内蒙古二连盆地努和廷勃尔和剖面
阿山头组底部鼠齿类一新属[1]

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摘要：努和廷勃尔和剖面位于内蒙古二连市西南 40 km 的呼和勃尔和地区,依据沉积间断可以将 50 m 厚的地层分为脑木根组和阿山头组,地层时代从中古新世到中始新世。在阿山头组下部层位中发现大量的啮齿类化石,其中一类原始的鼠齿类在此被命名为一个新的属种：*Erlianomys combinatus* gen. et sp. nov.（综合二连鼠）。其主要牙齿特征为：齿冠低,主尖较为发育,连接各尖的脊简单、细弱。有 P4, m1 有前压痕也表明有一个小的 p4 或者 dp4。M1 和 M2 大小相当。臼齿前齿带（下前齿带）明显,与原尖（下原尖）之间没有连接或连接很弱。M1 和 M2 原尖后臂、后脊和次尖前臂在中尖处相交。m1 的下前尖很弱或缺失,下原尖与下后尖之间连接很弱,基本为孤立的两个尖；m2–3 下次小尖明显,下次脊短,有时直接与下次小尖相连；下外脊低矮、不发育。上、下臼齿都没有中脊或很弱。新属种的发现,为进一步认识古近纪啮齿类的起源和演化提供了新的证据。

　　Erlianomys 与北美的 *Elymys* 和亚洲的 *Aksyiromys*,*Primisminthus*,*Allosminthus*,*Palasiomys* 都有很多相似的特征,预示着它们可能有共同的祖先。在牙齿形态上,*Erlianomys* 比中始新世的其他鼠齿类更为原始,可表明其产出层位即阿山头组下部的时代要早于中始新世,可能属于早始新世；其形态更接近亚洲的 *Aksyiromys*,*Primisminthus* 和 *Allosminthus*,而与北美的 *Elymys* 相差较大。因此推测鼠齿类的共同祖先可能与 *Erlianomys* 更为相似,早始新世时在亚洲起源,向其他大陆的迁移扩散不会晚于早始新世晚期。

关键词：内蒙古努和廷勃尔和,早始新世,阿山头组,鼠齿类

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ERLIANOMYS COMBINATUS, A PRIMITIVE MYODONT RODENT FROM THE EOCENE ARSHANTO FORMATION, NUHETINGBOERHE, NEI MONGOL, CHINA

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Abstract　A new myodont rodent is reported from the lower part of the Arshanto Formation in Nuhetingboerhe of Nei Mongol, which represents one of the earliest and most primitive myodont rodents in Asia. The new species is characterized by several primitive features, such as M1 and M2 subequal in size, anterior cingulum(id) pronounced and having weak or no connection with the protocone and protoconid, presence of a small p4 or dp4 in at least some individuals, the m1 anteroconid weak or absent, protoconid and metaconid isolated, anterolophulid absent, hypoconulid on m2−3 distinct, hypolophid short or extending to the hypoconulid on m2−3, ectolophid weak, mesoloph(id) absent or weak. The new species is most similar to the Asian *Aksyiromys*, *Primisminthus yuenus* and other species. The primitive features of the new species suggest that the common ancestor of Eocene myodonts is probably similar to *Erlianomys* and originated in Asia in Early Eocene.

Key words　Nuhetingboerhe, Nei Mongol; Early Eocene; Arshanto Formation; myodont

1　Introduction

Myodonta (Emry, 1981; McKenna and Bell, 1997) consists of two major groups: Muroidea and Dipodoidea, which contains Muridae and represents the most diverse and geographically widely distributed group of mammals today and probably during the geological history. The major difference traditionally recognized between Muroidea and Dipodoidea is the presence of P4 in dipodoids and the absence of that tooth in muroids. Recent study shows, however, that the cricetid *Pappocricetodon antiquus* (Wang and Dawson, 1994) and *Palasiomys* (Tong, 1997) have a small P4 or DP4. Walsh (1997) also indicated that some *Simimys* retain P4. Primitive muroids and dipodoids are difficult to distinguish for that they are similar morphologically and have some common evolutionary tendencies.
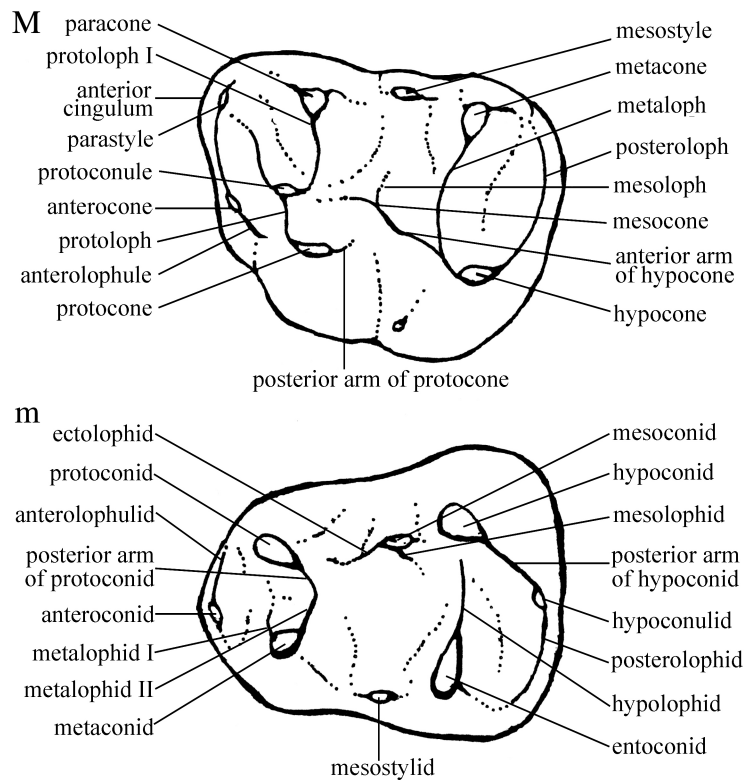

