

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/236617490>

The stratigraphy and small mammals from the Aral Formation, the Altynshokysu locality, Northern Aral area

Article in *Stratigraphy and Geological Correlation* · January 1996

CITATIONS

23

READS

234

1 author:



[Alexey V. Lopatin](#)

Russian Academy of Sciences

314 PUBLICATIONS 1,525 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



New genera of baleen whales (Cetacea, Mammalia) from the Miocene of the northern Caucasus and Ciscaucasia [View project](#)



Early evolution of mammals [View project](#)

The Stratigraphy and Small Mammals from the Aral Formation, the Altynshokysu Locality, Northern Aral Area

A. V. Lopatin

Moscow State University, Moscow, 119899 Russia

Received February 9, 1994

Abstract—Two assemblages of small mammals were identified in the Lower Miocene rocks of the Altynshokysu locality where they are confined to different stratigraphic units. The results promote more thorough correlations within the Aral Formation and comparisons with other localities of mammals in Asia and mammalian biozones in Europe. A list of small mammals of the Aral fauna is given with the description of three new species—two of cricetid rodents and one of insectivores.

Key words: *Aral Formation, lower Miocene, Northern Aral area, stratigraphy, correlation, small mammals.*

INTRODUCTION

Small mammals, primarily insectivores, lagomorphs, and rodents, constitute one of the most representative groups for biostratigraphic correlations of continental Cenozoic rocks. This group is characterized by a rapid evolution of some of the taxa of small mammals, by their relative abundance in biocoenoses, and by a high sensitivity and prompt reaction to environmental changes. The remains of these animals are now more frequently used for the subdivision and correlation of continental rocks, including, in particular, the Paleogene–Neogene formations. The mammal biozones in Europe are as detailed as the zones based on marine microorganisms (Mein, 1979; Agusti *et al.*, 1988).

The Aral faunal assemblage also called paraceratherian, is insufficiently studied. Apart from the classic Akespe (Agyspe) locality discovered in 1930, only a few other localities can be compared with it in terms of the abundance of material; e.g., the Kuzhasai, Zhilansai, and Sayaken localities on the northwestern coast of the Aral Sea. There is information about the finds of mammalian remains in other parts of the Aral Formation. The age of the complex was debated for a long time (late Oligocene–early Miocene). Now it is referred to the Aquitanian.

The Altynshokysu (Altyn–Chokusu) locality is 4 km northeast of the Chokusu Station and 45 km north of the Aral Sea coast line. The locality is unique due to its extensive taxonomic diversity of fossil vertebrates (various fishes, amphibia, reptiles, birds, mammals), and by the presence of marine organism remains (selachians, cetaceans). At the Altynshokysu, the Aral Formation is represented, apparently, in its complete volume, shows variable lithology, and has a maximal thickness (up to 20 m).

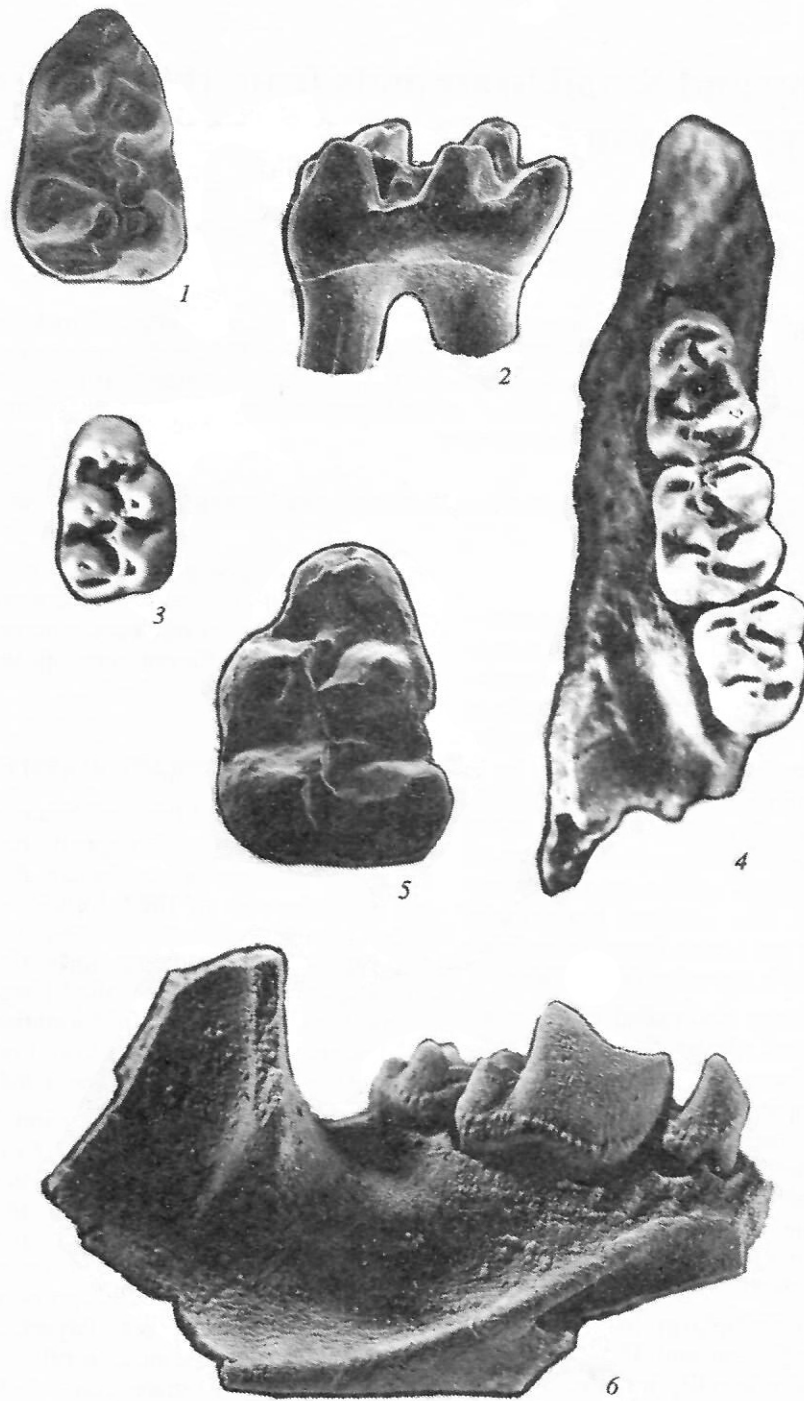
The material was obtained in 1992–1993 during my research in western Kazakhstan as a member of the expeditions of the Paleontological Institute of the Rus-

sian Academy of Sciences (PIN RAS). The mammalian remains were collected from the washed out surface or recovered by means of excavation and washing. In all, more than 500 different remains were collected and studied.

STRATIGRAPHY

The area north of the Aral Sea comprises numerous Paleogene and Miocene deposits represented, in most cases, by terrigenous–carbonate rocks. According to the environments of their formation, they are subdivided into “deposits of marine Paleogene” (Tas Aran, Saksaul’skaya and Chegan formations), the fresh and brackish-water deposits of the “Turgai Group” (Kutanbulak, Chilikty and Chagrai formations), and the brackish-water deposits of the Aral Formation (Yanshin, 1953; Ovechkin, 1962; Vyalov, 1964).

The time of the Aral Formation, also known as the “*Corbula* beds” or “beds with *Corbula helmersenii*,” corresponds to the regressive phase of Paratethys, and implies lagoon and lacustrine sedimentation on a coastal plain. The age of the beds is now defined as the terminal Oligocene–early Miocene (Popov *et al.*, 1993). The Aral Formation occurs in the northern part of the Aral area, in eastern Ustyurt, and in the southern part of the Turgai plain; as a rule, it is represented by grayish green carbonate clays with intercalations of multicolor clays, silts, and sands. The Aral Formation varies laterally and in thickness. Normally, two types of sections are exposed: the western sandy–silty–clayey type with a small amount of carbonate rocks (Sayaken, Kyzhasai, and Zhilansai), and the eastern clayey–carbonate type with a small share of sandy and silty rocks (Geologiya SSSR, 1970). The Altynshokysu section obviously belongs to the eastern type, though the proportion of silts and sands in this locality is larger than that, for example, in the Akespe locality.



The early Miocene mammals from Altynshokysu locality (the Northern Aral area), Aral Formation.

1—*Eumyarion tremulus* sp. nov., no. 4516-70, holotype, right M_1 , occlusal view, $\times 22$; 2—same, labial view, $\times 22$; 3—*E. tremulus* sp. nov., no. 4516-60, right M^1 ; $\times 12$; 4—*Eucricetodon occasionalis* sp. nov., no. 4516-196, holotype; the left fragment of the lower jaw with M_1 – M_3 ; $\times 12$; 5—*E. occasionalis* sp. nov., no. 4516-198, left M^1 ; $\times 22$; 6—*Exallerix efiates* sp. nov., no. 4516-1, holotype, the right fragment of the lower jaw with P_4 – M_2 ; $\times 5$.

