

Primates of the genus *Altanius* (Mammalia, Primates) from the Lower Eocene of Tsagan-Khushu, southern Mongolia

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ABSTRACT. *Altanius* is one of the oldest known euprimates discovered from the Early Eocene Naran-Bulak Formation, Tsagan-Khushu, southern Mongolia. In this paper, we describe three additional specimens of *A. orlovi* Dashzeveg et McKenna, 1977, and establish a new species, *A. magnus* **sp. nov.**, in which m2 is distinctly larger than in *A. orlovi*. The discovery of a new species of *Altanius* provides further information on the evolutionary history of early primates on the Eurasian continent.

KEY WORDS: euprimates, dentition morphology, Lower Eocene, Mongolia.

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Приматы рода *Altanius* (Mammalia, Primates) из нижнего эоцена Цаган-Хушу, Южная Монголия

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РЕЗЮМЕ. *Altanius* — древнейший известный эупримат Азии из нижнеэоценовой пачки Бумбан свиты Наран-Булак местонахождения Цаган-Хушу, Южная Монголия. В работе описываются три новых экземпляра *A. orlovi* Dashzeveg et McKenna, 1977 из Цаган-Хушу. На основании морфологических различий и пропорций m2, устанавливается новый вид *A. magnus* **sp. nov.**, у которого m2 значительно крупнее, чем у *A. orlovi*. Данные о новом виде дают дополнительную информацию об эволюции наиболее древних приматов Евразии.

КЛЮЧЕВЫЕ СЛОВА: эоприматы, морфология зубов, нижний эоцен, Монголия.

Introduction

Primate origins are one of the most interesting and controversial topics for primatologists. Many researchers accept that primates originated in North America or Europe as early as the latest Cretaceous, because many taxa of plesiadapiforms and euprimates have been discovered in Paleocene and Early Eocene sediments in these areas (Fleagle, 1999). However, recently, increased discoveries of early primates and plesiadapiforms from the Paleocene or Early Eocene in eastern Asia have prompted further controversy. Conversely, the fossil record of *Altiatlasius koulchii* Sigé et al., 1990, the oldest potential euprimate from the Late Paleocene of Morocco, North Africa, suggests the possibility of an African origin of the primates (Sigé et al., 1990). Recently some new genera of primates have discovered in the Lower and Middle Eocene of Asia (Gunnell et al., 2008; Ni et al., 2010), but the oldest primates are known only from Paleocene of North America and Africa.

In this paper, we report some additional specimens of *Altanius* discovered in the Lower Eocene Naran-Bulak Formation of Tsagan-Khushu locality, southern Mongolia. This material was collected by the Joint

Soviet-Mongolian Paleontological Expedition in 1970–1991. In this article we compare the new specimens with the plesiadapiforms and euprimates (adapoids and omomyoids) discovered in the early Paleogene of eastern Asia.

Altanius was first discovered in the 1970s and was originally described as a member of the Omomyidae (Dashzeveg & McKenna, 1977). However, some researchers regarded it as a plesiadapiform (Rose & Krause, 1984) and others assigned it just to the early euprimates without familial attribution (Gingerich et al., 1991; Rose, 1995; Beard, 1998, 2006; Fleagle, 1999). Thus, the phylogenetic position of *Altanius* is still contentious, although most recent workers treat it as an enigmatic possible euprimate (Fleagle, 1999; Gunnell & Rose, 2002; Rose, 2006).

The Tsagan-Khushu locality is situated in the Trans-Altai Gobi, which occupies the western part of the Nemegt Basin, 6 km west of the Naran-Bulak stream (Fig. 1). Its geographical coordinates are approximately 100°15' – 102°00'E and 43°45'N (Dashzeveg & McKenna, 1977). The Tsagan-Khushu locality was first discovered by the Soviet-Mongolian Paleontological Expedition organized by the USSR Academy of Sciences.

