

MAMMALIAN REMAINS IN THE CHINJI TYPE LOCALITY OF THE CHINJI FORMATION: A NEW COLLECTION

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ABSTRACT

Seven mammalian fossils specimens of varying preservation states are described and discussed. The recovered remains include the upper and the lower dentition, and derive mostly from the flood plain channel deposits. The systematics of the rare findings *Elachistocerus* sp., *Gazella* sp. and *Miotragocerus* sp. are also discussed in here. *Listriodon* cf. *pentapotamiae* is also recovered from the middle Miocene of the Chinji type locality and consequently discussed in this paper. The aim of the paper is to describe poorly documented Middle Miocene mammalian species.

Key words: Bovids, *Elachistocerus*, *Gazella*, *Listriodon*, *Miotragocerus*, Mammalian fossils, Chinji Formation.

INTRODUCTION

The identified taxa are recovered in the type locality outcrops of the Chinji village (Lower Siwaliks), district Chakwal, Punjab, Pakistan. The new material is housed in the Palaeontology Laboratory of the Zoology Department, GC University Faisalabad (institutional abbreviation PC-GCUF) and some specimens are housed in the Palaeontology Laboratory of the Punjab University (institutional abbreviation PUPC) are also included in this study. The catalogue number of the specimens consists of series *i.e.* yearly catalogue number and serially catalogue number, so figures of the specimen represent the collection year (numerator) and the serial number (denominator) of that year (e.g., 08/21).

Measurements are in millimeters with length being the maximum dimension parallel to the mesiodistal axis of the tooth, trigonid width the maximum through the protoconid and the metaconid perpendicular to the mesiodistal axis, and talonid width the maximum through the hypoconid and the entoconid perpendicular to the mesiodistal axis. Capital letters indicate dentition with superscript numbers for the upper dentition and subscript for the lower dentition. The terminology of the tooth crown elements and manners of measurements follow Gentry (1994) and Pickford (1988).

Systematic Palaeontology

Order Artiodactyla Owen, 1848

Family Bovidae Gray, 1821

Subfamily Bovinae Gray, 1821

Tribe Boselaphini Kottnerus-Meyer, 1907

Genus *Elachistoceras* Thomas, 1977

cf. *Elachistoceras khauristanensis* Thomas, 1977:

Abbreviated Diagnosis: Bovid of very small size, close to that of Steenbok (*Raphicerus campestris*). Rectilinear horn cores of very small dimensions, has oval section. These teeth are typical among that of Boselaphini. Compared with the lower teeth of *Tetracerus quadricornis*, it is noted that the morphological characteristics are: Molars rather brachydonts, definitely convex lingual wall; Non smooth lingual wall (being distinguished by from Neotragini); Enamel rugosed; Presence of a weak caprine fold (or antero-stylid), less developed lingual furrows distinguished from Cephalophinae (Thomas, 1977).

Referred Material: PUPC 97/18 – left mandibular fragment with M₃; PUPC 97/19 – right mandibular fragment with M₁-M₃.

Description: PUPC 97/18 (Fig. 1) comprises the lower third molar (M₃) with broken second molar (M₂). The roots of the second molar are preserved. The length of the mandibular ramus is 28.2 mm. The third left molar is in an excellent state of preservation and in middle wear. The enamel is rugose and the rugosity is more evident on the lingual side than the buccal side. The apices of the paraconid and the metaconid are sharp and the metaconid noticeably smaller and lower than the protoconid. The paraconid bears very sharp and distinct vertical crest extending along the anterolingual edge. A well developed hypoconulid is present posteriorly. The talonid is sharp, spine like having a closed fossette.

PUPC 97/19 (Fig. 2) is in early wear and the length of mandibular ramus is 35.6 mm. The metaconids of the first and the second molars are damaged. The protoconid is well developed and projected. Ectostylid is present in the transverse valley. The apices of the conids are somewhat conical. The enamel is rugose equally on

the both sides. The labially and lingually flattened metaconid and entoconid are slightly oblique to the long axis of the tooth and separated by a lingual embayment. The conids have non smooth convex lingual wall. The anterior cingulum is strong, forming a "goat-fold" anteriorly. There are deep medial valleys of the trigonid and the talonid. A well developed hypoconulid is present in the last molar.

Table 1. Comparative measurements of the studied material (*Elachistoceras khauristanensis*) in mm (millimeters).