System	Series	Subseries	Formation	Thickness, m	Lithological composition and paleontological description
Neogene	Miocene	Lower	Aral	1.5	Sandy limestones, sands
				18	Gray and greenish gray clays with intercalations of marls and remains of mammals, birds, turtles, fishes, bivalves and gastropods
				1	Silts, light gray clayey silts with the remains of mammals and fishes
				Paleogene	Oligocene
Chilikty	4.5	Alternating sands and clayey silts with the remains of mammals, turtles, and fishes			
Lower	Kutanbulak	6–7	Light gray, fine-grained and well-graded sands with quartz pebbles and sandy concretions		
	Chegan Rocks	5	Clayey, foliated, brownish gray silts with jarosite selvages and remains of mollusks		

Fig. 1. The stratigraphic scheme of the Paleogene–Neogene deposits on the southwestern slope of the Altynshokysu Plateau.

The Altynshokysu plateau is flat, and its steep southwestern slope exposes the Eocene–lower Miocene deposits about 40 m thick (Chegan, Kutanbulak, Chilikty, Chagrai, and Aral formations; Fig. 1).

The Aral Formation concordantly overlies sands of the Chagrai Formation. The sands are fine-grained, light gray, horizontally laminated, well-graded, micaceous, and often kaolinitized; they contain numerous ferro-manganese concretions and interbeds, and also quartz and argillite pebbles up to 4 cm long.

The Aral Formation is exposed in the upper part of the slope, where it is 15–20 m thick and consists of

clayey and carbonate–clayey rocks with a small admixture of clastic material. The formation is divisible into members with distinct lithological features. From the base upsection these are:

- (1) Light gray clayey silts (1 m).
- (2) Light gray and greenish gray clays with intercalations of marls (up to 18 m).
- (3) Sandy limestones, sandstones, and sands (up to 1 m).

In addition to the typical shells of bivalve mollusks *Corbula helmerseni* Mikh. and gastropod remains, the clays and silts of the Aral Formation contain bones of

various fishes, amphibia, turtles, birds, and mammals (insectivores, lagomorphs, rodents, carnivores, cetaceans, perissodactyls, artiodactyls).

On the southwestern slope of the Altynshokysu plateau, the following members are exposed from the base upsection:

Member 1

Bed 1. Clayey silts, light bluish gray, sand-rich in an upper portion enclosing the bone-bearing lenses and intercalations. The main bone-bearing level is at the top of the bed. Fragments of bones are usually mixed with small pebbles and gravels (1 m).

The first bone-bearing level (I) contains the remains of the vertebrates listed below.

Fishes: *Odontaspis* sp., *Esox aralensis* Sytch., *Acipenser* sp., and diverse specimens of Percidae and Cyprinidae (preliminary definitions by Sychevskaya).

Amphibia: Cryptobranchiidae indet. (definition by Shishkin).

Mammals represented according to my determinations by the following groups: insectivores *Amphelinus* cf. *minimus* (Bohlin, 1942), Erinaceidae indet., *Proscapanus* sp., Desmaninae indet., *Gobisorex* aff. *kingae* Sulimski, 1970; lagomorphs *Desmatolagus simplex* (Argyropulo, 1940), *D.* aff. *shargaltensis* Bohlin, 1937; rodents *Steneofiber kumbulakensis* (Lytshev, 1970), *Plesiosminthus* sp., *Aralocricetodon schokensis* Bendukidze, 1993, *Eumyarion tremulus* sp. nov., *Eucricetodon occasionalis* sp. nov.; cetaceans ?Delphinoidea indet.; and artiodactyls *Amphitragulus* sp.

Member 2

Bed 2. Bright gray-green rather dense clays: they form the main gently inclined part of the slope and contain numerous shells of *Corbula helmerseni* Mikh., which often compose lenses, intercalations and partings (up to 15 cm thick) of white coquina consisting of detritus, fragments and whole shells of corbulars. There are quartz pebbles up to 3 cm long, and a rose-gray marl interlayer up to 10 cm thick at the top of the bed (2 m).

The second bone-bearing level (II) contains fish bones, mainly vertebrae of Percidae.

Bed 3. Clays, greenish gray with a lighter shade than those in Bed 2 (1.5 m).

Bed 4. Clays, yellowish gray; when weathered yellowish brown (0.5 m).

Bed 5. Carbonate clays, rather dense and fresh, dark gray, when weathered greenish gray, fragmented. At the top, there is an intercalation (7 cm) of rose-gray silty marl (1.5 m).

Bed 6. Light gray clays, yellowish gray after weathering. One meter above the bottom of the bed, there is the third bone-bearing level (III) with fish skeletons of Clupeidae indet. as defined by Sychevskaya (2.5 m).

Bed 7. A sequence of alternating gray (yellowish gray if weathered) and greenish gray clays (3 m).

Bed 8. Greenish gray clays, plastic if fresh, fragmented if weathered; they contain numerous operculas of freshwater gastropods *Bithynia adornatus* Tolst. in association with rare shells of *Corbula helmerseni* and gastropods, fragments of turtle carapaces, birds bones of Anatidae, Ergilornithidae, Charadrii (definition by Karkhu), and teeth and bones of mammals (4 m).

The fourth bone-bearing level (IV) yielded the following mammalian remains: insectivores *Exalleryx efi-altis* sp. nov., *Amphelinus* cf. *minimus* (Bohlin, 1942), *Mygalea lavrovi* Bendukidze, 1993, *Asthenoscapter* sp., *Gobisorex* aff. *kingae* Sulimski, 1970; lagomorphs *Desmatolagus* aff. *robustus* Matthew et Granger, 1923, *D.* aff. *shargaltensis* Bohlin, 1937, *Sinolagomys pachygnathus* Li et Qiu, 1980; rodents *Ansomys* sp., *Steneofiber kumbulakensis* (Lytshev, 1970), *Asiacastor* aff. *orientalis* Lytshev, 1988, *Eucricetodon occasionalis* sp. nov., *Aralomys gigas* Argyropulo, 1939, *Tachyoryctoides glykmani* Vorontzov, 1963, *Yindirtemys birgeri* Bendukidze, 1993; carnivores ?Stenoplesictinae indet., Mustelidae indet.; perissodactyls Rhinocerotidae indet.; and artiodactyls *Amphitragulus* sp.

Member 3

Bed 9. Sands: light gray, fine-grained, silty, ferruginated (1m).

Bed 10. Sandy limestones: rose-gray, platy, containing rare casts of *Corbula helmerseni* and rounded fragments of mammalian bones. They are exposed at the armored plateau surface (up to 0.5 m).

THE PROBLEMS OF CORRELATION USING MAMMALS

The study of small mammals of the Aral fauna is obstructed by fragmentation and poor preservation of their remains. The description of most of their forms can be done only in an open nomenclature. A list of small mammals of the Aral assemblage and their localities is given in Table 1.

As a rule, two subassemblages of mammal species are recognized in the Aral fauna. The earliest was recovered at the Akespe locality, where it includes endemic rodents (*Eumysodon* and *Argyromys*), and lagomorphs *Desmatolagus simplex*. The Akespe level correlates either with the MN 1 zone of Mein's scale (Mein, 1979), or with MN 2 (Gabuniya, 1986) and, therefore, corresponds to the lower Aquitanian. The second subassemblage is typical of the Sayaken, Kuzhasai, and Zhilansai localities on the northwestern coast of the Aral Sea. These localities contain lagomorphs of the genus *Sinolagomys*, and rodents *Tachyoryctoides* and *Yindirtemys*. They are dated as the upper Aquitanian forms (Bendukidze, 1977). The ancient representatives of lagomorphs *Desmatolagus* aff. *shargaltensis*, beavers *Steneofiber kumbulakensis* and

Table 1. List of small mammals from the Aral faunal assemblages (after Argiropulo, 1939, 1940; Belyaeva and Borisyak, 1948; Bendukidze, 1977, 1989, 1993; Lavrov *et al.*, 1985; Gabuniya, 1981; Russel and Zhai, 1987; the finds of the author are marked with a cross in parenthesis)

