



Siamotragulus (Tragulidae: Artiodactyla: Mammalia) from the Siwalik Group of Indian Subcontinent (Pakistan)

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ABSTRACT

The present study deals with the description of a right mandibular fragment having p2-m3 referred to the genus *Siamotragulus*. This specimen was recovered from the Chinji Formation outcrops (Middle Miocene) of Dhok Bun Ameer Khatoon, District Chakwal, Punjab, Pakistan. The dentition of this mandibular ramus under study is characterized by selenodonty, premolars with very sharp edges, molars with preproto- and premetacristids are longer than the postproto- and postmetacristids, lingual cusps are flat without any prominent bend or rib and lack *Dorcatherium* platform. These characters differentiate it from the genus *Dorcatherium* and help to associate the mandibular fragment with the genus *Siamotragulus*. Based on its size, being larger than *S. nagrii* and *S. minimus*, it is referred to as *Siamotragulus* nov. sp.

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Siamotragulus, Middle miocene, Dhok Bun Ameer Khatoon, Siwaliks, *Dorcatherium*, Chinji Formation

INTRODUCTION

The Siwalik Group of Indian subcontinent represents the fluvial sedimentation phase in the Himalayan Foreland Basin, which developed south of the rising Himalayan in response to the collision between the Indian and Eurasian tectonic plates which started 50 million years ago and even continues today (Nanda *et al.*, 2022). Siwaliks are very famous for vertebrate fossils pertaining to almost all the major mammalian groups such as Rodentia, Artiodactyla, Perissodactyla, Proboscidea and Carnivora etc. (Colbert, 1935). Of these, the fossil artiodactyls are very well known in different formations of the Siwaliks. Artiodactyls are represented by a variety of suids, hippos, camels, cervids, giraffids, bovids and tragulids. There are four extinct genera

of the family Tragulidae in the Siwaliks; *Dorcatherium*, *Afrotragulus*, *Dorcabune*, and *Siamotragulus*. Among these, *Dorcatherium*, *Dorcabune*, *Afrotragulus* are known mostly by maxillary and mandibular fragments and isolated upper and lower teeth while the genus *Siamotragulus* is known only by postcranials except that have previously been described as *Dorcatherium*.

We describe here the Middle Miocene *Siamotragulus* from the Chinji Formation outcrops exposed west of village Dhok Bun Ameer Khatoon (DBAK), Chakwal district, Punjab, Pakistan. The specimen under study is a right mandible which provides the basis to discuss the taxonomic problems of the Siwalik tragulid allocated to the genus *Dorcatherium*. The geographic and geological settings of Dhok Bun Ameer Khatoon are given below.

The fossil site, Dhok Bun Ameer Khatoon (Lat. 32° 47' 34.6" N: Long. 72° 55' 36.1" E and altitude 1942.43 ft) is in the northeastern region of the Chua Saydan Shah town, district Chakwal, Punjab, Pakistan (Fig. 1) and about 50 km northeast of the Chinji stratotype, Chinji Formation. The studied deposits are located northwest of the Dhok Bun Ameer Khatoon village. Locally, the outcrops area in the west from where the specimen is

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collected is known as Jallowala. The exposed sediments cover a few hundred square meters, approximately 40 m thickness, bearing mammalian remains. The outcrops consist of shales, siltstones and sandstones deposited in a fluvial environment, mainly filled by unweathered igneous minerals (Cheema, 2003). Based on the faunal elements, the age is dated between 14 and 11.6 Ma.