Fig. 1　Terminology used for myodont molars, modified from Wang and Dawson (1994) and Tong (1997)

Here we report a new genus and species of myodont from the lower part of the Arshanto Formation at the Nuhetingboerhe (Camp Margetts) area, Nei Mongol. The specimens were collected by screenwashing. The new form displays some typical myodont dental features as well as a few unique features, primarily primitive, that are unknown in other Eocene myodont rodents. The new rodent specimens cast new light on the origin, early evolution and dispersal of myodont rodents during the Paleogene.

Fig. 1 illustrates the basic terminology used here for myodont molars, combining conventional rodent dental terminologies from other studies (Wang and Dawson, 1994; Tong, 1997).

2   Geological setting

The Nuhetingboerhe (Camp Margetts) area of Nei Mongol is about 40 km southwest to Erlian City and was first explored by the Central Asiatic Expedition (CAE) of the American Museum of Natural History in 1920s. In 1930, the CAE team set up a base named 'Camp Margetts' in this region, and by referring to which a few other localities were named (Meng, 1990; Meng et al., 2007b). The site "7 miles west of Camp Margetts" of the CAE is in the escarpment of Nuhetingboerhe-Wulanboerhe.

The lithological sequence of Nuhetingboerhe measures about 50 m. It contains two lithological units: the lower Nomogen Formation and the upper Arshanto Formation, separated by a depositional hiatus with uncertain time lap (Meng et al., 2007b). The Nomogen Formation contains at least two fossil levels: the Late Paleocene fauna characterized by *Lambdopsalis*, *Palaestylops* and *Prioenssus* in the basal beds and the Early Eocene fauna characterized by presence of *Gomphos elkema* and other mammals, including rodents and perissodactyls in the upper part. Immediately above the *Gomphos* bed is an assemblage that consists of fossils referable to *Pataecops parvus* and other mammals. Still higher in position but below the lower hiatus, a lower jaw of *Uintatherium* was found. The *Gomphos* bed was correlated to the earliest Bumbanian beds (Meng et al., 2004).

There are several fossiliferous levels within the Arshanto Formation. Large mammals including *Metacoryphodon*, *Gobiatherium* and *Litolophus* have been found in the basal fluvial beds above the hiatus. Although these fossils may have some difference in their stratigraphic occurrences, they can be lumped into one assemblage. The beds preserved a concentration of the chalicothere *Litolophus* skeletons (Bai et al., in press), lagomorphs (Li et al., 2007), a rodent (Meng et al., 2007a) and the myodont rodent reported here.

3   Systematic description

<div align="center">

Rodentia Bowditch, 1821
Myodonta Schaub, 1958
Family *incertae sedis*
***Erlianomys* gen. nov.**

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Type species   *E. combinatus*, a new and only species.

Etymology   For Erlian, Nei Mongol (Inner Mongolia), the city near the outcrops where the specimens were collected; and Greek *mys*, mouse.

Diagnosis   A primitive myodont, interpreted dental formula 1−0−1−3/1−0−?1−3; crown brachydont, with obtuse cusps and lower or weaker crests; presence of a small p4 or dp4 in at least some individuals as reflected by a contact facet at the anterior end of m1; M1 and M2 subequal; anterocone on M1 weak; anterior cingulum(id) pronounced and having weak or no connection with the protocone or protoconid; weak anterolophule on M2; anteroconid of m1 weak or absent; protoconid and metaconid on m1 isolated; anterolophulid absent; hypoconulid on m2−3

distinct；hypolophid short or extending to the hypoconulid on m2−3；ectolophid weak.

Erlianomys combinatus sp. nov.

Holotype　A left M1（IVPP V 14615.1）（Fig.2B）.

