

A NEW DOCODONT MAMMAL FROM THE JURASSIC KOTA FORMATION OF INDIA

G.V.R. Prasad and B.K. Manhas

ABSTRACT

The late Middle Jurassic to Lower Cretaceous Kota Formation of peninsular India has previously yielded “symmetrodontan” and eutriconodontan mammals. Bulk screen-washing of the clays and mudstones interbedded with the limestone band representing the Upper Member of the Kota Formation and exposed along a stream cutting 150 m west of Paikasigudem village, Adilabad District, Andhra Pradesh, India, produced an isolated mammalian upper premolar. The premolar with its asymmetrical occlusal outline, two labial cusps, pinching of crown lingual to the labial cusps, and a wide talon basin is very similar to the upper premolars of docodont mammals. Detailed comparisons with the upper dentition of various known docodont taxa showed that the new specimen from India has premolar morphology comparable to a *Haldanodon* pattern, and here it is assigned to *Gondtherium dattai* gen. et sp. nov. (Docodontidae). This represents the first discovery of docodont mammals from the Southern Hemisphere and suggests a wide geographic distribution for this group of mammals.

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INTRODUCTION

The Kota Formation of Pranhita-Godavari Valley in peninsular India has been divided into two members—the Lower Member represented by sandstones and clays and the Upper Member characterised by a limestone zone followed by clays, mudstones, siltstones, and sandstones (Rudra 1982). The Lower Member yielded dino-

saur: *Barapasaurus tagorei* Jain et al. 1975, *Kotasaurus yamanapalliensis* Yadagiri 1988; mammals: *Kotatherium haldanei* Datta 1981, *Indotherium pranhitai* Yadagiri 1984 (= *Indozostrodon simpsoni* Datta and Das 2001), and wood fragments. A wide range of fossils have been reported from the limestones and intercalated mudstones and clays, and sandstones of the Upper Member. The faunal list

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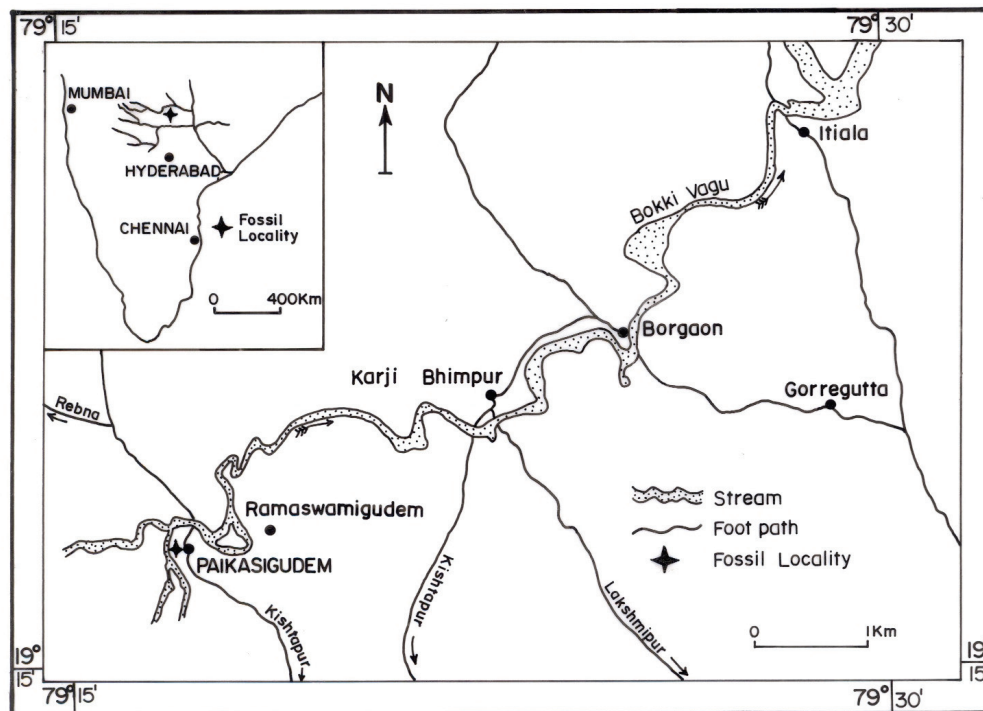


Figure 1. Map showing the location of mammal-yielding section of Kota Formation.

