The Journal of Animal & Plant Sciences, 20(4), 2010, Page: 271-276
ISSN: 1018-7081

CHEEK TEETH OF *LISTRIODON PENTAPOTAMIAE* FROM THE LOWER SIWALIK HILLS OF PUNJAB, PAKISTAN

K. Samiullah M. A. Khan* and M. Akhtar

Zoology department, Quaid-e-Azam campus, Punjab University, Lahore, Punjab, Pakistan
*Zoology Department, GC University, Faisalabad, Punjab, Pakistan
Corresponding author: Khizar502@yahoo.com

ABSTRACT

New dental material of *Listriodon pentapotamiae* has been described from the Miocene rocks of Dhok Bun Ameer Khatoon, district Chakwal, Punjab Pakistan. This material consists of an isolated lower left third premolar, an isolated lower right fourth premolar, an isolated lower left first molar and an isolated upper right canine. These specimens provide new data and give additional information on the distribution of species *Listriodon pentapotamiae* and contribute to recent work on the suids from the Lower Siwalik Hills of Pakistan.

Key words: *Listriodon pentapotamiae*, Dhok Bun Ameer Khatoon, Lower Siwaliks, Pakistan.

INTRODUCTION

Listriodon is an extinct genus of the class Mammalia, order Artiodactyla and family Suidae. It was erected by Von Meyer (1846) under the name *L. splendens* to describe some molar teeth discovered from molasses of Switzerland. In 1868 Falconer described an M^2 under the name *Tapirus pentapotamiae*. This was later referred to the genus *Listriodon* by Lydekker (1876, 1884), who gave a detailed account of this and other species in his list of "Tertiary mammalian Fauna of India", and provided a detailed account of additional material. Colbert (1935) also described some maxillary and mandibular fragments. The genus *Listriodon* is known by three species from the Siwaliks (Colbert, 1935), (i) *L. pentapotamiae* (ii) *L. theobaldi* (iii). *L. guptai. L. theobaldi* is much smaller than *L. pentapotamiae* (Chen, 1984). It evolved from a primitive *Palaeochoerus* type of ancestor and is quite separated from the more normal kind of the pig, *L. guptai* of the Kamlial formation. The Chinjian specimens of *Listriodon* belong both to a larger and a smaller form, and were referred by Lydekker to two species, *L. pentapotamiae* and *L. theobaldi*. The third species *L. guptai* is described from the lower Siwalik horizon of Sindh; the Kamlial Zone (Pilgrim, 1926). In lophodont pigs i.e. *Listriodon* the tooth crests are perfect with very sharp cutting edges. All lophodont pigs are placed in the genus *Listriodon*. Structurally it has the most primitive, small size of tooth with a simple crown (Khan *et al*., 2005). *Listriodon pentapotamiae* is a fairly long ranging species, extending from the base of the Lower Siwaliks well up into the Middle Siwalik beds (Khan *et al*., 2005). Lydekker (1876) distinguished *L. theobaldi* from L. *pentapotamiae* on the basis of size. No constant structural distinction could be drawn between the smaller teeth of *L. theobaldi* and the larger teeth of *L. pentapotamiae* (Colbert, 1935). Recently, Pickford and Morales (2003) considered the two species *L. theobaldi* and *L. pentapotamiae* as synonyms.

Geology and Stratigrphy: Dhok Bun Ameer Khatoon (DBAK) area contains an almost continuous geological record spanning approximately 18.5ma- 4.5BP (Johnson *et al.,* 1982). The Siwalik group in this area is composed of five lithostratigraphic units which are Kamlial, Chinji, Nagri, Dhok Pathan and Soan Formation. The overall lithological composition of these component formations are fairly identical with those described for their type sections but however are relatively less thick and contain more mud stones. Chinji Formation has its good exposure in DBAK area and is in strike continuation with its stratotype in Chinji area. The fossil site DBAK is a small village in district Chakwal; Punjab, Pakistan and Miocene deposits surround the village. Its geo-graphical co-ordinates are 32° 47' 26.4" N, 72° 55' 35.7" E. It is situated at about 16 Km, N-East of Chua Seydan Shah. It has two approaches, one from Chakwal and the other from Chua Seydan Shah. The fossiliferous deposits consist of shale, siltstone and sandstones. The locality represents lateral facies associations and pedogenesis within the fine grained fossil bearing floodplain deposits (Khan *et al.,* 2008). The Miocene fossil fauna of Dhok Bun Ameer Khatoon is much interesting. It consists of a number of holdovers of fore-runners of the Chinji Zone. Besides that it exhibits a number of faunal elements, which are its own.