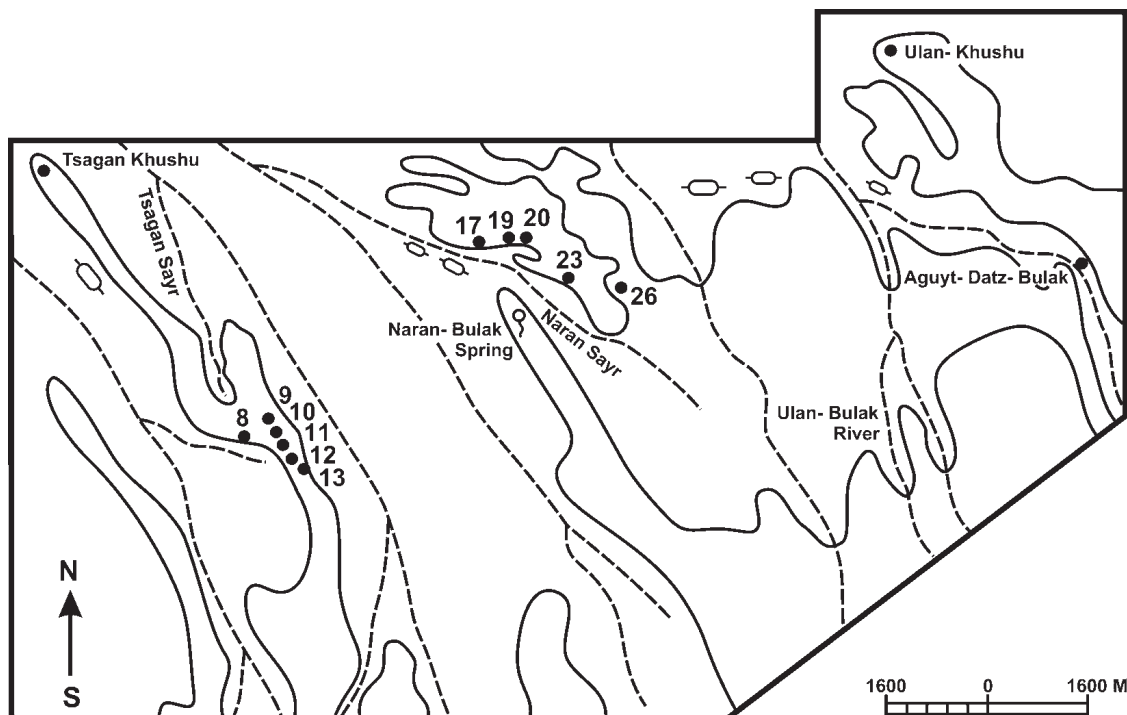


Figure 1. Detailed map of the Tsagan-Khushu locality. Filled circles with numbers represent (geological) observation and collection points. Modified from Badamgarav & Reshetov (1985).

A complete section at the Tsagan-Khushu locality was exposed in the 1980s, along the eastern edge of the Tsagan-Sayr (Fig. 1). The section exposed the deposits of the Naran-Bulak Formation divided in Zhigden, Naran, Bumban, Aguyt, and Ulan-Khure members (Badamgarav & Reshetov, 1985).

Dashzeveg (1982) considered the Zhigden and Naran members to be the Upper Paleocene, correlating with the Clarkforkian, and the Bumban Member to be the Lower Eocene, correlating with the Wasatchian NALMAs (North American Land Mammal Age), respectively. This dating of the Tsagan-Khushu section was followed by Badamgarav & Reshetov (1985) and other researchers.

All the present specimens of *Altanius* come from the base of the Upper Red Beds, corresponding to the Lower Eocene Bumban Member of the Naran-Bulak Formation. The material was screen-washed from the outlier at the right edge of the Tsagan-Sayr coulee watercourse and from the edge itself. This site corresponds to observation points 11, 12 and 13 located at the right bank wall and in the isolated rock (eastern slope) (Badamgarav & Reshetov, 1985) (Fig. 1). The field work was conducted by the party of the Soviet-Mongolian Paleontological Expedition headed by Valery Reshetov in 1970–1973, 1976, 1978–1980, 1985, 1987, and 1991 (Paleontological Institute USSR Academy of Sciences, Moscow). Recently the isolated rock at the right wall of Tsagan-Sayr has been completely exhaust-

ed. The outlier does not exist any longer as it was completely used for screen-washing.

In the observation points where the primate specimens were discovered, the Bumban Member is represented by alternation of lacustrine clays and gravels originated in a shallow bolson-type depression. In the observation points 11 and 12 the Bumban Member is composed of variegated clays, up to 2–2.5 m thick, called the transitive facies by Badamgarav & Reshetov (1985). The mammal remains from the observation points 11 and 12 were washed out of gravel lenses. In the observation point 13, the bed yielding mammal bones is localized in the lacustrine and shallow clayey depression sediments (brick-red clays) covered by siltstones. The total thickness of this sequence does not exceed 5 m. Small mammal remains from the site were examined by Alexey Lopatin in 2002–2003 (Lopatin, 2004, 2006).

ABBREVIATIONS

Upper dentition: I1, I2 (incisors); C (canine); P3, P4 (premolars); M1, M2, M3 (molars). Lower dentition: i1, i2 (incisors); c (canine); p3, p4 (premolars); m1, m2, m3 (molars). Abbreviations for the teeth measurements: MD — mesiodistal length, BL — buccolingual width.

PIN — Borissiak Paleontological Institute, Russian Academy of Science, Moscow, Russia; PSS — Paleontology and Stratigraphy Section of the Institute of Geology of the Mongolian Academy of Sciences, Ulan Bator, Mongolian People's Republic.