Number	Nature	Length	Width
PUPC 97/18	Left mandibular ramus having M ₃	M ₃ =13.4	M ₃ =7.6
PUPC 97/19	Right Mandibular ramus having M ₁ , 3	M ₁ = 9.5 M ₂ = 9 M ₃ = 12.5	M ₁ = 6.2 M ₂ = 7 M ₃ = 6
GSP 4278 (Thomas, 1977)	Right mandible having M ₁ - M ₂ and a former lobe of M ₃ .	M ₁ = 8.2 M ₂ = 8.9	M ₁ = 5.1 M ₂ = 5.4
GSP 5116 (Thomas, 1977)	Right M ₃	M ₃ = 11.6	M ₃ = 5.4

Brachydont molars, definitely convex non smooth lingual wall; rugose enamel and presence of weak caprine fold are distinct features of the studied specimens. These features being the characteristics of *Elachistoceras*, discriminate them from the genus *Gazella*. The teeth of *Gazella* can be distinguish from the teeth of *Elachistoceras*, for the presence of deep median valley of trigonid and talonid and well developed hypoconulid.

The apices of the paraconid and the metaconid are sharp and V-shaped. A deep median valley of trigonid and talonid and well developed hypoconulid development are the characteristic features of the studied specimens. These both teeth show typical features of *Elachistoceras* (Thomas, 1977). As the whole the teeth are compared very favorably with the type specimen. It has the almost same relative proportions of the length as the teeth of the holotype but the length and width are slightly greater than the holotype (Table 1). This difference is within the range of individual variation.

Genus *Miotragocerus* Stromer, 1928
***Miotragocerus* sp.**

Abbreviated Diagnosis: Molars quadrate, subhypsodont; presence of median basal pillar and anterior transverse flange; the parastyle is strongly developed.

Referred Material: PUPC 97/21 - left maxillary ramus with M¹⁻²; PC-GCUF 08/20 - broken left molar probably M₃.

Description: The length of the studied maxillary ramus (PUPC 97/21) is 28.2 mm. The first molar (M¹) is in the middle stage of wear and the dentine is clearly exposed (Fig. 3). The enamel on the lingual side is moderately thick and finely rugose. The metacone and the paracone are less broad than the hypocone and the protocone. The protocone is somewhat U-shaped in its general appearance. The metastyle is well-developed and stronger than the mesostyle and the parastyle. A rudimentary goat-fold is present anteriorly which is not prominent. The first upper molar (M¹) is remarkable for its subhypsodonty, surpassing in this respect the first molar of any other member of the family. The tooth itself is columnar and strongly curved, the convexity being outwards; it narrows greatly towards the base. On the outer face of the first molar the mesostyle is strongly developed, forming a sharp ridge extending up nearly to the root: the parastyle forms a sharp ridge but does not extend so far up. At the posterior end of the crown the metacone forms a sharp angle projecting backward. The paracone forms a slight convexity while the metacone is nearly flat. The valley between them extends up nearly to the neck of the tooth. The general form of the second upper (M²) molar is very similar to that of the first molar but it is larger size than the first one with subhypsodont.

PUPC 08/20 (Fig. 4) is in an early wear so that all the principal cones are well preserved. The talonid of the last molar is damaged. The enamel is moderately thick, rugose and equally dispersed. A weak goatfold is present anteriorly. The praeprotocristid and the postprotocristid are prominent on the buccal side of the molar while the praemetacristid and the postmetacristid are united with the divergent styles. The mesostylid is broken whereas the metatyloid and the entostylid are present. The ectostylids are strong and prominent.

Table 2: Measurements (mm) of the cheek teeth of *Miotragocerus* sp.

Specimens	Nature	Length	Width
PUPC 97/21	Left maxillary fragment having	M ¹ = 12.6	M ¹ = 13.8
PUPC 08/20	M ¹⁻² Left broken molar	M ² = 9.8 M ₃ = 21	M ² = 12.3
	M ₃		M ₃ = 9.2

Discussion: Subhypsodont molars, columnar and strongly curved tooth, wide crown rather than long in upper dentition while longer than wide in lower dentition and of the strong mesostyle on the buccal side are the distinct features that have been discussed (Table, 2). The studied specimens have subhypsodont molars which are

very distinct. The enamel is moderately thick and finely rugose. Goat fold is not well developed in both upper and lower molars. Morpho-metrically the teeth show the typical features of *Miotragocerus* (Stromer, 1928). However, the material is too complete to identify it up to species level.