Paleoclimate and Diet Adaptation: Physical and ecological characteristics of the habitat of an animal strongly influence the dietary habits of that animal (Kingston and Harrison 2007). Most of the Miocene period in Asia (northern Pakistan, Siwalik sequence) is represented by warm tropical, subtropical forest zones.

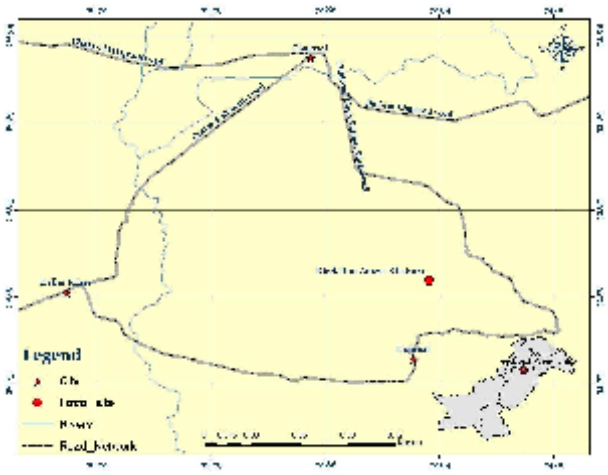
During that period in Asia; Chinji and Dhok Pathan faunas and late Middle and early Late Miocene of Europe are equivalent regarding the floral and faunal components (Bernor, 1984; Barry *et al.,* 1985). The rainy humid environment was responsible for the persistence of the forested environment in Africa. Wooded conditions may point towards the browsing nature of the mammalian fauna of that age that includes Deinotheres and Listriodonts (Agusti *et al.,* 1999).

Listriodon inhabited the whole of Eurasia to the Iberian Peninsula and eastern and central Europe (Made, 1996). They were lophodont, browsing on vegetation. Considering the lophodont dentition of *Listriodon*, Leinders (1976) argued that they were herbivores also concluded by Hunter and Fortelius (1994) considering their dental microwear. Microwear analysis has also indicated that *Listriodon* had a rather uniform diet which indicates a specialization in the browsing of vegetation. Maglio (1973) has described bunolphodonty associated with grinding-shearing mastication and browsing on foliages and fruits or both in herbivores. Pickford and Morales (2003) are of the view that *Listriodon* were browsers. Lengthening of distal limb segments may be interpreted as the adaptation for open habitats (Agusti *et al.,* 1999).

MATERIALS AND METHODS

Field trips were carried out to the site during 2006 and 2007. Different collecting methods were employed for the collection of fossils. Surface collection has been the primary mean of collecting fossil remains. The collected material was shifted to the laboratory and was carefully washed; cleaned, prepared, and broken parts were assembled by using various types of gums (resins) such as Araldite, Peligom, Elfy, Elite, Magic stone and Fixin. The specimens catalogue number consists of series i.e., yearly catalogued number and serial catalogued number, so figures on the specimen represents the year and serial number of that collection. For example, 06/70, the upper reading denotes year of the collected fossil material and the lower one the serial number. Various measurements of the specimens in millimeters were taken with the help of metric Vernier Calipers. A digital camera was used to photograph the studied specimens and amended hard copies were prepared by the computer. The material is housed in the Dr. Abu Bakr Fossil Display and Research Center, Zoology Department, University of the Punjab, Lahore, Pakistan.