from the Upper Member is represented by semionotid fishes: *Lepidotes deccanensis* Sykes 1851, *Tetragonolepis oldhami* Egerton 1878, *Paradapedium egertoni* Jain 1973; pholidophorid fishes: *Pholidophorus kingi* Yadagiri and Prasad 1977, *P. indicus* Yadagiri and Prasad 1977; a coelacanth fish: *Indocoelacanthus robustus* Jain 1974a; freshwater hybodont sharks: *Lissodus indicus* (Yadagiri 1986) Prasad et al. 2004, *?Polyacrodus* sp. (Prasad et al. 2004); anurans of uncertain affinity; a cryptodire turtle: *Indochelys spatulata* Datta et al. 2000; ?teleosaurid crocodiles (Owen 1852, Nath et al. 2002); undetermined teeth of ornithischian and theropod dinosaurs; sphenodontids: *Rebbanasaurus jaini* Evans et al. 2001, *Godavarisaurus lateefi* Evans et al. 2001; an iguanian lizard: *Bharatagama rebbanensis* Evans et al. 2002; pterosaurs: *Campylognathoides indicus* Jain 1974b, *Rhamphorhynchus* sp. (Rao and Shah 1963); and mammals: *Trishulotherium kotaensis* Yadagiri 1984, *Nakunodon paikasiensis* Yadagiri 1985, *Paikasigudodon yadagirii* (Prasad and Manhas 1997) and *Dyskritodon indicus* Prasad and Manhas 2002. In addition, ostracods (Govindan 1975, Misra and Satsangi 1979), estheriids (Tasch et al. 1973), insects (Rao and Shah 1959), charophytes (Feist et al. 1991, Bhattacharya et al. 1994), stromatolites and wood fragments (Gururaja and Yadagiri 1987,

Rudra and Maulik 1987), have been documented from the Upper Member of the Kota Formation. Based on semionotid (Jain 1973) and pholidophorid fishes (Yadagiri and Prasad 1977) an Early Jurassic (Liassic) age has been assigned to the Kota Formation. In contrast, the ostracod fauna favors a Middle Jurassic age (Govindan 1975). Finally, the latest palynological data indicated a late Middle Jurassic to Early Cretaceous age for this formation (Vijaya and Prasad 2001).

Mammals from the Kota Formation have previously been referred to the "symmetrodontan" families Kuehneotheriidae (*Kotatherium haldanei* Datta 1981), *incertae sedis* (*Trishulotherium kotaensis* Yadagiri 1984) and Amphidontidae (*Nakunodon paikasiensis* Yadagiri 1985), and to the morganucodontan family Morganucodontidae (*Indotherium pranhitai* Yadagiri 1984). *Indozostrodon simpsoni*, referred to Megazostrodonidae (Datta and Das 2001), was synonymized with *Indotherium pranhitai* (Prasad et al. 2006). *Kotatherium yadagirii* Prasad and Manhas, 1997, originally described as a "symmetrodontan," was later redesignated as *Paikasigudodon yadagirii* and transferred to Megazostrodonidae (Prasad and Manhas 2002). However, Kielan-Jaworowska et al. (2004) tentatively placed *Paikasigudodon* in the eutriconodontan family Amphilestidae. In addi-

tion to these mammals, a new ?eutricodontan tooth (*Dyskritodon indicus* Prasad and Manhas 2002) with affinities to the North African genus *Dyskritodon*, one fragmentary left lower molar exhibiting some amphilestid features (Prasad and Manhas 2002) and two upper premolars possibly related to dryolestids (Prasad et al. 2006) have been described from the Kota Formation.

An upper premolar described in this paper is derived from a section of the Kota Formation (Upper Member) exposed along a stream cutting 150 m west of the village Paikasigudem in Adilabad District, Andhra Pradesh (state), a site that has previously yielded *Trishulotherium*, *Nakunodon*, *Indotherium*, and *Paikasigudodon* (Figure 1). This tooth along with a right lower molar has been briefly described in a short communication (Prasad and Manhas 2001). Unfortunately, the lower molar was lost during the preparation for scanning electron microscopic study. The microvertebrate fauna from this site also includes disarticulated remains of *Lepidotes* and other semionotid fishes, a few teeth of elasmobranchs (*Lissodus indicus*, ?*Polyacrodus*; Prasad et al. 2004), anurans of uncertain affinity, two new sphenodontid taxa (*Rebbanosaurus jaini* Evans et al. 2001; *Godavarisaurus lateefi* Evans et al. 2001), one iguanian lizard (*Bharatagama rebbanensis* Evans et al. 2002), isolated teeth of crocodiles, ornithischian, and theropod dinosaurs.

Cusp nomenclature used in this paper is that of Butler (1997). Measurements were taken with a micrometer attached to Censico STB III A stereoscopic microscope.

Institutional Abbreviations

VPL/JU/KM - Vertebrate Palaeontology Laboratory, University of Jammu, Kota Mammals, India; USNM—National Museum of Natural History, Washington, D.C, USA; MNHN—Muséum national d’Histoire naturelle, Paris, France; BMNH J—Natural History Museum, London, United Kingdom; VJ—Museum of Serviços Geológicos de Portugal, Lisbon, Portugal.

SYSTEMATICS

Order DOCODONTA Kretzoi, 1946
Family DOCODONTIDAE (Marsh 1887) Simpson, 1929
Genus GONDATHERIUM gen. nov.

