Senckenbergiana lethaea	**81**	(2)	391 – 405	3 Text-figs, 2 Tabs, 3 Pls	Frankfurt am Main, 28.12.2001

Early Miocene Rodents from the Aktau Mountains (South-Eastern Kazakhstan)

With 3 Text-figures, 2 Tables and 3 Plates

Elena G. Kordikova & Hans de Bruijn

Abstract

The rodent assemblage from the Middle Members of the Chul'adyr Formation contains seven species that belong to six (sub)families. The dominant Cricetidae are represented by a new genus and species: *Aktaumys dzhungaricus* and by a new species of *Karydomys: K. dzerzhinskii.* Each of the other rodent species: ?*Sinosminthus* gen. et sp. indet., *Sayimys* aff. *obliquidens, Asiacastor* aff. *baschanovi* and Tachyoryctoidinae gen. A, sp. 1, is represented by a few cheek teeth only (altogether 8% of the specimens). The composition of the assemblage resembles Oligo-Miocene material from Anatolia, but the closest relatives of most of the species are found in Central Asia.

The stage of evolution of *Karydomys dzerzhinskii, Sayimys* aff. *obliquidens* and the tachyoryctoidine suggests an Early Miocene (MN4 rather than MN3) age for the assemblage.

Key words: Mammalia, rodents, Cricetidae, Tertiary, Early Miocene, Kazakhstan, Aktau Mts.

Kurzfassung

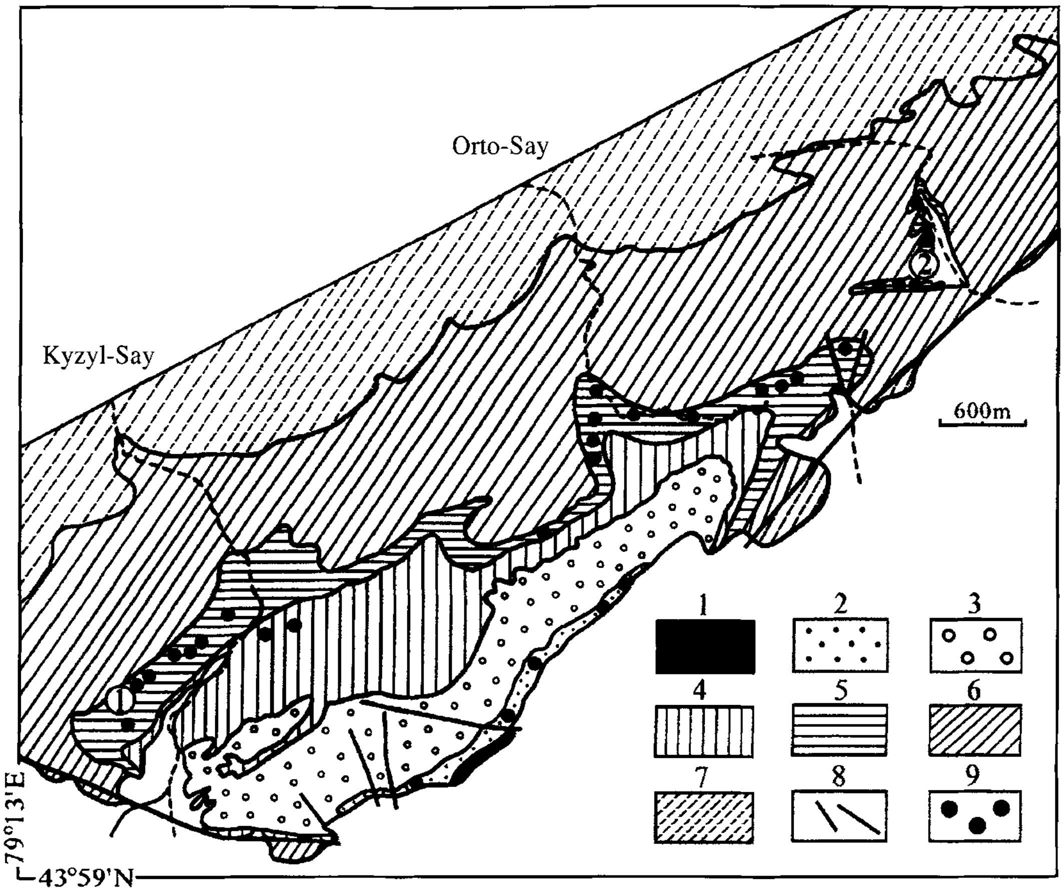
[Untermiozäne Rodentia vom Aktau-Gebirge (Südost-Kazakhstan).] — Die mittleren Anteile der Chul'adyr Formation enthalten sieben Arten von Nagetieren, die sechs (Sub-)Familien angehören. Der am häufigsten belegte Cricetide dieser Fauna wird einer neuen Gattung und einer neuen Art, *Aktaumys dzhungaricus*, und einer neuen Art, *Karydomys dzerzhinskii*, zugeordnet. Die anderen Nagetier-Taxa, ?*Sinosminthus* gen. et sp. indet., *Sayimys* aff. *obliquidens*, *Asiacastor* aff. *baschanovi* und Tachyoryctoidinae gen. A, sp. 1, sind jeweils nur durch wenige Einzelzähne nachgewiesen (insgesamt 8% der gesamten Nagetier-Fauna). Die Zusammensetzung der Nagetier-Fauna stimmt mit den Faunen des Oligo-Miozäns Anatoliens zwar gut überein, nähere Verwandte eines Großteils der Arten finden sich jedoch in Zentralasien.