Abbreviations: PUPC, Punjab University Palaeontological Collection; AMNH, American Museum of Natural History; P, premolar; M, molar; L, maximum preserved length; W, maximum preserved width; H, maximum preserved height; GSI, geological survey of India; W/L x 100, width length ratio; H/W x 100, height width ratio; DBAK, Dhok Bun Ameer Khatoon.



Map-1: Locality (Dhok Bun Ameer Khatoon) from where the fossils were collected.

RESULTS AND DISCUSSION

SYSTEMATIC PALAEONTOLOGY

Order:	ARTIODACTYLA Owen, 1848
Suborder:	SUIFORMES Jaeckel, 1911
Superfamily:	SUOIDEA (Gray, 1821) Cope, 1887
Family:	SUIDAE Gray, 1821
Subfamily:	LISTRIODONTINAE Simpson, 1945
Genus:	*LISTRIODON* VON Meyer, 1846

Type species: *Listriodon splendens* Von Meyer, 1846

Included species: *Listriodon splendens, Listriodon pentapotamiae, Listriodon theobaldi, Listriodon guptai, Listriodon latidens, Listriodon akatikubas, Listriodon meidamon, Listriodon Intermedius, Listriodon raetamaensis, Listriodon lockharti, Listriodon bartuensis, Listriodon aragoniensis, Listriodon akatikubas, Listriodon juba, Listriodon penisulus, Listriodon robustus, Listriodon mongoliensis, Listriodon lishanensis, Listriodon xinanensis* and *Listriodon bartulensis*.

Generic Diagnosis: Lophodont forms of molars are found. Tooth crests are perfect with sharp cutting edges. Tooth has smaller in size than other genus of the family Suidae. Talon with third molar present and vary in size in different species of that genus and symphysis also present (Colbert, 1935).

Distribution: The genus *Listriodon* is known from Europe, Africa as well as from the Siwaliks. In Europe it is known in the basal Middle Miocene deposits, in Africa it is known from Ngorora formation and from the

Siwaliks known from Chinji formation (Pilgrim, 1926; Pickford, 2001).

***LISTRIODON PENTAPOTAMIAE* Falconer, 1868**

Type specimen: GSI B 107, a complete right M^2 and fragment of right M^3. Also right and left P^4.

Locality: Khushalghar below Attock, Punjab (Colbert, 1935).

Stratigraphic Range: Chinji zone, Lower Siwaliks and lower portion of the Middle Siwaliks (Colbert, 1935).

Diagnosis: Similar to *Listriodon splendens* of Europe, but with a larger talon on the third molar, a strong cingulum in the fourth premolar, a shorter and more slender symphysis.

Specimens examined: PUPC 08/93, an isolated lower left third premolar, PUPC 08/21, an isolated lower right fourth premolar, PUPC 08/70, an isolated lower left first molar and PUPC 08/24, an isolated upper right canine.

Locality: Dhok Bun Ameer Khatoon, Chakwal district, Punjab, Pakistan.

DESCRIPTION

P_3 (Fig. 1): PUPC 08/93 is an isolated lower left third premolar. It is well preserved with quite thin and shinny enamel having thickness 1.5 mm. The tooth is in the middle stage of wear, low crowned with pointed conids. There are only two very strong cusps on the anterior side arranged in a transverse pattern. The cingulum is strongly developed at antero-posterior sides of the tooth in which the anterior cingulum is much stronger than posterior one.

P_4 (Fig. 1): PUPC 08/21 includes an isolated lower right fourth premolar. It is fairly preserved with quite shinny enamel. Since the tooth is unworn, so nothing could be said about the thickness of enamel and dentine. There are two cusps on the anterior side arranged in a transverse line. The cingulum is well developed at the anterior as well as posterior side of the specimen under study.

M_1 (Fig. 1): PUPC 08/70 is an isolated lower left first molar. It is finely preserved and from the stage of wear it probably belongs to an old individual. However, worn top of tooth shows that the enamel is shiny, thin all around the crown. The wear is more confined to the protoconid and hypoconid (lingual conids) as compared to metaconid and entoconid (buccal conids). Buccal conids are looking higher than buccal conids. Cingulum is present antero-posteriorly. Protoconid and metaconid (anterior conids) unite to make a loph called protoloph; at the anterior side of protoloph a depression is present. hypoconid and entoconid (posterior conids) unite to form another loph called metaloph. There are lingual and buccal depressions between protoloph and metaloph.