Subfamily Antilopinae Gray, 1821

Tribe Antilopini Gray, 1821

Genus *Gazella* Blainville, 1816

***Gazella* sp.**

Referred Material: PC-GCUF 98/101 – right maxillary fragment with P⁴-M³.

Description: PUPC 98/101 (Fig. 5) is well preserved right maxillary fragment with a small piece of palate having P⁴-M³. The length of the maxillary ramus is 61.1 mm. The P⁴ is in its early wear, horse-shoe shaped and shows all the morphological characteristics. The enamel is somewhat rugose. A prominent central cavity is present. A small, very thin, transverse enamel layer connects the posterior end of protocone with hypocone. The paracone is comparatively higher than the protocone. The median rib is very prominent and closer to the parastyle. The parastyle is damaged but the mesostyle and the metastyle are well preserved. The mesostyle is stronger than the metastyle. The anterior median rib is stronger than the posterior one and the both are distinct up to the base of the crown. The hypocone appears to be less crescentic because of the wear. The posthypocrista is thicker than the prehypocrista.

Table 3. Comparative measurements (mm) of the *Gazella* sp. studied material.

Number	Nature	Length	Width
PUPC 98/101	Right maxillary fragment having P ⁴ -M ³	P ⁴ = 9.6	P ⁴ = 9.7
		M ¹ = 14	M ¹ = 13
		M ² = 14	M ² = 12
		M ³ = 14.2	M ³ = 12.5
PUPC 83/67 (Akhtar, 1992)	Right maxillary fragment having P ⁴ -M ³	P ⁴ = 9	P ⁴ = 9
		M ¹ = 13.2	M ¹ = 12
		M ² = 14	M ² = 11.5
		M ³ = 15.5	M ³ = 11
PUPC 86/76 (Akhtar, 1992)	A left maxilla bearing M ¹⁻³	M ¹ = 13.4	M ¹ = 13
		M ² = 15.4	M ² = 12.5
		M ³ = 16.3	M ³ = 11

The M² is in early wear and subhypodont. All the principal cones are well developed. The anterior cones are wider than the posterior ones. The enamel is moderately thick. The parastyle is well developed and stronger than the mesostyle while the metastyle is weakly developed. The height of the parastyle is more as compare to the mesostyle. The posterior end of the protcone is moderately expanded. The central cavities are moderately wide and deep. No spurs project into these cavities. The entostyle is absent in the cheek teeth which is the characteristic of *Gazella* upper dentition.

Discussion: The transverse diameter of P⁴ in *G. lydekkeri* exceeds antero-posterior diameter (Pilgrim, 1937). The upper molars of *Gazella* have greater antero-posterior diameter than transverse diameter (Akhtar, 1992; Pilgrim, 1937, 1939). The studied molars are slightly broad. The lingual side of the studied specimen is somewhat rugose and convex. Buccally, it shows a strong, narrow parastyle, and equally strong and broader median rib and a much weaker metastyle. All these teeth show typical morphometrical features of *Gazella* (Table, 3). The molars have anterior and median folds of about equal strength and rather prominent; the posterior fold is weak. The median rib of the anterior lobe is strongly developed; that of the posterior lobe is weaker. The molar structure represents PUPC 98/101 is typically of the genus *Gazella* (Pilgrim, 1937). The prominent median ribs, narrow styles, the absence of median basal pillar show clearly their inclusion to *Gazella*. However, more material is required to identify it up to species level and due to scarcity of the material, *Gazella* sp. is attributed for the material.

Family Suidae Gray, 1821

Subfamily Listriodontinae Simpson, 1945

Genus *Listriodon* von Meyer, 1846

Listriodon pentapotamiae

Diagnosis: The listriodonts are middle Miocene suids possessing several archaic features such as primitive basicranium, unflared zygoma, parietal lines not widely separated, no canine flanges, rounded snout and low glenoids. The listriodonts possess a very elongated mandible, achieved both by elongation of the symphysis as well as by retiring the ascending ramus. In side view, the whole of M₃ is visible as well as gap behind M₃. The symphysis is splayed outwards, so that the lower canines emerge almost horizontally. The incisive margin is evenly curved and projects substantially in front of the canines. Between the canines and anterior premolar (P₂), there is long diastema, the borders of which lie well below the occlusal surface of the cheek teeth. P₁ is reduced or lost in most species. In Listriodontinae the I¹ is spatulate and occludes with I₁₋₂. In *Listriodon* females, upper canines are usually two rooted if they are not hypodont although the lower canines seem to be more