Aufgrund der Evolutionsniveaus der Taxa *Karydomys dzerzhinskii*, *Sayimys* aff. *obliquidens* und tachyoryctoidine läßt sich die Fauna biostratigraphisch am ehesten ins Untermiozän (eher MN4 als MN3) einstufen.

Addresses of the authors: Dr. Elena G. Kordikova, Kapchagay Geological Expedition of the Ministry of Ecology and National Resources of the Kazakhstan Republic, Shevchenko 162-Zh; 480008 Almaty, Kazakhstan. E-mail: e_l_n_@hotmail.com – Hans de Bruijn, Institute of Earth Science, PO Box 80021; NL-3508 TA Utrecht, The Netherlands. E-mail: hdbruijn@earth.ruu.nl

Contents

Text-fig. 1. Map of central Asia. Arrow indicates the position of the Aktau Mountains.



Text-fig. 2. Geological map of the south-eastern part of the Aktau Mountains. The position of localities Aktau I (1) and Aktau III (2) is indicated by crosses with numbers. Modified from KORDIKOVA & MAVRIN 1996 and KORDIKOVA, HEIZMANN & MAVRIN 2000.

Introduction

Four hundred and forty metres thickness of continental Tertiary deposits are exposed in the southern slope of the uplifted anticline forming the Aktau Mountains, Dzungarian Alatau, South-Eastern Kazakhstan (text-figs 1, 2).

KORDIKOVA & MAVRIN (1996) and LUCAS, BAYSHASHOV, TYUTKOVA, ZHAMANGARA & AUBEKEROV (1997) distinguish three formations in this sedimentary sequence: the Akbulak Formation (= Kyzylbulak Formation of LUCAS, BAYSHASHOV, TYUTKOVA, ZHAMANGARA & AUBEKEROV 1997) of Mid to Late Eocene age, the Aktau Formation of Eocene to Oligocene age and the Chul'adyr Formation of Oligocene to Miocene age. There are a number of disconformities in this sequence. There seem to be major breaks between the Akbulak Formation and the Aktau Formation, and between the Aktau Formation and the base of the Chul'adyr Formation. The Chul'adyr Formation has been subdivided into three members (KORDIKOVA & MAVRIN 1996). The Lower and Middle members of the Chul'adyr Formation are separated by a disconformity that seems to cover a large part of the Lower Miocene (MN 1-3). We consider the Lower Member with *Paraceratherium* to be of Late Oligocene age and the Middle Member that has yielded a diverse assemblage of mammals (KORDIKOVA 2000; KORDIKOVA, HEIZMANN & MAVRIN 2000) to represent the upper part of the Lower Miocene (MN4).

The rodents described below are part of the smaller mammal collection (KORDIKOVA 2000) from a lens of blue-green clay (stratum N129 of KORDIKOVA & MAVRIN 1996) in theMiddle Member. This lens is situated about five metres above the horizon that has yielded a diverse assemblage of larger mammals (KORDIKOVA, HEIZMANN & MAVRIN 2000, unpublished data) suggesting an Early Miocene age.

The isolated rodent cheek teeth that will be discussed below were collected by wet screening in bags of plastic mesh. The fragment of lower jaw of a beaver (pl. 3 figs 7a and 7b) is a surface find from the same level, but at some distance from the main locality - in Aktau III.

The rodent assemblage from the Middle Member of the Chul'adyr Formation contains seven species that represent six (sub)families: Cricetidae, Zapodidae, Tachyoryctoidinae, Ctenodactylidae, Castoridae and Sciuridae. Cricetid cheek teeth (two species) dominate the association with 144 specimens against 12 specimens of other rodents. Oligo-Miocene associations from Anatolia usually show a similar composition, whereas those from China and Mongolia contain a much larger share of ctenodactyloids and dipodids. The composition of the association from the Chul'adyr Formation therefore suggests affinities with Western Asia, a conclusion that is in accordance with the analysis of the insectivores (KORDIKOVA 2000) and the larger mammals by (LUCAS, BAYSHASHOV, TYUTKOVA, ZHAMANGARA & AUBEKEROV 1997).