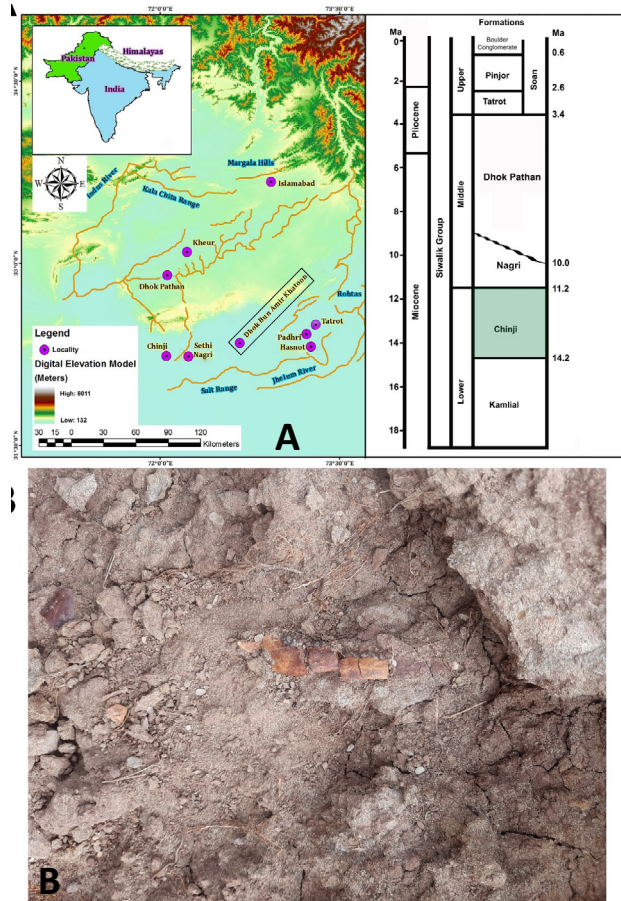


Fig. 1. A: The geographic position of Dhok Bun Ameer Khatoon from where the described mandible was collected. B: PUPC 25/34 in the field.

MATERIALS AND METHODS

The material includes a mandibular fragment with p2-m3 during the 2024 field visits. The specimen was found partially buried in the sediments (Fig. 1B) and recovered with the help of geological hammer and chisel in five pieces that were later glued with Elfy after preparation of the specimen. Fine needles and brushes were used to remove the sediments and clay. A hand lens was used for keen observations of very small and ambiguous morphological features of the teeth of the

mandible under study. Photographs were taken with the help of DSLR camera (Canon 6D). The measurements of the specimen were taken millimeters (mm) with the help of digital Vernier caliper. The specimens collected show the collection year and the serial number of that year e.g., PUPC 25/34. The upper figure denotes the collection year and the lower one the serial number of the respective year.

Abbreviations: PUPC, Punjab University Palaeontological Collection; PG, Pong.

SYSTEMATIC PALAEOLOGY

Mammalia Linnaeus, 1758

Artiodactyla Owen, 1848

Ruminantia Scopoli, 1777

Tragulina Flower, 1883

Tragulioidea Gill, 1872

Tragulidae Milne Edwards, 1864

Genus *Siamotragulus* (Thomas *et al.*, 1990)

Type species: *Siamotragulus sanyathanai* (Thomas *et al.*, 1990)

Holotype

PG1, left mandible with p2 (partly broken) to m3 (Thomas *et al.*, 1990).

Type locality and age

Pong, Phayao Province, Thailand and Middle Miocene in age (Thomas *et al.*, 1990).

Diagnosis

Small Tragulidae with a size intermediate between that of *Dorcatherium minus* Lydekker and *Dorcatherium minimus* west. The lower premolars, in particularly the p3, are very pointed and sharp, differing thereby from those of *Dorcatherium* and *Dorcabune*. The p4 possess an elongate posteriorly directed metaconid but no other lingual feature which may correspond to the entoconid or entostylid. The p3, long, treanchant and strongly compressed, has a tall protoconid, a minute paraconid and a distinct hypoconid. No posterolingual ridge (metaconid) is present on p3. Upper canines of males (?) saberlike. The limb bones are relatively long and slender (Thomas *et al.*, 1990).

Siamotragulus nov. sp.

(Fig. 2)

Referred specimen

PUPC 25/34, a right mandible bearing p3-m3, partially broken p2 and root of p1 (Fig. 2).

Locality and age

Dhok Bun Ameer Khatoon, Chakwal district, the

Punjab province, Pakistan.

Description

PUPC 25/34 is a mandible having p3-m3, partially broken p2, and root of p1 (Fig. 2).



Fig. 2. *Siamotragulus* nov. sp. PUPC 25/34 is a mandible having p3-m3, partially broken p2, and root of p1. (a) Occlusal view, (b) lingual view (c) labial view.