Generic Diagnosis. Upper premolariform (possibly P3) tooth with an asymmetrically triangular, transversely wide crown bearing two main labial

cusps and one lingual cusp, separated by a talon basin, and two small cuspules form the protruding anterior angle of the tooth. The tooth differs from the upper molars of all known docodont taxa in having labial cusps with diverging tips that are separated by a broad notch, a less steeply sloping labial face of lingual cusp X, the absence of a posterior lingual cusp Y, asymmetrical occlusal outline, and absence of a talon basin anterior to the crest from the cusps A to X. Differs from the P3 of *Haldanodon* in the presence of two anterolabial cuspules and a well-developed lingual part of the crown with an anteroposteriorly wide lingual cusp. Differs from the P3 of *Docodon superus* Simpson 1929 in its more developed lingual part with a large cusp and in the presence of two anterolabial cusps, B and E.

Etymology. Genus named in honour of the Gond tribe of people inhabiting the area where the fossiliferous section is exposed, and therion – Greek for beast.

Type Species. *Gondtherium dattai* sp. nov.

Holotype. - VPL/JU/KM/12, left ultimate upper premolar (P3) (pseudotribosphenic-like mammal of Prasad and Manhas 1999)

Horizon and locality. Mudstones associated with the limestone horizons of the Upper Member of the Kota Formation, Upper Gondwana Group, exposed along a stream cutting 150 m west of Paikasigudem village, Rebbana Mandalam, Adilabad District, Andhra Pradesh (State), India.

Specific Diagnosis. Same as for the genus.

Etymology. Species named after Mr. P.M. Datta, Director, Geological Survey of India, who described the first mammal from the Kota Formation.

Description. The tooth is asymmetrically triangular in occlusal outline (maximum labial length = 1.43 mm, maximum lingual length = 0.83 mm, maximum posterior width = 1.23 mm, maximum anterior width = 1.80 mm). The enamel of the crown is not preserved. The crown bears three main cusps: two on the labial margin and one on the lingual side of the tooth (Figures 2.1-2.5, 3.1-3.4). Cusp A is the highest cusp and is situated in the middle of the labial margin (Figures 2.2-2.3, 3.2-3.3). Posteriorly, this cusp is connected by an angulated crest to a smaller cusp C (half the height of A) located at the posterolabial corner of the crown and presenting a convex posterior face. A very broad notch separates these two labial cusps from each other. The tip of A points straight ventrally, that of C posteroventrally (Figures 2.2, 3.3). Cusp A extends fur-

