

## New Remains of *Tragoportax* (Boselaphini: Bovidae: Mammalia) from Middle Siwaliks of Dhok Pathan, Northern Pakistan

Muhammad Akbar Khan,<sup>1\*</sup> Javed Iqbal,<sup>2</sup> Sadaqat Ali<sup>2</sup> and Muhammad Akhtar<sup>1</sup>

<sup>1</sup>Palaeontology laboratory, Zoology Department, Quid-e-Azam Campus, University of the Punjab, Lahore

<sup>2</sup>Department of Wildlife & Fisheries, GC University, Faisalabad

**Abstract.**— *Tragoportax* is one of the best represented bovids in the Dhok Pathan type locality, northern Pakistan. The new tragoportacin remains comprise predominantly isolated teeth, maxilla and mandible fragments. There are eight specimens that can be referred to three tragoportacin taxa, namely *Tragoportax* cf. *punjabicus*, *Tragoportax* cf. *browni* and *Tragoportax* sp. The new material provides taxonomy updating of the Dhok Pathan type locality.

**Key words:** Ruminantia, vertebrate fossils, Late Miocene, Siwaliks, Tragoportacin.

### INTRODUCTION

The fossil record of the bovids from the Siwaliks is generally very good in comparison with that of other parts of the world and the Late Miocene locality of the Dhok Pathan has yielded one of the richest fossil bovid faunas from south Asia (Lydekker, 1878; Matthew, 1929; Colbert, 1935; Pilgrim, 1926, 1937, 1939; Thomas, 1979, 1984; Akhtar, 1992; Haile-Selassie *et al.*, 2004; Bibi, 2007; Khan and Farooq, 2006; Khan, 2007, 2008; Khan *et al.*, 2009a, b, 2010a, b, 2011a, b; Khan and Akhtar, 2011). Boselaphins are one of the dominant bovids found in the Late Miocene sites of Africa, Eurasia and especially of the Siwaliks (Gentry, 1970, 1971, 1994; Vrba and Schaller, 2000; Khan *et al.*, 2009a, 2010a). Now days, it is small group which consist of two living species Nilegauy (*Boselaphus tragocamelus*) and Tetracere (*Tetracerus quadricornis*).

*Tragoportax*, *Miotragocerus*, and other taxa such as *Protragocerus*, have been integrated in the old name *Tragocerina*/*Tragocerini* (Thomas, 1984) or recent name *Tragoportacini* (Bibi *et al.*, 2009). *Tragoportacins* are the dominant Late Miocene boselaphin members (Pilgrim, 1937; 1939; Moya Solà, 1983; Thomas, 1984; Bibi, 2007; Bibi *et al.*, 2009). It has wide distribution from beginning in the

Miocene of Indian Peninsula. This tribe comprises of two morphs, the first from the Middle Miocene of Europe and Asia and considered to be allied to modern boselaphins (Thomas, 1984).

The Miocene boselaphins can be divided into groups: medium sized boselaphin genera, *Miotragocerus* and *Tragoportax* and large-sized boselaphin genera, *Selenoportax* and *Pachyportax* (Moya Solà, 1983; Gentry, 1999; Khan *et al.*, 2009a). *Miotragocerus* and *Tragoportax* are represented by many species in the Siwaliks (Thomas, 1984; Akhtar, 1992; Khan *et al.*, 2010a). *Miotragocerus* and *Tragoportax* appeared in the Siwaliks during the latest Middle Miocene and diversified during the Late Miocene, before going extinct at the end of Pliocene. From Middle Miocene they are infrequently known and they are richly found from the Late Miocene of the Siwaliks.

Unidentifiable bones and tooth fragments often found in these conglomerate beds. Sandstone beds are gradually thicker and multistoried upsection. Shales of various colors ranging bright orange, brown, greenish and chocolate color present throughout the Formation range. The measured thickness is about 500-825 m and has a conformable contact with the underlying Nagri formation and overlying by the Soan Formation (Sheikh *et al.*, 2008). The Dhok Pathan Formation is an abundantly fossiliferous horizon containing the typical Middle Siwalik fauna an age range of 10.2-3.4 Ma (Barry *et al.*, 2002). The systematics of tragoportacin new remains from the Dhok Pathan type locality is the focus of the article.

