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**ARTIODACTYLA AND PERISSODACTYLA (MAMMALIA) FROM THE  
EARLY-MIDDLE EOCENE KULDANA FORMATION OF KOHAT  
(PAKISTAN)**

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# ARTIODACTYLA AND PERISSODACTYLA (MAMMALIA) FROM THE EARLY-MIDDLE EOCENE KULDANA FORMATION OF KOHAT (PAKISTAN)

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*Abstract.*—Chorlakki, yielding approximately 400 specimens (mostly isolated teeth and bone fragments), is one of four major early-to-middle Eocene mammal localities on the Indo-Pakistan subcontinent. On the basis of ungulates described in this paper we consider the Chorlakki fauna to be younger than that from Barbora Banda, older than the Kalakot fauna, and possibly comparable in age to the Ganda Kas/Lammidhan fauna.

Artiodactyls are abundant in the Chorlakki fauna. Two families are represented: Dichobunidae and Raoellidae. A new dichobunid, *Pakibune chorlakkensis* n. gen. et sp., and a new raoellid, *Indohyus major* n. sp., are described. A new diagnosis of Raoellidae is given here. Perissodactyls are rare at Chorlakki. However a few elements identified as isectolophid tapiroids, brontotheriids, and hyracodontids are known.

Raoellidae is endemic to the Indo-Pakistan subcontinent and may be related to European Dacrytheriidae. Pakistan dichobunids too seem to have European affinities. The perissodactyls are possibly more closely related to Eocene taxa from the rest of Asia than to those from Europe.

## INTRODUCTION

The locality of Chorlakki in the Kohat District, North-West Frontier Province of Pakistan, is one of the few Eocene localities on the Indo-Pakistan subcontinent yielding fossil mammals. A description of the locality and preliminary faunal list were presented by Gingerich et al. (1979, 1983). Chorlakki is located about 4 km NNW of the village of that name. Its coordinates are 33° 37' 20" N latitude, 71° 55' 20" E longitude. Most of its vertebrate fauna has already been published (Gingerich et al., 1979; Russell and Gingerich, 1980; Gingerich and Russell, 1981; Russell and Gingerich, 1981; Hartenberger, 1982; Gingerich et al., 1983; Wells and Gingerich, 1983; de Broin, 1987; Gayet, 1987; Rage, 1987; Russell and Gingerich, 1987). Table 1 provides an updated faunal list.

Concerning the ungulates, only one new artiodactyl was described since the discovery of the locality in 1977 (Gingerich et al., 1979). The fauna contains several new artiodactyl taxa, and others merit a closer comparison with related forms. Perissodactyls are rare at Chorlakki, in contrast to other Eocene mammal localities from the Indian subcontinent, such as Barbora Banda in Kohat (de Bruijn et al., 1982; Thewissen et al., 1983; Russell and Gingerich, 1987) and Kalakot in Kashmir (Ranga Rao, 1971 and 1972; Sahni and Khare, 1972 and 1973; Kahn, 1973; Ranga Rao and Obergfell, 1973; Ranga Rao and Misra, 1983; Kumar and Sahni, 1985). Another difference between Chorlakki and these faunas is the preservation of the material: specimens from Chorlakki are almost all isolated teeth,

TABLE 1 — Mammalian faunal list for the early-to-middle Eocene locality Chorlakkia, Kohat District, North-West Frontier Province, Pakistan.