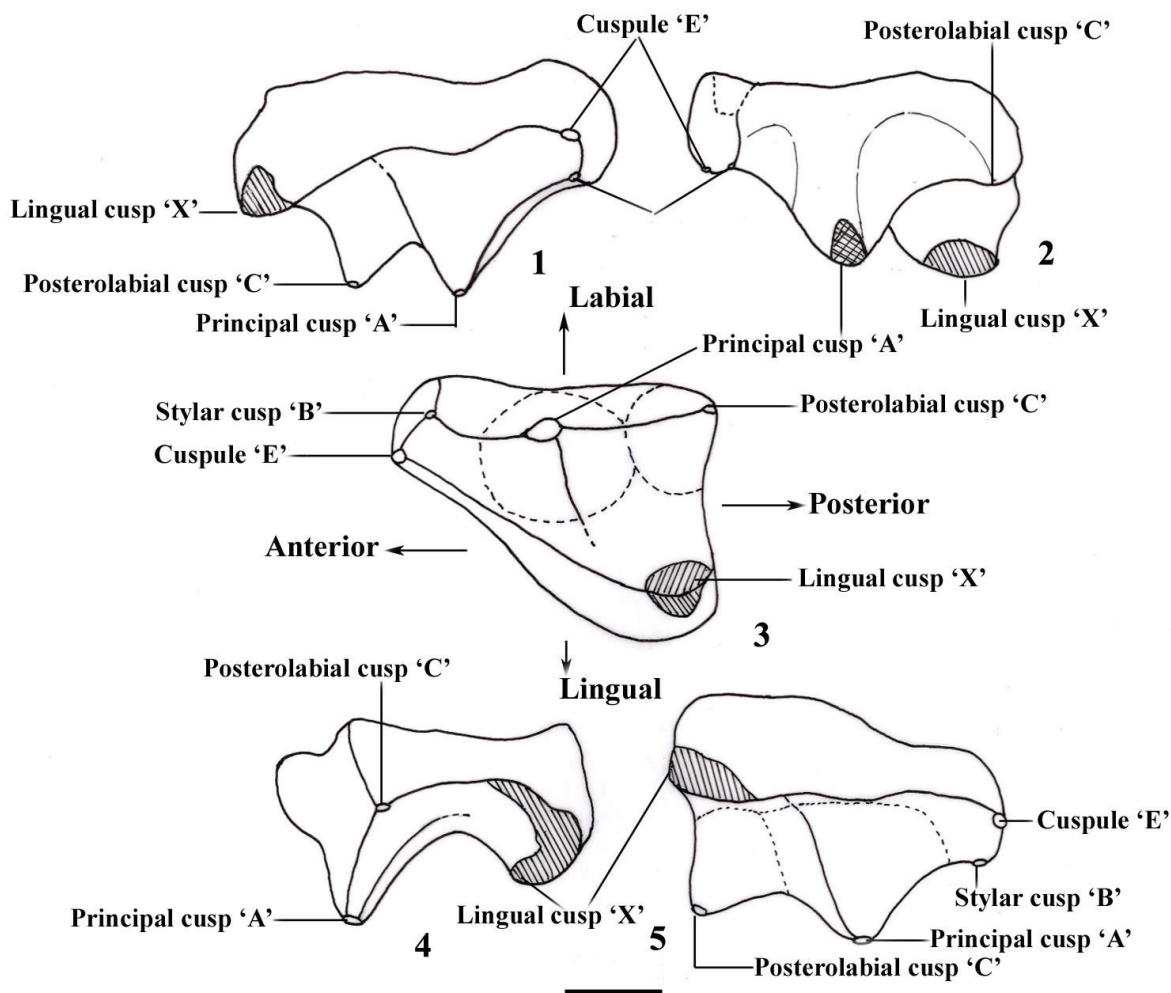


Figure 2. Line drawings of *Gondtherium dattai* gen. et sp. nov., left upper premolar, holotype VPL/JU/KM/12 in anterior (1), labial (2), occlusal (3), occluso-posterior (4), and occluso-lingual (5) views. Hatched areas mark spalling/breakage. Crossed hatching marks attritional wear. Scale bar equals 500 μ m.

ther lingually than C (Figure 2.3). A crest descends from the anterior tip of A, first anteriorly and then with a slight anterolabial turn at its base to merge with a small cuspule forming as a protuberance of the anterolabial margin (Figures 2.3, 3.2). This reduced cuspule possibly represents styler cusp B. At the anterolabial margin and slightly lingual to cusp B occurs another small worn cuspule, here called E (Figures 2.3, 3.2). The latter is of the same size as cusp B, but is situated at a slightly lower level and projects anteriorly. Cuspules B and E are connected by a crest (Figure 2.3). The two main labial cusps have nearly flat (C) or slightly convex (middle part of A) labial faces, but the crown is slightly concave labially because of the concavity between A and C and between the former and the anterolabial end of the tooth (Figures 2.2, 3.3).

Dorsally, the crown is broken at the level of the labial cingulum; from the preserved part, it appears that a very narrow labial cingulum might have been present. The anterolabial corner of the tooth has a flat, nearly vertical facet between cuspules B and E, possibly for receiving the posteriorly projecting C cusp of the preceding tooth.

A lingually extended talon with a large, stout and anteroposteriorly long lingual cusp X, lower than A but higher than C, is present (Figures 2.1-2.4, 3.1-3.4). This robust lingual cusp is separated from A by a deep basin. A completely worn crest descends lingually from the tip of A to the middle of its base and might have extended to the lingual cusp in the unworn condition. As the crown is spalled off in this area, this connection of A with X cannot be ascertained; only a weak trace of crest