nearly single rooted. I^2 is a robust triangular tooth set vertically in the premaxillae. The tip is triangular in lingual view, with a lingual cingulum and a central rib. The crown is slightly offset from the root. There are two wear facets along the occlusal edge of the tooth; the mesial one corresponds to the outer portion of the scoop-shaped distal edge of I_2 , while the distal one is caused by wear with the root ward half of the scoop in I_2 . In I_2 the facet caused by I^2 is very prominent along the distal edge and in the body of the scoop, while I^1 occludes only at the tip. I^2 has bifurcate tip when unworn. M^1 is a square tooth with four main cusps disposed in two lophs, with anterior and posterior cingula. The anterior, median and posterior accessory cusps, present in all suids are very small in *Listriodon*, and soon disappear with wear (Pickford, 1988).

Referred Material: PC-GCUF 08/21 – broken lower molar (M); PC – GCUF 08/22 upper incisor (I).

Description: The molar is damaged and in late wear stage (Fig. 6). Due to late wear its crown morphology is not very distinct and clear. The squared molar with four main cusps disposed in two lophs, with anterior and posterior cingula. Its posterior part is higher while the anterior one is lower. Molar enamel is thin and equally dispersed. The molar have less lingual and buccal flare. The posterior accessory cusps are prominent and centrally placed.

Table 4: Comparative measurements (mm) of the studied material (*Listriodon pentapotamiae*).

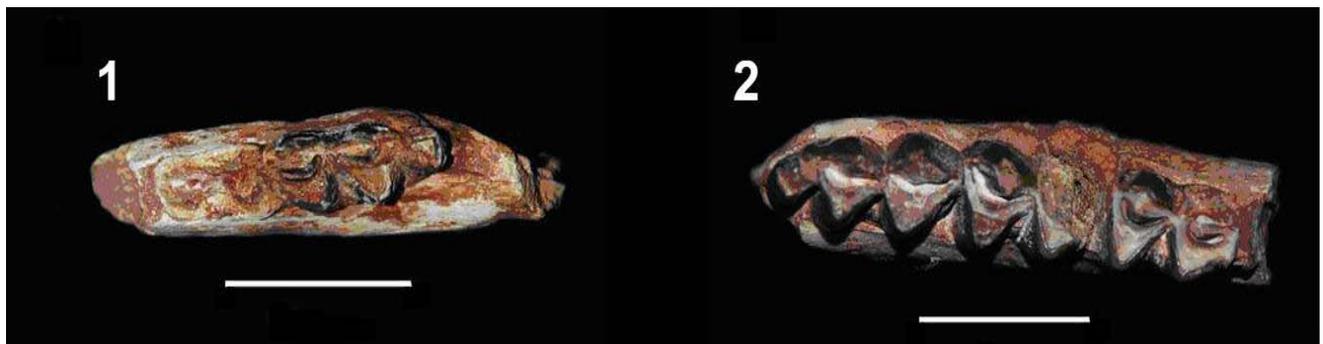
Name	Nature	Length	Width
PC-GCUF 08/21	broken molar (M)	M=17.2	M=14.5
PC-GCUF 08/22	incisor (I)	I=21.7	I=9.9
GSP 1424 (Pickford, 1988)	Left incisor I^1	I^1 =22.7	I^1 =11.3

PC-GCUF 08/22 (Fig. 7) is in good state of preservation. The enamel is rugose and the rugosity is more on the outer side than the inner one. It is a robust triangular tooth set vertically in the premaxilla with step cutting edge. The tip is triangular in view, with a lingual

cingulum and a central rib. There are two wear facets along the occlusal edge of the tooth. It is a bifurcate incisor which tip occludes with the opposite one.

Discussion: Lophodont molar; pointed cusps; anterior, median and posterior cusps are reduced; moderately thick enamel; incisors with simple pegs often with a divided tip; a central lingual rib mesial and distal borders raised ligually and lingual cingulum are distinct features that have been discussed. The I^1 of *Listriodon retamaensis* has two main grooves while *Listriodon pentapotamiae* possess only single groove in the labial surface of the crown. The morphometric features of the studied incisor suggest affinities with *Listriodon pentapotamiae* (Table, 4). It has long been suggested that listriodonts occur in early Miocene deposits at Bugti and Sind. Unfortunately, the Bugti specimens are extremely fragmentary and there is debate about their subfamilial status (Pickford, 1988; Van der Made, 1996).

