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TARSIROID PRIMATE FROM THE EARLY TERTIARY
OF THE MONGOLIAN PEOPLE'S REPUBLIC

Abstract.—A tiny tarsioid primate occurs in early Eocene sediments of the Naran Bulak Formation, southern Gobi Desert, Mongolian People's Republic. The new primate, *Altanius orlovi*, new genus and species, is an anaptomorphine omomyid and therefore belongs to a primarily American group of primates. *Altanius* is apparently not a direct ancestor of the Asian genus *Tarsius*. American rather than European zoogeographic affinities are indicated, and this in turn supports the view that for a time in the earliest Eocene the climate of the Bering Route was sufficiently warm to support a primate smaller than *Microcebus*.

INTRODUCTION

The discovery of a new genus and species of tiny fossil primate, *Altanius orlovi*, from the upper part of the early Tertiary Naran Bulak Formation of the southwestern Mongolian People's Republic extends the known geologic range of the order Primates in Asia back to the very beginning of the Eocene and establishes that anaptomorphine tarsioid primates were living in that part of the world a little more than fifty million years ago. Previously, the oldest known Asian animals referred by various authors to the Primates were *Pondaungia* Pilgrim, 1927, *Hoanghoni* Zdansky, 1930, *Amphipithecus* Colbert, 1937, *Lushius* Chow, 1961, and *Lantianius* Chow, 1964, described on the basis of a handful of specimens from late Eocene deposits in China and Burma about ten million years or more younger than the youngest part of the Naran Bulak Formation. These late Eocene animals were significantly larger than *Altanius orlovi* and not obviously relatives of *Altanius orlovi* on the basis of known morphology. Furthermore, considerable diversity of opinion exists concerning the affinities of the late Eocene forms, ranging from discussions of whether this or that genus is lemuroid, tarsioid, or anthropoid to denial in certain instances of primate status in favor of identification as primitive ungulates. Gingerich (1976) has compared *Lantianius* favorably with primitive ungulates; a strong similarity to *Metachriacus* has also been noted by Manning (personal communication). The only other known Asian close

relative of *Altanius* is the living *Tarsius* Storr, 1780, which at present inhabits various islands off the southeast coast of Asia from Samar in the Philippine Islands to Sumatra. "*Kansupithecus*" Bohlin, 1946, from the mid-Tertiary of northwestern China, is not similar to *Altanius*. *Altanius* is thus a surprising but very welcome addition to the Asian early Tertiary mammalian roster.

Anagale Simpson, 1931, was at one time considered to be a lemuriform primate (Simpson, 1945, p. 61), but studies by Evans (1942), Bohlin (1951), McKenna (1963), and others have shown that *Anagale* is not a primate. Rather, the known anagalid genera, ranging in age from Paleocene to early Oligocene of eastern Asia, appear to be related to the living and fossil macroscelidoids of Africa and currently are classified as Asian relatives of that group by McKenna (1975a).

The newly discovered Mongolian primate shares certain derived characters with the anaptomorphine omomyid tarsioids. We therefore classify it with them. The genus also retains various primitive characters modified by advanced members of the omomyid subfamilies and by various other primates. In our opinion, *Altanius* resembles the North American genera *Tetonius* Matthew, 1915, *Anemorhysis* Gazin, 1958, and *Pseudotetonius* Bown, 1974 most closely among known primates, but also resembles *Tarsius* and *Teilhardina* Simpson, 1940 to a significant but lesser extent primarily because of the retained primitive features on P_4-M_3 of these last two genera. *Altanius* shows still less similarity to the relatively much larger Asiatic genus *Hoanghoni* but cannot be compared directly except by its smaller size with *Lushius* because *Lushius*, whatever its affinities, is known from upper teeth only. *Amphipithecus* and *Pondaungia* from the late Eocene of Burma are much larger as well, and in any case are not anaptomorphines.

Within the Tarsioidea *Altanius* is not known to share unique derived characters with *Tarsius* that are not also shared with omomyids in general. For this reason the new genus is not identified as either a direct ancestor or even a sister group of the only surviving tarsioid genus, although it could actually be one without this being knowable. Collection of additional material may indeed establish that *Altanius* is a sister taxon of some other taxon that includes *Tarsius*. For the moment, however, it is still satisfactory procedure to regard *Tarsius* as more closely related to the omomyines and microchoerines of North America and Europe than to the Anaptomorphinae. That is, *Tarsius* may be a modified survivor of early Tertiary omomyids that ranged from North America to Europe around the north end of the North Atlantic Ocean (McKenna, 1975b) and were later distributed along the north shores of the Tethyan Ocean, rather than a direct descendant of anaptomorphine stock represented by the new early Tertiary Mongolian genus *Altanius*. We simply leave this question open and await eventual cladistic analysis of additional material.

Altanius is evidently the smallest known tarsiid primate, living or fossil, and in size is rivaled among primates and primate-like animals only by the smallest microsyopids. Body size and weight can only be guessed at, but P_4-M_3 length is approximately 60% of the length of the same teeth in *Microcebus murinus* (Miller, 1777) the smallest living primate, a cheirogaleine strepsirhine from Madagascar, and the same teeth are somewhat smaller than those of the early Tertiary North American microsyopids *Palenochtha minor* (Gidley, 1923) and *Tinimomys graybulliensis* Szalay, 1974. The microsyopid *Micromomys silvercouleei* is, however, apparently slightly smaller than *Altanius orlovi*, judged from the scale of illustrations of the type specimen of the former, which do not agree with the measurements reported in the text of the same paper (Szalay, 1973). The deep jaw of *Altanius* does compare well in depth below M_2 with the same measurement in shallow-jawed larger forms (table 2), but body size and weight of *Altanius* must have been smaller and the skull less elongated than in those animals. By analogy with modern primates, such a small animal probably lived in a warm climate in which food was rather constantly available, probably primarily in the form of insects and other small invertebrates rather than primarily fruits or gums.

The described material is housed in the Geological Institute Section of Paleontology and Stratigraphy, the Academy of Sciences of the Mongolian People's Republic, Ulan Bator, abbreviated as GI SPS.

