New Fossil Remains of *Listriodon* from the Chinji Zone near Dhok Bun Ameer Khatoon, Chakwal District, Salt Range, Punjab, Pakistan.

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Received : 25 June 2011 ; Accepted : 13 September 2011

Abstract
Several new fossil remains of *Listriodon* have been found and described from the Chinji zone near Dhok Bun Ameer Khatoon. Determinations are based mainly on incisor, premolar and molar teeth inserted into left and right mandibular rami, probably belonging to the same individual. The study of these specimens presents new data and gives additional information on the distribution of species *Listriodon pentapotamiae* from the Lower Siwalik hills of Pakistan.

Keywords: New fossil, *Listriodon pentapotamiae*, Lower Siwaliks.

Introduction
*Listriodon* is an extinct genus of the class Mammalia, order Artiodactyla and family Suidae. It was erected by Von Meyer¹ under the name *L. splendens* to describe some molar teeth discovered from molasses of Switzerland. In 1868 Falconer described an M₂ under the name *Tapirus pentapotamiae*. This was later referred to the genus *Listriodon* by Lydekker²,³, 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. Colbert⁴ 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*.⁵ 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. *L. guptai* is probably a species transitional in structure between the normal bunodont pig and specialized Listriodont forms⁶. 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 Zone⁶. 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 crown⁷. According to Made and Hussein⁸, there is no sound evidence for the presence of *Listriodon* in Africa but Pickford⁹ described it from Tugen hills, Kenya, East Africa.

*Listriodon pentapotamiae* is a fairly long ranging species, extending from the base of the Lower Siwaliks well up into the Middle Siwalik beds⁷. Lydekker² distinguished *L. theobaldi* from *L. pentapotamiae* on the basis of size. He admitted that no constant structural distinction could be drawn between the smaller teeth of *L. theobaldi* and the

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larger teeth of *L. pentapotamiae*. Recently, Picford and Morales considered the two species *L. theobaldi* and *L. pentapotamiae* as synonyms.

Fossil site Dhok Bun Ameer Khatoon (Figure 1) has well-exposed outcrops of the Chinji and Nagri formations and has been dated approximately from 14.2 Ma - 9.5 Ma. Its geo-graphical co-ordinates are 32° 47' 26.4" N, 72° 55' 35.7" E. This age corresponds with the divergence of different mammalian genera and is important palaeoecologically, palaeogeographically and palaeoclimatologically. Sedimentological evidence of the site supports that the fossiliferous sediments were deposited in lacustrine or fluvial environments, as Chinji formation is composed primarily of mudstone while the Nagri formation is sand dominated. Palaeoenvironmental data indicates that the Miocene climate of Pakistan was probably monsoonal, as today. The recovered genera from this site are mostly the same as in the overlying younger Dhok Pathan formation of the Siwaliks, while the size variation in dentition is taxonomically important for vertebrate evolutionary point of view and this is the main reason to conduct this study at this specific site to add additional information in the field of Palaeontology.

**Abbreviations**

- P.U.P.C, 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/Lx100, width length ratio.

**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 and Listriodon lockharti.*

**Generic Diagnosis**

Lophodont forms of molars are found. Tooth crests are perfect with sharp cutting edges. Teeth are smaller in size than other genera of the family Suidae. Talon in third molar is present and varies in size in different species of the genus and symphysis is also present.

**Distribution**

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

**LISTRIODON PENTAPOTAMIAE** Falconer, 1868

**Type specimen**

GSI B 107, a complete right M² and fragment of right M³. Also right and left P⁴.

**Locality**

Khushalghar below attok, Punjab.

**Stratigraphic Range**

Chinji zone, Lower Siwaliks and lower portion of the Middle Siwaliks.

**Diagnosis**

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

PUPC 08/9, comprising a right mandibular ramus with P4-M3, and a left mandibular ramus with M1-3 and a left upper incisor.

Locality

Dhok Bun Ameer Khatoon, Chakwal district, Salt range, Punjab, Pakistan.

Description

Mandibles (Figure 2)

The mandibles are unworn and were collected from the same place, suggesting that they came from young animals, and possibly the same individual. They are very well preserved and both ramii are thick transversely and deep vertically.

Right mandible (Figure 2)

The anterior and posterior parts of the right mandible are missing preserving P4-M3. P4 is well preserved with quite thin and shiny enamel. Since the tooth is unworn, nothing can be said about the thickness of the enamel and dentine. It is low crowned with pointed conids. There are only two cusps on the anterior side arranged in a transverse line. The inner cusps are much stronger. Strongly developed anterior and posterior cingula are present. The anterior cingulum is much stronger than posterior one.

M1 is finely preserved and the enamel shows a uniform thickness all over the crown of tooth. Little or no wearing is observed in M2. The enamel is smooth and not rugose. M3 is badly damaged anteriorly. The protoconid and metaconid are broken and only base is present. The tip of the hypoconid is also broken. The sharp chisel shaped crests are present. These crests are perfect with very sharp cutting edges. A large talonid is present and is of equal height to the other conids of the molar.