Table 1. Dental and mandible measurements (mm) of *Altanius orlovi* and *A. magnus* sp. nov. (Dashzeveg & McKenna, 1977; Gingerich *et al.*, 1991).

	p3		p4		m1		m2		m3		Mandible depth at m2
	MD	BL	MD	BL	MD	BL	MD	BL	MD	BL	
<i>A. magnus</i> sp. nov., PIN 3104/1084	-	-	-	-	-	-	1.67	1.27	-	-	2.44
<i>A. orlovi</i> , PIN 3104/1083	0.91	0.59	1.01	0.82	1.07	0.94	1.12	1.13	1.59	1.05	2.37
<i>A. orlovi</i> , PIN No 3104/1085	-	-	-	-	-	-	0.98	1.03	1.4	0.88	2.13
<i>A. orlovi</i> , PIN 3104/1086	-	-	1.04	0.84	-	-	-	-	-	-	-
<i>A. orlovi</i> , PSS 7/20-8	-	-	0.93	0.88	1.09	1.15	1.08	1.22	1.58	1.15	2.40
<i>A. orlovi</i> , PSS 20-58	0.96	0.72	0.92	0.87	1.13	1.05	1.17	1.15	1.62	1.08	2.12
<i>A. orlovi</i> , PSS-20-85	-	-	-	-	-	-	1.14	1.05	1.58	0.92	2.38
<i>A. orlovi</i> , PSS 20-136	0.78	0.71	0.94	0.8	1.13	0.92	1.16	1.07	-	-	-

SYSTEMATIC PALEONTOLOGY

Order Primates incertae sedis

Genus *Altanius* Dashzeveg et McKenna, 1977

Altanius orlovi Dashzeveg et McKenna, 1977

Table 1, Fig. 2, 1–3.

Synonyms. *Altanius orlovi*: Dashzeveg & McKenna, 1977, p. 127, Table 1; Gingerich *et al.*, 1990, p. 638, Fig. 1.

Holotype: PSS 7/20-8, left mandibular fragment with p4–m3 (m2 with damaged trigonid); southern Mongolia, Trans-Altai Gobi, Nemegt Basin, Tsagan-Khushu, Lower Eocene, Naran-Bulak Formation, Bumban Member.

Description. All the new material conforms to the diagnosis of the material described in previous papers, in both size and morphology (Dashzeveg & McKenna, 1977). The unicuspid p3 has a trapezoidal occlusal outline, no paraconid, and the heel-like talonid is very small and much lower than the trigonid. The p4 is much higher and larger than p3, in both mesiodistal length and buccolingual width. The p4 talonid, which is much larger than that on p3, protrudes distolingually, retaining a small but distinct hypoconid. Although the mesiolingual part of m1 is somewhat damaged in the new specimen (PIN 3104/1083), m1 is certainly smaller than m2 and m3. On the two specimens of m2 (PIN 3104/1083 and PIN 3104/1085), the trigonid and talonid have nearly the same buccolingual width. The

paraconid and metaconid are closely appressed on m2, whereas they are almost twinning on m3. The buccal cingulid is weakly developed on m1, whereas it is well developed at the mesiobuccal base of the trigonid on m2 and m3. The hypoconid and entoconid are approximately equal in size on m2, whereas the hypoconid is higher than the entoconid on m3. The hypoconulid is well developed, protruding distobuccally on m3. Both on m2 and m3, the talonid notch is relatively deep and the cristid obliqua runs mesiolingually, terminating at the distal base of the protoconid. A small hypoconulid appears on the distal margin of the talonid, situated on the central line of the tooth. There is a deep buccal groove between the hypoconid and hypoconulid.

Size. The measurements of the new specimens of *A. orlovi* are listed in Table 1.

Distribution: Lower Eocene (Bumbanian Asian Land Mammal Age), Mongolia.

Referred material: In addition to the holotype, there are the specimens PSS 20-58, dentary fragment with alveolus of i1–2, p2–3 and the p3–4 and m1–3; PSS 20-61, left maxillary fragment with the P3–M3; PSS-20-85, left mandibular fragment with damaged m1 and m2–3; PSS 20-136, left dentary fragment with p3–3; PSS 20-168, left maxillary fragment with P4-3 (Gingerich *et al.*, 1991).

New material of *A. orlovi* from the type locality includes: PIN 3104/1083, right dentary fragment preserving p3–m3 (Fig. 2, 1); PIN 3104/1085, left dentary fragment with m2–m3 (Fig. 2, 2); PIN 3104/1086, right dentary fragment with p4 (Fig. 2, 3).