Corpus

The corpus though cracked at various places and thin, but it is extremely stout. The corpus is concave lingually and convex labially (Fig. 2A). It also preserves a small part of symphysis, diastema, angular process, and ascending ramus. A large myloheid line is present at the base of the corpus stating under the p2 on the lingual side (Fig. 2B). There are two mental foramina: the anterior and larger under the diastema and a posterior and smaller under the p3 (Fig. 2C). The diastema is very small and has a length between mandibular symphysis and p2 is 6.5 mm. The depth of the corpus increases under the teeth from p1 to m3 and the vertical depth of the mandible below the m1 is about 13 mm and transverse width is about 6 mm. The antero-posterior length of mandible is 80 mm and of p2-m3 series is 62.36 mm. Length of premolar series 29.01 mm length of molar series 33.35 mm.

Premolars

The dentition is also well preserved except for the p1 and p2. Only the root of p1 is preserved. The p2 is in early stages of wear and partially broken anteriorly resulting in loss of paraconid and some part of the protoconid which is large and connected to the hypoconid and metaconid through its posteristid. A prominent valley is present between the metaconid and hypoconid. The p3 is also in early stage of wear and well preserved. It has a large paraconid which is connected to the large and bulbous protoconid through its posteristid. A shallow valley is

present between the paraconid and protoconid lingually and small groove labially. The metaconid is large, more lingually and posteriorly oriented and is in contact with large and round hypoconid. A large groove is present between the protoconid and hypoconid and a large, lingually open valley is present between the metaconid and hypoconid. The p4 is most worn among premolars and is in the early middle stage of wear. It is slightly smaller than p3 (Table I) and is most developed. Most of its morphology is similar to p3 except the posterior half in which the posthypocristid is large the posterior valley is extremely narrow.

Molars

Except the extreme wear, the molars are also well preserved. The m1 is the most worn and smallest among the molars. The metaconid is partially broken resulting in loss of the enamel in the center. It is in the late stage of wear resulting in loss of both anterior and posterior fossette. However, the distinction between the cusps is still possible. A large ectostylid is present in the median valley. The *Tragulus* fold has been lost due to wear, but the *Dorcatherium* fold is still recognizable. The m² is less worn and it is also in late stage of wear. The anterior posterior side of the anterior fossette is preserved rest is lost due to wear. It is a selenodont and brachyodont tooth. The preprotocristid is longer than the postprotocristid and premetacristid which is longer than the postmetacristid. Similarly, the prehypocristid is longer than the posthypocristid and preentocristid while postentocristid is extremely reduced. The *Dorcatherium* fold present on the postmetacristid is large and prominent while a small part of the *Tragulus* fold is preserved. The median valley is blocked by a moderate sized ectostylid. The posterior cingulid is present at the posthypocristid that runs posterotransversely. The m³ is least worn, most preserved in terms of its morphology and trilobed. It is extremely selenodont. The cusp morphology is similar to the m². Both fossettes are well preserved and these are narrow and crescentic especially the posterior fossette. The M/Σ structure is complete and pronounced as both the *Dorcatherium* fold on the postmetacristid and *Tragulus* fold on the postprotocristid are intact and complete. The median valley has a weak ectostylid and a small cingulid is present at the base of postprotocristid. The postentoconid groove is open. The third lobe is composed of hypoconulid and very small entoconulid. The hypoconulid has prominent pre- and posteristids while a small entoconulid completely closes the prominent back fossette of m3 lingually. The posthypocristid is bifurcated and makes a small fold which is in contact with the hypoconulid. *Dorcatherium* platform is completely absent. The lingual walls of the metaconid and entoconid are flat. The enamel is extremely rugose.

Table I. Comparative measurements of the lower cheek teeth of middle miocene tragulids.