- Order PROTEUTHERIA (?)  
 Family *incertae sedis*  
*Pakilestes lathrius* Russell and Gingerich, 1981
- Order LIPOTYPHILA  
 Family undetermined  
*Seia shahi* Russell and Gingerich, 1981
- Order CHIROPTERA  
 Family undetermined  
 Chiropteran indet. A of Russell and Gingerich, 1981  
 Chiropteran indet. B of Russell and Gingerich, 1981
- Order PRIMATES  
 Family OMOMYIDAE  
*Kohatius coppensi* Russell and Gingerich, 1980  
 Family ADAPIDAE  
*Panobius afridi* Russell and Gingerich, 1987  
 Cf. *Agerinia* sp.
- Order CREODONTA  
 Family HYAENODONTIDAE  
*Paratritemnodon indicus* Ranga Rao, 1973
- Order CETACEA  
 Family PROTOCETIDAE  
*Pakicetus inachus* Gingerich and Russell, 1981
- Order PROBOSCIDEA  
 Family ANTHRACOBUNIDAE  
*Lammidhania wardi* (Pilgrim, 1940)  
*Pilgrimella pilgrimi* Dehm and Oettingen-Spielberg, 1958
- Order ARTIODACTYLA  
 Family DICHOBUNIDAE  
*Diacodexis pakistanensis* Thewissen et al., 1983  
*Chorlakkia hassani* Gingerich et al., 1979  
*Pakibune chorlakkensis* n. gen. n. sp.  
*Dichobunidae* indet.
- Family RAOELLIDAE  
*Khirtharia dayi* Pilgrim, 1940  
*Indohyus indirae* Ranga Rao, 1971  
*I. major* n. sp.
- Order PERISSODACTYLA  
 Family ISECTOLOPHIDAE  
 Gen. and spec. indet.
- Family BRONTOTHERIIDAE  
*Eotitanops dayi* Dehm and Oettingen-Spielberg, 1958
- Family HYRACODONTIDAE?  
 "*Forstercooperia*" *jigniensis* (Sahni and Khare, 1973)
- Order TILLODONTIA  
 Family TILLOTHERIIDAE  
*Basalina basalensis* Dehm and Oettingen-Spielberg, 1958
- Order RODENTIA  
 Family CHAPATTIMYIDAE  
*Birbalomys woodi* Sahni and Khare, 1973  
*B. sondaari* (Hussain et al., 1978)  
*B. ijlsti* (Hussain et al., 1978)  
*B. vandermeuleni* (Hussain et al., 1978)  
*Chapattimys wilsoni* Hussain et al., 1978  
*C. debruijini* Hartenberger, 1982
- Family YUOMYIDAE  
 cf. *Petrokozlovia* sp. indet. 2 of Hartenberger, 1982

while material from Barbora Banda and Kalakot often consists of more complete dentitions. Localities near the village of Ganda Kas in Punjab (Pilgrim, 1940b; Dehm and Oettingen-Spielberg, 1958; Gingerich, 1977; Hussain et al., 1978; West, 1980) resemble Chorlakki in mode of preservation.

Specimens cited in this study are housed in the American Museum of Natural History, New York (AMNH); British Museum of Natural History, London (BMNH); Geological Survey of Pakistan, Islamabad (GSP-UM and H-GSP); Geology Department of Lucknow University, Lucknow (LUV and VPL/ K); Institut für Paläontologie und Historische Geologie, München (München); Directorate of Geology, Oil and Natural Gas Commission, Dehra Dun (ONG/K); Princeton University Museum of Natural History, Princeton (PU); and University of Michigan Museum of Paleontology, Ann Arbor (UM).

#### SYSTEMATIC PALEONTOLOGY

##### Class MAMMALIA

Superfamily RHINOCEROTOIDEA Gill, 1872  
 Family ?HYRACODONTIDAE Cope, 1879  
 “*Forstercooperia*” Wood, 1939  
 “*Forstercooperia*” *jigniensis* (Sahni and Khare, 1973)  
 Fig. 8E-H

*Referred material.*—GSP-UM 753 (fragment of a lower molar), 1446 (fragment of L trigonid), and 1542 (R M<sup>3</sup>).

*Description.*—GSP-UM 1446 (Fig. 8G-H) is the labial part of a premolar trigonid. The paralophid extends anteriorly from the protoconid; it is slightly convex on the labial side. At its most anterior extension, the paraconid is only slightly lower than the protoconid. Anteriorly, the tooth is narrow, a clear indication that it is one of the anterior premolars. Part of the metalophid is preserved lingual to the protocone; it is somewhat worn posteriorly and a weak cingulum is present anteriorly. The length of the trigonid on the labial side is 8.5 mm.

GSP-UM 1542 is a poorly preserved M<sup>3</sup> (Fig. 9C-D). Enamel is only present on an outline of the tooth and on either side of the centrocrista. Remnants of the maxillary bone are preserved, roots are present below the protocone, paracone, metacone, and hypocone. The metacone is lingually displaced. Length is 27.5 mm and width 37 mm.

*Discussion.*—The premolar fragment is larger than in insectivores and helaeids known from the Indo-Pakistan subcontinent. It is smaller than *Pakotitanops*, *Eotitanops*, *Hyrachyus asiaticus*, and *Teleolophus*. The only perissodactyls from the Eocene of the Indo-Pakistan subcontinent that it may match in size are the Indian hyracodontids and the brontothere *Mulkrajanops*. It does not resemble the anterior premolars of brontotheres, because these lack a transverse metalophid. Assuming that the specimen is from one of the perissodactyl families that are known from Indo-Pakistan, we refer it to Hyracodontidae.

The lingual position of the metacone in the described M<sup>3</sup> is a hyracodontid feature unlike other large perissodactyls from Indo-Pakistan, such as brontotheres (Dehm and Oettingen-Spielberg, 1958; West, 1980; Kumar and Sahni, 1985) and *Hyrachyus* (Ranga Rao and Oberfell, 1973).

Two hyracodontids have been described from Indo-Pakistan: “*Prothyracodon*” *kalakotensis* Kahn, 1973 (this genus was synonymized with *Triplophus* by Radinsky, 1967) and “*Forstercooperia*” *jigniensis* Sahni and Khare, 1973. Lucas et al. (1981) indicate that *F. jigniensis* may not be referable to *Forstercooperia*, and we therefore place the name in quotation marks. The last upper molar is not known in either “*Forstercooperia*” *jigniensis* nor “*Prothyracodon*” *kalakotensis*, but GSP-UM 1542 matches the holotype P<sup>3</sup>-M<sup>2</sup> of “*Forstercooperia*” *jigniensis* (LUVF 15009) in size. GSP-UM 1446 agrees in size with both the paratype of “*Forstercooperia*” *jigniensis* (P<sub>3</sub>-M<sub>2</sub>; LUVF 15008) and the holotype of “*Prothyracodon*” *kalakotensis* (ONG/JK/1), being slightly smaller than both. We refer it provisionally to “*Forstercooperia*” *jigniensis*.

## CONCLUSIONS

Early to middle Eocene fossil mammal localities from the Indo-Pakistan subcontinent are rare; the most important ones occur along the southwest border of the Himalayas in Pakistan and northwest India. These are, from west to east: Barbora Banda, Chorlakkhi, Ganda Kas, and Kalakot. The red beds in which these faunas occur may be diachronous (Gingerich and Russell, 1981; de Bruijn et al., 1982).

Faunal composition differs markedly from west to east between these localities: Barbora Banda, the most western locality, has the most primitive fauna. Artiodactyls are only represented by a single dichobunid, *Diacodexis pakistanensis*, which is the most primitive of the continent. Only one perissodactyl is known, and it is a primitive isectolophid slightly larger than the isectolophid from Chorlakkhi. It may be more primitive than the other known Indo-Pakistan isectolophids, but no detailed comparison has been made. A few rodents are known from Barbora Banda; these may form the initial stock of the continent (de Bruijn et al., 1982). Russell and Gingerich (1987) described an omomyid primate, cf. *Kohatius* sp., from Barbora Banda.

Chorlakkhi is about 80 km northeast of Barbora Banda. It has a greater diversity of artiodactyls and perissodactyls than the latter locality. The fauna is also more diverse in that it has insectivores and bats (Russell and Gingerich, 1981), Primates (Russell and Gingerich, 1980 and 1987), Hyaenodontidae, Cetacea (Gingerich et al., 1983), Anthracobunidae (Wells and Gingerich, 1983), and Tillodontia. The rodents are more diverse than those of Barbora Banda (Hartenberger, 1982). Hussain et al. (1978) concluded that the species occurring at Chorlakkhi are endemic to the Indo-Pakistan subcontinent. The artiodactyls and perissodactyls of Chorlakkhi are more derived than those from Barbora Banda. The localities share primitive *Diacodexis* and isectolophids, but more evolved dichobunids, such as *Chorlakkia* and *Pakibune* occur at Chorlakkhi, besides endemic raoellids and derived perissodactyls such as brontotheres and hyracodontids. We suggest that this fauna is younger than that of Barbora Banda and that it indicates a period of relative isolation of the continent in which endemic forms developed.

A third fauna is not well known; it is found at a number of separate localities near the village of Ganda Kas, about 30 km east of Chorlakkhi. Separate localities have been named Lammidhan (Pilgrim, 1940b and Gingerich, 1977), Basal (Dehm and Oettingen-Spielberg, 1958), Jhalar (Pilgrim, 1940b and Hussain et al., 1978) and Ganda Kas (Dehm and Oettingen-Spielberg, 1958; West, 1980). In most respects the fauna from Ganda Kas resembles the Chorlakkhi fauna. Concerning the ungulates, the faunas differ in rare forms, such as the absence of *Indohyus* from Ganda Kas, and the presence of *Haqueina* there. These differences may reflect sampling rather than faunal differences. Possibly the single partial upper molar referred to *Gobiohyus* cf. *G. orientalis* by West from Ganda Kas (1980) is actually part of the upper dentition of *Haqueina*. An  $M_3$  originally referred to *Lammidhan* (BMNH 32168) by Gingerich (1977) is from a selenodont anthracothere. No anthracotheres have been collected at Lammidhan or Ganda Kas. It is likely, as mentioned by Wells and Gingerich (1983), that this species came from the Miocene Murree Formation. The Ganda Kas localities may be contemporaneous with Chorlakkhi or slightly younger.

The fourth and most eastern major fauna is Kalakot, over 200 km east of Ganda Kas. It is known from a number of localities that are closely spaced on a 6 km section of the Kalakot-Rajauri road in northwestern India. Only the larger mammals of this fauna are well known; dichobunids are absent, lophialetids are present and are more abundant than isectolophids, and *Indohyus* dominates over *Khirtharia*. This is in contrast to the Chorlakkhi and Ganda Kas assemblages, where *Khirtharia* is more abundant than *Indohyus*. The absence of dichobunids and the dominance of the evolved lophialetids over primitive isectolophids could mean that this fauna postdates the Chorlakkhi and Ganda Kas faunas.

Dichobunids from the Indo-Pakistan subcontinent have little in common with the Eocene dichobunids that were described from central Asia. *Aksyiria oligostus* is based on a single upper molar (or

deciduous molar) described by Gabunia (1973). It resembles *Lantianius xiehuensis*, a form referred to Dichobunidae by Gingerich (1976), in that its cingula extend far lingually (they are even complete lingually in the case of *Lantianius*), making the molars more or less quadrate.

A jaw fragment referred to *Hoanghoniuss stehlini* by Woo and Chow (1957), was considered to be a possible artiodactyl by Gingerich et al. (1979); P<sub>4</sub> has a very distinct metaconid, a feature unlike small dichobunids (it is present in certain larger bunodont forms like the holotype of *Bunophorus sinclairi*, PU 13448, and *Hyperdichobune*, see Sudre, 1978).

Zdansky (1930) described a few forms from the Eocene of China that are sometimes considered artiodactyls. The tooth of *Haplomyilus?* sp. is probably a dP<sub>4</sub> and may or may not be an artiodactyl. *Heptacodon dubium* is represented by a single upper molar. It may be a dichobunid but it is a much more advanced form with a large hypocone. Zdansky's *Dichobune?* sp. was thought to be related to anthracotheres by Gingerich et al. (1979). The P<sub>4</sub> of the specimen has a large metaconid, unlike primitive anthracotheres. Its affinities are not yet clear, but the selenodonty of its cusps indicates that it was certainly not a dichobunid. The Indian dichobunids are, with the exception of *Diacodexis*, endemic to the Indo-Pakistan subcontinent, just as the raoellids are.

Many authors have commented on the resemblances between the early and middle Eocene faunas from the Indian subcontinent and those of Asia and Europe (Pilgrim, 1940a; West, 1980; Sahni et al. 1981; de Bruyn et al., 1982; Hartenberger, 1982; Buffetaut, 1978; Thewissen et al., 1983; Kumar and Sahni, 1985). We suggest that only *Diacodexis pakistanensis* is closely related to non-Indo-Pakistan dichobunids, it compares well with European *Diacodexis* (Thewissen et al., 1983). Other Indo-Pakistan dichobunids and raoellids are endemic, but the latter family may be related to the European dacrytheriid *Tapirus*. Thus we consider think that the early to middle Eocene artiodactyls of the Indo-Pakistan subcontinent have European rather than Asiatic affinities.

Three of the four families of perissodactyls are only weakly indicative of affinities to forms of other continents. Tapiroids and hyracodontids are known from Indo-Pakistan, Europe, and Asia. Although genera described for the Indo-Pakistan subcontinent are often the same as those from Asia (*Hyrachyus*, *Teleolophus*, and *Triplopus*), we doubt that the material for these is complete enough to be absolutely diagnostic. The fourth family, Brontotheriidae, suggests affinity of the faunas of Indo-Pakistan and Asia. No brontotheres are known from Europe (except for *Diplacodon* from Rumania, see Osborn, 1929, but the locality from which it comes from is paleogeographically on the Asian and not on the European continent).

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