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GEOLOGICAL OCCURRENCE

The specimen discussed in this paper was found in the earliest Eocene of the Nemegt (Nemeget) Basin, Mongolia (fig. 1). The Nemegt Basin is a complex structural depression in the southwestern part of the Mongolian People's Republic whose longitudinal and latitudinal coordinates are approximately $100^{\circ}15' - 102^{\circ}00'$ E.; $43^{\circ}15' - 43^{\circ}45'$ N. The basin is bounded on the north and south by uplifted Paleozoic blocks and trends nearly east-west for more than 100 km. Its width between bounding ranges is about 35—45 km., depending on the location. To the north lie ranges

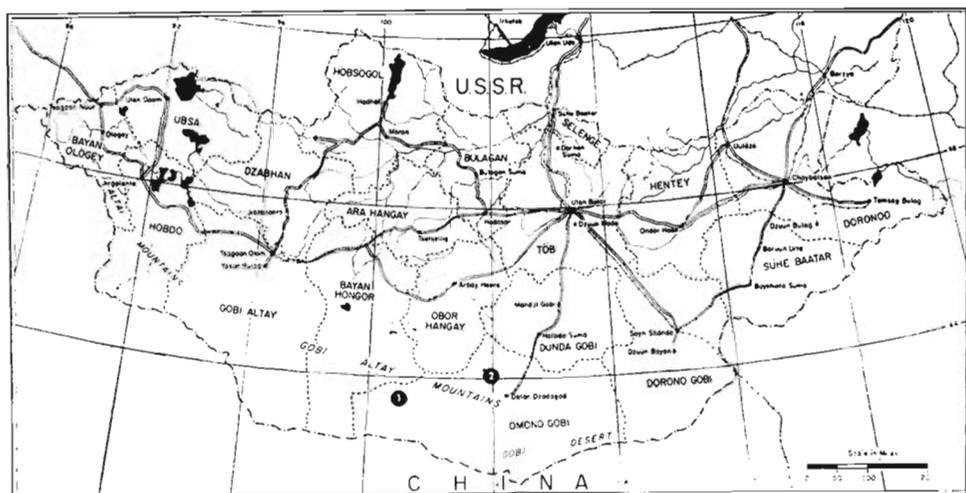


Fig. 1. Index map of the Mongolian People's Republic. *Altanius orlovi* has been found thus far only in the Naran Bulak Formation of the Nemegt Valley. (1) Nemegt Valley, (2) Gashato.

known as Altan Ula, Nemegt Ula, and Gilbert Ula, while to the south are found the Tost Ula and Noyon Ula. Dissected, gently south-southwest dipping, late Cretaceous sediments are extensively exposed in badland outcrops along the north side of the Nemegt Basin, where they are in fault contact with much older rocks of the uplifted blocks to the north. These late Cretaceous sediments are nonmarine and have produced large numbers of well-preserved vertebrate fossils, notably dinosaurs. To the southwest, these late Cretaceous sediments are disconformably or, more probably, slightly unconformably overlain by an unknown thickness of gently south dipping, early Tertiary, nonmarine sediments north of the west end of the range known as the Tost Ula. The relationships of these early Tertiary sediments to the structure of the Tost Ula or to similar sediments northwest of the Nemegt Basin have not yet been studied by field geologists.

Early Tertiary vertebrate fossils have been found by various expeditions at several levels at three general localities north of the Tost Ula: Ulan Bulak (Red Spring), Naran Bulak (Sunshine Spring), and Tsagan Khushu (White Promontory). These localities extend more or less in a line from east to west, south of Ekhin Dzooganay (Ekhin Tszuluganai) Gol [Wash] and appear on maps prepared by Novozhilov (1954, fig. 1) and Gładziński *et al.* (1969, fig. 1). The distance from the west end of the explored part of the Tsagan Khushu exposures in the west to Ulan Bulak in the east is about 12 km. Naran Bulak is situated about midway between these extremes at $100^{\circ}26'00''$ — $100^{\circ}27'30''$ E; $43^{\circ}27'30''$ — $43^{\circ}28'30''$ N.; 1460—1530 meters above sea level. The spring responsible for the name Naran Bulak is surrounded by a prominent green patch of vegetation that can be seen from some distance away.

The geology of the deposits containing early Tertiary vertebrates in the Nemegt Basin has been discussed by Rozhdestvensky 1949, pp. 465—466, Efremov (1954, p. 22), Novozhilov (1954), Dashzeveg (1968), Gradziński *et al.* (1969), and Shishkin (1975) on the basis of first-hand knowledge. Recently it has been claimed that these same deposits also occur outside the Nemegt Basin at a site called Khaichin Ula II, about 50 km. northwest of Altan Ula (Shuvalov *et al.*, 1974). Analyses by paleontologists lacking first-hand knowledge of the field relations but incorporating studies of the fossils known thus far from the early Tertiary of the Nemegt Basin have been provided by Flerov (1957) and by Szalay and McKenna (1971). No generally accepted formal stratigraphic nomenclature has been employed by the Soviet, Mongolian, or Polish workers who have dealt with these deposits, but Flerov (1957, pp. 37, 39) provided the term *naranbulakskaya svita*, which we translate in English as Naran Bulak Formation. This is more or less a formalization of Novozhilov's (1954, p. 37) Naran-Bulak beds (fig. 2), also called Naranbulak beds by Dashzeveg (1968). For precision of future discussion we herein fix the type section (stratotype) of the Naran Bulak Formation as those Tertiary sediments depicted at Naran Bulak in figure 12 of Gradziński *et al.* (1969), including the underlying conglomeratic sequence (Pink beds). The latter are not the same as Novozhilov's (1954) "Sandstone-conglomerate series", which is probably Cretaceous in age. The sediments of the Naran Bulak Formation have been subdivided by Novozhilov (1954) and also later in a somewhat different way by Gradziński *et al.* (1969). Novozhilov's uppermost unit, his "red-brown, sandy-clayey Bumbin-Nuru beds", is not represented in the type section (stratotype) of the Naran Bulak Formation but is nevertheless referred by us to the Naran Bulak Formation as an upward extension. Dashzeveg (1968, p. 415) stated that these upper red-brown beds are "sharply distinguished from the underlying deposits of the Naranbulak [sic] beds", but he did not discuss whether this is because of a disconformity, unconformity, color change, or other change in sedimentary characteristics or genesis. At present we believe that there is no significant stratigraphic break. Novozhilov's (1954) informal term for the uppermost unit, above the White Beds, was "red-brown, sandy-clayey Bumbin-Nuru beds" (Bumban or Boombin Nooru beds), emended to Bumbin Nuru beds by Dashzeveg (1968). These sediments are the same as the Upper Red Beds of Gradziński *et al.* (1969). We deliberately select the type section (stratotype) of the Naran Bulak Formation in such a way as to exclude the Bumbin Nuru beds, although we do not exclude them from the Naran Bulak Formation as a whole. Their age is presently unknown in detail other than that they are younger by some unknown amount or amounts than the youngest sediments of the White Beds at the top of the type section (stratotype) of the Naran Bulak Formation. Efremov (1954, chart opposite p. 12) referred these and probably additional overlying sediments,

with a query, to the middle Eocene and gave a thickness of 500 meters for them, but he presented no substantiation. Dashzeveg (1968), on the basis of a few fossils including an undescribed notoungulate larger than and differing somewhat from described species of *Palaeostylops*, regarded the Bumbin Nuru beds as “not younger than lower Eocene”, but whether this determination, based on fossils from a single locality, will hold for the entire sequence of the Bumbin Nuru and overlying beds is not yet known.