The lengthening of the crown is reflected to a great degree in the root morphology which becomes strongly triangular in lingual or labial view, tapering sharply towards the apex. Study of the number of grooves in listriodont upper incisors lead to the suggestion that several lineages of listriodonts can be recognized. The I^1 of *Listriodon retamaensis* has two main grooves whereas its contemporaries *L. lockharti* and *Eurolistriodon adelli* had one and none respectively. The two species *L. latidens* and *L. meidamon* have two main grooves and the cutting edge of the crown is often heavily beaded, suggesting that they may well be descendants of *L. retamaensis*, *L. splendens*, *L. pentapotamiae*, and *L. intermedius* represent a second lineage in which there was one main groove in the labial surface of the crown. The condition in African *L. akatikubas* is not clear because the only known upper central incisor is heavily worn but its length/breadth index suggests affinities with *L. retamaensis* (Wilkinson, 1976). Species of *Lopholistriodon* have two main grooves in their I^1 but they differ from those of other *Listriodon* species by having more cylindrical roots that do not taper so markedly towards their apices, and the crown is less elongated mesio-distally (Pickford and Morales, 2003).



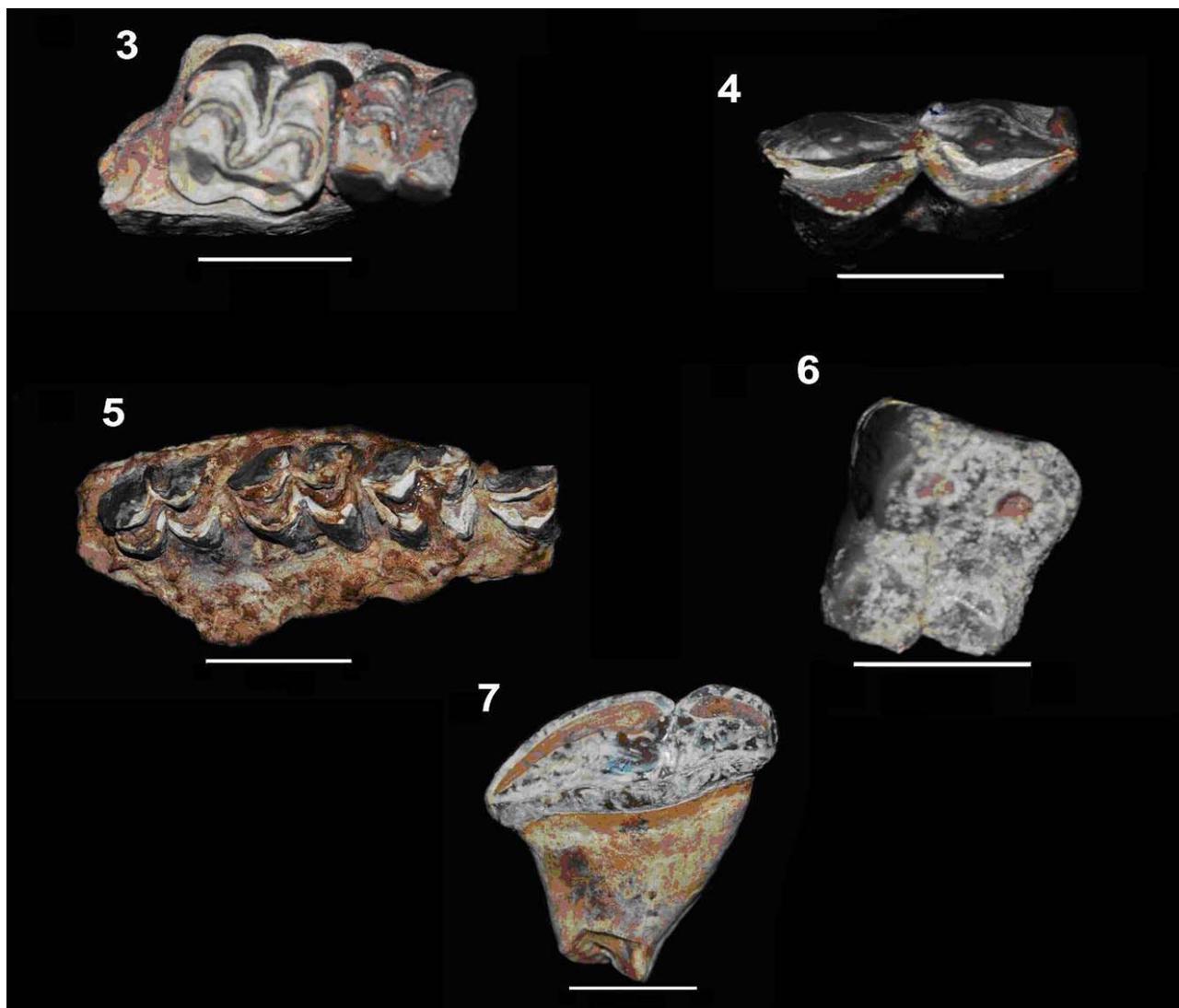


Plate 1. *Elachistoceras*: 1. PUPC 97/18 – M₃; 2. PUPC 97/19 – mandibular ramus having M₁-M₃. *Miotragocerus*: 3. PUPC 97/21 – left maxillary fragment with M¹-M₂; 4. PUPC 08/20 – broken M₃. *Gazella*: 5. PUPC 98/101 – right maxillary fragment having P⁴-M³. *Listriodon*: 6. PC-GCUF 08/21 – broken molar (M); 7. PC-GCUF 08/22 – incisor (I). Scale bar 10 mm and all photos in occlusal view.

Conclusion: The new collection from the Chinji Formation of the middle Miocene includes small sized bovids *Elachistocerus* sp., *Gazella* sp., *Miotragocerus* sp. and commonly found middle Miocene suid *Listriodon* cf. *pentapotamiae*. The *Elachistocerus* is a four horned tetracere like boselaphine found in the Lower and Middle Siwaliks (Thomas, 1977). *Tetracerus quadricornis* live in the open areas of Indian peninsula, testify the palaeontological history of the *Elachistocerus* (Thomas, 1977). The *Tragoportax* and *Miotragocerus* are large boselaphines from the late Miocene assemblages. The differences between *Tragoportax* and *Miotragocerus* have not always been clear and researchers have differed over how best to diagnose them (Bibi and Gulec, 2008).