\* Corresponding author: akbaar111@yahoo.ca  
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## MATERIALS AND METHODS

The outcrops of the Dhok Pathan type locality of (Dhok Pathan Formation, Middle Siwaliks) the Chakwal district, Punjab, Pakistan, were thoroughly investigated. Surface collection was the primary method to collect the fossils however the embedded material was excavated with the help of the geological hammers and chisels. During excavation, careful measures were taken to prevent fossils fragments from disintegration. Each specimen was wrapped with a cotton piece to prevent it from the transportation shocks. The collected specimens were transported to the laboratory for the taxonomic and morphological studies. The recovered dental material includes the upper and lower dentitions and preserves enough to elaborate the taxonomic characteristics. The morphological and metrical characters of the specimens are described and their systematic determination is discussed.

The specimens were carefully washed and cleaned in the Paleontology laboratory of the Zoology Department, GC University Faisalabad for the clear observation. Fine needles and brushes were used to remove sediments or clay particles. The broken parts were assembled by using elfy (gum). A hand lens was used for keen observation of small and ambiguous morphological characteristics. The measurements of the specimens were expressed in millimeters and taken with the help of a caliper.

The catalogue number of the specimens consists of series *i.e.*, yearly catalogue number and serial catalogue number, so figures on the specimen represent the collection year (numerator) and serial number (denominator) of that year (*e.g.*, PC-GCUF 10/24, PC-GCUF-institutional abbreviation for the Palaeontological Collection of Government College University Faisalabad, Punjab, Pakistan. Uppercase letters stand for upper dentition (*e.g.*, M) and lower case for lower dentition (*e.g.*, m). The terminology of the tooth crown elements and manners of measurements follow Pilgrim (1937), Gentry (1994) and Bibi *et al.* (2009).

## SYSTEMATIC PALAEOLOGY

Suborder Ruminantia Scopoli, 1777  
Family Bovidae Gray, 1821

Tribe Boselaphini Knottnerus-Meyer, 1907  
Genus *TRAGOPORTAX* Pilgrim, 1937

*Tragoportax cf. punjabicus* Pilgrim, 1910

### *New material*

PC-GCUF 10/31 – an isolated lower third premolar (p3), PC-GCUF 10/24 – a right mandible fragment with m2-3.

### *Description*

PC-GCUF 10/31 is a partial third lower premolar and in early wear (Fig. 1A). The metaconid is backwardly directed and prominent. The p3 is long, with separated parastylid as well as paraconid and entoconid. It has posteriorly slanted metaconid, and open lingual valleys.

The specimen PC-GCUF 10/24 having length of 75 mm is damaged antero-posteriorly and bears second and third molars (Fig. 1B). The molars are well preserved and in early middle wear. The enamel is moderately thick and rugose. The m2's metaconid is slightly damaged, while the protoconid, the hypoconid and the entoconid are complete. The protoconid is crescentic in shape. The praeprotocristid is larger than the postprotocristid. There is a crack between the metaconid and the entoconid. The metaconid rib is more prominent than the entoconid one. The ectostylid is present in the transverse valley between the protoconid and the hypoconid. The V-shaped hypoconid is pointed in the middle and it is narrower than the protoconid transversely. The fossettes with crescentic outlines have slight indentations. The pre-fossette is more crescentic than the post-fossette. The anterior transverse flange is present.

The 3<sup>rd</sup> molar of the mandible is also well preserved like the 2<sup>nd</sup> one. The major conids and the hypoconulid are well developed. The protoconid is high in the middle with anteriorly and posteriorly sloping cristids. The tip of the protoconid is slightly damaged. The metaconid is somewhat crescentic in shape; the praemetacristid is greater in length than the postmetacristid. The hypoconid is as high as the protoconid. The praehypocristid and the posthypocristid are almost in equal size. The entoconid is more crescentic in shape than the metaconid. The praentocristid is longer than the

postentocristid. The fossettes are crescentic in shape with no indentation. The pre-fossette is slightly longer than the post-one. The hypoconulid is very well developed, long and narrow, with a wide and inflated area.

#### Comparison

The crescentic conids of selenodont nature indicates that it can safely be included in the order Artiodactyla. The compressed outer conids favour its inclusion in the family Bovidae. Further more, the divergent stylids of the teeth make their inclusion in boselaphins. Many genera of the boselaphins are recorded from Dhok Pathan (Pilgrim, 1937, 1939; Thomas, 1984; Khan *et al.*, 2009a) having variation in body size *e.g.*, *Selenoportax* and *Pachyportax* are large size boselaphins found in the Dhok Pathan Formation (Khan *et al.* 2009a) and *Helicoportax*, *Elachistocerus* and *Eotragus* are comparatively small size boselaphins (Pilgrim, 1937, 1939; Akhtar, 1992; Khan *et al.*, 2009a). The medium size boselaphins recorded from the Siwaliks are *Tragoportax* and *Miotragocerus*.