To the northwest of the Nemegt Basin Shuvalov *et al.* (1974) recognize the presence of what they identify as the Naran Bulak Formation beneath their vaguely defined middle and late Eocene Khaichin Formation (*ibid.*, p. 322), but they do not discuss why the latter is not a local extension and facies of the Bumbin Nuru beds. These matters will have to be dealt with as the geology of the whole area becomes better known.

Novozhilov, 1954		Gradziński <i>et al.</i> , 1969	This paper		
(12) Red-brown, sandy-clayey Bumbin-Nuru beds		Upper Red Beds	Bumbin Nuru beds	Naran Bulak Formation	EOCENE
(4-11) Sandy-clayey white series (bone- bearing series)	Naran-Bulak beds	White Beds	Type Naran Bulak Formation		
(3) Sandy-clayey purple bed, = lowest level of white series		Lower Red Beds			
		Pink Beds (conglomeratic)			

Fig. 2. Stratigraphic divisions of the Naran Bulak Formation, Nemegt Basin, Mongolian People's Republic.

Table 1

FOSSIL VERTEBRATES REPORTED FROM THE WHITE BEDS OF THE NARAN BULAK FORMATION.

Taxon	Locality	Local Level	Authority
Large amiid fish	Various	Upper, ?Lower	Novozhilov, 1954
<i>Pseudochrysemys gobiensis</i> Sukhanov & Narmandakh, 1976	Tsagan Khushu	?	Sukhanov & Narmandakh, 1976
<i>Mongolemys tatarinovi</i> Sukhanov & Narmandakh, 1976	Naran Bulak	?	Sukhanov & Narmandakh, 1976
<i>Macrobaena mongolica</i> Tatarinov, 1959	Naran Bulak	Middle, Lower	Tatarinov, 1959
<i>Alligator</i> sp.	Tsagan Khushu	?	Efimov, 1976
Pelecaniform bird	Naran Bulak	?Uppermost	Kurochkin, 1976
Romainvilline ananid	Naran Bulak	?Uppermost	Kurochkin, 1976
Ardeid-like heron	Tsagan Khushu	?Uppermost	Kurochkin, 1976
Scolopacid shorebird	Tsagan Khushu	?Uppermost	Kurochkin, 1976
Small anseriform	Tsagan Khushu	?Uppermost	Kurochkin, 1976
? <i>Prionessus lucifer</i> Matthew & Granger, 1925	Naran Bulak	Upper	Gradziński <i>et al.</i> , 1969
<i>Pseudictops lophiodon</i> Matthew, Granger, & Simpson, 1929	Naran Bulak and Tsagan Khushu	Upper, Lower	Gradziński <i>et al.</i> , 1969
<i>Eurymylus laticeps</i> Matthew & Granger, 1925	Naran Bulak	Upper, Lower	Gradziński <i>et al.</i> , 1969; Dashzeveg, MS.
<i>Sarcodon</i> sp.	Naran Bulak	?	Reshetov, 1976
<i>Sinopa</i> -like hyaenodont	Tsagan Khushu	Middle	Dashzeveg, MS.
<i>Altanius orlovi</i> Dashzeveg & McKenna, nov.	Tsagan Khushu	Uppermost	This paper
<i>Dissacus indigenus</i> Dashzeveg, 1976	Naran Bulak	Middle	Dashzeveg, 1976
<i>Pachyaena nemegetica</i> Dashzeveg, 1976	Naran Bulak	Lower	Dashzeveg, 1976;
<i>Hyopsodus orientalis</i> Dashzeveg, 1977	Tsagan Khushu	Uppermost	Dashzeveg, 1977
<i>Archaeolambda planicanina</i> Flerov, 1952a	Ulan Bulak and Naran Bulak	Lower	Gradziński <i>et al.</i> , 1969
<i>Coryphodon tsaganensis</i> Reshetov, 1976	Tsagan Khushu	Upper	Reshetov, 1976; Dashzeveg, MS.
<i>Mongolotherium plantigradum</i> Flerov, 1952a	Ulan Bulak and Naran Bulak	Upper	Flerov, 1957
<i>Mongolotherium efremovi</i> Flerov, 1957	Ulan Bulak	Lower	Flerov, 1957
<i>Palaeostylops iturus</i> Matthew & Granger, 1925	Naran Bulak	Upper	Gradziński <i>et al.</i> , 1969
<i>Palaeostylops macrodon</i> Matthew, Granger, & Simpson, 1929	Naran Bulak	Lower	Reshetov, 1976; Dashzeveg, MS.