Specimens　V 14615.2, left P4；V 14615.3−8, left M1；V 14615.9−17, right M1；V 14615.18−26, left M2；V 14615.27−30, right M2；V 14615.31−34, right M3；V 14615.35−44, left m1；V 14615.45−52, right m1；V 14615.53−59, left m2；V 14615.60−68, right m2；V 14615.69−78, left m3；V 14615.79−86, right m3.

Type locality and horizon　Nuhetingboerhe, Erlian Basin, Nei Mongol（Inner Mongolia）; lower part of the Arshanto Formation；Early Eocene.

Diagnosis　The same as for the genus.

Etymology　From Latin *combinatus*（combined）, indicating a combination of dental features from several groups of early rodents in the new species.

Description　P4 is small, peg-like and single-rooted, with an oval contour in occlusal view（Fig.2A）.

Molars are low-crowned and have three roots：a major lingual one and two minor labial ones（Fig.2C）. The M1 is identified by its being wider posteriorly than anteriorly（Fig.2B）. Its tendency of tapering anteriorly and the contact facet on the anterior surface（Fig.2D）are consistent with presence of a small P4. The maximum width（transverse dimension）and length（anteroposterior dimension）are nearly equal. The anterior cingulum is distinct and separated from the protocone and paracone by a transverse, shallow groove. The cingulum inflates to form cusps at the lingual and labial ends；by position the labial one most comparable to the parastyle and the lingual one to the anterocone. Four main cusps are distinct and crests are low. The protocone and paracone are closer to each other than are the metacone and hypocone. The protocone is conical and the protoloph（the anterior arm of the protocone）is short and low and extends labially to connect the protoloph I from the paracone. A small protoconule is present on the protoloph, which is more distinct on the worn M1（Fig.2E）and has a small spur projecting anteriorly, perhaps suggesting an initiation depart of the crest that extends to the parastyle in later forms. The paracone is lightly anterior to and more transverse than the protocone. Similar to the paracone, the metacone is transverse, but its lingual extended. The hypocone is smaller and more lingual than the protocone. A mesostyle is at the labial margin between the paracone and metacone and anteroposteriorly extended. The posterior arm of the protocone is a very low, narrow ridge that joins posteolabially to a small mesocone（or metaconule, Emry et al., 1998）. The anterior arm of the hypocone is low and extends anterolabially to the mesocone but not further into the central basin. The metaloph turns anterolingually toward the protocone and ends at the mesocone. The mesocone therefore marks the triple junction of the posterior arm of the protocone, the anterior arm of the hypocone and metaloph. A mesoloph is absent. The posterior margin of M1 is formed by a low posterior arm of the hypocone that extends labially to the posterior side of the metacone as the posteroloph. The central basin of the tooth is broad and structureless.

The M2 is rectangle in occlusal outline, longer than wide and narrower posteriorly than anteriorly（Fig.2F）. The hypocone is considerably smaller than the protocone, and not extends posteriorly as in M1. Other cusps are similar to M1, except the main cusps of part of the specimens are slightly more anteroposteriorly longer than the corresponding ones on M1. The anterior cingulum is as distinct as that on M1, and has a weak anterocone that connects posteriorly to the protocone by a weak anterolophule（Fig.2G）. The connection between the protocone and paracone is similar to that of M1. The posterior arm of the protocone is short and narrow. The anterior arm of the hypocone is low and narrow, but more distinct than that of M1. The metaloph extends anterolingually and joins the anterior arm of the hypocone and is stronger than the ante-
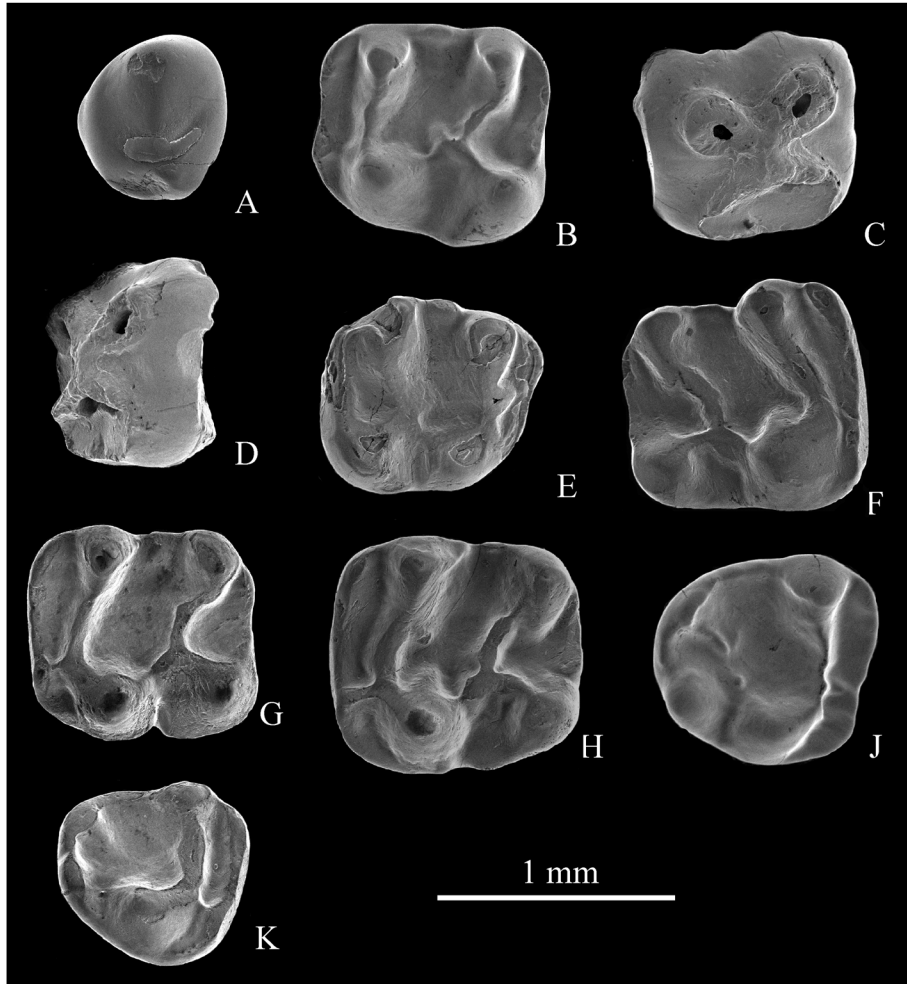
Fig. 2　Upper teeth of *Erlianomys combinatus* gen. et sp. nov.
A. V 14615. 2, left P4; B. V 14615. 1, left M1(holotype); C–D. V 14615. 3, root and anterior views of a left M1; E. V 14615. 9, right M1; F. V 14615. 27, right M2; G. V 14615. 21, left M2; H. V 14615. 23, left M2; J–K. V 14615. 31–32, right M3; all in crown view except C and D