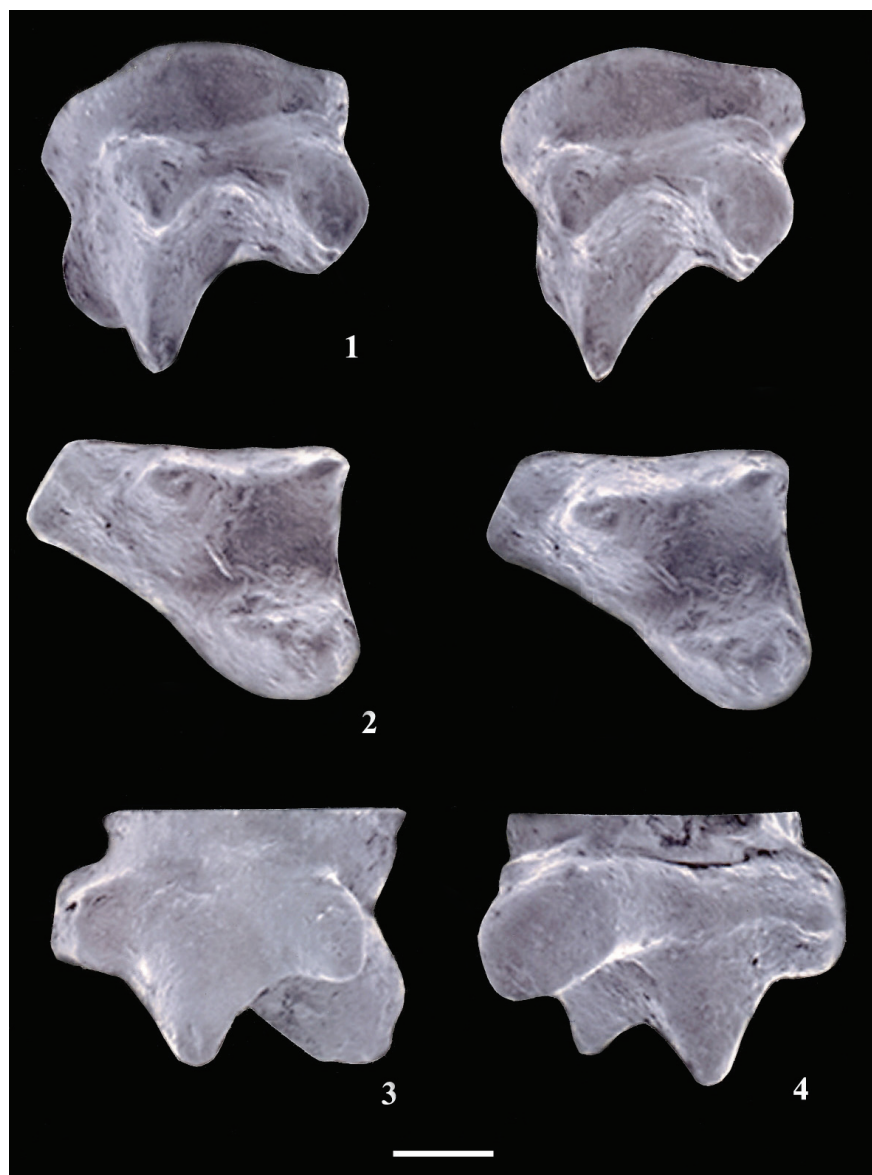


Figure 3. SEM photomicrographs of *Gondtherium dattai* gen. et sp. nov., left upper premolar, holotype VPL/JU/KM/12 in occluso-posterior (1), occlusal (2), labial (3), and anterior (4) views. (1) and (2) are in stereo pairs. Scale bar equals 500 μ m.

exists lingual to the base of A (Figure 2.3). The deep talon lies posterior to this weak trace of crest and occupies the space between the lingual junction of the labial cusps and the labial base of X, which slopes posterolabially (Figures 3.1-3.2). A highly worn cingular crest extends from the posterolabial tip of X to the lingual base of C. Another crest extending from the tip of X forms a gentle anterolabial slope and terminates at the lingual base of E. This crest is situated at a higher level than the posterior crest and forms a discrete anterior cingulum. The anterolingual face of X is convex dorsally but becomes flat ventrally and has a rela-

tively larger area than the posterolingual face, which is also convex; the latter shows some sort of enamel chipping. The posterior face of the tooth is nearly at right angle to the labial face, whereas the anterior face is very obliquely oriented to it (Figures 2.3, 3.2). The tooth is pinched at the lingual base of the labial cusps, particularly on the posterior face of the crown (Figure 3.2). Wear facets are not discernible as the enamel is not preserved. The roots are not preserved, but from the broken dorsal surface it appears that there were probably three roots. The pulp chamber is widely open and has a

smooth surface and rounded edges as in permanent teeth.

COMPARISONS

Prasad and Manhas (1999) briefly compared the morphology of the present upper premolariform tooth with docodonts and shuotheriids and placed it in neither of the two groups. As its coronal morphology, particularly asymmetrical occlusal outline, two labial cusps, a wide talon, and pinching of the crown lingual to the labial cusps, is strongly reminiscent of docodont upper teeth, Prasad and Manhas (2001) assigned the tooth to the Family Docodontidae. A detailed comparison of the premolar with the casts of various docodont taxa and other early mammalian groups was carried out at MNHN, Paris at a later stage. The Family Docodontidae is known by *Haldanodon* (Kühne and Krusat 1972), *Docodon* (Marsh 1881), *Simpsonodon* (Kermack et al. 1987), *Boreolestes* (Waldman and Savage 1972), *Peraiocynodon* (Simpson 1928, Averianov 2004), *Krusatodon* (Sigogneau-Russell 2003), *Dsungarodon* (Pfretzschner et al. 2005), *Cyrtlatherium* (Freeman 1979, Sigogneau-Russell 2001), *Tegotherium* (Tatarinov 1994), *Tashkumyrodon* (Martin and Averianov 2004), *Sibirotherium* (Maschenko et al. 2003), indeterminate docodontids (Averianov et al. 2005), *Itadodon* (Lopatin and Averianov 2005), *Castorocauda* (Ji et al. 2006), and possibly *Delsatia* (Sigogneau-Russell and Godefroit 1997). Among these, the first seven taxa are known from both upper and lower dentitions, whereas the rest are known from the lower dentition only.

The coronal morphology of VPL/JU/KM/12 is more reminiscent of the premolar morphology of docodonts than their molars. Among all known docodonts, upper premolars are known only in *Haldanodon expectatus* Kühne and Krusat 1972 and *Docodon* Marsh 1881. Indeed, a comparison of VPL/JU/KM/12 with P3 of *Docodon superus* Simpson 1929 (USNM 2715), shows several similarities: asymmetrical triangular crown outline, development of cingular crests anteriorly and posteriorly from X, and X higher than C. However, in marked contrast to VPL/JU/KM/12, on the P3 of *D. superus*, A is a trenchant cusp occupying more than 75% of the crown and extending almost to the lingual margin of the crown, C is only incipient, and B and E are rudimentary. Moreover, P3 of *D. superus* has a tiny accessory lingual cusp (Y) split from the posterior part of X. Finally and mostly there is no talon, and X is completely posterior in position in the P3 of *D. superus*.

In *Haldanodon*, the transverse width of molars is greater than their labial length, but in the premolars the reverse is the case, as on VPL/JU/KM/12. In fact, P3 of *Haldanodon* (Krusat 1980, VJ 1008-155, figure 20 D) is morphologically closer to VPL/JU/KM/12 than to its molars in having an asymmetrically triangular crown, a distinct cusp C, a narrow labial cingulum, a posteriorly protruding lingual part, and in the absence of cusp D. The lingual extension and its posterior protrusion are less extensive than in the Indian specimen, and the tooth has already developed two lingual cusps (X and Y). A deciduous premolar (dP3) of *Haldanodon* (Krusat 1980, VJ1030-155, pl.VIII, figures F-H) resembles VPL/JU/KM/12 in its more posteriorly placed lingual lobe, transversely narrow and small X, absence of Y, C cusp leaning away from A, and a more or less similar anterolabial corner. Only minor differences, such as in size, degree of posterior rotation of the lingual lobe and tilt of C, distinguish the two. But VJ 1030-155 is more like an upper molar than a premolar in the almost equal indentation of the anterior and posterior margins and the near symmetrical outline of the crown.

The upper premolar of *Delsatia rhupotopi* (Sigogneau-Russell and Godefroit 1997, figures c-e), considered as the most primitive member of docodonts (see Butler (1997) for a contrary view), is distinguished from VPL/JU/KM/12 in possessing a transversely narrow crown, a distinct medially interrupted labial cingulum, and no lingual extension of the crown. The only similarities between these two taxa are in the presence of cusp B and a detached E cuspule.

In *Haldanodon*, the contour of upper molar crowns is an asymmetrical triangle, and the molars are indented on the anterior and posterior borders lingually to the labial cusps. However, these borders of *Haldanodon* upper molars are nearly at right angles to the labial face, whereas on VPL/JU/KM/12, only the posterior face is at right angles to the labial face, whereas the anterior face is obliquely oriented to the latter. On the upper molars of *Haldanodon*, the labial cingulum is narrow, as seems to have been the case on VPL/JU/KM/12. Also in both taxa, the labial cusps are flat labially and convex lingually; A is the largest cusp; C is nearly half the height of A; X is lower than A, higher than C; talon basin is deep; and the cusp A is connected anterolabially to B by a crest. However, in *Haldanodon*, cusps A and C are separated close to their tips by a V-shaped valley, and the long axes of the two cusps are almost parallel to each other contrary to their diverging nature on VPL/JU/KM12

(the angle between them being close to 90°). Finally, again in both taxa, a cingular crest extends from the tip of *X* to *E* (anterior to the base of *B*). A second crest descending from the posterior tip of *Y* reaches the posterolabial base of *C* in *Haldanodon*; on VPL/JU/KM/12, as there is no cusp *Y*, a posterior crest from cusp *X* merges with *C* at its lingual base. Absence of a well-developed crest from the lingual base of *A* to *X*, less steep labial face of *X*, absence of cingular cuspule *D*, and shallow sulcus between *B* and *E* on VPL/JU/KM/12 further differentiate it from *Haldanodon* upper molars.

Upper molars with triangular occlusal outline and unequal labial cusps, as in *Haldanodon* and VPL/JU/KM/12, are also known from the Upper Bathonian Kirtlington mammal bed. VPL/JU/KM/12, however, differs from these teeth referred to *Borealestes serendipitus* Waldman and Savage 1972 in its asymmetrical crown and the absence of cusp *Y*. The upper molars attributed to *B. mussetti* Sigogneau-Russell 2003 are also distinguished from VPL/JU/KM/12, in the presence of a supplementary cuspule on the crest from *A* to *X* and hollowing of the lingual face of *A*.

Though the upper molar of *Dsungarodon zuoi* Pfretzschner et al. 2005 has a triangular occlusal outline, the crown is not asymmetrical as in VPL/JU/KM/12. Further, the upper molar of *Dsungarodon* differs from VPL/JU/KM/12 in having a crest originating at the lingual base of cusp *A* instead of its apex, strongly labially bent hook-like cusp *X*, a crest from the lingual base of *A* to *X* forming the anterior border of the talon basin, and a wide labial shelf with a deep ectoflexus.