Table 2

MEASUREMENTS OF *ALTANIUS ORLOVI* AND VARIOUS OTHER PRIMATES

Specimens	P ₄ —M ₂ length	P ₄ —M ₃ length	P ₄ length	M ₁ length	M ₂ length	M ₃ length	Lingual depth of jaw at M ₂	Labial depth of jaw at M ₂
<i>Palenochtha minor</i> ⁽¹⁾	3.6	5.3	1.1—1.3	1.2—1.3	1.3	1.4—1.5	2.7	2.5
Type, <i>Micromomys silvercouleei</i> ⁽²⁾ UW 6893 and 6894,	3.3	—	1.4	—	1.1	—	2.0	1.9
<i>Tinimomys grabulliensis</i>	3.5, 3.6	— 5.1	1.4, 1.5	1.2, 1.2	1.1, 1.2	— 1.5	— 2.8	— 2.7
Type, <i>Omomys minutus</i> ⁽³⁾	—	—	—	2.0	1.9	2.2	2.5	2.2
Type, <i>Teilhardina americana</i> ⁽⁴⁾	5.3	7.6	1.4	1.8	1.8	2.0	—	3.2
Type, <i>Teilhardina belgica</i> ⁽⁵⁾	5.0	6.8	1.5	1.8	1.8	1.8	2.7	2.7
<i>Donrussellia gallica</i> ⁽⁶⁾	—	—	2.3—2.5	2.3—2.7	2.5—2.8	2.5—2.9	—	—
Type, <i>Altanius orlovi</i>	3.2	4.5	1.0	1.2	1.2	1.5	2.6	2.4
Type, <i>Hoanghoniuss stehlinii</i> ⁽⁷⁾	—	—	—	—	4.1	4.7	—	—
Type, <i>Anemorhysis sublettensis</i>	4.4	—	1.5	1.6	1.7	—	3.1	2.9 ⁽⁸⁾
Type, <i>Anemorhysis pearcei</i>	4.8	—	1.5	1.7	1.7	—	—	3.5 ⁽⁸⁾
Type, <i>Anemorhysis musculus</i> AMNH 80956,	—	—	—	—	—	2.0	3.4	3.3
<i>Anemorhysis tenuiculus</i> AMNH 15066,	—	—	—	1.7	1.7	—	2.7	2.4
<i>Anemorhysis tenuiculus</i>	4.7	—	1.4	1.7	1.8	—	—	—
<i>Elphidotarsius</i> cf. <i>E. florencae</i> ⁽⁹⁾	4.4, 4.7	6.3, 6.6	$\bar{x} = 1.79$ ± 0.02	$\bar{x} = 1.50$ ± 0.01	$\bar{x} = 1.41$ ± 0.02	$\bar{x} = 1.95$ ± 0.02	—	3.1, 3.6

⁽¹⁾ Measurements from Gidley (1923) and Simpson (1937) except jaw depths and P₄—M₂ length, which were measured on AMNH 35451.

⁽²⁾ Measurements from Szalay (1973, illustrations, not text).

⁽³⁾ Measurements from Szalay (1976, illustrations, not text).

⁽⁴⁾ Measurements from Bown (1976, both text and illustrations).

⁽⁵⁾ Measurements calculated from illustrations in Teilhard (1927), Hürzeler (1948), and Bown (1976).

Measurements derived from Teilhard's various illustrations are inconsistent and indicate scale inaccuracies.

Hürzeler's (1948) illustrations yield values close to Bown's. Teilhard's (1927, p. 17) published measurements of individual teeth are uniformly too small and may have been made from photographs whose scale was incorrectly calculated.

⁽⁶⁾ Measurements from Russell *et al.* (1967). See also Szalay (1976).

⁽⁷⁾ Measurements from Zdansky (1930).

⁽⁸⁾ Measurements calculated from illustrations in Gazin (1952, 1962).

⁽⁹⁾ Measurements from Rose (1975, table 1) for Rock Bench Quarry sample or from illustrations in the same paper.

Rozhdestvensky (1949), Efremov (1954), Novozhilov (1954), Flerov (1957), and Tatarinov (1959) regarded the fossils then known from the White Beds of the Naran Bulak Formation (fig. 2) as indicative of early Eocene age, even in one case (Flerov, 1957, p. 80) going so far as to correlate the lower part of the White Beds with the Gray Bull Beds and the upper part with the late Wasatchian Wind River Formation of Wyoming in North America. Flerov's upper fossil-producing level in the White Beds is, of course, younger than the lower one, but it remains to be established whether the difference is significant. Most other authors have preferred to regard the fossils from these two fossil-producing levels of the White Beds as representing a single fauna for practical purposes and have also correlated that fauna with faunas at the Paleocene-Eocene boundary elsewhere in the Northern Hemisphere. The matter has been discussed at length by Dashzeveg (1968), Kielan-Jaworowska and Dovchin (1969), Szalay and McKenna (1971), Shuvalov *et al.* (1974), Flerov and Dashzeveg (1974), and Flerov *et al.* (1974), all of whom opted for latest Paleocene age of both previously described fossil-producing levels within the White Beds of the Naran Bulak Formation. As will be seen below, however, in this paper we adopt the view that the Naran Bulak Formation of Asia is indeed as young as the American Clarkforkian and Wasatchian and the European Conglomérat de Meudon and overlying Sparnacian sediments. We are less certain about the relation of the Paleocene/Eocene boundary with respect to the base of the Conglomérat de Meudon (Berggren *et al.*, in press; Gingerich & Rose, in press).

Most of the fossils from the Naran Bulak Formation reported in the literature thus far have been recovered from the White Beds alone (table 1). Two principal fossil vertebrate producing levels have been reported to occur within the White Beds at Naran Bulak and also at Ulan Bulak about 8 km. to the east, separated by a few meters in each case, but whether these are exactly the same two levels or whether they are significantly different in age from one another remains questionable (Gradziński *et al.*, 1969; Szalay & McKenna, 1971). The combined published vertebrate faunal list from the White Beds is still a brief one, but it is clearly correlative with or is indicative of an age or ages only slightly younger than that of the Gashato (Khashat, Khashaat) fauna, known from the southern Gobi more than 350 km. to the east (Dashzeveg, 1968; Szalay & McKenna, 1971).

In addition to the fossil vertebrates, fifteen species of Ostracoda (Szczuchura, 1971; Khand, 1976), five species of Gastropoda (Tolstikova & Badamgarav, 1976), nineteen species of Charophyta (Karczewska & Ziembińska-Tworzydło, 1972), five species of Conchostraca (Trusova & Badamgarav, 1976), and four species of vascular plants (Fotyánova & Badamgarav, 1976) have been reported from various localities at various levels within the White Beds of the Naran Bulak Formation. These fossils have

not proven to be useful in correlation at the power of resolution necessary, however, because they either represent previously unknown taxa or, if already known, they have long or conflicting stratigraphic ranges.

Remains of *Altanius orlovi* and several as yet undescribed taxa including species referable to *Hyopsodus*, and a tapiroid (Dashzeveg, MS) have now been recovered in the course of washing and screening operations at localities in the highest part of the White Beds unit of the Naran Bulak Formation, as well as in the lowest Bumbin Nuru beds. Until washing and screening operations are attempted at lower levels in the White Beds, it will remain uncertain whether these taxa of the uppermost White Beds and Bumbin Nuru beds are restricted to those higher levels or occur also in the previously known levels of the White Beds lower in the stratigraphic section, which have been sampled previously by surface prospecting and standard quarrying only.

Close correlation of these levels of the Naran Bulak Formation and their fossils with strata and faunas in other parts of the world is very difficult, so that it is perhaps enough to assert that the difference in age of these various fossil-producing levels within the Naran Bulak Formation did not cover a long time span and that this time span possibly coincides with part of the Sparnacian of Europe and the Clarkforkian and early Wasatchian of North America (Gingerich & Rose, in press). Although it may extend beneath the Eocene as recognized by micropaleontologists, the lower boundary of the Sparnacian is today generally equated by non-marine biostratigraphers with the Eocene/Paleocene boundary, approximately 54 million years before the present according to American geochronologists working with K—Ar dating methods and using American ⁴⁰K decay constants (Berggren *et al.*, in press). Correlation of these interesting Mongolian early Tertiary fossils and the sediments that contain them will surely become more accurate as more of the fauna of the Naran Bulak Formation becomes known and as biostratigraphic problems peculiar to North America and Europe, such as the "Clark Fork Problem" in North America, are brought into clearer focus.

DESCRIPTION

Family **Omomyidae** Trouessart, 1879
Subfamily **Anaptomorphinae** Cope, 1883
Altanius gen. n.

Type species: Altanius orlovi sp.n.

Derivation of the name: Altanius, after Altan Ula, prominent mountain and landmark of the north side of the western end of the Nemegt Basin, Transaltai Gobi, southwestern Mongolian People's Republic, 100°20' E., 43°40' N.

Age.—Early Eocene (i.e., equivalent to some part of the American Clarkforkian and early Wasatchian and to the European Sparnacian. See Gingerich and Rose, in press).

Distribution.—Known only from the Nemegt Basin in the southwestern part of the Mongolian People's Republic.

Diagnosis.—Tiny tarsioid primate with heel of P_4 reduced but P_4 metaconid present; M_1 trigonid open, with unreduced, conical paraconid; M_3 with large, lingually placed paraconid, expanded talonid; molars lacking mesoconids. Jaw deep.

Differential diagnosis.—Differs from microsopines (including *Plesiolestes*) by unreduced paraconids, open trigonid of M_1 , reduced heel of P_4 , progressive reduction from M_1 to M_3 of molar protoconids, and lack of mesoconids on cristid obliqua (Matthew, 1915; Jepsen, 1930; McKenna, 1960; Szalay, 1969, 1973; Gazin, 1971; Bown & Gingerich, 1972, 1973); from *Purgatorius* by apomorphic progressive appression of paraconids and metaconids, reduction of P_4 heel, possession of a distinct though small metaconid on P_4 , and progressive reduction from M_1 to M_3 of molar protoconids (Clemens, 1974); from *Palenochtha* by possession of larger P_4 metaconid, more blade-like P_4 , and larger M_3 paraconid; from paromyiids and *Saxonella* by unreduced paraconids (Simpson, 1955; Russell, 1964); from plagiomenids (including *Elpidophorus*) by unreduced molar paraconids, open trigonid of M_1 , reduced heel of P_4 , smaller metaconid of P_4 , and expanded heel of M_3 (Matthew, 1918; Szalay, 1969); from *Omomys* by higher P_4 with less projecting paraconid, smaller P_4 metaconid, and lingually placed and unreduced molar paraconids (Matthew, 1915; Gazin, 1958); from *Hoanghoni* by much smaller size and by unreduced molar paraconids (Zdansky, 1930); from microchoerines by unreduced paraconids (especially on M_2 and M_3), larger entoconids, smooth enamel, larger M_3 , and anteroposterior compression of M_1 and M_2 (Hürzeler, 1948); from *Tarsius* by higher P_4 with less projecting paraconid, lingually placed and unreduced molar paraconids, and less pinched hypoconulid of M_3 ; from *Teilhardina* by more reduced heel of P_4 , unreduced and more lingually placed paraconid of molars, and more expanded, less pinched heel of M_3 (Teilhard, 1927; Hürzeler, 1948; Russell, Louis, & Savage, 1967; Bown, 1976); from *Tetonius* by M_3 expansion and less reduced paraconids (Matthew, 1915; McKenna, 1960; Bown, 1974); from *Pseudotetonius* by higher P_4 trigonid, unreduced P_3 (judged from large alveolus), and less reduced paraconids (Bown, 1974); from *Anemorhysis* by size, higher trigonid of M_1 , and by talonid of M_3 with almost smooth lingual wall rather than pinched, projecting hypoconulid (Matthew, 1915, fig. 34; Gazin, 1962); from carpolestids by unreduced paraconids and by lack of a blade-like modification of an expanded P_4 , to which extra cuspules are added (Rose, 1975); from *Micromomys* and *Tinimomys* by lack of an expanded, blade-like P_4 and by possession of P_4 metaconid and reduction of P_4 talonid (Szalay, 1973).

Altanius orlovi sp.n.

(pl. 1, 2)

Holotype: G. I. SPS, coll. 7, no. 20-8, left lower jaw fragment with P_4 — M_3 (M_2 with damaged trigonid).

Type horizon and locality: Lowest Bumbin Nuru (Bumban or Boombin Nooru) beds at early Eocene Tsagan Khushu exposures of the Naran Bulak Formation, just above the White Beds. Additional material has been found in the uppermost White Beds.

Derivation of the name: Patronym for the late Soviet Academician Yurii Aleksandrovich Orlov (1893—1966), paleontologist, esteemed colleague, and friend of both the authors.

Diagnosis.—Sole known species. Diagnosis as for the genus.

Description.—Jaw small, relatively deep, with mental foramen beneath roots of P₄; coronoid process with anterior lamina extending lingual to posterior root of M₃; masseteric fossa well-developed; teeth with crowns set at angle to roots; no trace of any enlarged anterior tooth root below level of P₃ alveoli, where anterior part of lower jaw is broken away; comparative measurements in table 2.

P₄ with high, anteriorly overhanging trigonid dominated by protoconid; A—P length 1.0 mm.; paraconid and metaconid lingually appressed to protoconid; anterior base of paraconid connected to protoconid apex by notched paracristid, but this does not isolate a tiny basin; precingulid running posteroventrolabial from next to paraconid base around anterior base of protoconid, but indistinct and not anteriorly embracing heel of P₃ to extent seen on more posterior teeth; paraconid essentially a small conical cusp subordinated to protoconid, not a blade-like extension from protoconid; protoconid with flattened lingual and posterior faces, curved and sloping buccal face; metaconid small, scarcely more than a small swelling on posterolingual corner of protoconid; heel with two minute cusps flanking remnant of a basin, but heel short and tucked beneath overhanging trigonid of M₁; roots slightly splayed, posterior one larger.

M₁ smallest and narrowest molar, with high, anteriorly narrowing trigonid that overhangs talonid of P₄; A—P length 1.2 mm.; trigonid cusps of about equal height with respect to functional occlusion of dentition, but protoconid would ordinarily be described as highest cusp; lingual side of protoconid convex rather than flattened as on P₄; paraconid and metaconid widely separated at apices, conical but somewhat laterally compressed; paraconid with tiny crest (lingual half of paracristid) connecting its anterobuccal base with anterior base of protoconid, thus isolating a tiny basin on trigonid buccal to paraconid; metaconid set posterolingual to protoconid and provided with three crests—a minor anterior crest, a posterior crest connecting basally to anterior crest of entoconid via talonid notch, and a continuation of the cristid obliqua, which produces a marked offset in posterobuccal wall of trigonid—resulting in hypoflexid groove worn by contact with opposing paracone of M¹; precingulid beginning indistinctly at base of protoconid and rising anterolingually to terminate abruptly as small cuspule, lingual to which is notch for reception of heel of P₄; hypocoid large with about 85° angle between anterobuccal and posterobuccal faces; small entoconid with flat anterobuccal face, convex lingual face, and slightly concave posterior face; hypoconulid very small medial swelling at rear of talonid, supplied with weak postcingulid descending along rear of hypoconid and becoming indistinct near buccal base of latter; talonid basin mostly rounded and smooth-surfaced.

M₂ slightly larger than M₁, especially entoconid; damaged in area of trigonid so that nothing can be said of paraconid or metaconid other than that they were not so widely separated as on M₁; A—P length 1.2 mm.; rear wall of trigonid not so offset as on M₁ by cristid obliqua/hypoflexid groove for reception of opposing paracone of M²; protoconid much lower than on M₁ but still higher than that of M₃; crest (buccal half of paracristid) running anterolingual from protoconid apex, functionally continued by hypoconulid of M₁, so that metacone of M¹ wears against both M₁ and M₂ and its edges shear against crests leading toward hypoconulid of M₁ (M₁ post-cristid, M₂ buccal half of paracristid); talonid larger and broader than on M₁, with much bigger talonid basin and much larger, more posterolingually projecting entoconid whose posterobuccal surface is concave for reception of paraconid base

of M_3 ; deep talonid notch anterior to entoconid; hypoconulid weak, serving more as indexing device than in shearing function, functionally a continuation of precingulid of M_3 ; cristid obliqua formed by edge of anterobuccal wall of hypoconid, not offsetting posterior wall of trigonid so much as on M_1 but instead merging with wall lower on crown than on M_1 ; buccal overhang (exodaenodonty) of base of hypoconid marked; two roots essentially equal in size.

M_3 narrower and much longer than M_2 , very little worn and undamaged; A—P length 1.5 mm.; trigonid continuing trends seen in more anterior preserved cheek-teeth; protoconid lowest of all protoconids, forming low, rounded cusp at joined buccal bases of paraconid and metaconid; these latter cusps with separate but nearly equally high apices, but metaconid smaller because of steep posterior trigonid wall that falls abruptly from position just to rear of its apex; at rear of metaconid a crest that runs buccoventrad joining similar crest that runs posterolingual from the protoconid to form protocristid cutting edge of trigonid's posterior wall; remainder of buccal surface of metaconid flat, continuous with convex lingual face of paraconid; buccal face of protoconid also convex, so that two tiny basins present anterolingual and posterolingual to protoconid at buccal bases of paraconid and metaconid, respectively; together metaconid and paraconid forming serrated crest continued antero-ventrally, then buccally and posterobuccally as upper edge of anterior trigonid wall (paracristid) to join anterior base of protoconid after anteriorly skirting anteriormost of two tiny trigonid basins mentioned above; heavy, ledge-like precingulid beginning anterior to base of protoconid as functional continuation of hypoconulid of M_2 , serving an indexing function as in more anterior teeth; from its abrupt beginning precingulid swinging posteroventrobuccally along base of protoconid to be interrupted at hypoflexid groove, resuming in diminished form as an ectocingulid more posteriorly along base of hypoconid; talonid much enlarged and elongate, mainly because of much expanded area posterobuccal to entoconid, essentially an enormously enlarged hypoconulid supplied with its own narrow root or expansion of normal posterior root; hypoconid smaller than on M_2 , completing trend begun on M_1 , and its anterobuccal and posterobuccal sides forming right angle; cristid obliqua formed by edge of anterobuccal side of hypoconid, but not offsetting posterior wall of trigonid as on M_1 and (weakly) on M_2 ; cristid obliqua joining trigonid's posterior wall at even lower point than on M_2 ; entoconid incorporated in lingual talonid crest, but entoconid apex still discernible; flat facet worn on its buccal side; entoconid continued to rear by slightly cuspidate crest formed by junction of surface of lingually rising floor of expanded talonid basin and lingual enamel wall of talonid; deep talonid notch anterior to entoconid.

WEAR FACETS

Butler (1973) and Kay and Hiiemae (1974) have recently published stimulating but somewhat conflicting discussions of dental wear facets in primitive primates. We will not review the subject here; we simply present our identification of wear facets on the lower dentition of *Altanius orlovi* (pl. 2 D) using the numbering system of Kay and Hiiemae. Facets 1—8 are the result of the upward and anteromedial motion of the lower dentition during phase I of the occlusal power stroke. Facets 9 and 10 were created during the anteromedial and downward motion of phase II occlusion (Kay & Hiiemae, 1974, p. 236).

Following a suggestion of Butler (1973) we attempt in plate 2 C to illustrate the lower dentition of *Altanius orlovi* so that the viewer is looking down the approximate average "axis" of phase I occlusion. Such an illustration may be more useful for comparative purposes and for functional analysis than the usual orientations given in descriptive papers, but it should be remembered that the "axes" of occlusion for each tooth are in reality a family of concentric curves. The plane of the illustrated view should pass through the mandibular joint, but this can only be approximated.

DISCUSSION

Altanius is in most respects a very primitive (plesiomorphous) omomyid tarsioid primate; it is clearly not so primitive as microsopids or *Purgatorius*. *Purgatorius* has a primitive P_4 and retains open trigonids on M_2 and M_3 as in tupaiids. Although the upper teeth of *Altanius* have not yet been reported, nevertheless the hypocone (or pseudhypocone) of these teeth in *Altanius* must be quite small or merely consist of a cingulum because of the presence of large, lingually placed paraconids on the lower molars. In centric occlusion the paraconids occupy the volume that the hypocones would occupy, were they of significance. Moreover, no wear facets for a hypocone are seen on the lower molars. Most primates have departed from this condition by enlarging the upper molar hypocone region in one way or another and/or by reducing or buccally shifting the paraconids of the lower molars, as for instance in omomyines, microchoerines, and *Tarsius*. Anaptomorphine omomyids are plesiomorphous in this regard, but are synapomorphous with *Altanius* in the shared-derived acquisition of a high, incipiently blade-like P_4 . The most primitive carpolestid, *Elphidotarsius* Gidley, 1923, is quite similar in known features (Rose, 1975) to *Altanius*, but has further modified the P_4 and possesses more reduced and buccally shifted paraconids as well as a reduced number of premolars. Although Rose (1975) allied the carpolestids with the plesiadapids, the latter possess a mesoconid on the cristid obliqua of the lower molars and have lost the metaconid on their characteristic P_4 . Carpolestid molars are somewhat exodaenodont, a presumably derived condition shared with the anaptomorphines.