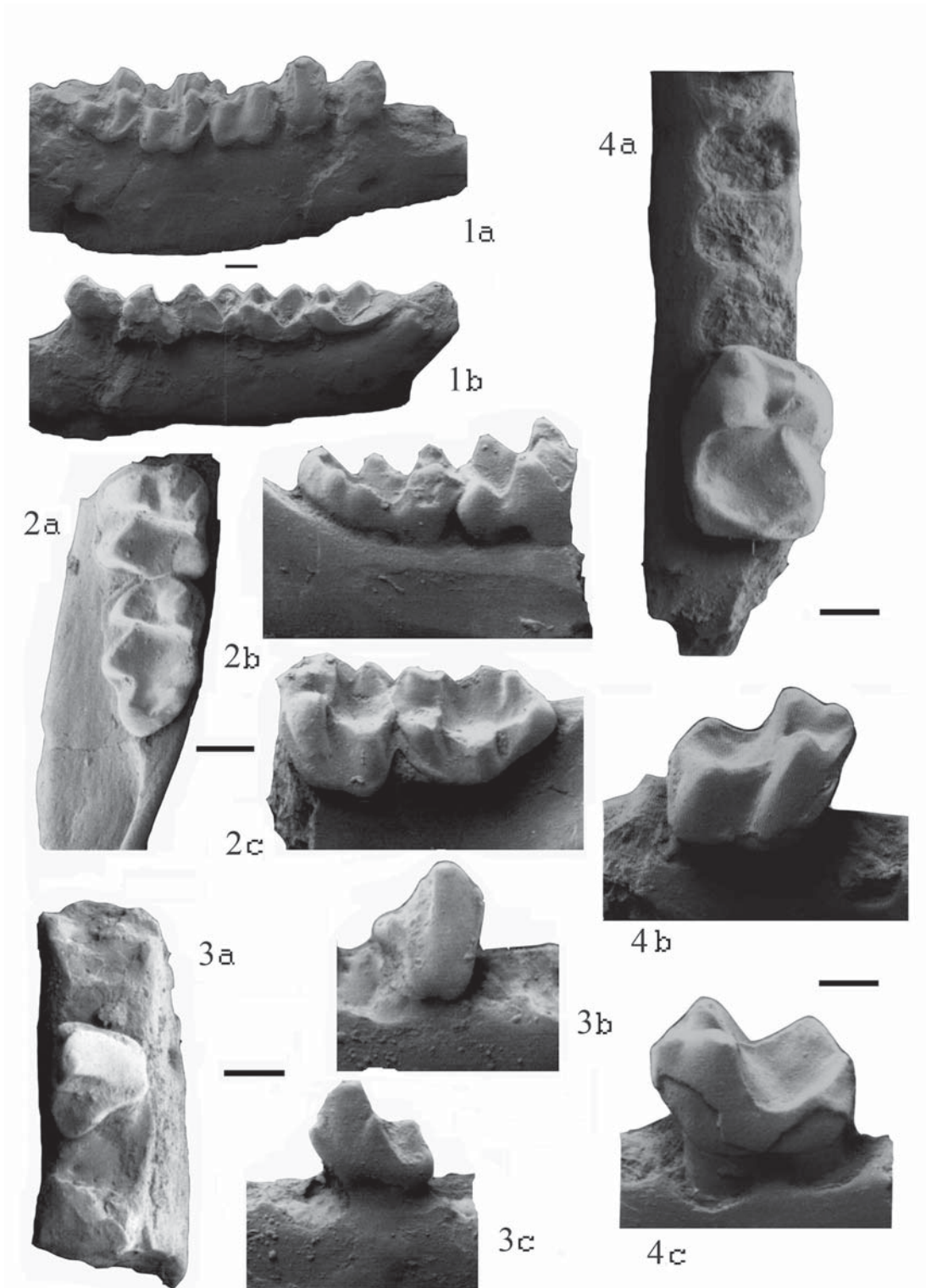


Figure 2. SEM micrographs and digital photo (1 c) photos of new specimens of *Altanius*.

1–3. *Altanius orlovi* Dashzeveg et McKenna, 1977: 1 — PIN, no. 3104/1083, fragment of the right mandible with p3 — m3: 1a — buccal view, 1b — lingual view; 1c — occlusal view; 2 — PIN, no. 3104/1085, fragment of the left mandible with m2–m3: 2a — occlusal view, 2b — buccal view, 2c — lingual views; 3 — PIN, no. 3104/1085, fragment of the right mandible with p4: 3a — occlusal view, 3b — buccal view, 3c — lingual view;

4. *Altanius magnus*, **sp. nov.**, type specimen PIN 3104/1084, the fragment of the right mandible with m2 and alveolus of p3–m1: 4a — occlusal view, 4b — buccal view, 4c — lingual view; Tsagan-Khushu, Mongolia, Lower Eocene, Naran-Bulak Formation, Bumban Member. Scale bar for the figure 1c is 1mm, scale bar for all other figures, 0.5 mm.

Altanius magnus sp. nov.

Fig. 2: 4.