The protoconid is attached to the metaconid and a loph is formed. Similarly a loph between the hypoconid and entoconid is also formed. At the anterior side of the protoloph a depression is present. The protoconid and hypoconid and also the metaconid and entoconid are separated by a deep valley. There is a downward slope from the hypoconid to the metaconid. All four conids of the molars are pointed at the top. In general appearance all the conids are V shaped. The protoconid is vertically higher than the metaconid. No conules are visible. The metaconid is high compared to other conids. The protoconid and hypoconid are equal in height. The entoconid is less high than the metaconid but higher than the protoconid and hypoconid. On the anterior side of the molars a deep depression is present and it makes a V shape valley in the mid and anterior side of the protoloph.

Left mandible (Figure 2)

It consists of M1-3 and is broken anteriorly. The remaining parts are very well preserved. It is moderately thick transversely and deep vertically. The total length of the molar series is 61 mm. The depth of the mandible below the M2 is 32 mm and the width is 19 mm, and M3 is 22 mm. The preserved horizontal ramus is 63 mm. The preserved ascending ramus is 22 mm and the reconstructed ascending ramus is 37 mm. The protoconid is joined with the metaconid, and the hypoconid is joined with the entoconid, forming lophs.

Left incisor

The left incisor (Figure 2) is chisel shaped, it is well preserved and the enamel is shiny. It is embedded in the jawbone. The single cusp is sharp and eroded. It is in an early stage of wear and its physical characteristics also confirm this status. Its crown length is 18 mm, width 8.2 mm and height 11 mm. A small portion of bone in which incisor is inserted i.e. the premaxilla is well preserved. Its length is 37.5 mm and its width is 19.5 mm. Symphysis length is 19 mm and width 7 mm.
Figure 1 Map of site (Dhok Bun Ameer Khatoon) from where the fossils were collected.

Figure 2 *L. pentapotamiae*, (PUPC 08/9), right mandibular fragment having P₄ and M₁-₃, 1a- occlusal view 1b- lingual view 1c- buccal view, left mandibular fragment having M₁-₃, 2a- occlusal view 2b- lingual view 2c- buccal view, left upper incisor, 3a- occlusal view 3b- lingual view. (Scale bar 10mm)
Discussion
The sharp chisel shaped crest is a major feature of the molar teeth of Deinotheriids, proboscideans, lophodont pigs and some metatheres. The teeth under discussion are too small to be referred to any of the proboscideans. In lophodont metatheres the crest is imperfect. In lophodont pigs i.e. listriodonts, the tooth crests are perfect with very sharp cutting edges. The specimens under study compare favorably with Ind. Mus B. No. 697 and AMNH 19519 described by Pilgrim and Colbert respectively. Under the species Listriodon pentapotamiae Colbert described the type specimen GSI No. B107, a complete right M² and fragment of right M³, also right and left Pᵢ. He described AMNH 19457 having M₁ and 19432, 19624 having M₂ while 19519 having M₃. All these specimens were collected from Phadial, Rammagar, Nathot and Hills near Chinji rest house. Colbert described these specimens as Listriodon pentapotamiae. After measurements of PUPC 08/9 were taken and compared with specimens AMNH 19519, 19432, 19457, 19624 and 19625, it is evident that specimens have the same features and the slight differences in size can be attributed to individual variation. The teeth under study are lophodont and resemble the specimens from the Amer. Mus. Collection given in Table-1. They show all the basic features of the species i.e. prominent lophs, M₃ having two cross crests followed by a talonid. A faint cingulum is present on the anterior side. This cingulum and the longitudinal ridges are also seen in the diagram by Pilgrim, though not mentioned by him. M₁ and M₂ are similar to the specimens Ind. Mus. B.697 and AMNH 19519 drawn by Pilgrim and Colbert respectively. A strong cingulum in the fourth premolar is present. These features are similar to specimens of Ind. Mus. B.697 and AMNH 19519. This structure is similar to the specimen described by Pilgrim and Colbert.

Among early workers Colbert described specimen AMNH 19586 as I¹. The left upper incisor has the same structure as Colbert mentioned in the figure of AMNH 19586 (Colbert, p.233). This compares favorably with the incisor PUPC 08/9, in size and general appearance. Pilgrim mentioned a specimen as I¹, P-32, but does not refer it to any species. Molars of the both mandibular ramii also resemble each other in all the structural details and in antero-posterior length and crown width as given in table-I. On the bases of these similarities and resemblance to the studied specimen PUPC 08/9, we refer this to the species Listriodon pentapotamiae.

Molar teeth (M₁₋₃) were also compared using FISHER EXACT test which showed that there was non significant difference between specimen under study and American museum collection.

Conclusion
The morphological and metrical characters of the specimens are described here and their systematic determination is discussed. Studied site has yielded a rich and diversified fossil fauna including both micro- and macro-mammals. Listriodon pentapotamiae are the common elements of the fauna of Dhok Bun Ameer Khatoon.

Acknowledgement
We thank Phil Jardine (University of Birmingham, UK) for his help with proof reading and many suggestions to improve manuscript.

References
5. Chen G. Suidae and Tayassuidae (Artiodactyla, Mammalia) from the Miocene of Steineheim (Germany). Palaeontographica, 1984; 184(1-4): 79-83.
Table 1: Measurements of teeth referred to *L. pentapotamiae* Falconer, 1868\(^1\). (Data compared with American Museum specimens). *The studied specimens.

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Total length of molar series is 78 mm.

Depth below M\(_2\) is 32 mm.

Width below M\(_2\) is 19 mm.

Total preserved length of horizontal ramus is 89.7 mm.
Size variation (in mm) of the lower dentition of *Listriodon pentapotamiae*