The studied p3 indicates T-shaped metaconid which is the feature of the genus *Tragoportax*. The described character somewhat corresponds to the medium-sized boselaphin *Tragoportax* from the Siwaliks to which this specimen could be attributed. Morphometrically, the studied teeth resemble to *T. punjabicus* (Table I) and consequently assign to *T. cf. punjabicus*, because of the imperfect material (Pilgrim, 1937, 1939; Khan *et al.*, 2010a).

*Tragoportax cf. browni* Pilgrim, 1937

#### New material

PC-GCUF 10/30 – a left maxillary fragment with P3, PC-GCUF 10/27 – a left mandible fragment with m3, PC-GCUF 10/29 – an isolated left m3.

#### Description

PC-GCUF 10/30 is a maxillary fragment of 23 mm length with left third premolar (Fig. 1C). The premolar is in an excellent state of preservation with triangular shape and in middle wear. The

anterior rib is close to the parastyle confirming the 3<sup>rd</sup> premolar in the teeth series. The protocone and the metacone are well developed. The hypocone is poorly expanded lingually. The fossette is shallow and wide with no indentations. A weak furrow is present lingually, separating the hypocone from the protocone. The protruding paracone rib and the parastyle develop a narrow furrow anteriorly.

PC-GCUF 10/27 is a left last lower molar with a mandible fragment of 39 mm length, which is broken antero-posteriorly (Fig. 1D). PC-GCUF 10/29 is an isolated lower third molar (Fig. 1E). The molar crowns are comparatively high and it can be considered hypsodont. The ectostylid is weakly present. The protoconid is high with sloping praeprotocristids. The hypoconid is pointed with the prae-posthypoconid. The entoconid is crescent but lower than the metaconid. The metastylid is moderately developed. The fossettes are moderately narrow having no indentations. The hypoconulid is well preserved and wide with inflated central area forming an ovate shape.

#### Comparison

The teeth are small size, having divergent styles/stylids and selenodont. The teeth may be distinguished at a glance from teeth of *Pachyportax* and *Selenoportax* by their smaller size and the weaker ectostylid (Pilgrim, 1937, 1939; Khan *et al.*, 2009a, 2010a). The studied P3 indicates inflated hypocone which is the feature of the genus *Tragoportax*. The third molars display feature of *Tragoportax* (Spassov and Geraads, 2004). The morphometric somewhat corresponds to numerous medium-sized boselaphin *Tragoportax* from the Siwaliks to which this specimen could be attributed. Morphometrically, the teeth match with *T. browni* (Fig. 1C-E, Table I) and can be assigned to *T. cf. browni*.

*Tragoportax* sp.

#### New material

PC-GCUF 10/28 – a left broken dp4, PC-GCUF 10/25 – a right mandible fragment with p3, broken dp4 and semi erupted anterior lobe of m1, PC-GCUF 10/32 – an isolated left p4.



Fig. 1. *Tragoptortax* cf. *punjabricus*: A. PC-GCUF 10/31 – lp3. B. PC-GCUF 10/24 – a right mandible fragment with m2-3. *Tragoptortax* cf. *browni*: C. PC-GCUF 10/30 – lp3. D. PC-GCUF 10/27 – a left mandible fragment with m3. E. PC-GCUF 10/29 – lm3. *Tragoptortax* sp.: F. PC-GCUF 10/28 – a left broken dp4. G. PC-GCUF 10/25 – a right mandible fragment with p3, broken dp4 and semi erupted anterior lobe of m1. H. PC-GCUF 10/32 – an isolated lp4. a = occlusal view, b = lingual view, c = labial view. Scale bar 10 mm.