Taxa/Catalog No.	Position	Length	Width	References
<i>Siamotragulus</i> nov. sp.				
PUPC 25/34	p1	-	-	This study
	p2	8.71 est.	2.95	
	p3	9.46	3.51	
	p4	8.84	3.80	
	m1	8.87	6.57	
	m2	9.81	7.11	
	m3	14.67	7.14	
<i>Siamotragulus nagrii</i>				
VPL/AS/H/101	p2	5.2	2.3	Gaur, 1992
	p3	7.0	2.6	
VPL/AS/H/102	p4	8.2	3.3	
	m1	5.8	3.4	
	m2	7.1	4.2	
	m3	11.0	4.3	
<i>Siamotragulus sanyathanai</i>				
PG1	p3	9	3	Thomas <i>et al.</i> 1990
	p4	8	3	
	m1	6.7	4	
	m2	8	5	
	m3	11.7	5.1	
<i>Dorcatherium minus</i>				
SNSB-BSPG 1956 II 2489	p3	12.0	3.5	Guzmán-Sandoval and Rössner, 2021
	p4	10.0	4.4	
	m1	10.5	6.2	
	m2	11.4	6.6	
PUPC 68/313	m1	8.95	5.60	Khan and Akhtar, 2013
	m2	10.25	6.70	
	m3	15.65	7.40	
GSI-B 594	p4	10.0	4.8	Pilgrim, 1915
	m1	10.8	6.8	
	m2	12.5	7.5	
	m3	16.7	8.3	
<i>Dorcatherium guntianum</i>				
SNSB-BSPG1956 II 2554	m1	7.7	4.3	Guzmán-Sandoval and Rössner, 2021
	m2	9.1	5.0	
	m3	14.5	6.6	
SNSB-BSPG 1881 IX 737	m1	8.6	5.5	
	m2	10.0	6.1	
	m3	14.7	6.4	

Comparison

The studied specimen proves strongly its inclusion in the family Tragulidae, based on the selenodont pattern,

rugosity of enamel and the presence of M/Σ structure. The family Tragulidae in the Siwalik hills are represented by two extinct genera *Dorcatherium* and *Dorcabune*, with many species. The *Dorcabune* is a large extinct tragulid of the Siwaliks and very close to anthracotheriids having bunodont molars. The paraconus rib is more conspicuous in *Dorcabune* than in *Dorcatherium* (Colbert, 1935; Farooq *et al.*; 2007; Farooq *et al.*, 2008; Khan and Akhtar, 2013). The specimen studied differs from *Dorcabune* having more selenodont cusp pattern.

Dentition in PUPC 25/34 is characterized by selenodontology, premolars with very sharp edges, molars with preproto- and premetacristids are longer than the postproto- and postmetacristids, lingual cusps are flat without any prominent bend or rib and lack *Dorcatherium* platform. These characters differentiate it from the genus *Dorcatherium* and help to associate the mandibular fragment with the genus *Siamotragulus*. Table I and Figure 3 show that the dentition in PUPC 25/34 is larger than *Siamotragulus sanyathanai* and the range in the size previously described as *Dorcatherium guntianum* from the Siwaliks. Hence, it became evident that measurements of PUPC 25/34 match with most of the classically described material of Siwalik species *Dorcatherium minus* while the tooth morphology is like that of *Siamotragulus* and size is like that of *guntianum*. Such morphometric analysis is

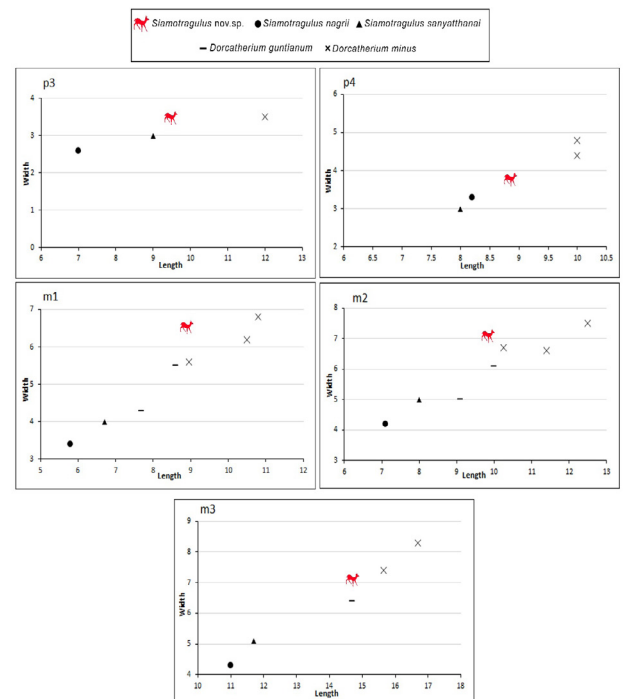


Fig. 3. Graphical representation of size comparison with the help of bivariate chart based on Table I.