Materials and methods

Comparative materials of different rodent taxa including *Karydomys* THEOCHAROPOULOS 2000 and *Sayimys* WOOD 1937 were was studied in the Institute of Earth Science, Utrecht University.

The measurements have been taken with a Leitz Ortholux microscope, with mechanical stage and measuring scale, and are given in 0,1 mm units. The cheek teeth on the plates are approximately × 30 and figured as if they are from the left side. If the original is from the right side the relevant number on the plate has been underlined. The dipodid M2 and m1 (text-figs 3a, b) have been drawn and are approximately × 40.

The material discussed below is housed in the collection of the Kapchagay Geological Expedition of the Ministry of Ecology and National Resources of the Kazakhstan Republic.

Systematic paleontology

The rodent association from the Chul'adyr Formation of the Aktau Mountains contains two cricetids: the most abundant of these resembles the megacricetodontine *Megacricetodon* FAHLBUSCH 1964 and the myocricetodontine *Sindemys* WESSELS 1996 in having a symmetrically split anterocone in the M1 and in the overall dental morphology. However, there are dental characteristics in the Kazakhstan material that occur in aberrant specimens of species of *Megacricetodon* and *Sindemys* only. Recent research on *Megacricetodon* and *Sindemys* from Asia (QUI 1996) and the Indian Subcontinent (WESSELS 1996) shows that there is a large array of small cricetid species with M1 with split anterocones for which the phylogenetic relationships are not understood. WESSELS (1996) interprets the similarity of *Sindemys* and *Megacricetodon* as parallel evolution in different groups. We are inclined to explain the similarity of primitive megacricetodontines and myocricetodontines in terms of common ancestry. Our working hypothesis is that an unspecialized member of this ancestral group migrated from Asia to Europe (true *Megacricetodon*) while others migrated to the Indian Subcontinent and evolved into Myocricetodontines, which in turn migrated to Africa where they underwent a second radiation and possibly gave rise to the Dendromurinae and the Gerbillidae. The extreme stability of the dental pattern among European *Megacricetodon* species throughout the Miocene seems to argue against the allocation of the Kazakhstan material, showing double protolophules and metalophules in most M2, to that genus. Similarly, the long labial spur of the anterolophule and the long mesoloph(ids) differentiate our material from the myocricetodontines. We therefore prefer to erect the genus *Aktaumys* on the basis of this material and refrain from suggesting its allocation to a subfamily.

The second abundant species in the association from the Chul'adyr Formation is a rather large democricetedontine that shows close resemblance to *Karydomys symeonidisi* THEOCHAROPOULOS 2000, the type species of *Karydomys* THEOCHAROPOULOS 2000. This group of democricetodontines was long known from a few teeth from Vieux Collonges described as *Lartetomys zapfei* MEIN & FREUDENTHAL 1971 as well as unpublished scattered finds from the Early Miocene of Anatolia that, judging by their size differences, represent various species (ÜNAY pers. comm.) A good collection of *K. zapfei* has recently become known from Hambach (MN5, Germany, MÖRS, HOCHT VON DER & WUTZLER 2000: 155, text-figs 6v, w).

Other than cricetids, the association from the Chul'adyr Formation contains a few teeth of a species of *Sayimys* WOOD 1937, a dipodid, *Tachyoryctoides* BOHLIN 1937 (= *Aralomys* ARGYROPULO 1939) and *Asiacastor* LYTSCHEV 1971. The Sciuridae are represented by one rolled M3. Unfortunately none of these taxa are well enough represented to allow a detailed comparison with their Chinese and Anatolian counterparts, but they serve to give a fair impression of the composition of the Early Miocene rodent fauna of Kazakhstan.

Family Cricetidae ROCHEBRUNE 1883
Subfamily insertae sedis

Aktaumys n. gen.

Derivatio nominis: Named after the Aktau Mountains.

Type species: *Aktaumys dzhungaricus* n. sp.

Diagnosis: Upper molars: the anterocone of the M1 is divided into two cusps of equal size, lingual and labial branch of the anteroloph of the M2 well developed and of about the same length. The labial spur of the anterolophule and the mesoloph of the M1 are usually long and reach the labial side of the occlusal surface. M2 with double protolophule and often double metalophule. Mesoloph of the M2 long and independent of the double connections between the lingual and labial cusps. M3 small and rounded.