rior arm of the hypocone and the posterior arm of the protocone (Fig. 2H). Neither the mesostyle nor the mesoloph is present. The posteroloph arm is weak and short.

The M3 is of a rounded triangular outline in occlusal view and broader anteriorly than posteriorly (Fig. 2J, K). The protocone is the largest cusp in M3; the second large ones are the paracone and hypocone; the metacone is reduced and a slight elevation suggests an indistinct metacone at the anterobuccal angle. The anterior cingulum is distinct from anterior of the paracone to the protocone. The protoloph connects to the protoloph I. There is no protoconule. The metaloph is weak and short. The central basin is broad and structureless.

All lower molars are double-rooted. The anterior surface of most m1 bears a contact facet (Fig. 3A), indicating a small p4 or dp4. The m1 is smaller than m2 and tapers anteriorly (Fig. 3B). The protoconid and metaconid are subequal, with the latter more anteriorly. There is no ridge connecting the protoconid and metaconid, except a weak one in V 14615. 45(Fig. 3C), which could be tentatively interpreted as a partial metalophid II. An anteroconid is usual-

ly present and isolated (Fig. 3D). The entoconid is taller than the hypoconid, and the hypolophid is distinct (Fig. 3E). The posterior arm of the hypoconid is low and continues with the posterolophid. A weak hypoconulid is suggested by a wear pit on the posterolophid. A small mesostylid presents on the lingual margin of the tooth. There is no mesolophid. The ectolophid is weak and positioned labially. The mesoconid is small.
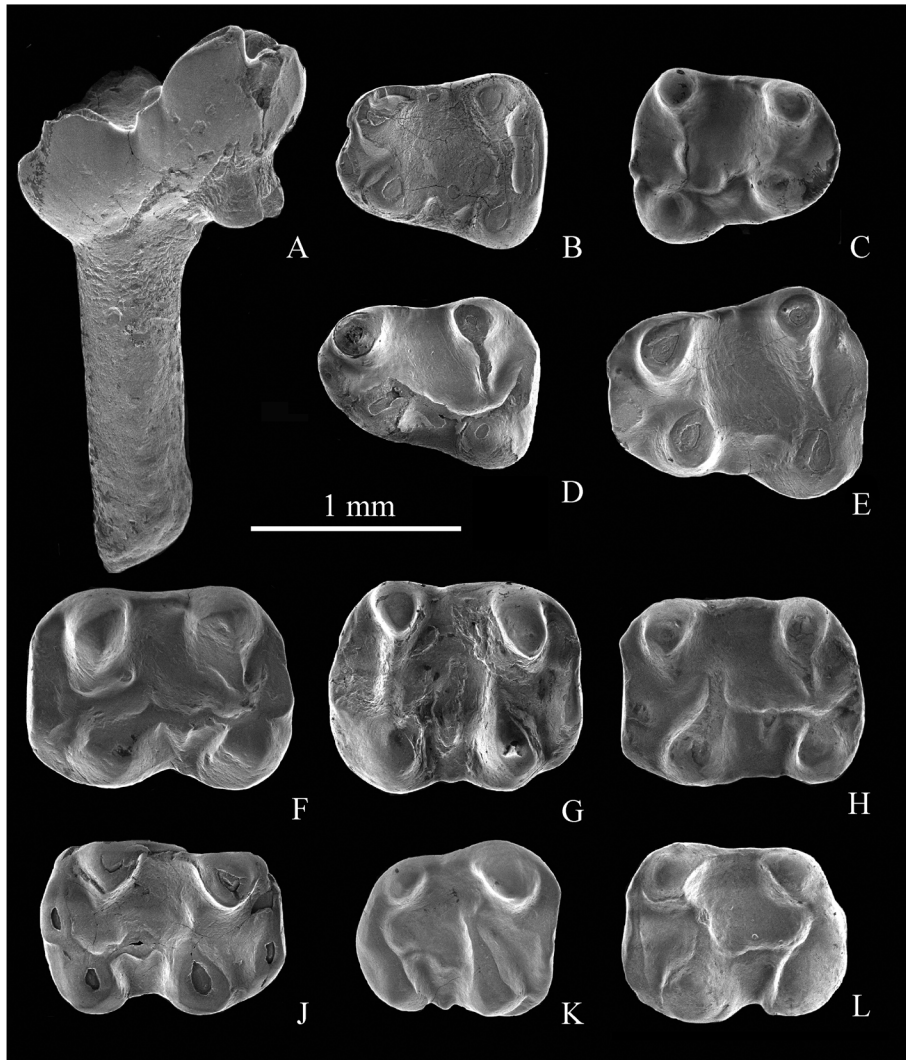