Likewise, the upper molars attributed to *Krusatodon kirtlingtonensis* Sigogneau-Russell 2003 are triangular in outline as in VPL/JU/KM/12. But in *Krusatodon* the labial cusps form an arch in occlusal view; the crest from *A* to *X* is absent; the lingual part of the crown is inflated both anteriorly and posteriorly labial to *X*. The upper molars of *Simpsonodon oxfordensis* Kermack et al. 1987 and those attributed to *Peraiocynodon major* Sigogneau-Russell 2003 are also quite distinct from the present specimen in their trapezoidal or squarish crowns, in the development of labial cusps, the presence of extensive basins both anteriorly and posteriorly to the central crest from *A* to *X*, and the nearly symmetrical anterior and posterior borders with deep indentations. No upper premolars are known for these taxa.

VPL/JU/KM/12 is thus morphologically closer to P3 of *Haldanodon* than to that of *Docodon* and as such identified as an ultimate upper premolar.

The only characters which would negate its referral to the family Docodontidae are the absence of a distinct crest connecting *A* with the lingual cusp *X* and the absence of an additional lingual cusp *Y* (M5 of *Haldanodon* also lacks cusp *Y*, Krusat 1980, figure 20A; but, in contrast to VPL/JU/KM/12, it also lacks cusp *C* and with respect to the lingual part its labial part is small and compact). Absence of these two features might, however, be attributed to the chipping of the crown in the position of *Y* and to the rolled state of VPL/JU/KM/12. The weak crest from *A*-*X* on VPL/JU/KM/12 might be an artefact of the poor preservation of the tooth. It may also be a feature of the premolar. Similarly, absence of cusp *Y* is a premolar condition and therefore, does not preclude its referral to docodonts.

DISCUSSION

Prior to 1994, docodont mammals were known only from the Upper Triassic, Middle and Upper Jurassic, and Lower Cretaceous deposits of North America and Europe. This points to a typical Euramerican distribution for this group (Kron 1979). *Tegotherium gubini* Tatarinov 1994 was the first docodont mammal described from Asia (Late Jurassic of Mongolia). More recently, a number of docodont taxa have been reported from the Jurassic and Cretaceous rocks of Asia. These include *Castorocauda lurasimilis* Ji et al. 2006 from the Middle Jurassic of Inner Mongolia, *Tashkumyrodon desideratus* Martin and Averianov 2004 from the Middle Jurassic of Kyrgyzstan, *Itadodon tatarinovi* Lopatin and Averianov, 2005 from the Middle Jurassic of Western Siberia, *Dsungarodon zuoi* Pfretzschner et al. 2005 from the Late Jurassic of Junggar Basin of Northwest China, and *Sibirotherium rossicus* Maschenko et al. 2003 from the Early Cretaceous of Western Siberia. These discoveries demonstrated that docodont mammals had wide geographic distribution and formed an important component of Mesozoic vertebrate fauna of Asia.

Based on phylogenetic analysis of docodont lower molar characters, Averianov and Lopatin (2006) suggested that *Borealestes*, *Haldanodon*, and *Docodon* are plesiomorphic taxa restricted to Europe and North America, whereas *Tashkumyrodon*, *Itadodon*, *Tegotherium*, and *Sibirotherium* are more derived taxa confined to Asia. According to them, certain European taxa, such as *Krusatodon* and *Cyrtlatherium*, were Middle Jurassic immigrants from Asia. *Reigitherium bunodontum* Bonaparte 1990 from the Upper Cretaceous (Campanian–Maastrichtian) La Colonia Formation,

Argentina, originally described as a dryolestoid, was allocated to a highly derived docodont family Reigitheriidae, a possible sister group of Docodontidae and was considered as the first record of docodonts from the Gondwanan continents (Pascual et al. 2000). More recently, based on new material of Reigitheriidae from the La Colonia Formation, Rougier et al. (2003) transferred *Reigitherium* back to dryolestoids. In light of this, the new specimen from the Kota Formation is considered as the first record of docodont mammals from the southern continents indicating a wide geographic distribution for this group. Phylogenetic relationship of *Gondtherium* to the Asian taxa is difficult to assess as it is represented by an upper premolar, whereas a majority of the Asian taxa are known by lower molars and in a few cases by upper molars, but not by premolars. Within the clade consisting of *Boreolestes*, *Haldanodon*, and *Docodon* (Pfretzschner et al. 2005, Averianov and Lopatin 2006), the holotype of *Gondtherium* compares well with *Haldanodon* pattern of premolar morphology.