Holotype. PIN 3104/1084, right mandibular fragment preserving m2 and alveoli for p3 – m1, the only known specimen.

Etymology. Latin *magnus*, large. Because it is larger than *A. orlovi*, the type species.

Description of the new species. The trigonid of m2 is much higher than the talonid, and retains three cuspids (paraconid, metaconid, and protoconid). The metaconid and protoconid are almost the same size, but the former is slightly higher than the latter. The paraconid is conical and much smaller and lower than the others. Although the paraconid is well separated from the metaconid, there is no distinct lingual notch between the paraconid and metaconid. The paraconid is situated not centrally but more lingually, just mesial to the metaconid. The preprotocrista protrudes mesially from the protoconid and turns lingually at the mesiobuccal corner of the trigonid. There are three main cuspids on the talonid: the hypoconid, the entoconid, and an indistinct hypoconulid. The hypoconid is slightly higher than the entoconid, and the hypoconulid is located centrally, on the distal margin of the talonid. The buccal cingulid is not as well developed but a small distal cingulid is present on the buccal part of the distal face. The cristid obliqua runs mesiolingually, terminating at the distal base of the protoconid. The talonid notch is not distinct. The mandibular corpus is very shallow (about 1.5 times taller than m2) relative to m2 size (Tab. 1).

The specimen PIN 3104/1084 does not have a labial cingulid. It is not obliterated by wear as evidenced by the almost unworn main cuspids. In occlusal aspect, PIN 3104/1084 shows no sign of any buccolingually narrowing (Fig. 2, 4a). The molar looks wide enough.

Holotype measurements (mm): mandible depth at m2 — 2.44, MD m2 — 1.67, BL m2 — 1.27. The m2 height, by protoconid — 1.88.

Comparison. Lower molars are larger and proportionally longer than that of *A. orlovi*. There is no buccal cingulid on m2 (Fig. 2, 4). The nearly complete labial cingulid of *Baataromomys* and other early Eocene euprimates has been well documented (e.g., fig. 3 in Ni *et al.*, 2007) suggesting that the labial cingulid is hard to be worn out in most fossil specimens.

Remarks. Attribution to the genus *Altanius* is based on the following characters: not reduced protoconid and long crown of m2, already mentioned in the genus diagnosis by Dashzeveg & McKenna (1977). The new species differs from *A. orlovi* in much larger lower molar size, no distinct buccal cingulid on m2, and longer mesiodistal proportions in the occlusal view (Tab. 1, Fig. 2: 4). Differs from *Teilhardina* in having no distinct lingual trigonid notch and a less developed buccal cingulid on m2. Differs from *Baataromomys* Ni *et al.*, 2007 in much smaller size and in lacking distinct buccal cingulid. Differs from *Altiatlasius* Sigé *et al.*, 1990 in having a more lingually situated paraconid and a small but distinct mesiobuccal cingulid on m2. Dif-

fers from several small Paleogene euprimates, such as *Anaptomorphus* Cope, 1872, *Asiomomys* Wang *et al.*, 1990, *Stockia* Gazin, 1958, and *Utaia* Gazin, 1958, in its much shallower mandibular depth. Differs from utahiin omomyines in having no enamel crenulation on the lower molar.

Material. Holotype.

Type locality and horizon. Tsagan Khushu locality, southern Mongolia, Trans-Altai Gobi, Nemegt Basin, Tsagan-Khushu, Lower Eocene, Naran-Bulak Formation, Bumban Member (Bumbanian Asian Land Mammal Age).

Discussion

The taxonomy of many euprimates and the stem groups that are still under debate is considered in a following short review of Paleocene and Eocene Asian primates.

Altanius orlovi was originally described as a member of the Anaptomorphinae Cope, 1883, Omomyidae Trouessart, 1879, on the basis of the similarity of its lower dentition to that of the anaptomorphines (Dashzeveg & McKenna, 1977). Several studies supported this classification (Gingerich *et al.*, 1991; Fleagle, 1999). Some authors, however, questioned its affinity to the anaptomorphine omomyids and instead regarded it as a primitive plesiadapiform, emphasizing the similarity in the structure of m1 between *A. orlovi* and some carpolestid plesiadapiforms, such as *Elphidotarsius* Gidley, 1923 (Rose & Krause, 1984; Rose *et al.*, 1994; Rose, 2006). In their discussion, the rather premolariform but not blade-like p4 structure was considered the primitive condition of the early plesiadapiforms (Rose & Krause, 1984).