Altanius seems closest in known morphology among anaptomorphines to the poorly known genus *Anemorhysis* (see Szalay, 1976), although it is only about 70% or even smaller in size than species of that genus in tooth measurements and has a deeper jaw relative to tooth lengths (table 2).

Among known fossil and Recent Asian primates *Altanius* most resembles the living genus *Tarsius*. It is not closely similar to any of the fossil primates reported from Asia thus far. As yet, however, *Altanius*

cannot be directly compared in morphology with the much larger, late Eocene *Lushius*. *Lushius* has rudimentary hypocones on its upper cheek-teeth (Chow, 1961) and therefore can be expected to possess a lower dentition in which paraconids are still prominent and lingually placed. *Hoanghonius* (Zdansky, 1930; Woo and Chow, 1957, except the lower jaw figured in their fig. 2 and plate 1, figs. 3, 4, and 5, which is not a primate and belong to an artiodactyl) is a much larger animal than *Altanius* (table 2) in spite of what might be concluded from Zdansky's legend for his plate 5 (*ibid.*), where the scale is erroneously reported as $\times 5$. *Hoanghonius* appears to us to be an omomyid or omomyid derivative, but it is obviously much more advanced than *Altanius*, a statement that could be made of *Amphipithecus* and *Pondaungia* as well. *Hoanghonius* has been placed in the Anaptomorphinae by Woo and Chow (*ibid.*) but the reasoning was based on the incorrectly attributed jaw noted above. *Hoanghonius* seems to be an omomyine instead.

It is significant that *Altanius*, like several other members of the faunal list from the Naran Bulak Formation, has American rather than European zoogeographic affinities. Evidently, limited earliest Eocene dispersal between North America and Asia via the Bering Route was more important than has been realized previously, although not so important as to break down endemism completely. It is also significant that American zoogeographic affinities imply that the climate of the Bering Route, at least for a time, was able to support tiny primates approximately the size of *Altanius*. No matter how close to the rotational pole position, the climate of the Bering Route would almost certainly have to have been temperate, even warm-temperate, if *Altanius*-like primates were present there.

CONCLUSIONS

A new genus and species of tarsioid primate occurs in the Naran Bulak Formation of southern Mongolia (present latitude: $43^{\circ}30' N$). *Altanius* is the earliest known primate in the Asian fossil record. In terms of stage-age correlation the part of the Naran Bulak Formation from which *Altanius* is known is roughly equivalent in age to some part of the Clarkforkian and early Wasatchian North American Land Mammal Ages, and to the early Sparnacian of Europe. The relation of these stage-age level units to the Paleocene/Eocene boundary depends on the fixation of that boundary in the type area in Europe, not in North America or Asia.

Altanius is a primitive tarsioid primate and is placed in the subfamily Anaptomorphinae of the family Omomyidae. It is apparently not ancestral to *Tarsius*. The animal is smaller than any extant primate; among fossil primates and primate-like animals only the smallest microsopids appear

to have been comparable or smaller in size. In *Altanius* the jaw was relatively deep, however, and the snout was probably shortened.

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TARSJUSZ (NACZELNE) Z WCZESNEGO TRZECIORZĘDU MONGOLSKIEJ
REPUBLIKI LUDOWEJ*Streszczenie*

W osadach formacji Naran Bułak w południowej Mongolii, w miejscowości Naran Bułak (43°30' szer. geogr. północnej) stwierdzono występowanie nowego gatunku i rodzaju tarsjusza (naczelne). Na cześć nieżyjącego radzieckiego paleontologa nowy naczelnny został nazwany *Altanius orlovi* gen. et. sp.n. *Altanius* jest najstarszym naczelnym znalezionym dotychczas na terenie Azji. Warstwy formacji Naran Bułak z których pochodzi odpowiadają przypuszczalnie części piętra klarfork (Clarkforkian) i wczesnemu wasacz (Wasatchian) Ameryki Północnej, oraz wczesnemu sparnakowi Europy. Stosunek tych jednostek stratygraficznych do granicy między paleocenem i eocenem zależy od ustalenia tej granicy w typowych odsłonięciach Europy, a nie Ameryki Północnej i Azji.

Altanius jest prymitywnym naczelnym z grupy tarsjuszy i został zaliczony do podrodziny Anaptomorphinae, w obrębie rodziny Omomyidae. Przypuszczalnie nie jest on przodkiem rodzaju *Tarsius*. Jest on mniejszy od wszystkich współczesnych naczelnnych, a wśród znanych kopalnych naczelnnych i form do nich zbliżonych, jedynie najmniejsi przedstawiciele rodziny Microsypidae mają wymiary porównywalne lub mniejsze z wymiarami *Altanius*. Zuchwa *Altanius* była stosunkowo wysoka, natomiast pysk był przypuszczalnie skrócony.

ДЕМБЕРЕЛЫИН ДАШЗЕВЕТ & МАЛЬКОЛЬМ К. МАККЕННА

ДОЛГОПЯТ (ПРИМАТЫ) ИЗ ПАЛЕОГЕНА МОНГОЛЬСКОЙ
НАРОДНОЙ РЕСПУБЛИКИ*Резюме*

В отложениях формации Нاران Булак Южной Монголии, местности Нاران Булак (43°30' геог. северной широты) был обнаружен новый вид и род долгопята

(приматы). Новый примат был назван в честь покойного советского палеонтолога *Altanius orlovi* gen. et sp. n. *Altanius* является самым древним приматом, найденным до сего времени на территории Азии. Отложения формации Наран Булак, где были обнаружены остатки *Altanius*, по-видимому, соответствуют части яруса кларфорк (Clarkforkian) и раннему васачян (Wasatchian) Северной Америки, а также раннему спарнаку Европы. Положение этих стратиграфических единиц по отношению к границе между палеоценом и эоценом зависит от определения этой границы в типичных обнажениях в Европе, а не в Америке и Азии. *Altanius* является примитивным приматом подотряда долгопятов и был причислен к подсемейству Anartomorphinae в границах семейства Omomyidae. Он, по-видимому, не является предком рода *Tarsius*. *Altanius* является наименьшим среди всех современных приматов, а среди известных ископаемых приматов и форм близких к ним только наименьшие представители семейства Microsyoridae имеют одинаковые или даже меньшие размеры. Нижняя челюсть *Altanius* была относительно высокая, в то время как морда была, по всей вероятности, укороченной.