**Table I.- Comparative measurements (in mm) of the cheek teeth of the Dhok Pathan type locality boselaphins.**

Taxa	Number	Nature/ Position	Length	Width
<i>T. cf. punjubicus</i>	PC-GCUF 10/31*	lp3	13.5	7.0
	PC-GCUF 10/24*	rm2	18.5	11.5
		rm3	23.0	11.0
	PUPC 83/204	lp3	13.0	7.40
	PUPC 97/12	lp3	14.0	7.00
<i>T. punjubicus</i>	GSI B563	m2	21.0	13.0
		m3	30.0	13.5
		p3	16.0	8.50
	GSI B564	m2	20.5	14.0
		m3	26.0	13.5
		lp3	14.4	8.00
	PUPC 87/324	lm2	18.5	11.0
	PUPC 86/25	lm2	18.0	10.5
	PUPC 83/617	lm2	18.0	10.5
	PUPC 99/28	rm2	19.0	11.0
	PUPC 83/701	lm2	17.0	12.0
	PUPC 83/680	lm3	25.0	11.0
	PUPC 83/767	lm3	22.0	10.0
PUPC 83/277	lm3	24.0	11.0	
<i>T. cf. browni</i>	PC-GCUF 10/30*	IP3	15.0	10.0
	PC-GCUF 10/27*	lm3	26.0	12.0
	PC-GCUF 10/29*	lm3	25.0	12.0
<i>T. browni</i>	PUPC 87/281	IP3	13.0	11.0
	PUPC 83/265	lm2	17.0	10.4
		lm3	22.0	11.0
		lm3	26.0	11.0
	PUPC 97/11	lp3	15.0	8.00
	AMNH 29884	lp4	15.5	9.00
		lm2	19.0	12.0
lm3	25.5	12.0		
<i>Tragoportax</i> sp.	PC-GCUF 10/25*	rp3	14.5	6.00
	PC-GCUF 10/32*	lp4	13.0	7.00
<i>M. gluten</i>	AMNH 19993	m1	14.5	9.00
		m2	16.5	11.0
<i>M. larger</i> sp.	PUPC 83/708	rp3	15.2	6.30
	PUPC 83/709	lp3	14.0	8.00
	PUPC 83/742	rp4	17.0	8.40
	PUPC 87/294	lp4	16.0	8.70
	PUPC 93/277	lp4	15.0	8.00
		lm1	14.0	10.3
		lp4	14.7	9.00
	PUPC 09/86	lm1	16.0	11.5
		lm2	17.0	11.0
		lm3	25.4	11.4
		lp4	17.0	8.00
	PUPC 96/05	lm1	16.0	10.0
		rm2	18.4	11.0

\*the studied specimens. Referred data are taken from Pilgrim (1937), Akhtar (1992) and Khan *et al.* (2010a).

### Description

PC-GCUF 10/28 is a broken deciduous molar in which the first lobe is missing (Fig. 1F). The enamel is thin and finely rugose. The enamel tubercles are present lingu-labially. The transverse valley between the first and the second lobe is jointed at the base by a tubercle and the ectostylid is present in the transverse valley of the second and third lobes. The styles are bulky and divergent comparatively. The fossettes of both lobes are isolated and deep. The ribs are strongly broad and highly projected. The rib of the third lobe is slightly tilted forward near the apex.

PC-GCUF 10/25 is a damaged right mandible fragment having length of 61 mm (Fig. 1G). The mandible fragment is shallow and fragile representing numerous cracks. The teeth are in early wear. The protoconulid is well pronounced in the p3. The metaconid is more in height than the paraconid. The anterior valley is wider than the posterior one. The posterior cavity appears in the form of post sinus posteriorly and not fully developed. The protoconid and hypoconid are well differentiated. The deciduous p4 with broken anterior lobe is placed next to the p3. The first lobe root is present in the alveolus. The second and third lobes are well preserved showing the early stage of wear. A tubercle is present between the transverse valley of the first broken lobe and the second complete lobe. The ectostylid is present in the transverse valley between the second and the third lobes. The second lobe is wider at the base and less pointed at the apex while the third lobe is wider and pointed at the apex than its base. The fossette of the second lobe is less wide than the third one. The anterior lobe of the broken semi erupted m1 is embedded in the mandible fragment. The posterior lobe is missing. The anterior lobe has a broad fossette. The metaconid is pointed with strong rib and the protoconid is crescentic in outlines. The praeprotocristid is attached to the base anteriorly of the deciduous molar. The praemetacristid is isolated and not attached to the deciduous molar.