Canine (Fig. 1): PUPC 08/24 is an isolated upper right canine. It is almost complete anteriorly and missing posteriorly. It is in an excellent stage of preservation. The antero-posterior preserved length is 30 mm and transverse width is 17 mm. It is entirely composed of dentine and probably is in the middle stage of wear. The length of wear stage from anterior to posterior is 23 mm and width is 16 mm. The cross section of the tooth from the posterior side is circular as shown by diagram.

Comparison and Discussion: It has long been suggested that listriodonts occur in early Miocene deposits at Bugti hills and Sindh. Unfortunately, the Bugti hills specimens are extremely fragmentary and there is debate about their subfamilial status (Pickford, 1988; Made, 1996). Lophs of the molar are imperfect in *Bunolistriodon* with much wider incisors. In *Listriodon* the second loph of upper and lower molars consists of two cusps, connected by a thin crest. There is a straight facet over the whole structure while in *Lopholistriodon*, two cusps of the second loph are flattened and meet in the middle and form a crest. There is no perfectly straight facet over the posterior loph. *Lopholistriodon juba* and *L. kidogoasana* seem likely characterized by size decrease and increase in height of lophs of the molars (Made, 1992).

Some of the *Listriodon* have enormous male upper canines and extremely wide central upper incisors in comparison with *Listriodon* from the rest of Europe. Molars lophodont formed of two transverse crests, with tendency to reduce the median accessory cusp. Talon weak, talonid strong formed of extra lingual cusp. The male canines are robust upward curving teeth with open roots, while in the female, it is a two rooted downward pointing tooth, like as in *L. splendens* with more prominent median accessory cusps; lingual cusp of P4 not directly opposite the protocone, so that the loph on P4 is not as clear as in *L. splendens* (Pickford, 2006).

In lophodont pigs i.e. Listriodonts, the tooth crests are perfect with very sharp cutting edges. Under the heading of *Listriodon pentapotamiae*, Colbert (1935) described the type specimen GSI B107, a complete right M^2 and fragment of right M^3, also right and left P_4. He described AMNH 19457, AMNH 19929 and AMNH 19928 having M_1 while AMNH 19519 having $M_{1\text{-}3}$. These all specimens were collected from Phadial, Rammagar, Nathot and from type locality Chinji near Chinji rest house. Colbert described these specimens as *Listriodon pentapotamiae*. Specimens PUPC 08/21, PUPC 08/24, PUPC 08/70, and PUPC 08/93 are collected from Dhok Bun Ameer Khatoon, District Chakwal, Chinji formation. After measurements of PUPC 08/70 and comparing them with AMNH 19519, AMNH 19457 and AMNH 19929, it is evident that both specimens have same features. It is true that slight difference in size can be attributed to individual variation.

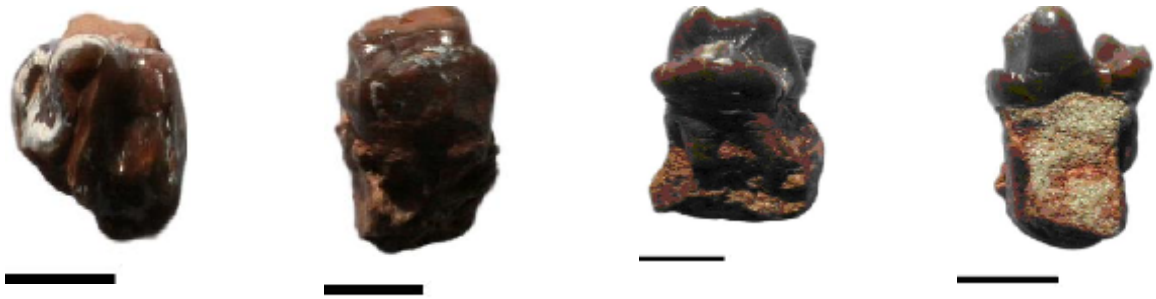
The teeth under study are lophodont because lophs are formed between protoconid and metaconid, hypoconid and entoconid. In this respect the specimens under study resemble with Amer. Mus. collection described in table 1. They show all the basic features of the species i.e. prominent lophs, M_1 having two cross crests followed by talonid. A faint cingulum is present on the anterior side. This cingulum and the longitudinal ridges are also seen in the diagram by Pilgrim (1926), though not mentioned by him.

