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First mammal of Gondwanan lineage in the early Eocene of India

Premiers mammifères de la lignée gondwanienne dans l'Éocène inférieur de l'Inde

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ABSTRACT

Based on well-preserved lower dentition, a new adapisoriculid from the Cambay Shale Formation (basal Eocene, ~54.5 Ma) in the open cast lignite mine of Vastan, Gujarat State, western India, is described. *Indolestes kalamensis* gen. et sp. nov adds significantly to the diversity of basal eutherians from Vastan as it represents a family hitherto not known from the Eocene of the Indian Subcontinent. Phylogenetic analysis suggests that *Indolestes* is derived relative to *Deccanolestes* and *Afrodon*, but primitive relative to the European adapisoriculids *Bustylus* and *Adapisoriculus*. The new data from the early Eocene provide evidence for continued survival of a Gondwanan mammal lineage following the Deccan volcanic activity (Cretaceous–Paleogene transition) in the Indian Subcontinent.

Mots clés :
Adapisoriculidés
Shale de Cambay
Éocène inférieur
Gondwana
Inde
Mammifères

RÉSUMÉ

Basée sur une dentition inférieure, la description d'un nouvel adapisoriculidé de la formation Cambay Shale (Éocène basal, environ 54,5 Ma) dans la mine à ciel ouvert de Vastan, État de Gujarat, Inde occidentale, est ici présentée. *Indolestes kalamensis* gen. et sp. nov. ajoute de manière significative à la diversité des euthériens de base de Vastan, en ce qu'il représente une famille jusqu'à présent inconnue dans l'Éocène du sous-continent Indien. Une analyse phylogénétique suggère que *Indolestes* serait dérivé de *Deccanolestes* et *Afrodon*, mais primitivement des adapisoriculidés européens *Bustylus* et *Adapisoriculus*. Les nouvelles données sur l'Éocène inférieur fournissent l'évidence d'une survie continue d'une lignée mammalienne gondwanienne suivant l'activité volcanique du Deccan à la transition Crétacé–Paléogène dans le sous-continent Indien.

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1. Introduction

Small mammals belonging to the family Adapisoriculidae have perplexed paleontologists for over a century and have been variously assigned to different groups including didelphids, nyctitherids, leptidectids, mixodectids and palaeoryctids owing to the presence of several plesiomorphic dental characters (e.g., De Bast et al., 2012). These characters include transverse elongation of teeth, prominent parastyle and stylocone, variable stylar cusps, long prepara- and postmeta-cristae on a wide stylar shelf, rectilinear or dilambdodont centrocrista, separation of paracone and metacone down to their bases, reduced height difference between trigonid and talonid compared to cimolestids, and cristid obliqua extending high on to the posterior wall of the trigonid. Currently, adapisoriculids are represented by seven genera (*Deccanolestes, Afrodon*, *Bustylus*, *Adapisoriculus*, *Garatherium*, *Remiculus* and *Proremiculus*) with the oldest record (*Deccanolestes*) known from the Late Cretaceous (Maastrichtian) Deccan intertrappean deposits of peninsular India (Prasad et al., 2010). Adapisoriculids are also known from the Paleocene and Eocene of Europe and Africa (De Bast et al., 2013; Gheerbrant, 1995; Gheerbrant and Russell, 1991). Taxa restricted to Africa include *Garatherium*, while those known only from Europe include *Bustylus*, *Proremiculus* and *Remiculus*. Still others, such as *Adapisoriculus* and *Afrodon* are common to Africa and Europe (De Bast et al., 2012, 2013; Gheerbrant, 1988, 1991, 1995; Gheerbrant and Russell, 1989, 1991; Gheerbrant et al., 1998; also refer Table 1, Figs. 1 and 2, present study).

Though possible euarchonton affinities have been suggested for adapisoriculids based on tarsal bone morphology (Boyer et al., 2010; Prasad and Godinot, 1994; Smith et al., 2010), phylogenetic analysis of combined dental and tarsal characters demonstrated that adapisoriculids are basal eutherians and that *Deccanolestes*, the oldest known adapisoriculid, is a sister taxon of the Early Paleogene *Afrodon* from Africa (Goswami et al., 2011). Here we describe a new adapisoriculid from the same geographic region (peninsular India) that is known to yield the oldest record of this group (i.e., *Deccanolestes*). The new find reported here is approximately 10 million years younger in age than *Deccanolestes*.

2. Locality and age

The material described in this paper comes from the North Pit of the Vastan Lignite Mine (21°25′47″N; 73°07′30″E) situated about 65 km northeast of the city of Surat and close (about 3 km) to a small village Nani Naroli in District Surat, Gujarat, western India (Fig. 3). Details of lithofacies and depositional environments are discussed in Prasad et al. (2013). Data on dinoflagellates, $\delta^{13}C$ and

Table 1
List of known adapisoriculids.
Tableau 1
Liste des adapisoriculidés.

Taxon	Locality	Geographic area	Age	Author(s)
Deccanolestes hislopi	Naskal, India	Indian Subcontinent	Late Cretaceous (Maastrichtian)	Prasad and Sahni, 1988
Deccanolestes robustus	Naskal, India	Indian Subcontinent	Late Cretaceous (Maastrichtian)	Prasad et al., 1994
Deccanolestes cf. *hislopi*	Naskal, India	Indian Subcontinent	Late Cretaceous (Maastrichtian)	Prasad et al., 1994
Deccanolestes narmadensis	Kisalpuri, India	Indian Subcontinent	Late Cretaceous (Maastrichtian)	Prasad et al., 2010
Afrodon chleuhi	AdrarMgorn 1, Morocco	Africa	Late Paleocene	Gheerbrant, 1988
Afrodon tagourtensis	N'Tagourt 2, Morocco	Africa	Early Eocene	Gheerbrant, 1993
Afrodon ivani	Pyrenees, Spain	Europe	Late Paleocene	López-Martínez and Peláez-Campomanes, 1999
Afrodon gheerbranti	Hainin, Belgium	Europe	Early Paleocene (MP1-5)	De Bast et al., 2012
Bustylus cernaysi	Cernay, France	Europe	Late Paleocene	Gheerbrant and Russell, 1991
Bustylus marandati	Hainin, Belgium	Europe	Early Paleocene (MP1-5)	Gheerbrant, 1991
Bustylus folieae	Hainin, Belgium	Europe	Early Paleocene (MP1-5)	De Bast et al., 2012
Bustylus marandati	Hainin, Belgium	Europe	Early Paleocene (MP1-5)	De Bast et al., 2012
Bustylus germanicus	Walbeck, Germany	Europe	Late Paleocene	De Bast et al., 2013; Gheerbrant and Russell, 1989
Garatherium mahboubii	El-Kohol, Algeria	Africa	Early Eocene	Crochet, 1984
Proremiculus lagnauxi	Hainin, Belgium	Europe	Early Paleocene (MP1-5)	De Bast et al., 2012
Remiculus deutschi	Walbeck, Germany	Europe	Late Paleocene	Russell, 1964
Remiculus delsatei	Dormaal, Belgium	Europe	Early Eocene	Smith, 1997
Adapisoriculus minimus	Cernay, France	Europe	Late Paleocene	Lemoine, 1885
Indolestes kalamensis gen. et sp. nov.	Vastan, India	Indian Subcontinent	Early Eocene	Present study