In the 1990s, the discovery of the upper dentition of *A. orlovi* (Gingerich *et al.*, 1991) and isolated teeth of *Altiatlasius* Sigé *et al.*, 1990 from the latest Paleocene of Morocco (Sigé *et al.*, 1990) allowed further progress on the knowledge of the evolution of the early primates. Many workers compared the two genera with other early primates, such as *Teilhardina* Simpson, 1940 and *Donrussellia* Szalay, 1976, and regarded both *Altanius* and *Altiatlasius* as early primates, although their phylogenetic positions were unclear because their upper dentition was mutually very different. In *Altanius*, M2 has a much greater buccolingual width, distinct para- and metaconules, and a discontinuous lingual cingulum, whereas in *Altiatlasius*, M2 is buccolingually narrow, retaining a tiny paraconule and a complete basal lingual cingulum. Based on these morphological features, most researchers consider that *Altiatlasius* is more derived than *Altanius* (Fleagle, 1999; Gunnell & Rose, 2002) and some workers consider that *Altiatlasius* may even belong to the early anthropoids rather than to the omomyoid primates (Hooker *et al.*, 1999; Beard, 2004).

Recently, there have been further progresses in the discussion of the early primates, such as *Teilhardina*. Ni *et al.* (2003) described a well-preserved skull of a

new species of *Teilhardina*, *T. asiatica* Ni et al., 2003, from the earliest Eocene of China, and proposed a phylogenetic analysis of the early primates. In their conclusion, two Eurasian species of *Teilhardina*, *T. belgica* (Teilhard de Chardin, 1927) and *T. asiatica*, form a primitive independent clade, separated from another North American species, *T. americana* Brown, 1976. *A. orlovi* was included in the clade of the plesiadapiforms, rather than in that of the euprimates. However, the dental and mandibular specimens of *A. orlovi* do not show any similarity to plesiadapiforms discovered from eastern Asia.

In addition, Ni et al. (2007) described a new omomyid genus, *Baataromomys* Ni et al., 2007 from the Early Eocene of Inner Mongolia, China, admitting two species, *B. ulaanus* Ni et al., 2007 and *B. brandi* (Gingerich, 1993), the latter is the American species transferred from *Teilhardina*. They discussed the m2 morphology of *Baataromomys* in detail, comparing with many early primates including *A. orlovi*, and concluded that *A. orlovi* and *Baataromomys* are quite different from each other without close affinities between them. On the other hand, *Baataromomys* and *A. magnus* resemble in basic structure of m2, but differ from each other in much smaller size and in lacking a continuous buccal cingulid in the latter. Especially, the difference in the m2 size between *B. ulaanus* and *A. magnus* **sp. nov.** is larger than the size range of *Teilhardina belgica* and *T. asiatica*, suggesting the taxonomic difference at least at the species level (Figure 2 of Ni et al., 2008).

Ni et al. (2010) described a new omomyid genus and species, *Tarkops mckennai* Ni et al., 2010 from the Early Eocene of Inner Mongolia, China. *T. mckennai* is not a tiny primate and is approximately more than twice as much as *Altanius*. But *T. mckennai* is substantially smaller, than *Tarcastes montanensis* McKenna, 1990 from the Middle Eocene of North America. A detailed phylogenetic analysis including 59 taxa of euprimates from the Upper Paleocene and Lower Eocene of North America allowed Ni and coauthors to attribute *Altanius* to the omomyids. At the same time, these researchers concluded that its phylogenetic position is still unclear (Ni et al., 2010). The characters of m2 in *Altanius* differ in a reduction of buccal cingulid and in a lingually displaced paraconid.

Plesiadapiforms and euprimates have been reported from the latest Paleocene to Early Eocene sites in eastern Asia (Rose, 2006), apart from Tsagan-Khushu, such as Gashato, Wutu (Shandong Province, China), the upper part of the Lingcha Formation (Hunan Province, China), and Turpan Basin (Xinjiang Province, China). Many specimens of plesiadapiforms have been discovered, especially from Wutu, including *Chronolestes simul* Beard et Wang, 1995 and *Carpocristes oriens* Beard et Wang, 1995 (Carpolestidae) and *Asioplesiadapis youngi* Fu et al., 2002 (Plesiadapidae) (Beard & Wang, 1995; Fu et al., 2002; Tong & Wang, 2006). *Altanius orlovi* is quite different from *Chronolestes* and *Carpocristes* in lacking a plagiolacoid blade on p4,

which is the definitive feature of carpolestids (Rose, 2006). Meanwhile, *A. orlovi* is differentiated from *Asioplesiadapis* not by its p4 structure but by the morphology of i1, which is enormously enlarged and procumbent anteriorly in plesiadapids (Beard & Wang, 1995; Fu et al., 2002; Tong & Wang, 2006). According to Gingerich et al. (1991), the alveoli of the lower incisors in *A. orlovi* show that its i1 is not horizontally procumbent but inclined at an angle of about 35° forward of vertical and that there is no distinct diastema between the incisors and premolars.