Fig. 3   Lower teeth of *Erlianomys combinatus* gen. et sp. nov.
A. V 14615. 36, left m1 in lingual view, showing the contact facet; B. V 14615. 35, left m1; C. V 14615. 45, right m1; D–E. V 14615. 40–41, left m1; F. V 14615. 53, left m2; G. V 14615. 66, right m2; H. V 14615. 54, left m2; J. V 14615. 62, right m2; K. V 14615. 79, right m3; L. V 14615. 74, left m3; all in crown view except A

The m2 is generally rectangular (Fig. 3F). The cusps of m2 are larger than those of m1. The anterior cingulid is distinct. An elevated region anterolingual to the protoconid suggests an anteroconid (Fig. 3G). The anterolophulid that connects the anteroconid and the protoconid is absent. The protoconid and hypoconid are conical whereas the labial two cusps are more trans-

verse. The protoconid and metaconid are separated by a longitudinal trough, without any connection between the two cusps. The metaconid is rectangular and isolated. The posterior arm of the protoconid is short and extends posterolingually toward the central basin or base of the metaconid (Fig. 3H). The ectolophid is slim and low and positioned on the labial side of the tooth. A swollen area of the ectolophid near the hypoconid indicates a small mesoconid. The mesoconid of m2 is more distinct than that of m1 (Fig. 3J). The hypoconulid is a low cusp but distinct on the low posterolophid. In some specimens the hypolophid is short and extends posterolabially or even toward the hypoconulid.

The m3 is broader anteriorly (across the protoconid-metaconid) than posteriorly (across the entoconid-hypoconid). Unlike m2 that has a straight posterior edge and a contact facet on the posterior end, the posterior contour of the m3 is rounded (Fig. 3K). The anterior cingulid is low and pronounced. In some specimens the posterior arm of the protoconid of m3 is longer than that of m2 and extends to the posterolabial base of the metaconid, but it does not connect with the metaconid (Fig. 3L). The metaconid is oriented obliquely and nearly isolated. Both hypoconid and entoconid are reduced in comparison with those of m2. The hypoconid tapers posterolingually as a short ridge that joins the hypoconulid (Fig. 3L). The hypolophid is short and extends posterolabially toward the hypoconulid. There is no mesolophid. A small mesostylid and mesoconid are present.

Measurements　See Table 1.

Table 1　**Measurements of teeth of *Erlianomys combinatus* gen. et sp. nov.**　（mm）

Tooth	n	Length		Width	
		Min ~ max	mean	Min ~ max	mean
P4	1	0.625	0.625	0.69	0.69
M1	16	0.94 ~ 1.09	0.99	0.78 ~ 0.94	0.88
M2	13	0.91 ~ 1.09	1.01	0.81 ~ 1.03	0.94
M3	4	0.81 ~ 0.94	0.89	0.78 ~ 0.88	0.82
m1	18	0.88 ~ 1.09	0.98	0.75 ~ 0.88	0.80
m2	16	1.06 ~ 1.16	1.10	0.78 ~ 0.94	0.87
m3	18	0.94 ~ 1.13	1.02	0.72 ~ 0.94	0.81

4　Comparisons

With muroids　The early muroids are more diverse and abundant in Asia than in other continents. The earliest records of undoubted cricetids are Middle Eocene in Asia, Late Eocene in North America and the beginning of Oligocene in Europe (Dawson and Tong, 1998). Many muroids have been reported from the Middle Eocene Liguanqiao and Yuanqu basins, including *Pappocricetodon*, *Palasiomys* and *Raricricetodon* (Tong, 1992, 1997). *Pappocricetodon* is one of the oldest known cricetids and includes 4 species：*P. rencunensis* (Tong, 1992), *P. schaubi* (Zdansky, 1930; Tong, 1992, 1997), *P. antiquus* (Wang and Dawson, 1994) and *P. kazakstanicus* (Emry et al., 1998), although *P. antiquus* could belong to a separate genus (Wang and Dawson, 1994; Dawson and Tong, 1998). Differences between *Erlianomys* and *Pappocricetodon* are distinct. *Pappocricetodon* lacks P4. *Erlianomys* is smaller than *Pappocricetodon* and its lophs connecting with main cusps are simple. Cheek teeth of *Pappocricetodon* have higher and stronger crests and cusps. M1 of *Pappocricetodon* has a distinct parastyle and protoloph. The mesostyle and mesoloph of upper molars of *Pappocricetodon* is developed. The hypocone of M3 of *Pappocricetodon* is reduced, and the metaloph is complete. The mesolophid and ectolophid of m2 and m3 of *Pappocricetodon* are developed, the metalophid I is complete, and the metalophid II is distinct.

Palasiomys is a small cricetid with only one species *P. conulus*, that bears some primitive characters: M1 and M2 are similar in size; the parastyle of M1 minute, the anterolobe less developed, the anterocone of M2 and M3 less elevated, the M3 hypocone located posterolingually to the protocone and the metaloph weak. Tong (1997:117) recognized that the dental pattern of *Palasiomys* may be considered as the primitive type for those of *Pappocricetodon* and is more similar to those of zapodoids than to those of later cricetids. Tong noted that some of the M1s of *Palasiomys* bear small interdental contact facet, showing the presence of P4 or DP4. *Palasiomys* is similar to *Erlianomys* in size but different from the latter in following features: more inflated molar cusps, anterior cingulum of M1 weaker, stronger anterior arm of the hypocone extending to the center of the basin; M2 metaloph developed; M3 hypocone reduced; m1 ectolophid and posterior arm of the protoconid complete; m2 anterolophulid distinct, better developed metalophid II; m3 ectolophid curved.

Raricricetodon includes three species: *R. zhongtiaensis*, *R. ? minor* and *R. ? trapezius*. *R. zhongtiaensis* is similar to *P. rencunensis* morphologically; *R. ? minor* is similar to *R. zhongtiaensis*, but smaller; *R. ? trapezius* resembles *Palasiomys* in dental formula and some characters, but the protoloph of *Palasiomys* M1 terminated to the parastyle and the protoloph extended labially and attached to the paracone in M1 of *R. ? trapezius*. Therefore, the differences between *Erlianomys* and *Pappocricetodon* or *Palasiomys* also exist between *Erlianomys* and *Raricricetodon*.

With dipodoids　The cheek teeth of *Erlianomys* are generally similar to those of Eocene dipodoids in having miniscule size and P4, molar longer than wide, four main cusps on molars subequal in size, conules usually indistinct, metaloph less developed. Among early dipodoids, the tooth pattern of *Erlianomys* is most comparable with those of zapodoids, including the North American *Elymys* and Asian *Aksyiromys*, *Primisminthus* and *Allosminthus*.

Elymys complexus (Emry and Korth, 1989) was considered a miniscule myodont from the early Bridgerian (early Middle Eocene) Sheep Pass Formation near Ely, Nevada. Emry (2007) reported many specimens of *Elymys* from the type locality, which adds substantially to our knowledge of this early myomorph. *Elymys complexus* is smaller than *Erlianomys* in size. Similar to *Erlianomys*, a small peg-like P4 is present. All of the molars of *Elymys* are low crowned and the four major cusps distinct, more or less conical, with their apices being distinctly higher than the crests. *Elymys* differs from *Erlianomys* in having prominent protoloph on M1, which extends to the anterior cingulum. M1 of *Elymys* ha the parastyle in some specimens, but there is no anterocone. M2 of *Erlianomys* lacks the mesostyle and protoconule. Most of m1 of *Erlianomys* have the hypolophid extending labially from the entoconid and directly connecting the hypoconid. The m1 hypoconid of *Elymys* is transversely elongate with the posterior wing extending into the posterolophid that contacts the posterior base of the entoconid. Most m2 of *Elymys* have a well-defined arcuate lophid connecting the anterolingual base of the protoconid to the anterior cingulid. On m2−3 of *Erlianomys*, the crests are absent or weak between the protoconid and metaconid.

