

A Cretaceous Hoofed Mammal from India

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Ungulate or hoofed mammals represent the most important herbivores of Cenozoic land mammal communities. Condylarths or archaic ungulates are a paraphyletic group regarded as an ancestral or sister taxon to living ungulate mammals (1) and are known by fossils from the Early Paleocene of North America and South America, the Late Paleocene and Eocene of Europe, and the Eocene of Africa and possibly Australia. The earliest definitive ungulates represented by *Protungulatum*, *Oxyprimus*, *Baioconodon*, and *Mimatuta* (1, 2) come from the Early Paleocene (Puercan) of north-eastern Montana. No Cretaceous condylarth has yet been documented. Here, we describe an isolated lower molar (m_1 or m_2) of a condylarth mammal from the Late Cretaceous (Maastrichtian) lacustrine rocks interbedded with Deccan volcanic flows of Central India [Supporting Online Material (SOM) text and fig. S1]. The tooth is cataloged as VPL/JU/IM/31 and deposited in the Vertebrate Paleontology Laboratory of Jammu University.

Class: Mammalia Linnaeus, 1758. **Order:** Condylarthra Cope, 1881. **Family:** Incertae Sedis. *Kharmerungulatum vanvaleni* genus et species nova.

Holotype. VPL/JU/IM/31, isolated right lower molar.

Generic Diagnosis.

Asymmetrical trigonid wider and longer than talonid, bulbous cusps, paraconid slightly labial to the lingual margin, voluminous protoconid twice as large as metaconid and closely appressed to it, metaconid slightly posterior to protoconid with the posterior trigonid wall

slightly oblique to the long axis, entoconid smaller than hypoconulid and basally conjoined to it forming an oblique posterolingual crest, hypoconid is the most voluminous talonid cusp, talonid basin partially closed lingually, obliquely transverse talonid groove, size smaller as compared to other archaic ungulates (SOM text).

Etymology. Genus named after the nearby Kharmer River; species named in honor of Leigh Van Valen.

Specific Diagnosis. As for genus.

Basal expansion and sidewall convexity of the lower molars are conspicuous differences between archaic ungulates and Cretaceous eutherians such as *Cimolestes*, *Procerberus*, *Batodon*, *Gypsonictops*, and *Deccanolestes*. Archaic ungulates developed the ability to crush and grind food through reduced height difference between the trigonid and talonid, cusp bunodonty, the possession of a large hypoconid, and characteristic abrasion causing

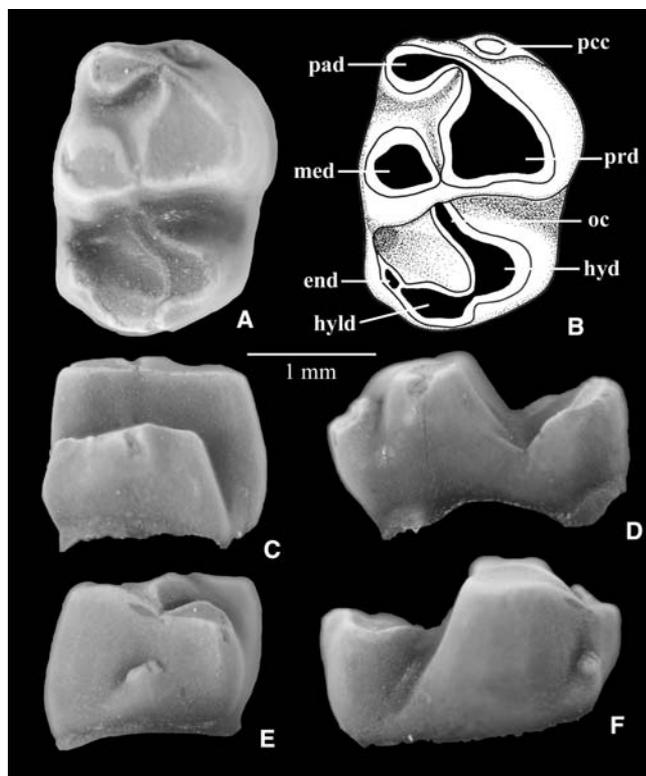


Fig. 1. Holotype of *Kharmerungulatum vanvaleni* genus et species nova, isolated right lower molar (m_1 or m_2 , VPL/JU/IM/31). End, entoconid; hyd, hypoconid; hyld, hypoconulid; med, metaconid; oc, cristid obliqua; pad, paraconid; pcc, precingulid cuspule; and prd, protoconid. (A) Occlusal view. (B) Line drawing of (A). (C) Posterior view. (D) Lingual view. (E) Anterior view. (F) Labial view.

beveling of cusp apices (1). The morphology of *Kharmerungulatum* (Fig. 1, A to F) is like that of the lower molar morphology of archaic ungulates, but the latter are relatively larger and have more bunodont cusps. *Kharmerungulatum* retains many plesiomorphic characters that occur variably in *Protungulatum*, *Oxyprimus*, *Baioconodon*, and

Mimatuta. These include trigonid moderately taller than the talonid; paraconid slightly labial to the lingual margin and well separated from the metaconid, as in *Mimatuta*, *Protungulatum gorgun*, and *Baioconodon middletoni*; obliquely oriented paracristid, as in *Protungulatum* and *Oxyprimus*; obliquely oriented posterior trigonid wall with a slightly posteriorly developed metaconid and asymmetrical trigonid, as in *Protungulatum dommae*; short entocristid partially closing the talonid lingually, as in *Protungulatum*, *Oxyprimus*, and *Baioconodon*; and a cristid obliqua joining the posterior trigonid wall below the posterolabial base of the metaconid. However, in relative dimensions of talonid cusps and closely appressed entoconid and hypoconulid forming a posterolingual crest, *Kharmerungulatum* is also comparable to South American *Molinodus* (3).

Among all species of archaic ungulates, *Kharmerungulatum* is closest to *P. gorgun* in cusp morphology except that it lacks cingulids [figure 3F of (4)] and to *Baioconodon* in having a talonid shorter and narrower than the trigonid (SOM text). We consider *Kharmerungulatum* to represent an early stage in the evolution of ungulates.

The presence of an archaic ungulate in the latest Cretaceous of India may reflect that (i) archaic ungulates had a pan-Gondwanan distribution, and their absence in other landmasses may be an artifact of limited field investigations; (ii) *Kharmerungulatum* immigrated to India from Western Asia, which had a diversified assemblage of zhelestids (85 million years ago) regarded by some as ancestral to archaic ungulates (5), although any connection is disputed (6); and (iii) the drifting Indian subcontinent may have served as a center of origin for many mammalian orders and other vertebrate and plant groups.

References and Notes

1. J. D. Archibald, *Univ. Calif. Publ. Geol. Sci.* **122**, 1 (1982).
2. L. Van Valen, *Evol. Theory* **4**, 45 (1978).
3. C. de Muizon, R. L. Cifelli, *Geodiversitas* **22**, 47 (2000).
4. J. J. Eberle, J. A. Lillegraven, *Rocky Mount. Geol.* **33**, 49 (1998).
5. J. D. Archibald, *Science* **272**, 1150 (1996).
6. J. R. Wible, G. W. Rougier, M. J. Novacek, R. J. Asher, *Nature* **447**, 1003 (2007).
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Supporting Online Material

www.sciencemag.org/cgi/content/full/318/5852/937/DC1
SOM Text
Fig. S1
References

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