EXPLANATION OF PLATES

Plate 1

Altanius orlovi gen.n., sp.n.

Early Eocene, Naran Bulak Formation, Nemegt Basin, Mongolian People's Republic

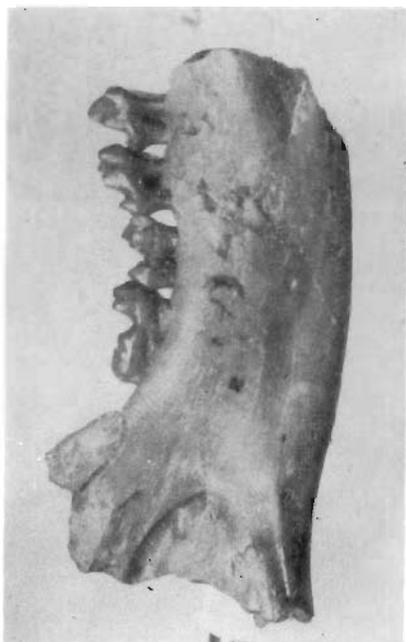
Left lower jaw fragment with P₄, M₁, damaged M₂, and M₃. Holotype, GISPS coll. 7, no. 20-8. Scale in mm (all figures ×9). Above lingual stereophoto, below labial and occlusal stereophotos.

Plate 2

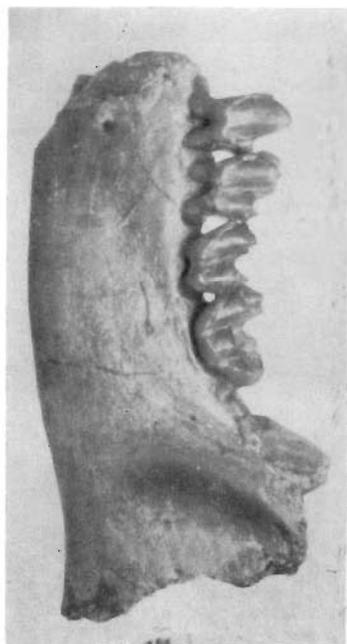
Altanius orlovi gen.n., sp.n.

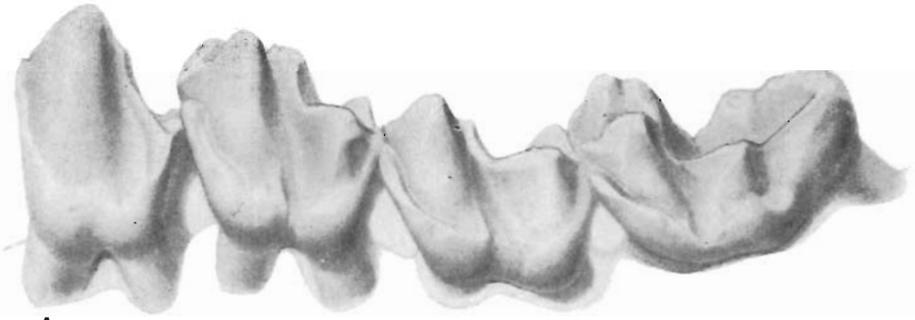
Early Eocene, Naran Bulak Formation, Nemegt Basin, Mongolian People's Republic

Left P₄, M₁, damaged M₂, and M₃. Holotype, GISPS coll. 7, no. 20-8. All views ×25. A labial (buccal) view, B standard "occlusal" view, C functional occlusal view perpendicular to phase I occlusion "axes", D identification of wear facets, following numbering system of Kay and Hiiemae (1974).

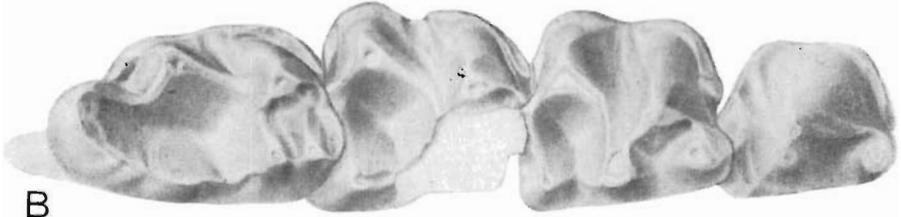


mm

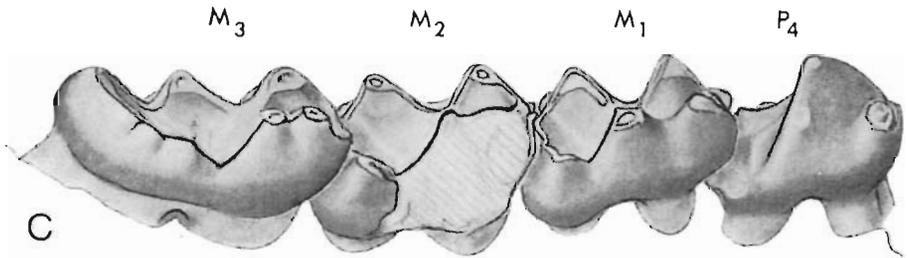




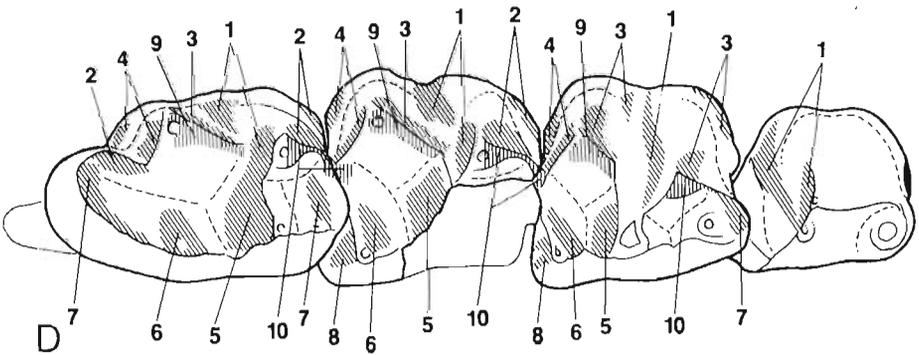
A



B



C



D