Lower molars: the anteroconid of the m1 is a single cusp. Shape of the occlusal surface of the m1 sub-triangular, less elongate than in typical *Megacricetodon* and in most primitive myocricetodontines. The mesolophids of the m1 and m2 are usually long and often reach the lingual border of the occlusal surface.

Differential diagnosis: *Aktaumys* cheek teeth differ

- from those of *Megacricetodon* in having: long transverse mesolophs(ids) in the first and second upper and lower molars, a long labial spur of the anterolophule in most M1, double protolophules in all M2, double metalophules in most M2 and a shorter, more triangular, occlusal surface in the m1;
- from those of *Sindemys* in having: a long labial spur of the anterolophule in most M1, on average longer mesoloph(ids) in the first and second molars, never a true entostyl in the M1 and M2 and a strong ectomesolophid in many m1 and m2.

Aktaumys dzhungaricus n. gen. et sp.

Pl. 1 figs 1-17

Derivatio nominis: After the Dzhungarian Alatau Mountains.

Holotype: M1 sin. - N KE-Akt4 (pl. 1 fig. 1).

Type locality: Aktau I, stratum N129 of KORDIKOVA & MAVRIN (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Referred specimens: 16 teeth of M1, 26 teeth of M2, 7 teeth of M3, 16 teeth of m1, 29 teeth of m2 and 9 teeth of m3.

Tab. 1. *Aktaumys dzhungaricus* n. gen. et sp. – Material and measurements

	Length			Width	
	Range	**mean**	**N**	**range**	**mean**
M1	15.5-18.0	6.85	17	11.38	9.9-12.7
M2	11.9-14.1	13.07	26	11.02	9.8-11.4
M3	7.0-9.7	8.76	7	9.37	8.4-9.8
m1	13.4-16.2	15.11	16	9.59	8.4-10.5
m2	11.4-13.8	13.06	29	10.92	10.0-12.5
m3	10.7-12.1	11.77	9	9.79	9.2-10.2

Diagnosis and differential diagnosis as for the genus *Aktaumys*.

Description

M1: Anterocone symmetrically divided into two cusps in eight specimens. In the other five specimens the valley dividing the cusps of the anterocone is weak (pl. 1 fig. 3). The labial spur of the anterolophule is usually long and transverse, but may be absent. The mesoloph is always long and reaches the labial border of the occlusal surface. The protoloph and metaloph are directed posteriorly and connect lingually to the posterior arm of the protocone and hypocone respectively.

M2: The lingual and labial branch of the anteroloph are well developed and of about equal length. The protolophule is always double. The metalophule is double in many specimens. These double connections between the lingual and labial cusps give the dental pattern a very modern aspect reminiscent of the modern Cricetinae. The mesoloph is long.

M3: The protolophule is directed forwards suggesting that protolophule I of the M2 is the original protoloph. The dental pattern is reduced.

m1: The anteroconid is a single cusp that is situated on the median axis of the occlusal surface. The metalophulid and hypolophulid are directed forwards. The mesolophid is long and reaches the lingual border of the tooth in most specimens. The ectomesolophid is strong in eleven specimens, weak in ten others and absent in one m1.

m2: The labial branch of the anterolophid is much longer than the lingual branch. The metalophid and the hypolophid are slightly directed forwards. The mesolophid and the ectomesolophid are on average shorter than in the m1.

m3: The labial branch of the anterolophid is stronger than the lingual branch. The metalophulid is weak in some specimens and may connect with the mesolophid (pl. 1 fig. 17). The mesolophid is short and the ectomesolophid is absent.

Democricetodontinae Lindsay 1987

Karydomys Theocharopoulos 2000

Type species: *Karydomys symeonidisi* Theocharopoulos 2000.

Karydomys dzerzhinskii n. sp.

Pl. 2 figs 1-13

Derivatio nominis: The species is named after the Russian zoologist F. Ya. Dzerzhinski.

Holotype: M1 sin. – N KE-Akt34 (pl. 2 fig. 1).

Type locality: Aktau I, stratum N129 of Kordikova & Mavrin (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Referred specimens: 7 teeth of M1, 13 teeth of M2, 6 teeth of M3, 8/9 teeth of m1, 2/3 teeth of m2 and 7 teeth of m3.

Diagnosis: *Karydomys* with cheek teeth that are on average somewhat smaller than those of the type species *K. symeonidisi*. Cusps of cheek teeth not inflated. Lingual sinus of M1 and M2 and labial sinus of m1 and m2 not antero-posteriorly compressed.

For differential diagnosis see Remarks.

Tab. 2. *Karydomys dzerzhinskii* n. sp. – