	16
PUPC 15/26	M_3	26	16	26	14
PUPC 85/01	D_4	26	13	27	14.8
	M_1	21.5	14	23	14.6

According to their morphology, the studied fossils belong to a large-sized Boselaphine species. The crescentic pattern of crown suggests that the specimens under study belong to genera *Selenoportax* (Khan *et al.,* 2007). Originally, Pilgrim (1937) described large sized genera *Selenoportax* on the basis of teeth and horn-core measurements. The *Selenoportax* is moderate to large sized Boselaphine (Khan *et al.,* 2007). The narrow crown around the root and at the neck, it is broad in *Selenoportax.* The general view of our studied material, the enamel's rugosity, the median ribs which are prominent and the strong entostyles revealed the relationship of presently described specimens with the genus *Selenoportax.* The teeth show all morphological features belonging to the Siwalik *Selenoportax* which is only reported from the Nagri formation of the Siwaliks (Khan, 2007).As the length and width measurements of the studied teeth correspond to the genus *Selenoportax* and the crown of the studied specimens are narrow at the base so it reveals that our specimen belong to the *Selenoportax vexillarius*. The described specimens show basics tructural characters of the species *Selenoportax vexillarius* as stated by Pilgrim (1937) such as quadrate molars with prominent and diverging styles around the apex of crown and median basal pillar strongly developed. The teeth of *Selenoportax vexillarius* are extremely hypsodont and narrow crowned as suggested by Bibi (2007).Siwalik Boselaphini clearly shows increased size, molarization and hypsodonty indicating a move towards a diet having fibers and open habitats as suggested by Janis (1982). The large body size evolution and dental morphologies in *Selenoportax* are consequences of climatic change during late Miocene. More arid and intense conditions may have increased inter specific competition among these Boselaphini species allowing for greater niche differentiation as observed by Bibi (2007).

CONCLUSION

In the present study one genus is identified on the basis of morphometeric comparison of the newly collected fossils with the previous records of these genera from the Middle Siwaliks of Pakistan. The specimens are identified as *Selanoportaxvexillarius.*The presence of the species in Hasnot area suggests a forest cover and woodland landscape during the Late Miocene Siwaliks that supported the Boselaphine. The faunal elements ofHasnot suggest extensive vegetation that supported the Bovid evolution during Late Miocene as suggested by Khan (2007). However according to the Barry *et al.* (2002), a more humid and better vegetation cover supported the large sized bovid, *Selenoportax,* during the Late Miocene Siwaliks of Hasnot. Fossil evidence suggests that Boselaphine moved from Middle Miocene to Late Miocene and they become adapted to drier and less vegetated environment (Khan *et al.,* 2007).The

evolution of large body size in Boselaphine was a result of environmental changes, as the harsh season was intensified in southern Asia during the age of late Miocene. More seasonally arid conditions would have maximizedinter-specific competition between all herbivores and directed the evolution of morphologies (Bibi, 2007).

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