Because paleobiogeographic interpretation using a single premolar with poorly established taxonomic relationship would rest on a tenuous ground, the biogeographic significance of *Gondtherium* needs to be approached cautiously. However, the associated mammalian taxa help us in reconstructing a generalized paleobiogeographic scenario. The more recent discovery of *Dyskritodon* from the Kota Formation (Prasad and Manhas 2002), first recorded from the Early Cretaceous of Morocco, represents an example of faunal continuity across India and Africa. Furthermore, *Indotherium pranhitai*, another mammalian taxon documented from the Kota Formation (Yadagiri 1984, Prasad and Manhas 2002) exhibits some similarities to morganucodontid upper molars from the Middle Jurassic Kirtlington Quarry, England. Finally, *Kotatherium yadagirii*, originally described as a “symmetrodon,” is now referred to a new combination *Paikasigudodon yadagirii* (Prasad and Manhas 2002) within the “triconodont” family Morganucodontidae with close morphological similarities to Late Triassic *Megazostrodon* of South Africa (Crompton and Jenkins 1968). The occurrence of closely related mammals in the Jurassic of India and Late Triassic and Early Cretaceous of Africa, as well as Middle and Late Jurassic of Europe points to biogeographic connections between these regions. This is not surprising because paleogeographic maps show Europe in close proximity of NW Africa and India adjacent to Africa in the Early/Middle Jurassic (Scotese 1997, Chatter-

jee and Scotese 1999). The cosmopolitan distribution of the Kota fauna has also been corroborated by the non-mammalian vertebrate groups, ostracods, and charophytes. *Barapasaurus* and *Kotasaurus*, sauropod dinosaurs from the Kota Formation of India, and the Early Jurassic sauropod *Vulcanodon* of Zimbabwe appear to be closely related to the Late Triassic sauropod *Isanosaurus* of Thailand (Gillette 2003). The pterosaur *Campylognathoides indicus* is supposed to be closely related to *Dimorphodon* of Upper Liassic of Holzmaden, Germany (Jain 1974b). The ostracod *Darwinula* cf. *D. sarytirmenensis* has been described from the Lower Jurassic Kayenta Formation of North America (Kietzke and Lucas 1994), Middle Jurassic of Russia, and upper Middle to Upper Jurassic rocks of China (Govindan 1975). The charophyte taxon *Aclistochara* cf. *A. jonesi* is also known from the Upper Jurassic and Lower Cretaceous strata of Colorado and Wyoming (USA) and China (Feist et al. 1991). Presence of large sauropod dinosaurs similar to those of Africa, Europe, and Asia in the Jurassic of India has been cited in support of land connections that facilitated faunal interchanges between these landmasses (Chatterjee and Hotton 1986).

In a comprehensive account on the biogeography of Indian plate during the Mesozoic, Chatterjee and Scotese (1999) argued that, from Late Triassic to Late Jurassic, the Indian plate was tectonically a part of Gondwanaland and maintained two biogeographic corridors with central Africa (via Madagascar) and southern Africa (via Antarctica), and one with western South America (through Antarctica), resulting in the influx of several Laurasian as well as Gondwanan taxa. They predicted Morocco as a possible biogeographic link between the Laurasian and Gondwanan continents. The latest discovery of *Dyskritodon* from the Kota Formation (Prasad and Manhas 2002) is consistent with their interpretation. A Late Jurassic trans-Tethyan dispersal for primitive mammals such as “triconodonts,” dryolestoids, and peramurids of Laurasian origin into Africa was suggested recently (Rauhut et al. 2002). A somewhat similar dispersal during the Late Jurassic–Earliest Cretaceous was suggested for albanerpetontid and discoglossid amphibians and early mammals (*Thereudon*, *Tribotherium*, *Hypomylos*, *Gobiconodon*, *Hahnodon* and *Denisodon*) based on Early Cretaceous (?Berriasian) terrestrial vertebrate fossil record of Morocco (Kielan-Jaworowska et al. 2004). In view of this continuity of mammalian as well as non-mammalian taxa during the Jurassic and Early

Cretaceous across Gondwanan continents, it is predicted that early docodonts might have existed on other southern continents as well. The possible reasons for not finding them on the southern continents until now are 1) restricted occurrence of Jurassic continental sequences in this part of the globe, 2) low intensity sampling of the known deposits, and 3) taphonomic factors. Meanwhile if the Early Jurassic age is accepted for the Kota Formation, the tooth described earlier in this report would represent the oldest report of docodonts. However, there are conflicting views on the age of the Kota Formation. It has been dated as Early Jurassic (Upper Liassic) based on the fish fauna (Jain 1973), whereas the ostracod fauna favoured a Middle Jurassic age (Govindan 1975). Palynoflora, on the other hand, indicate a late Middle Jurassic to Early Cretaceous age (Vijaya and Prasad 2001). Therefore, a concerted effort by vertebrate paleontologists, micropaleontologists, and palynologists is necessary to resolve this issue. Notwithstanding the disparities in these datings, the new find from India is of paramount importance as it testifies to the presence of typical docodont mammals in Gondwanan continents.

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