Gazella is recorded from the Lower and the Middle Siwaliks (Khan, 2008, 2007; Akhtar, 1992). Pilgrim and Hopwood (1928) simply summarized all the nomenclature of fossil gazelles propagating the existence of a large number of species. *Gazella lydekkeri* recovered from the late Miocene and the middle Miocene assemblages of the Siwaliks respectively (Pilgrim, 1937, 1939). *Gazella capricornis*, the best known of the European Pontain species is represented by more material than *Gazella deperdita* (Gentry, 1966). It differs from *Gazella lydekkeri* in having large size of skull, and less hypsodonty. In this respect, *Gazella lydekkeri* is more primitive than *Gazella capricornis*. The most progressive feature of *Gazella lydekkeri* is hypsodonty. The Chinese Pontain gazelles are more progressive especially the

species *Gazella lydekkeri* although the width at the orbits is greater. The horn-cores seem to be identical in their morphology with *Gazella lydekkeri* and the nasal are somewhat shorter. In *Gazella dorcadoides* and *Gazella altidens* the teeth are still more hypsodont than *Gazella lydekkeri*.

Pickford (1988) described that the Siwalik *Listriodont pentapotamiae* is very similar to *L. splendens* of Europe, both in size and morphology. The only consistent major differences between the two are the smaller central incisors and upper canines. Whether these differences are great enough to warrant separate specific identity or whether they reflect geographic variation in a single species is difficult to tell without better record from geographically intermediate areas.

The collection leads us to admit existence of *Elachistocerus* sp., *Gazella* sp., *Miotragocerus* and *Listriodon* cf. *pentapotamiae* in the Chinji Formation of the Siwaliks. Highly lophodont *Listriodon pentapotamiae*, and its synonym *L. theobaldi*, is abundant in the Chinji succession and deposits of similar age elsewhere in the Potwar Plateau. Biostratigraphy and palaeomagnetic stratigraphy indicate that the Chinji levels correspond to MN6 and MN7/8 (Barry *et al.*, 2002; Badgely and Tauxe, 1990). The Boselaphini small species *Elachistocerus* sp. indicates that there was probably a variety of boselaphine bovids in the Lower Siwaliks. The fossil range in age between 14.2 and 11.2 million years old and provide evidence for the existence of small bovid faunas in the Chinji Formation of the Siwaliks.

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