PC-GCUF 10/32 is a well preserved p4, presenting an advanced stage of wear (Fig. 1H). A crack is present on the labial side of the tooth. The protoconulid is well preserved and the metaconid is

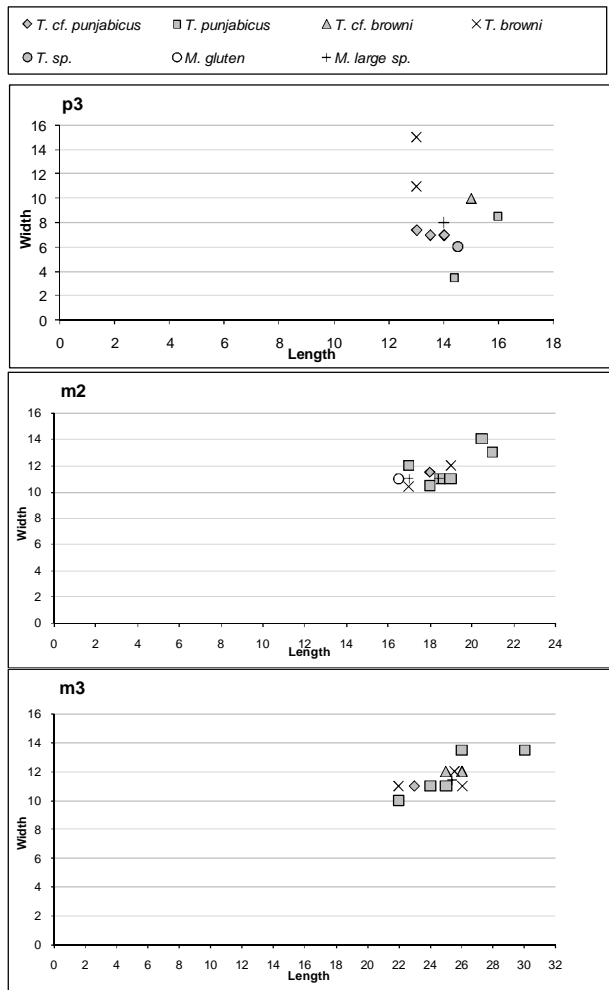


Fig. 2. Size variation (in mm) in the described species of the Dhok Pathan tragoportacins.

relatively higher than the protoconulid. The entoconid is strong, fused rapidly with the endostylid. The prae- and post-metacristid are more developed and extend anteroposteriorly, tending to close the medial valley. The anterior valley is wider than the medial valley and is somewhat U-shaped.

#### Comparison

These studied specimens have typical structure of Miocene boselaphins. The studied premolars and molars are well distinguished in morphometrically and reflect the diagnostic features of *Tragoportax* (Spassov and Geraads, 2004). However, the material is incomplete and insufficient

for the specific determination and designates *Tragoportax* sp.

#### Discussion

The genus *Tragoportax* studied by Pilgrim (1937), based on *T. salmontanus* which is a well known species from the Siwaliks. *Tragoportax* is widespread in much of Europe and southern Asia during the Turolian (Bibi and Gulec, 2008). Recently, this group was named Tragoportacini (Bibi *et al.*, 2009). The genus *Tragoportax* possesses characteristics intermediate between *Selenoportax* and *Miotragocerus*. *Tragoportax* horn-cores are much similar to *Miotragocerus* in cross-section, having scalene triangle with sharp postero-external keel while different from the isosceles triangle of *Selenoportax*, with rounded postero-external keel. *Tragoportax* differs from *Miotragocerus* in horn-cores position, which are more widely spaced in *Miotragocerus* (Pilgrim, 1937; Solounias, 1981; Khan *et al.*, 2010a).

*Tragoportax* exhibits fairly large range of size and morphology representing two large Siwaliks species *T. punjabicus* and *T. browni* which overlap in size. But the diagnostic features are enough to distinguish them from each other. *Tragoportax browni* might be a synonym of *T. punjabicus*, left open-ended pending further research (Kostopoulos, 2005, 2009; Khan *et al.*, 2010a).

#### CONCLUSIONS

Three species of tragoportacin, *Tragoportax punjabicus*, *Tragoportax browni* and *Tragoportax* sp. are documented from the Dhok Pathan type locality. *Tragoportax* range throughout the Late Miocene (10.5 Ma – 5.5 Ma), and are found across Eurasia from China to Spain, in the Siwaliks, and to the far south of South Africa.

Previous studies show that some taxa of the Dhok Pathan deposits inhabit variously drier bush and woodlands into moisture valleys and forests. The tragoportacins possess teeth of smaller size, lower crowned with simple occlusal morphology and occupy special niches within natural ecosystems, which indicate their diet with a greater reliance on softer food items such as browse. The



browsed tragoportacins prefer forests with closed habitat. It is concluded that during the Late Miocene and Early Pliocene of the Dhok Pathan region was considerably presented mosaic palaeoenvironment.

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