M_1 is similar to those of GSI B 697 and AMNH 19519 drawn by Pilgrim (1926) and Colbert (1935) respectively. Both of these teeth have two transverse ridges connected by a diagonal ridge. Tooth with crests having sharp edges. A strong cingulum in fourth premolar can also be observed. These entire features are similar to those of GSI B 697. These are followed by a low talonid. This structure is similar to the specimen described by Pilgrim (1926) and Colbert (1935). On the basis of described comparison and characteristics, the specimens under study are being referred to the genus *Listriodon* and species *Listriodon pentapotamiae.*

Table 1: comparative measurements (in mm) of cheek teeth referred to *Listriodon pentapotamiae*.

Number	Position	Length (L)	Width (W)	Height (H)	W/L index	H/W index
PUPC 08/93	P_3	13	11.5	8	88.4	69.5
PUPC 08/21	P_4	15	11	13	73.3	118
PUPC 08/70	M_1	14	13	6.5	92.8	50
PUPC 08/24	canine	30	17	-	56.6	-
PUPC 08/70	M_1	14	13	-	92.8	-
*AMNH 19519	M_1	16	12	-	75	-
*AMNH 19457	M_1	17	13.5	-	77	-

*AMNH taken from Colbert, 1935



PUPC 08/93 A B PUPC 08/21 A B

PUPC 08/70 PUPC 08/24 A B

Fig. 1:- *Listriodon pentapotamiae*, PUPC 08/93; an isolated lower left third premolar (A) - occlusal view (B) - anterior view. PUPC 08/21; an isolated lower right fourth premolar (A) - posterior view (B) - buccal view. PUPC 08/70; an isolated lower left first molar, occlusal view. PUPC 08/24; an isolated upper right canine (A) - lingual view (B) - buccal view. Scale bar 10 mm.

Conclusion: The new collection from the Chinji Formation of the Late Miocene includes small sized Miocene suid, *Listriodon pentapotamiae.* 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 acknowledge existence of *Listriodon 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 fossil range in age between 14.2 and 11.2 million years old (Khan *et al*., 2009).

REFERENCES

Agusti, J., O. Oms and J. M. Pares (1999). Calibration of the Early–Middle Pleistocene transition in the continental beds of the Guadix-Baza Basin (SE Spain), Quaternary Science Reviews, 18: 1409-1417.

Badgley, C. E. and L. Tauxe (1990). Paleomagnetic stratigraphy and time in sediments: studies in alluvial Siwalik rocks of Pakistan. J. Geology, 98: 457-477.

Barry, J., M. Morgan, L. Flynn, D. Pilbeam, A. K. Behrensmeyer, S. M. Raza, I. Khan, C. Badgely, J. Hicks and J. Kelley (2002). Faunal and Environmental change in the Late Miocene Siwaliks of Northern Pakistan. Palaeobiology, 28: 1-72.

Barry, J. C., N. M. Johnson, S. M. Raza and L. L. Jacobs (1985). Neogene mammalian faunal change in southern Asia: correlations with climatic, tectonic, and eustatic events. Geology, 13: 637–640.

Bernor, R. L. (1984). A zoogeographic theater and biochronologic play: the time/biofacies phenomena of Eurasian and African Miocene mammal provinces. Paleobiologie Continentale, 14(2): 121–142.

Chen, G. (1984). Suidae and Tayassuidae (Artiodactyla, Mammalia) from the Miocene of Steineheim (Germany). Palaeontographica, 184(1-4): 79-83.