convincing enough that PUPC 25/34 can be associated with the genus *Siamotragulus* as well as most of the material previously described as *Dorcatherium guntianum*. Hence, based on its morphology and size, it is referred to as *Siamotragulus* nov. sp. awaiting more material and in-depth study of all the Siwalik tragulid material.

DISCUSSION

The genus *Dorcatherium* was created by Kaup (1833) based on the material from the Germany. Since the wide geographic acceptance of the genus, most of the tragulid material from Miocene to Pliocene deposits was allocated to this genus without any detailed study (Rössner, 2007; Sánchez *et al.*, 2010, 2015). This led the status of the genus to a potpourri or waste bucket for most of the tragulid material and such a status of this genus was partly compromised by Thomas *et al.* (1990) by the creation of a new genus, *Siamotragulus*, for the tragulid material from Thailand. However, despite this study, the genus *Dorcatherium* remained a primary choice of researchers for the description of their tragulid material until the work of Sánchez *et al.* (2010) who identified the genus *Siamotragulus* from Africa after the indication of (Rössner, 2007). Further work was carried out by Barry (2014) who reported the presence of the genus *Siamotragulus* from the Siwalik Group based on the postcranial material. The next work was done by Sánchez *et al.* (2015) who identified yet another tragulid genus, *Afrotragulus*, from the material that was previously described as member of the genus *Dorcatherium*. This further shows the waste bucket nature of the genus *Dorcatherium*. Finally, such nature is also shown in Barry (2025) who described *Dorcatherium nagrii* as *Siamotragulus nagrii* and *Dorcatherium minimus* as *Siamotragulus minimus* and identified two more species of this genus. Such a nature also applies to the Siwalik tragulids and the description of PUPC 25/34 is an example to demonstrate it.

PUPC 25/34 is morphologically shows the characteristics of the genus *Siamotragulus* similar to the specimen AMNH 19365, right mandibular fragment with m²-m³. Even in the AMNH 19365, the preprotocristid is longer than the postprotocristid and premetacristid which is longer than the postmetacristid. Even the lingual walls of the metaconid and entoconid are flat and it is also selenodont like PUPC 25/34. However, the illustration of AMNH 19365 shows the *Dorcatherium* platform but this could be due to the illustration bias. Similarly, most of the material described as *Dorcatherium minus* by Khan and Akhtar (2013), Khan *et al.* (2005, 2010, 2012a, b, 2013, 2017), Batool *et al.* (2014), Samiullah *et al.* (2015, 2021), and Draz *et al.* (2020, 2021) shows similar features as

in PUPC 25/34 including the measurements. Hence, all such material can be allocated to the genus *Siamotragulus* without any hesitation.

CONCLUSIONS

We are describing a tragulid mandible collected from the Chinji Formation deposits of Dhok Bun Ameer Khatoon, Chakwal, Punjab, Pakistan. The teeth in the mandible show the characteristics of the genus *Siamotragulus* (selenodonty, premolars with very sharp edges, molars with preproto- and premetacristids are longer than the postproto- and postmetacristids, labial cusps are flat without any prominent bend or rib and lack *Dorcatherium* platform) while the measurements are in the range of previously described material as *Dorcatherium guntianum*. Further, most of the material previously described as *Dorcatherium* clearly shows the characteristics of the genus *Siamotragulus*. Hence, we are describing this mandible as *Siamotragulus* nov. sp. until more material is recovered and/or comprehensive study of all the Siwalik tragulid material is done.

DECLARATIONS

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Generative AI or AI-assisted technology statement

No AI technology is used in this manuscript.

Statement of conflict of interest

The authors have declared no conflict of interest.

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