Taxon	Locality							
	Early Aralian fauna		Late Aralian fauna					
	Akespe	Altyynsho-kysu I	Altyynsho-kysu IV	Shokysu	Akotau	Sayaken	Kuzhasai	Zhilansai
INSECTIVORA								
Erinaceidae:								
Echinosoricinae:								
<i>Lantanothereum</i> sp.	-	-	-	+	+	-	-	-
Erinaceinae:								
<i>Exallerix efiates</i> sp. nov.	-	-	(+)	-	-	-	-	-
<i>Amphechinus</i> cf. <i>rectus</i> (Matthew et Granger, 1924)	-	-	-	+	-	-	-	+
<i>A. minimus</i> (Bohlin, 1942) (? = <i>Palaeoscaptor acridens</i> Matt. et Gr., 1924–Belyaeva, Borisyak, 1948)	+	-	-	+	-	-	-	-
<i>A.</i> cf. <i>minimus</i> (Bohlin, 1942)	-	(+)	(+)	-	-	-	-	-
Talpidae:								
Desmaninae:								
<i>Mygalea lavrovi</i> Bendukidze, 1993	-	-	(+)	+	-	+	-	-
Urosilinae:								
<i>Asthenoscapter</i> sp.	-	-	(+)	+	-	-	-	-
<i>Proscapanus</i> sp.	-	(+)	-	+	-	-	-	-
Soricidae, Heterosoricinae:								
<i>Gobisorex kingae</i> Sulimski, 1970	-	-	-	+	-	-	-	-
<i>G.</i> aff. <i>kingae</i> Sulimski, 1970	-	(+)	(+)	+	+	-	-	-
LAGOMORPHA								
Palaeolagidae, Desmatolaginae:								
<i>Desmatolagus</i> aff. <i>robustus</i> Matt. et Gr., 1923	-	-	(+)	+	-	-	-	-
<i>D.</i> aff. <i>shargaltensis</i> Bohlin, 1937	+	(+)	(+)	+	+	+	-	-
<i>D. simplex</i> (Argyropulo, 1940) (= <i>D.</i> aff. <i>gobiensis</i> Matt. et Gr., 1923–Bendukidze, 1993)	+	(+)	-	+	-	-	-	-
Ochotonidae, Sinolagomyinae:								
<i>Sinolagomys pachygnathus</i> Li et Qiu, 1980 (= <i>S.</i> aff. <i>kansuensis</i> Bohlin, 1937; = <i>S.</i> aff. <i>gracilis</i> Bohlin, 1946–Bendukidze, 1993)	-	-	(+)	+	+	+	-	+
RODENTIA								
Aplodontidae, Ansomyinae:								
<i>Ansomys</i> sp.	-	-	(+)	-	-	-	-	-
Sciuridae:								
<i>Palaeosciurus</i> sp.	-	-	-	-	-	-	-	+
Dipodidae:								
<i>Argyromys aralensis</i> (Argyropulo, 1939) (= <i>Schaubeumys aralensis</i>)	+	-	-	-	-	-	-	-
	(+)							
<i>A. woodi</i> (Argyropulo, 1939)	+	-	-	-	-	-	-	-
? <i>Protalactaga borissiaki</i> Argyropulo, 1939	+	-	-	-	-	-	-	-
Zapodidae:								
<i>Plesiosminthus</i> sp.	-	(+)	-	-	-	-	-	-

Table 1. (Contd.)

Taxon	Locality							
	Early Aralian fauna		Late Aralian fauna					
	Akespe	Altynsho-kysu I	Altynsho-kysu IV	Shokysu	Akotau	Sayaken	Kuzhasai	Zhilansai
<i>Parasminthus</i> aff. <i>tangingoli</i> Bohlin, 1946	-	-	-	+	-	-	-	-
Cricetidae, Eucricetodontinae:								
<i>Eucricetodon sajakensis</i> Bendukidze, 1993 (= <i>E. aff. asiaticus</i> (Matt. et Gr., 1923); = <i>E. aff. deploratus</i> (Shevyreva, 1967))	-	-	-	+	+	+	-	-
<i>E. occasionalis</i> sp. nov. (= <i>E. aff. caducus</i> (Shevyreva, 1967)–Bendukidze, 1993)	+	(+)	(+)	+	+	-	-	-
<i>Eumyarion tremulus</i> sp. nov. (= <i>Eucricetodon</i> aff. <i>youngi</i> Li et Qiu, 1980–Bendukidze, 1993)	(+)	(+)	-	+	-	-	-	-
<i>Aralocricetodon schokensis</i> Bendukidze, 1993	-	(+)	-	+	-	-	-	-
Ctenodactylidae:								
<i>Yindirtemys sajakensis</i> Bendukidze, 1993 (= <i>Tataromys</i> aff. <i>deflexus</i> Teilhard, 1926–Bendukidze, 1977)	-	-	-	+	+	+	-	-
<i>Y. birgeri</i> Bendukidze, 1993	-	-	(+)	+	+	+	-	-
" <i>Tataromys</i> " cf. <i>sigmodon</i> Matt. et Gr., 1923	-	-	-	-	-	-	+	+
Rhizomyidae:								
<i>Tachyoryctoides</i> aff. <i>obrutschewi</i> Bohlin, 1946	+	-	-	+	+	+	-	-
<i>T. glikmani</i> (Vorontzov, 1963) (= <i>T. spurius</i> (Argyr., 1939)–Bendukidze, 1993)	-	-	(+)	+	-	-	-	-
<i>Aralomys gigas</i> Argyropulo, 1939	+	-	(+)	+	+	+	-	-
<i>Aralomys</i> sp.	-	-	-	+	+	+	+	-
<i>Eumysodon spurius</i> Argyropulo, 1939	+	-	-	-	-	-	-	-
<i>E. orlovi</i> Argyropulo, 1939	+	-	-	-	-	-	-	-
Castoridae:								
Trogontheriinae:								
<i>Steneofiber kumbulakensis</i> (Lytshev, 1970) (= <i>Propalaeocastor kumbulakensis</i>)	+	(+)	(+)	+	-	-	-	-
Castoroidinae:								
<i>Palaeocastor</i> sp. (= <i>Agnotocastor</i> sp.)	+	-	-	+	-	-	-	-
<i>Capatanka schokensis</i> Bendukidze, 1993	+	-	-	+	+	-	-	-
<i>C. aff. schokensis</i> Bend., 1993	-	-	-	-	-	-	-	+
<i>Capacikala sajakensis</i> Bendukidze, 1993	-	-	-	-	-	+	-	-
<i>C. aff. sajakensis</i> Bend., 1993	-	-	-	+	+	-	-	-
<i>C. cf. sciuroides</i> (Matt., 1907)	-	-	-	+	+	-	-	-
Asiacastorinae:								
<i>Asiacastor</i> aff. <i>orientalis</i> Lytshev, 1988	-	-	(+)	+	+	-	-	-

Palaeocastor sp., cricetid rodents of genus *Eucricetodon* and *Aralomys gigas* occur in both subassemblages (Table 1).

The lowermost bone-bearing level (I) at the Altynshokysu locality is of the early Aquitanian age according to the remains of small mammals. The comparison of *Eucricetodon occasionalis* sp. nov. with the Euro-

pean counterpart of the genus shows that by the degree of morphological evolution of teeth, the Aralian representative is similar to the stage of *E. herperius* Engesser, 1985 (zone MN 1 of the Mein's scale, the Paulhiac locality; Engesser, 1985). *E. occasionalis* sp. nov. is probably the direct descendant of the Oligocene *E. caducus* (Shevyreva, 1967), which is also referred to

the lineage *E. praecursor* (Schaub, 1925)—*E. collatus* (Schaub, 1925)—*E. hesperius* (stage of *E. praecursor*; Shevyreva, 1967). *Eumyarion tremulus* sp. nov. is similar to *E. carbonicus* Bruijn et Sarac, 1991, from the lower Miocene in Turkey (zone MN 1 or 2, the Harami I locality); the former, however, differs from the latter by the reduced posterior arms of hypoconids that is typical of the Miocene *Eumyarion* from Europe. The structure of the teeth of *Plesiosminthus* sp. from the first bone-bearing level at the Altynshokysu locality is rather similar to that of *P. myarion* Schaub, 1930 (the double protoleph M^2 and the well-developed posterior arm of protoconid M_2), the form typical of the lower Miocene in Europe (zone MN 1–2a).

Eumyarion tremulus sp. nov. and *Desmatolagus simplex* were also found in the Akespe level. Therefore, we may compare this and the lower bone-bearing level of the Altynshokysu locality, and consider the latter as representing the early Aral subassemblage. According to results of the analysis of the composition of small mammals, this subassemblage can be dated as corresponding to zone MN 1.

The remains of *Sinologomys pachygnathus* Li et Qiu, 1980, recovered from the upper (IV) bone-bearing level of the Altynshokysu locality, suggests its Aquitanian age. *S. pachygnathus* is recovered and described from the Xiejia Formation (Qinghai, China) dated by zones MN 2–4 (Li et al., 1981), MN 1–2 (Li et al., 1984), or MN 1–3 (Qiu and Qiu, 1990). The remains of Desmatolaginae forms, defined as *Desmatolagus* aff. *robustus* and *D.* aff. *shargaltensis*, suggest a somewhat older age of this assemblage. However, in fact, these lagomorphs are represented by forms with some progressive features. For example, *D.* aff. *robustus* is larger than *D. robustus* Matthew et Granger, 1923, and has cement in the anteroexternal fold of P_3 and in the folds separating the hypoconulids from the talonids of P_4 – M_2 . *D.* aff. *shargaltensis* shows an obvious tendency to merging of roots of P_4 – M_2 and to reduction of hypoconulids. It seems evident that these two forms are independent species.

Ansomys sp. from the Altynshokysu seems to be, as it is evident from the P_4 structure, an intermediate form between the late Oligocene *A. shantungensis* (Rensberger et Li, 1986) and the middle Miocene *A. orientalis* Qiu, 1987 and *A. shanwangensis* Qiu et Sun, 1988 (China). A fairly isolated large hypoconid and the undeveloped low crest of metastylid imply the close affinity of *Ansomys* sp. to *A. shantungensis*, whereas the well developed mezostylid, the accessory crests of the talonid basin, ectolophid, and hypolophid show its resemblance to *A. orientalis* (features typical of the Miocene Ansominae; Qiu et Sun, 1988). Perhaps, *Aralomys* should be treated as a separate Miocene genus of Rhizomyidae (Bendukidze, 1993) in so far as it differs from the ancestral Oligocene *Tachyoryctoides* by a somewhat reduced M_3 . *Tachyoryctoides kokonorensis* Li et Qiu, 1980, the representative of rhizomyids

from Xiejia, may also belong to this genus. The ctenodactylids *Yindirtemys birgeri* and, in particular, *Y. sajakensis* are very similar to *Y. suni* Li et Qiu, 1980, from the same locality. The beavers *Steneofiber kumbulakensis* and *Asiacastor orientalis* also occur in the Akzhar Formation of the Zaisan depression dated by the early Miocene (Lychev, 1987).

At present, we know *Mygalea* and *Asthenoscapter* only from the Miocene. Unlike *E. hsandagolensis* McKenna et Holton, 1967, of the Oligocene age, *Exallerox efialtes* sp. nov. has certain features progressive for Brachyricini taxa; i.e., the relatively larger and narrower M_1 with a cutting paralophid, and reduced metaconid, small P_4 , and massive masseteric ridge. On the other hand, *Amphelchinus* cf. *minus* and *Gobisorex* aff. *kingae* are almost identical to corresponding species of Oligocene insectivores of Mongolia in the size and structure of teeth (Sulimski, 1970).

The listed species belong to the late Aralian subassemblage of small mammals of the Aral fauna (Table 1). Their age, apparently, corresponds to the Xiejian Age of mammals of the Chinese scale (MN 2–3).

Bendukidze (1993) described the abundant complex of small mammals from the Akotau and Shokysu localities of the studied region. He identified two bone-bearing levels, and compared the lower assemblage with Akespe and the upper one with Sayaken, Kuzhasai, and Zhilansai faunas. As described, they correspond to beds 8 and 9 of the Altynshokysu section, and, in my opinion, both are of the late Aralian age. Their typical species are found in the Sayaken, but not in the Akespe section and the lower (I) bone-bearing level at the Altynshokysu locality (Table 1).

If these conclusions are confirmed by further research, then the Altynshokysu section can be considered as the most important locality of the Aral faunal complex comprising remains of small mammals of both its early and late stages.

A comparison of the Aral assemblages with the Asiatic and European Oligocene–Miocene faunas shows that they contain rather numerous forms that retained the features of late Oligocene organization; this well-known feature also characterizes the Aquitanian mammals of Europe. This is typical primarily of erinaceids, paleolagids, aplodontids, ctenodactylids, certain rhizomyids and cricetids. The greatest similarity is noted between these and the late Oligocene faunas of China (Shargaltein Gol and Taben Buluk localities). On the other hand, it is obvious that many of the above taxa have specific features distinguishing them from their Oligocene ancestors. Some of the species are identical or very similar to the species from the Xiejia fauna (China), which at the moment is the most ancient Miocene fauna of Asia; e.g., by the morphological evolution of their teeth, the rodents *Eucricetodon* and *Eumyarion*, are comparable with the European and western Asiatic (Turkey) species typical of the Aquitanian.

In sum, it seems obvious that before the beginning of the early Miocene, the Aral fauna was at the last stage of the Oligocene epoch of evolution of the mammalian fauna in Central Asia.

PALEOECOLOGY

The mammals of the Aral fauna dwelt in different biotopes of two main groups; i.e., in the humid forests near rivers and lakes, and in dry open and semiopen landscapes. This conclusion is based on the results of a study of fossil remains of small mammals from the Akespe and Altynshokysu localities, confirming that the Aral fauna included two main ecological groups, among which the dwellers of open and semiopen areas were dominant (Flerov and Yanovskaya, 1971; *Zoogeografiya* ..., 1974).

The dwellers of open landscapes (meadows, dense bushes, steppe or savannalike areas, dry watershed woods, and open woodland) were hedgehogs *Amphelinus* and *Exallerox*, lagomorphs *Desmatolagus* and *Sinolagus*, rhizomyid representatives of *Aralomys* and *Tachyoryctoides*, and *Yindirtemys* of the ctenodactylid family. The ancient cricetids lived in moderately humid and dry woods on watershed divides, and were the ecological analogues to modern mice (Shevyreva, 1967). According to the morphology of teeth, *Aralocricetodon schokensis* could feed on cellular tissue, whereas *Eumyarion tremulus* and *Eucricetodon occasionalis* preferred protein nutriment. *Ansomys* was probably dwelling in woods and bush thickets, while the diverse beavers, muskrats, and soricids inhabited areas near rivers and lakes.

Large mammals also comprise two ecological assemblages. The animals living near water, such as *Aprotodon borissiakii* and Aminodontidae, constitute one of the assemblages; the other includes obvious dwellers of open landscapes; i.e., gigantic rhinoceros *Paraceratherium prohorovi* and *Aceratherium aralense*, hyracodonts, prodromotheres, and others (Yanshin, 1953; Lavrov, 1959; Lychev and Aubekerova, 1971; Bendukidze, 1979).

The identified groups of biocoenosis correlate well with palynological data characteristic of extensive areas covered with deciduous and coniferous woods with subtropical elements and xerophytic vegetation in steppe and meadow areas (Chenopodiaceae, *Sparganium*, *Artemisia*, Compositae, and others; Panova, 1979).

TAPHONOMY

The common feature of the formation of early Miocene burials in the northern Aral area is the accumulation of bone remains in numerous lakes and lagoons on the coastal plain north of the North Usturt sea bay that filled the depression of the same name. The coeval existence of water basins, varying in size, depth, and salinity and having different connections with the sea and river basins, accounts for the specific

diversity of facies in the Aral deposits often noted by the researchers (Yanshin, 1953; Lavrov, 1979).

The taphonomical data for the Altynshokysu locality indicate that the depositional settings of the Aral Formation became progressively more continental. As the sea retreated, all of the lagoons first became a brackish-water lake, and then gradually turned into a freshwater basin. This was responsible for the increasingly shallow-water aspect of sediment, which successively changed from silty to predominantly clayey types. The growth of the carbonate content caused the formation of intercalations of limestones and marls. The study on the taphonomic peculiarities of every bone-bearing level shows how the character of the sedimentary basin changes in the course of time (Fig. 2). As regards the actual process of the formation of burials, it appears that it did not essentially change with time, and included the transportation of bone material by water flows (temporary or permanent) and its deposition in coastal areas of water basins.

TAXONOMY

Order Insectivora Bowdich, 1821

Family Erinaceidae Fisher von Waldheim, 1817

Subfamily Erinaceinae Fisher von Waldheim, 1817

Tribe Brachyericini Butler, 1948

Genus *Exallerox* McKenna et Holton, 1967

Species *Exallerox efiates* Lopatin, sp. nov.

Plate, no. 6; Fig. 3

The name of the species is derived from "efiates," which in Greek means "nightmare," or "the demon causing nightmares."

Holotype—PIN RAN, no. 4516-1; a fragment of the right bone of the lower jaw with P₄-M₂; Kazakhstan, the Northern Aral region, Altynshokysu locality; lower Miocene.

Diagnosis. The dimensions are average (P₄-M₂ is 10.5 mm long) and comparable with those of *E. hsandagolensis* McKenna et Holton, 1967. P₄ is greatly reduced (2.75 times shorter than M₁). M₁ is fairly large and narrow, with a cutting paralophid and a rather small metaconid. M₂ is small with a flattened paraconid. The size of the talonid is a little less than a half of the total length of the tooth. The masseteric ridge of the lower jaw is very massive and broad.

Description. The lower jaw has a very short dental arm, and the coronoid process is at right angles to the arm. The masseteric fossa is very deep; the masseteric ridge is powerfully developed, and its anterior border is below P₄. The mental foramen, large and funnel-shaped, is located under the anterior part of M₁. The alveole I₁ is very long, and reaches the level of the posterior border of M₁. The dental row retains the root of P₃ with a pulp cavity and absolutely whole slightly abraded P₄, M₁, and M₂. The crown of the double-rooted P₄ is strongly reduced (the paraconid and the

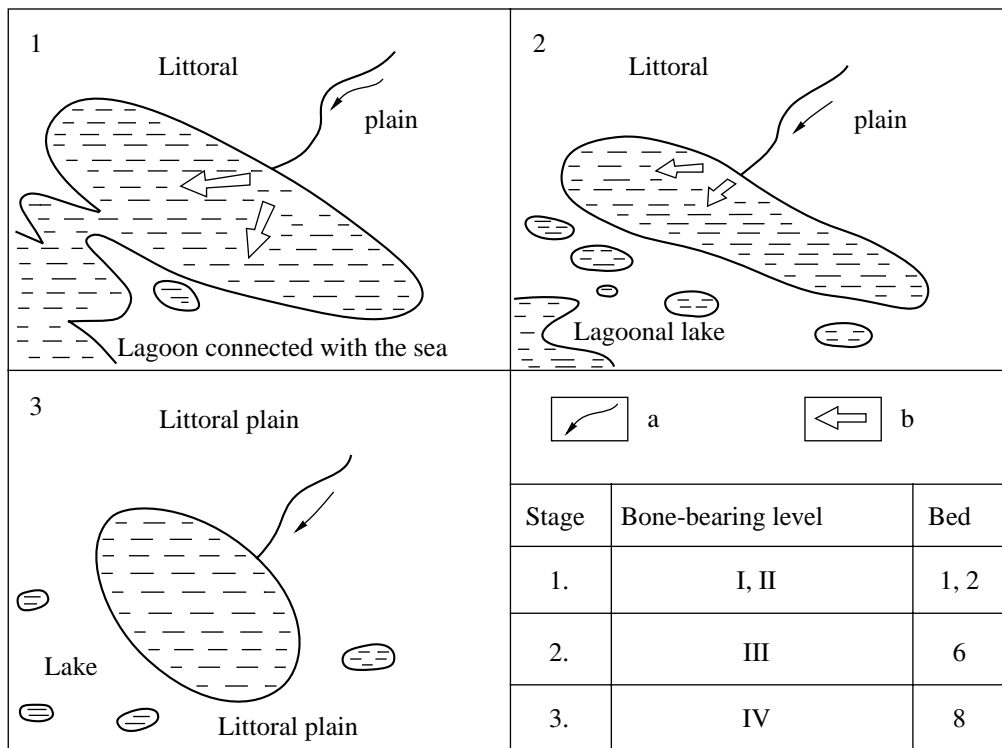


Fig. 2. The scheme of development of the lacustrine-lagoonal basin in the Altynshokysu area in Aralian time: a—direction of remain drifting with water flows; b—direction of material drifting within water basins.

metaconid are absent). The height of P₄ is somewhat greater than that of the M₁ paraconid, which is large and has a cutting bladelike paralophid. The metaconid is reduced; it is smaller and lower than the protoconid. Its apex is slightly more advanced than that of the protoconid, and they are divided by a shallow trough. The talonid is short but high, with a well-developed hypoconid and entoconid. M₂ is reduced to almost half of M₁. The trigonid is somewhat longer than the talonid. The paraconid is flattened. The protoconid is the most massive of the cusps. The metaconid is slightly smaller

than the protoconid, but almost as high. The hypoconid and entoconid are relatively small and low. P₄ and both molar teeth have labial cingulum with a distinct relief of small rounded cusps arranged lengthwise in a single row (Fig. 3).

Table 2 shows the size of the lower jaw and teeth.

Comparison. *Exallerix hsandagolensis* McKenna et Holton, 1967 differs from the type species by a relatively smaller P₄ and a larger M₁ (P₄ of *E. hsandagolensis* is only twice as short as M₁), by the cutting paralophid and greatly reduced metaconid of M₁, and by the

Table 2. The size of the lower jaw and teeth of *Exallerix efiates* sp. nov. (in mm)

Tooth	Length			Width	Height				
	total	trigonid	talonid		Pcd	Prcd	Mcd	Hcd	Ecd
P ₄	2.0	—	—	2.0	—	2.5	—	—	—
M ₁	5.5	4.0	1.5	2.6	2.25	3.75	2.25	2.3	1.7
M ₂	3.0	1.75	1.25	2.25	1.0	2.25	1.5	1.5	1.5

Length P₄-M₂ is 10.5

Distance from M₂ to the anterior border of the coronoid process is 1.75

Height of the dental branch on the labial side: under M₁ is 6.1

under M₂ is 7.5

Note: Pcd—paraconid, Prcd—protoconid, Mcd—metaconid, Hcd—hypoconid, Ecd—entoconid.

much more developed masseteric ridge of the lower jaw.

Discussion. McKenna and Holton (1967) refer the genus *Exallerix*, defined by them, to a special subfamily of short-muzzle hedgehogs Brachyericinae, including *Brachyrix* Matthew, 1933, *Metechinus* Matthew, 1929, and *Dimylechinus* Hurzeler, 1944. Gureev (1979) attributes this group to the rank of tribe Brachyericini in the subfamily Erinaceinae. All these genera are characterized by the reduction of teeth rows: the 1–2 premolars in the lower jaw and 2–3 in the upper jaw, M_3 is absent. The number of molars of *Exallerix* is still uncertain, because it was defined in a single fragment of the lower jaw of a type species (the anterior part of the teeth arm of the holotype is broken off right behind the paraconid M_2). Consequently, some of the researchers consider the taxonomic position of *Exallerix* to be uncertain; e.g., Carroll (1988) defines it as Erinaceoidea incertae sedis. The teeth row of *E. efiates* sp. nov. is completely preserved. The presence of two molars confirms the correctness of the previously established teeth formula for *Exallerix* ($I_2C_1P_2M_2$) and refers it to Brachyericini. Moreover, the PIN RAN collection has several fragments of the lower jaws of *E. hsandagolensis* from the middle Oligocene of Mongolia (Shand Gol Formation; collections of the Joint Soviet–Mongolian Paleontological Expedition, JSMPE), which show that this species does not have M_3 .

The presence of *E. efiates* sp. nov. in the Aral Formation extends the stratigraphic range of the genus from the middle Oligocene to lower Miocene. As compared to *E. hsandagolensis*, the new species has certain progressive features, such as the large and narrow M_1 with a cutting paralophid, the reduced metaconid and P_4 , and a powerful masseteric ridge, which, as I believe, indicates the adaptation to mainly carnivorous habit.

Distribution. The species is recovered only from the Altynshokysu locality, the Northern Aral region, Kazakhstan; lower Miocene.

Material. Only a holotype is available. The jaw and teeth are well preserved.

Order Rodentia Bowdich, 1821

Family Cricetidae Rochebrune, 1883

Subfamily Eucricetodontinae Mein et Freudenthal, 1972

Genus *Eumyarion* Thaler, 1966

Species *Eumyarion tremulus* Lopatin, sp. nov.

Plate, nos. 1–3; Fig. 4a–4f

Eucricetodon aff. *youngi* Li et Qiu, 1980—Bendukidze, 1993.

The name of the species is derived from the Latin “tremulus” (shivering, trembling).

Holotype—PIN RAN, no. 4516-70; the right M_1 ; Kazakhstan, the Northern Aral region, Altynshokysu locality; lower Miocene.

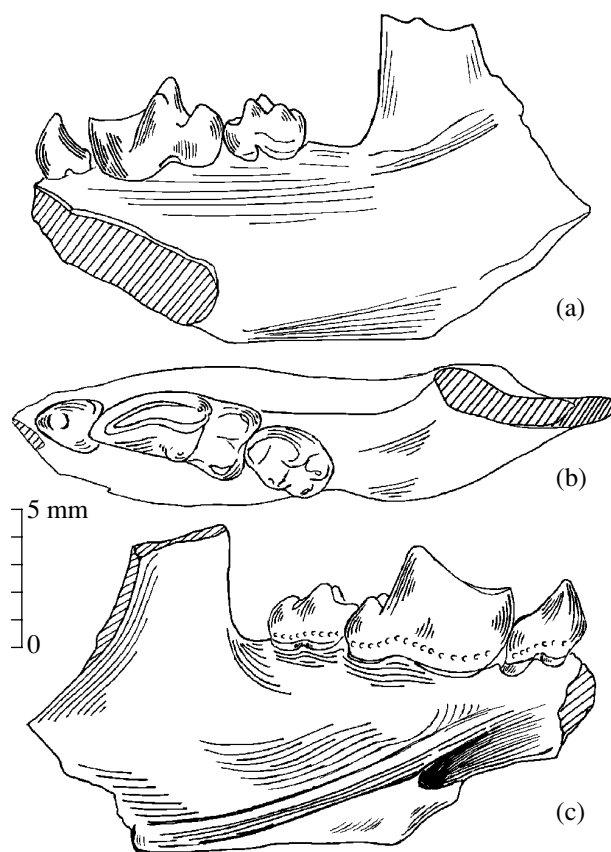


Fig. 3. *Exallerix efiates* sp. nov. no. 4516-1, holotype, the right fragment of the lower jaw: (a) lingual side; (b) occlusal side; (c) labial side.

Diagnosis. The size is average for the genus. M_1 is 1.5–1.85 mm long of elongated–triangular shape, with isolated anteroconid and well-developed mesolophid and ectomesolophid. The posterior branch of M_1 hypoconid is rudimental; it is absent on M_2 and M_3 . The anteroconid of M_1 is slightly forked; there are also anterophule, the anterior arm of protocon, the labial calcar of anterocon, the posterior calcar of paracon, and the short mesoloph. M_2 has a paracon calcar and a relatively long mesoloph. The mesoloph of M_3 and the posterior arm of the M_3 protoconid reach the border of the occlusal surface of the corona.

Description. The shape of M_1 is pearlike, asymmetric, and angular. All cusps are well developed. The anterocon is transversally elongated and occupies the central position to the longitudinal axis of the tooth, or is somewhat displaced toward the external cusps. The protosinus and anterossinus are divided by anterolophule, which joins the anterior process of the protocon. On the outside of the latter, there is a distinct calcar of the anterocon; the calcar sharply bends labially, sometimes reaching the labial cingulum. The calcar can also be straight or double-branched, and often joins the anterior process of the protocon. The paracon almost invariably has a posterior calcar. The metalophule is

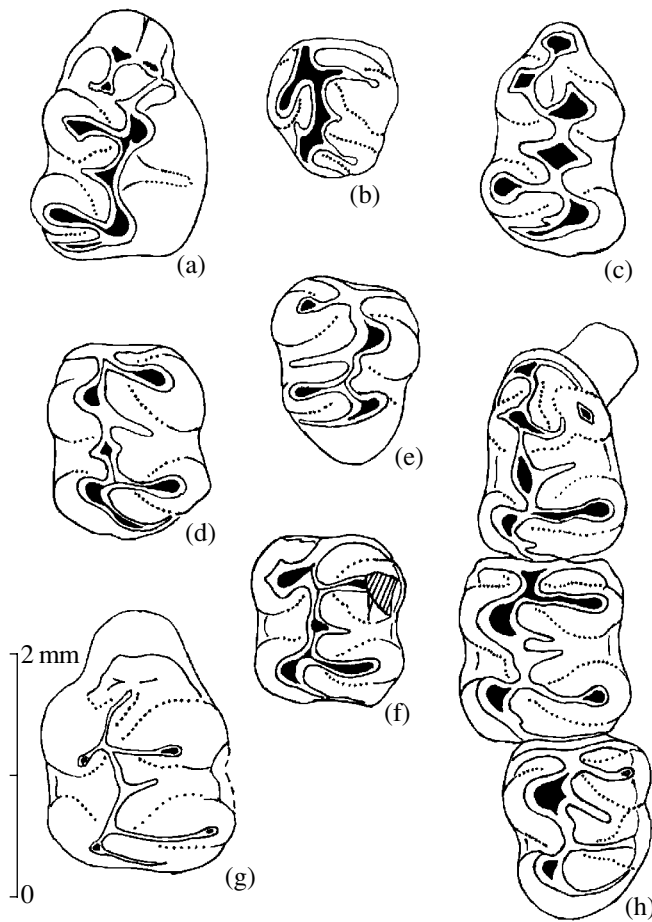


Fig. 4. The teeth of representatives of Eucricetodontinae from the Aral Formation at Altynshokysu: (a–f) *Eumyarion tremulus* sp. nov.: (a) no. 4516-60, right M_1^1 ; (b) no. 4516-389, left M_3^3 ; (c) no. 4516-70, holotype, right M_1^1 ; (d) no. 4516-15, left M_2^2 ; (e) no. 4516-402, right M_3^3 ; (f) no. 4516-46, left M_2^2 ; (g–h) *Eucricetodon occasionalis* sp. nov.: (g) no. 4516-198, left M_1^1 ; (h) no. 4516-196, holotype, left M_1^1 – M_3^3 .

formed by the arm of metacon joining the anterior arm of hypocon. From the place where the protocon and paracon branches merge, an oblique or almost straight longitudinal crest (entoloph) projects and joins the hypocon bearing a well-developed short mesoloph, which is parallel to transversal crests. The posterior cingulum is separated from the metacon by a narrow deep posterosinus.

M_2^2 is rounded–square in shape. The external branch of the anterior cingulum is well developed; the internal branch is almost reduced. The cusps are massive; the transversal crests are almost straight. The paracon has a distinct posterior calcar. The mesoloph is narrow, tapering, usually long, and reaches the calcar of the paracon. The posterior cingulum is well developed. The posterosinus is deep, long, and rather wide.

M_3^3 is very small, rounded, with well-developed anterior elements of an occlusal surface (the external

branch of the anterior cingulum, protocon, paracon, and mesoloph), and the reduced metacon and hypocon. The mesoloph, as a rule, reaches the labial border of the occlusal surface.

M_1^1 is elongated–triangular with a broadening posterior heel. The anteroconid is small, well separated, and joins the metaconid. The anterior process of the protoconid reaches the base of the anteroconid; the posterior branches of the protoconid and metaconid form the slightly backward bending metalophid. The hypolophid is formed by the branches of the hypoconid and entoconid directed slightly forward. The oblique ectolophid is directed from the point where the protoconid merges with the arms of the metaconid, toward the convergence point of the hypoconid and entoconid arms; it has a well-developed mesolophid and ectomesolophid turned toward the anterointernal and posteroexternal sides of the tooth. The posterior cingulum is long, arch-like, and separated from the entoconid by a rather vast posterosinusid occasionally crossed by a rudimentary crest of the posterior branch of the hypoconid.

The rectangular M_2^2 has a well-developed anterior cingulum with two branches. The straight metalophid is formed by the anterior branches of the protoconid and metaconid. The posterior arm of the protoconid is long, and situated at right angles to the longitudinal axis of the tooth. The hypolophid is straight. The short oblique ectolophid occasionally carries the poorly developed mesolophid and (or) ectomesolophid. The posterior cingulum is long, straight, and separated from the entoconid by a deep posterosinusid.

The angular M_3^3 is elongated–triangular; it narrows in the posterior part. The anterior cingulum has two developed branches. The crests join it with the metaconid and protoconid. The free posterior branch of the protoconid is long and, as a rule, reaches the border of the occlusal surface of the tooth. A rudimentary mesolophid is seldom present (Fig. 4).

The dimensions are shown in Table 3.

Comparison. The new species differs from *E. latior* (Schaub et Zapfe, 1953) by the presence of a massive posterior calcar of paracon of the upper molars, by the slightly forked anterocon of M_1^1 , and by the covered lingual sinus of M_3^3 . It also differs from *E. bifidus* (Fahlbush, 1964) by the more delicate anterocon of M_1^1 , and from *E. medius* (Lartet, 1851) and *E. leemanni* (Hartenberger, 1966) by small low-corona teeth. The new species is larger than *E. microps* Bruijn et Sarac, 1991, and *E. intercentralis* Bruijn et Sarac, 1991; unlike these species, it lacks the developed posterior branch of hypoconids of the lower molars. The species differs from *E. montanus* Bruijn et Sarac, 1991, by a massive posterior calcar of paracon of the upper molars, and from *E. carbonicus* Bruijn et Sarac, 1991, by the absence of the posterior branch of the hypoconid of M_2^2 and M_3^3 , by its rudimentary state on M_1^1 , by the longer posterior arm of the protoconid of M_3^3 , and by the less developed mesolophid and ectomesolophid of M_2^2 .

Discussion. The *E. tremulus* sp. nov. is the first authentic find of the representatives of the genus *Eumyarion* in the lower Miocene of Asia (except Turkey). Having, in general, the primitive teeth structure similar to that of *E. carbonicus* from the Harami I locality in Turkey (early Miocene, MN 1 or 2), the species has completely lost the posterior branch of the hypoconid on M_2 and M_3 , whereas on M_1 there is sometimes an almost reduced crest, which is typical of the middle Eocene *Eumyarion*. This fact apparently indicates the independent development of this *Eumyarion* lineage, and confirms the supposed Asiatic origin of the genus (Brujin and Sarac, 1991).

Distribution. Kazakhstan, the Northern Aral area; lower Miocene.

Material. Besides the holotype, 136 teeth and their fragments were recovered from the lower bone-bearing level of the Altynshokysu locality; 36 of them are M^1 , 14 are M^2 , 7 are M^3 , 31 are M_1 , 30 are M_2 , 18 are M_3 ; one M^1 is from the Akespe locality.

Genus *Eucricetodon* Thaler, 1966

Species *Eucricetodon occasionalis* Lopatin, sp. nov.

Plate, nos. 4, 5; Fig. 4g, 4h

Eucricetodon aff. *caducus* (Shevyreva, 1967)—Bendukidze, 1993.

The name of the species is derived from the Latin "occasionalis" (incidental).

Holotype—PIN RAN, no. 4516-196; a fragment of the left bone of the lower jaw with M_1 – M_3 ; Kazakhstan, the Northern Aral region, Altynshokysu locality; lower Miocene.

Diagnosis. The small representatives of the genus (M_1 – M_3 are 4.9 mm long; M_1 is 1.5–1.75 mm long) have rather low and broad coronas of the molars. M_1 is rounded-triangular, and the anteroconids are poorly isolated. On M_1 and M_2 , the posterior arm of the protoconid, the mesolophid, and the posterior arm of the hypoconid are well developed. The posterior arm of the M_3 protoconid is short. The anterocon of M^1 is low, not forked. The mesoloph of M^1 – M^3 is short. All folds are shallow, but rather long.

Description. M^1 is rounded-triangular with a central anterocon, which is small and slightly detached from the rest of the cusps; it is small and very low, with a single apex. The anterior part of the protocon is free and does not reach the base of the anterocon. The transversal crests are almost straight. The entoloph is slightly inclined, directed from the junction of the arms of the protocon and paracon toward the hypocon. The mesoloph is straight and short. The posterior cingulum is narrow and underdeveloped. The posterosinus is narrow and long.

M^2 is rounded-square. The external arm of the anterior cingulum is well developed, but its internal arm is somewhat reduced. The longitudinal and transversal crests are almost straight. The mesoloph is broad, flat, short and parallel to the transversal crests. The posterior cingulum is underdeveloped. The posterosinus is long and narrow.

M^3 is small, rounded, with greatly reduced hypocon and metacon. The mesoloph is short, and does not reach the labial border of the occlusal surface.

M_1 is rounded-triangular, and broadens in the rear. The anteroconid is low, reduced, and joins the anterior arm of the protoconid. The metalophulid is U-shaped and the hypolophulid is straight. The ectolophid is straight, and stretches from the protoconid to the merging point of the hypoconid and entoconid branches. It is slightly displaced toward the external side of the tooth and has a well-developed mesolophid pointing toward the anterointernal wall. The hypoconid and entoconid are widely spaced. There is a fairly developed posterior arm of the hypoconid. The posterior cingulum is poorly developed. The posterosinusid is small, but broad and long.

M_2 is large and rectangular. Both branches of the anterior cingulum are developed. The transversal crests are slightly bent, and the ectolophid is somewhat inclined with an obvious short mesolophid. The posterior branch of the protoconid is free and no longer than the mesolophid. The posterior cingulum is underdeveloped. Occasionally, there is a posterior branch of a hypoconid.

Table 3. The size of teeth of *Eumyarion tremulus* sp. nov. (in mm)

Tooth	Number of measurements	Length			Width		
		min	aver.	max	min	aver.	max
M^1	29	1.75	1.9	2.05	1.1	1.25	1.35
M^2	13	1.35	1.45	1.55	1.2	1.3	1.4
M^3	6	1.0	1.1	1.2	1.05	1.15	1.25
M_1	18	1.5	1.7	1.85	1.0	1.1	1.15
M_2	20	1.4	1.5	1.65	1.05	1.2	1.3
M_3	13	1.4	1.45	1.5	1.1	1.15	1.2

Table 4. The size of teeth and of the lower jaw of *Eucricetodon occasionalis* sp. nov. (in mm)

Tooth	Number of measurements	Length			Width		
		min	aver.	max	min	aver.	max
M ¹	4	1.7	1.8	2.05	1.1	1.15	1.5
M ²	2	–	1.45	–	1.25	–	1.3
M ³	1	–	1.0	–	–	1.0	–
M ₁	3	1.5	1.65	1.75	1.0	1.15	1.2
M ₂	2	1.4	–	1.6	1.15	–	1.35
M ₃	2	1.25	–	1.4	1.0	–	1.25

Note: The length of M₁–M₃ is 4.9; the height of the dental branch is 3.8 under M₁, 3.9 under M₂, and 4.0 under M₃.

M₃ is rounded-triangular, short, slightly narrowing at the rear. Both branches of the anterior cingulum are developed. The protoconid and metaconid are widely spaced; the posterior branch of the protoconid does not reach the wall of the tooth by a quarter of the corona width. The hypoconid and the posterior cingulum are well developed; the entoconid is considerably reduced.

The dimensions are given in Table 4.

Comparison. The small uniaxed anterocon distinguishes the new species from *E. gerandianus* (Gervais, 1848), *E. infralactorensis* (Viret, 1930), *E. aquitanicus* Baudelot et Bonis, 1968, *E. occitanicus* Bonis, 1970, *E. hurzeleri* Vianey-Liaud, 1972, *E. cetinensis* Daams, 1976, and *E. margaritae* Daams et al., 1989. The short mesolophids of M¹–M², the absence of the mesolophid of M₃, and the weak posterior cinguli of the new species distinguish it from *E. collatus* (Schaub, 1925), *E. dubius* (Schaub, 1925), and *E. longidens* Huguency, 1969. The absence of the M₁ ectomesolophid and M₃ mesolophid distinguish *E. occasionalis* sp. nov. from *E. atavus* (Misonne, 1957), *E. praecursor* (Schaub, 1925), *E. asiaticus* (Matthew et Granger, 1923), and *E. caducus* (Shevyreva, 1967). The small size and less massive cusps distinguish it from *E. robustus* Agusti et Arbiol, 1989; the greatly reduced posterior part of M₃ from *E. gergovianus* (Gervais, 1848) and *E. huberi* (Schaub, 1925); the small anterocon and short mesolophids from *E. incertus* (Schlosser, 1884), *E. hochheimensis* (Schaub, 1925), *E. haslachensis* (Schaub, 1925), *E. leptaleos* Wang et Meng, 1986, and *E. sajakensis* Bendukidze, 1993. A relatively larger anteroconid distinguishes the new species from *E. schaubi* (Zdansky, 1930); the absence of mesostyls distinguishes it from *E. meridionalis* Wang et Meng, 1986; the long posterosinuses, straight protolophule and more developed lingual branch of the anterior cingulum of M² distinguish it from *E. youngi* Li et Qiu, 1960; and the absence of calcar of the anterocon along with the larger size from *E. murinus* (Schlosser, 1884); from *E. hesperius* Engesser, 1985 it differs

because of a smaller anterocon, weaker posterior cinguli, and posterior branch of the hypoconid of M₁–M₂.

Distribution. Kazakhstan, the Northern Aral area; lower Miocene.

Material. Besides the holotype, there is one fragment of the left bone of the lower jaw with M₁, an isolated M¹ recovered from the upper bone-bearing level of the Altynshokysu locality, and 12 teeth from the lower level: 5 of them are M¹, 2 are M², 1 is M³, 2 are M₁, 1 is M₂, and 1 is M₃.

CONCLUSION

Two assemblages different in age and composition were defined as a result of the study on the small mammal remains recovered from the Altynshokysu locality. The first assemblage from the lower bone-bearing level Altynshokysu (I) is of the early Aquitanian age. It is correlative with the MN 1 zone of the Mein's scale and with the Akespe fauna. The mammal assemblage from the upper bone-bearing level Altynshokysu (IV) can be compared with the fauna of other localities on the northwestern coast of the Aral Sea. The age of this complex is the late Aquitanian.

The described mammalian remains from the Altynshokysu locality indicate the considerable diversity of the Aral fauna and its similarity with the late Oligocene and early Miocene assemblages of China. Three new taxa were distinguished: *Eumyarion tremulus* sp. nov., *Eucricetodon occasionalis* sp. nov., and *Exallerix efi-altus* sp. nov. The peculiar features of many other small mammals suggest that further research will show how these species differ from the cognate Oligocene forms. These results would be useful for a more fundamental understanding of the development history of the Aral fauna.

ACKNOWLEDGMENTS

I am grateful to the late V.Yu. Reshetov for his guidance in my scientific research and advice concern-

ing the present paper. I also thank M.A. Akhmet'ev, A.K. Agadzhanian, E.K. Sychevskaya, M.A. Shishkin, B.A. Trofimov, A.A. Karkhu, A.V. Lavrov, and B.T. Yanin for consultations and helpful comments.

Reviewer M.A. Akhmet'ev.

REFERENCES

- Agusti, J., Cabrera, J., Anadon, P., and Arbiol, S., A Late Oligocene–Early Miocene Rodent Biozonation from the SE Ebro Basin (NE Spain): A Potential Mammal Stage Stratotype, *Newsl. Stratigr.*, 1988, vol. 18, no. 2, pp. 84–97.
- Argiropulo, A.I., New Cricetidae (Glires, Mammalia) from the Oligocene of Central Asia, *Dokl. Akad. Nauk SSSR, Nov. Ser.*, 1939, vol. 23, no. 1, pp. 111–114.
- Argiropulo, A.I., Review of Finds of Tertiary Rodents on the Territory of the USSR and the Adjacent Areas of Asia, *Priroda*, 1940, no. 12, pp. 74–82.
- Belyaeva, E.I. and Borisyak, A.A., *Mestonakhozheniya tretichnykh nazemnykh mlekopitayushchikh na territorii SSSR* (Localities of Tertiary Land Mammals on the Territory of the USSR), *Tr. Paleontol. Inst.*, 1948, vol. 15, issue 3.
- Bendukidze, O.G., Remains of Vertebrate in the Lakustrine–Lagoonal Deposits and the Neogene Biotopes in North Aral Area and Turgai, in: *Velikii ozernyi etap v neogenovoi istorii Zaural'ya i ego paleolandshafty* (The Great Lacustrine Stage in the Neogene History of East Ural Region and Its Paleolandscapes), Leningrad: Geogr. Obshch. SSSR, 1972, pp. 34–45.
- Bendukidze, O.G., The Biostratigraphy of Miocene Deposits of the Northwestern Coast of the Aral Sea, Abstracts of Papers, 21 *Nauchnaya sessiya Instituta paleobiologii AN GSSR* (21 Scientific Session of the Inst. of Paleobiology, Acad. Sc. GSSR), Tbilisi: Metsniereba, 1977, pp. 8–12.
- Bendukidze, O.G., New Data on the Fauna of Small Mammals from the Agyspe Locality, *I Vsesoyuznoe soveshchanie po paleoterologii, Otd. obshch. biol.* (First All-Union Meet. on Paleotheriology, Dept. Gen. Biol.), Moscow, 1989, pp. 11–13.
- Bendukidze, O.G., *Melkie mlekopitayushchie miotsena yugo-zapadnogo Kazakhstana i Turgaya* (Miocene Small Mammals of Southwestern Kazakhstan and Turgai), Tbilisi: Metsniereba, 1993.
- Bruijn, H. de and Sarac, G., Early Miocene Rodent Faunas from the Eastern Mediterranean Area, Part I, The Genus *Eumyarion*, *Proc. Kon. Ned. Akad. v. Wetensch.*, 1991, vol. 91, no. 1, pp. 1–36.
- Carroll, R.L., *Palaeontology and Evolution of Vertebrate*, New York: W.H. Freeman, 1988.
- Engesser, B., Die Gattung *Eucricetodon* (Mammalia, Rodentia) im Grenzbereich Oligozoen (Miozaen), *Eclogae Geol. Helv.*, 1985, vol. 78, no. 3, pp. 669–692.
- Flerov, K.K. and Yanovskaya, N.M., *Ekologicheskie komplekсы mlekopitayushchikh oligotsena Azii i ikh zoogeograficheskaya kharakteristika* (Ecological Assemblages of Oligocene Mammals from Asia and Their Zoogeography), *Tr. Paleontol. Inst.*, 1971, vol. 130, pp. 7–30.
- Gabunia, L., Traits essentiels de l'évolution des faunes de Mammifères neogènes de la région mer Noir–Caspienne, *Bull. Mus. Nat. Hist. Natur., Paris, Ser. 4*, 1981, vol. 3, no. 2, pp. 195–204.
- Gabuniya, L.K., *Nazemnye mlekopitayushchie. Neogenovaya sistema* (Terrestrial Mammals. The Neogene System), Moscow: Nedra, 1986, pp. 310–327.
- Geologiya SSSR* (Geology of the USSR), Moscow: Nedra, 1970, vol. 21, part 1, book 1.
- Gureev, A.A., Insectivores (Mammalia, Insectivora), *Fauna SSSR, Mlekopitayushchie* (The Fauna of the USSR, Mammals), Leningrad: Nauka, 1979, vol. 4, issue 2.
- Lavrov, V.V., *Kontinental'nyi paleogen i neogen Aralo-Sibirskikh ravnin. Stratigrafiya, litologiya i paleogeograficheskaya obstanovka* (The Continental Paleogene and Neogene of the Aral–Siberia Plains: Stratigraphy, Lithology and Paleogeographic Environment), Alma-Ata: Akad. Nauk KazSSR, 1959.
- Lavrov, V.V., Deposits of the Miocene Aral Horizon and Paleogeography of the Great Lacustrine Stage on the Plains and Intermontane Depressions of the Area East of the Urals, in *Velikii ozernyi etap v neogenovoi istorii Zaural'ya i ego paleolandshafty* (The Great Lacustrine Stage in the Neogene History of East Urals Region and Its Paleolandscapes), Leningrad: Geogr. Obshch. SSSR, 1979, pp. 5–33.
- Lavrov, V.V., Bendukidze, O.G., and Chkhikvadze, V.M., A Type Section of the Aral Formation in Sayaken (Northern Aral Area) and Its Fauna, *Soobshch. Akad. Nauk GruzSSR*, 1985, vol. 117, no. 1, pp. 173–175.
- Li, C.K. and Qiu, Z.D., Early Miocene Mammalian Fossils of Xining Basin, Qinghai, *Vertebr. Palasiat.*, 1980, vol. 18, no. 3, pp. 198–214.
- Li, C., Qiu, Z., and Wang, S., Discussion on Miocene Stratigraphy and Mammals from Xining Basin, Qinghai, *Vertebr. Palasiat.*, 1981, vol. 19, no. 4, pp. 313–320.
- Li, C.K., Wu, W.Y., and Qiu, Z.D., Chinese Neogene: Subdivision and Correlation, *Vertebr. Palasiat.*, 1984, vol. 22, no. 3, pp. 163–178.
- Lychev, G.F., New Data on Extinct Beavers in Zaisan Area and the Adjacent Sinkiang, *Materialy po istorii fauny i flory Kazakhstana* (Materials on the History of Fauna and Flora of Kazakhstan), Alma-Ata: Akad. Nauk Kaz.SSR, 1987, vol. 9, pp. 69–81.
- Lychev, G.F. and Aubekerova, P.A., The Fossil Beavers of Kazakhstan, *Materialy po istorii fauny i flory Kazakhstana* (Materials on the History of Fauna and Flora of Kazakhstan), Alma-Ata: Akad. Nauk KazSSR, 1971, vol. 5, pp. 12–33.
- McKenna, M.C. and Holton, Ch.P., A New Insectivore from the Oligocene of Mongolia and a New Subfamily of Hedgehogs, *Am. Mus. Novitates*, 1967, no. 2311, pp. 1–11.
- Mein, P., Rapport d'activité du groupe de travail vertèbres mise à jour de la biostratigraphie de Neogene basée sur les mammifères, *Ann. Geol. Pays Hell.*, 1979, no. 3, pp. 1364–1372.
- Ovechkin, N.K., *Biostratigrafiya paleogenovykh otlozhenii Turgaiskogo progiba i Severnogo Priaral'ya* (Biostratigraphy of Paleogene Deposits in Turgai Depression and Northern Aral Area), *Tr. Vses. Geol. Inst., Nov. Ser.*, 1962, vol. 77, pp. 3–269.
- Panova, L.A., Palynological Assemblages of the Early Miocene Lagoon–Lacustrine Stage in Kazakhstan, in *Velikii ozernyi etap v neogenovoi istorii Zaural'ya i ego paleolandshafty* (The Great Lacustrine Stage in the Neogene History of East Urals Region and Its Paleolandscapes), Leningrad: Geogr. Obshch. SSSR, 1979, pp. 80–88.

- Popov, S.V., Voronina, A.A., and Goncharova, I.A., *Stratigrafiya i dvustvorchatye mollyuski oligotsena–nizhnego miotsena vostochnogo Paratetisa* (Stratigraphy and Bivalve Mollusks in the Oligocene–lower Miocene of Eastern Paratethys), *Tr. Paleontol. Inst.*, 1993, vol. 256, pp. 1–207.
- Qiu, Z.X. and Qiu, Z.D., Neogene Local Mammalian Faunas: Succession and Ages, *J. Stratigr.*, 1990, vol. 14, no. 4, pp. 241–260.
- Qiu, Z. and Sun, B., New Fossil Micromammals from Shanwang, Shandong, *Vertebr. Palasiat.*, 1988, vol. 26, no. 1, pp. 50–58.
- Russell, D.E. and Zhai, R.-J., The Paleogene of Asia: Mammals and Stratigraphy, *Mem. Mus. Nat. Hist. Paris, Natur. C.*, 1987, vol. 52, pp. 1–488.
- Shevyreva, N.S., Hamsters of the Genus *Cricetodon* from the Middle Oligocene in Kazakhstan, *Paleontol. Zh.*, 1967, no. 2, pp. 90–98.
- Sulimski, A., Some Oligocene Insectivore Remains from Mongolia, *Palaeontol. Polonica*, 1970, no. 21, pp. 53–70.
- Vyalov, O.S., The Oligocene and Lower Miocene Deposits of Usturt and the Northern Aral Area—Analogues of the Maikop Group, *I Kollokvium po mikrofaune i Biostratigrafii maikopskoi tolshchi i ee vozrastnykh analogov* (I Colloquium on Microfauna and Biostratigraphy of the Maikop Deposits and Their Age Analogues), Kiev: Naukova Dumka, 1964, pp. 144–145.
- Yanshin, A.L., Geology of the Northern Aral Region. Stratigraphy and History of Geological Evolution, *Materialy k poznaniyu geologicheskogo stroeniya SSSR, MOIP, Nov. Ser.*, 1953, issue 15 (19).
- Zoogeografiya paleogena Azii* (The Paleogene Zoogeography in Asia), *Tr. Paleontol. Inst.*, 1974, vol. 146.