Colbert, E. (1935). Siwalik mammals in the American Museum of Natural History. Trans. Amer. Philos. Soc. 26: 1-401.

Hunter, J. P. and M. Fortelius (1994). Comparative dental occlusal morphology, facet development, and microwear in two sympatric species of *Listriodon* (Mammalia: Suidae) from the Middle Miocene of western Anatolia (Turkey). J. Vertebrate Paleontology, 14: 105–126.

Johnson, N. M., N.D. Opdyke, G.D. Johnson, E. H. Lindsay and R. A. K. Tahirkheli (1982). Magnetic polarity stratigraphy and ages of Siwalik Group rocks of the Potwar Plateau, Pakistan. Palaeogeography, Palaeoclimatology, Palaeoecology, 37**:** 17-42.

Khan, M. A., A. Ghaffar, Z. Ali, U. Farooq, Z. H. Bhatti and M. Akhtar (2005). Report on Mammalian Fossils of Chinji Formation, Dhulian, Pakistan**.** Amer J. Appl Sci., 2(12): 1619-1628.

Khan, M. A., M. Akhtar, A. Ghaffar, M. Iqbal, A. M. Khan, and U. Farooq (2008). Early ruminants from Dhok Bin Mir Khatoon (Chakwal, Punjab, Pakistan): Systematics, Biosratigraphy and Paleoecology. Pakistan J. Zool., 40(6): 457-463.

Khan, M. A., A. M. Khan., M. Iqbal and M. Akhtar (2009). Mammalian remains in the Chinji type locality of the Chinji Formation: a new collection, J. Anim. and Plant Sci., 19(4): 224-229.

Kingston, J. D. and T. Harrison (2007). Isotopic dietary reconstructions of Pliocene herbivores at Laetoli: Implications for early hominin paleoecology. Palaeogeography, Palaeoclimatology and Palaeoecology, 243.

Leinders, J. (1976). Some aspects of the ankle joint of artiodactyls with special reference to *Listriodon* (Suina). Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, ser. B. 79: 45–54.

Lydekker, R. (1876). Molar teeth and other remains of Mammalia from the India Tertiaries. Pal. Ind., 10(2): 12-87.

Lydekker, R. (1884). Additional Siwalik Perissodactyla and Proboscidea. Mem. of the Geol. Sur. of India-Palaeontologica Indica, 3 (10): 1-34.

Made, J. V. D. (1992). African Lower and Middle Miocene suoidea (pigs &peccaries).2 taxonomy of the Listriodontinae (suidae, pigs). museu de geologia de barcelona sociedad española de paleontologia. pp 91-92.

Made, J. V. D. (1996). Listriodontinae (Suidae, Mammalia), their evolution, systematics and distribution in time and space. Contrib. Tert. Quat. Geol., 33(1-4): 3–160.

Maglio, V.J. (1973). Origin and evolution of the Elephantidae: Transactions of the American Philosophical Society, 63: 1-49.

Pickford, M. and J. Morales (2003). New Listriodontinae (Mammalia, Suidae) from Europe and a review of listriodont evolution, biostratigraphy and biogeography. Geodiversitas, 25 (2): 347-404.

Pickford, M. (2001). New species of *Listriodon* (Suidae, Mammalia) from Bartule, Member A, Ngorora Formation (13 Ma), Tugen Hills, Kenya. Annales de Paléontologie 87: 209-223.

Pickford, M. (2006). New suoid specimens from Gebel Zelten, Libya. Geológicos, 62(1): 499-514.

Pickford, M. (1988). Revision of the Miocene Suidae of the Indian Subcontinent Münchner Geowissenschaften Abhandlungen, 12: 1-91.

Pilgrim, G.E., (1926). The fossil Suidae of India: Mem. geol. Surv India, Palaeont. indica, ns 8(4): 1-65.

Von Meyer, H. (1846). Über die fossilen vonWirbeltieren welche die Herren von Schlagintweit von ihren Reisen Indien und Hochasien mittgebracht haben. Palaeontographica, 15: 1-40.