Aksyiromys dalos was named and described by Shevyreva (1984) on the basis of a single tooth (M1 or M2) from the Zaysan Basin of eastern Kazakstan. Emry et al. (1998) found *A. dalos* from Paleogene red beds of the Kolpak Formation, the Taldy-Kurgan region of eastern Kazakstan. Lucas et al. (1997) suggested that this assemblage is of Irdinmanhan age (middle Middle Eocene). As Emry et al. (1998) noted, Shevyreva (1984) recognized that *Aksyiromys* differs from all representatives of Cricetidae, Zapodidae and Eomyidae by the complete lack of a mesoloph (or the posterior arm of the protocone) and by the direct connection between the protocone and metacone. Additional specimens from the Shinzhaly locality in eastern Kazakstan, have provided considerable new morphology to *Aksyiromys* (Emry et al., 1998). *Erlianomys* is similar to *A. dalos* in size and general morphology, but different from the latter in some detail

morphologies. In the upper molar, the anterior cingulum of *Erlianomys* inflates to form cuspules at the lingual and labial ends as parastyle and anterocone; the metaloph of *Erlianomys* is developed; *A. dalos*, in contrast, has a stronger mesocone (metaconule) and has a prominent anteroconid in m1 and better developed metalophid II and mesoconid in lower molars. The hypolophid is developed in *Erlianomys*, but it is either absent or extends labially to the hypoconid instead of posterolabially to the hypoconulid in *A. dalos*.

　　Primisminthus was described by Tong (1997) as a new zapodid. It includes 3 new species: *P. jinus* (Naduan), *P. shanghenus* (Sharamurunian) and *P. yuenus* (Irdinmanhan). *Primisminthus* is similar to *Erlianomys* in size. The differences between them are as follows: on M1 of *Primisminthus*, the anterior cingulum less developed, parastyle and anterocone weak, posterior arm of protocone absent or weak in most examples, metaloph of M1 of *P. jinus* and *P. shanghenus* absent in half examples, on m2 and m3 of the two species the anterior arm of protoconid developed and connecting to anteroconid. *P. yuenus* is most similar to *Erlianomys* in *Primisminthus*. However, on m1 of *P. yuenus* the protoconid and metaconid have weak connecting, and the mesoconid of lower molars is prominent, and the ectolophid is better developed and completed than in *Erlianomys*.

　　Allosminthus was established by Wang (1985). Based on specimens from Shanxi and Henan, China, Tong (1997) erected *Banyuesminthus*, including two species: *B. diconjugatus* and *B. uniconjugatus*. Wang (2008) suggested that *Banyuesminthus* is a junior synonym of *Allosminthus*, which, if valid, would include five species: *A. uniconjugatus* (late Middle Eocene), *A. diconjugatus* (latest Middle-Late Eocene), *A. ernos* (Late Eocene), *A. majusculus* (Late Eocene) and *Allosminthus* sp. (Late Eocene). The following features of *Allosminthus* distinguish it from *Erlianomys*: a better developed mesoloph, presence of the ectolophid, the mesolophid short or absent and the metalophid II complete on m1 and m2.

　　Emry (2007) suggested that there is close identity among *Primisminthus*, *Banyuesminthus* (*Allosminthus*) (Tong, 1997) and the Shinzhaly teeth that Emry et al. (1998) referred to *Aksyiromys dalos*. Emry (2007) considered that they are very closely related, if not congeneric. In comparison of Tong's collection with illustrations and description of *A. dalos*, we found that similarities and differences are present among *Primisminthus*, *Allosminthus* and *A. dalos*. For example, on the upper molar of *A. uniconjugatus*, the anterior cingulum is distinct, the parastyle and anterocone are developed. In contrast, the parastyle and anterocone of *A. dalos* are absent or weak. On the lower molar of *A. uniconjugatus*, the ectolophid is present, and mesolophid is more distinct than *A. dalos*. The ectolophid of *Primisminthus* is better developed and more completed than that of *A. dalos*. Nonetheless, although we observed these differences and similarities, we do not attempt to clarify the taxonomy of these taxa, which needs a more careful and thorough comparative study that involves specimens from the Shinzhaly's and Tong's collections.

　　With other myomorphs　*Pauromys* was established by Troxell (1923) on the lower jaw with p4–m3 from the Bridger Basin. *Pauromys* of North America was recognized as cricetid by Schaub and Stehlin (Schaub, 1925; Stehlin and Schaub, 1951). Dowson (1968) suggested *Pauromys* is basically a sciuravid. Tong (1997) noted that there are some similarities between *Pauromys* and *Primisminthus yuenus*, suggesting that *Pauromys* is closely related to myomorphs, or even related to dipodoids. Tong considered that *Pauromys* is too young to be ancestral to *Elymys*, *Primisminthus* and *Palasiomys*, and sciuravids are already too specialized to give rise to the Eocene Asian myomorphs. Tong proposed that myomorphs could have derived from a miniscule Early Eocene rodent that has well-developed hypocone and entoconid. Walsh (1997) regarded *Pauromys* as a primitive member of Myodonta. *Pauromys* is similar to *Erlianomys*. Both possess developed four main cusps, protoconule on the protoloph, metaloph and anterior arm of hypocone connecting, m2 developed anterior cingulid, ectolophid weak or absent. However,

Pauromys differs from *Erlianomys* in having no reduced P4 and p4, weak posterior arm of proto-cone, developed posterior arm of protoconid extended entire width of tooth to base of meta-conid, mesoconid elongate. Those comparisons suggest that *Erlianomys* is more primitive than *Pauromys*.