Recently, another carpolestid plesiadapiform, *Subengius mengi* Smith et al., 2004, was reported from the late Paleocene locality of Subeng in Inner Mongolia (Smith et al., 2004). The lower molars of *Subengius* are similar to those of *A. orlovi*, although p4 retains the plagiolacoid blade, which is the typical feature of carpolestid plesiadapiforms (Smith et al., 2004; Missiaen & Smith, 2008). Thus, *A. orlovi* is not similar to any member of the carpolestid or plesiadapid plesiadapiforms discovered from the early Paleogene sites of eastern Asia. The plesiadapiform affinity is thus poorly defensible for *A. orlovi*.

In Jilin Province of China, an omomyid, *Asiomomys changbaicus* Beard et Wang, 1991, has been discovered from the Middle Eocene Huadian Formation (Beard & Wang, 1991). Unlike those of *A. magnus*, the trigonids of m2 and m3 of *Asiomomys* are more mesiodistally compressed, with a centrally situated paraconid, only slightly higher than the talonid, and lingually closed by the premetacristid; the lingual talonid notch is rather strong; the hypoflexid is not deep; and the buccal cingulid is nearly complete. Thus, *Asiomomys* shows the typical omomyid features, suggesting a distant relationship to *Altanius*.

In southern Asia, several small primitive primates have also been reported from Paleogene sediments: *Kohatius coppensi* Russell et Gingerich, 1980 and *Panobius afridi* Russell et Gingerich, 1987 from the Early or early Middle Eocene of Pakistan (Russell & Gingerich, 1980, 1987; Thewissen et al., 1997, 2001); *Marcgodinotius indicus* Bajpai et al., 2005, *Vastanomys gracilis* Bajpai et al., 2005, and *Anthrasimias gujaratensis* Bajpai et al., 2008 from the Early Eocene of India (Bajpai et al., 2005, 2008; Rose et al., 2006, 2009). The fossil materials of *Kohatius* and *Panobius* are isolated teeth so fragmentary that it is hard to make direct comparisons between them. *Kohatius* obviously differs from *A. orlovi* in having a large, conical paraconid on m1 and in having no paraconid and a well-developed large talonid on p4 (Russell & Gingerich, 1981, 1987; Thewissen et al., 1997). *Panobius afridi* is known only from two isolated molars discovered together with *Kohatius*. It differs from *Altanius orlovi* by the large, distinct paraconid at the m1 trigonid and by the absence of the buccal groove between the hypoconid and hypoconulid.

Marcgodinotius Bajpai et al., 2005 has been tentatively classified in the adapoids based mainly on the presence of a double-rooted p2 and four premolars, and

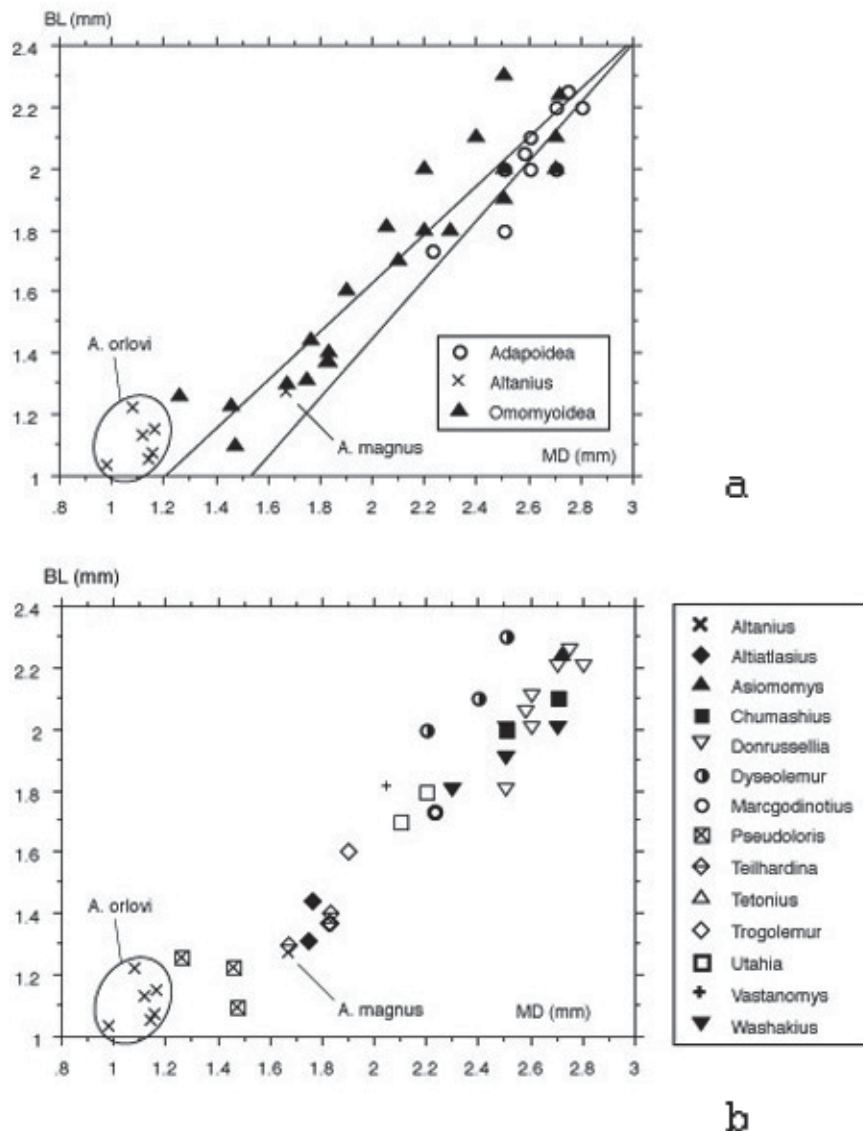


Figure 3. Scatterplots of the mesiodistal length versus the buccolingual width of m2 (a, b) in several tiny primitive primate taxa discussed in the text. The dental measurement data are from Gazin (1958), Russell *et al.* (1967), Estravis (2000), Bajpai *et al.* (2005), Gingerich *et al.* (1991), Sigé *et al.* (1990), Beard & Wang (1991), Ni *et al.* (2003), and Szalay (1976). R^2 values of the regressions for the adapoids and omomyoids are 0.746 and 0.875, respectively. Note that the measurements of *Altanius orlovi* fall above the regression lines of both adapoids and omomyoids. MD, mesiodistal length; BL, buccolingual width.

the relatively elongated m3 with a large, centrally positioned hypoconulid (Bajpai *et al.*, 2005). *Altanius orlovi* is distinct from *Marcgodinotius* in having a double-rooted unreduced p1, a high paraconid, short talonid, and higher lingual cuspids (Bajpai *et al.*, 2005).

Thus, *A. orlovi* does not show an especial resemblance to any early Paleogene euprimates or plesiadapiformes, suggesting instead an independent status. The discovery of *A. magnus* **sp. nov.**, PIN 3104/1084, however, makes the problem more complicated. As already

mentioned, *A. magnus* **sp. nov.** is distinctly larger than *A. orlovi* in the size of the lower molar, so it is classified as a new species of the same genus. However, the crown proportions of m2 are probably substantially different between the two species, indicating the possibility of a generic difference. In scatterplots of the mesiodistal length *versus* the buccolingual width of m2, *A. orlovi* is obviously located above the regression lines of the adapoids and omomyoids, whereas *A. magnus* **sp. nov.** falls on the regression lines (Fig. 3), indicating

that m2 of *A. orlovi* has more mesiodistally compressed and buccolingually wide proportions than m2 of *A. magnus* **sp. nov.** and that of other tiny euprimates.

In contrast, m2 of *A. magnus* **sp. nov.** is similar to that of *Marcgodinotius*, *Teilhardina*, and *Baataromomys*: the paraconid is situated rather lingually and is slightly smaller and lower than the metaconid and protoconid; the hypoconulid is also centrally situated; and the small distal cingulid is present at the buccal part of the distal side. However, in *Marcgodinotius*, *Teilhardina* and *Baataromomys* m2 retains a more complete buccal cingulid (Bajpai *et al.*, 2005; Beard, 2006; Smith *et al.*, 2006; Ni *et al.*, 2007), whereas in *A. magnus* **sp. nov.** m2, of which basal enamel is unfortunately partly damaged, unlikely has continuous buccal cingulid as in these taxa. *A. magnus* **sp. nov.** may potentially be included together with *Teilhardina* and *Baataromomys* (and also with *Marcgodinotius*) in the same taxonomic category in the future. More specimens of lower and upper dentition of *A. magnus* would resolve this problem.

Apart from the taxonomic revision of these early 'primates' from eastern Eurasia (*Altanius*, *Teilhardina*, *Baataromomys*, *Marcgodinotius*, *Vastanomys*) and northern Africa (*Altiatlasius*) made possible by these materials, it is remarkable that these early 'primates' from the broad areas show similar configurations, at least in their m2 morphology. This similarity in m2 figuration among these taxa may be the primitive condition among the early euprimates, including adapoids, omomyoids, and eosimiids, in the Late Paleocene to Early Eocene. However, some workers consider such m2 morphology as the morphotype of anthropoid ancestor (Kay & Williams, 1994), but others are suspending the judgement on the evolutionary polarity on the dental characters of m2 (Beard, 2006; Ni *et al.*, 2007). If the morphological similarity in m2 among *A. magnus* and these Eurasian and African early primates actually correlates with a phyletic proximity, it probably means that the early euprimates were much more widely distributed in Eurasia and Africa as early as in the Late Paleocene than was previously thought.

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