　　Simimys is an Eocene myomorphs genus of North America, from the late Unintan and Du-chesnean (Wilson, 1935, 1949; Emry, 1981). *Simimys* was attributed to Cricetidea by Wil-son (1935). Then, it has been regarded as a "more or less primitive survivor into the Late Eo-cene of a stalk which was ancestral to both cricetids and the Dipodoidea" (Wilson, 1949). *Simimys* combined a hystricomorphous skull with a separate neurovascular canal, and it has been included in the Dipodoidea (Emry and Korth, 1989; Wang and Dawson, 1994). The features of *Simimys* are different from that of *Erlianomys* in several aspects of cheek tooth, such as P4 absent, M1 larger than M2, the anterior arm of the protocone developed and connecting to the parastyle, the anterocone weak, M3 hypocone reduced and the mesolophid distinct.

　　The new specimens described here apparently represent a new form among early muroids and dipodoids, which still possesses several primitive features, including P4 present, M1 and M2 subequal in size, the parastyle of M1 minute, the paracone and protoloph connected, the metaloph and anterior arm of the hypocone connected, m1 smaller than m2, the metalophid I absent, the ectolophid weak, the mesoconid small and the mesolophid absent. In general dental morphology, *Erlianomys* is more similar to dipodoids than to muroids.

5　Discussion

5.1　Geological age of the lower part of Ashanto Formation

　　Erlianomys was collected from the lower beds of Arshanto Formation at the Nuhetingboer-he. There are numerous jaws and isolated teeth of rodents, primarily belonging to ctenodac-tyloids, collected from the same beds at the same locality. Meng et al. (2007b) suggested that the lower part of the Arshanto Formation is probably late Early Eocene rather than Middle Eo-cene as previously considered. From the same locality and beds, Li et al. (2007) described the earliest known Asian lagomorph, *Dawsonolagus antiquus* and Meng et al. (2007a) de-scribed a unique rodent *Archetypomys erlianensis*. A recent study of paleomagnetism on these sections also indicated that most of the Arshanto Formation is Early Eocene and only a small up-per portion of the Arshanto Formation belongs to Middle Eocene (Sun et al., 2009). *Erliano-mys* is primitive in dental morphology compared to known Eocene myodonts, which is consistent with its age. From known records *Erlianomys* is the earliest myodont with an estimated paleo-magnetic age of 54 Ma.

5.2　Origin and evolution of myodont rodents

　　Based on temporal and spatial occurrences, there are two primary hypotheses for the ori-gin, evolution and dispersal of myodont rodents. Vianey-Liaud (1985) believed that the source for dipodids was the Asian ctenodactyloids, and that the earliest cricetids were also known from Asia (Tong, 1992, 1997; Wang and Dawson, 1994; Dawson and Tong, 1998). Therefore, Vianey-Liaud hypothesized that dipodids and cricetids spread from Asian to Europe after the closure of the Turgai straits at the close of the Eocene, and migration from Asia to North Ameri-can happened several times, with dipodoids first arriving in the Late Eocene (*Simimys*) and again with typical dipodids in Miocene, and cricetids arriving in the latest Eocene with the ap-pearance of the eumyines. The other hypothesis supports endemic origin of North American *Ely-mys* and other myomorph groups (Eomyidae, Geomyoidae). Emry (2007) suggested that myo-morphs evolved from Sciuravidae in North America at least as early as the beginning of the Mid-dle Eocene, and the emigration of an *Elymys*-like myomorph from North American to Asian be-

gins in the early Middle Eocene, while the diversification of Asian dipodoids and muroids occurs in the later Eocene. Emry and Korth (1989) proposed that *Elymys* is probably ancestral to both *Simimys* and later zapodids.

　　The discovery of *Erlianomys* casts some new light on the origin and early evolution of myodonts. The similarities between *Erlianomys* and North American *Elymys* and Asian Middle Eocene myodonts such as *Aksyiromys*, *Primisminthus*, *Allosminthus* and *Palasiomys*, suggest that they possibly share a common ancestry. Because *Erlianomys* is geologically older than the Middle Eocene Asian myodonts and North American *Elymys*, and is more similar to Asian *Aksyiromys*, *Primisminthus* and *Allosminthus* than to the North American *Elymys*, and is morphologically more primitive than other known early myodonts, it seems appropriate to propose that these myodonts share a common ancestor similar to *Erlianomys* and that they had originated in Asia at the beginning of Early Eocene and diversified immediately thereafter.

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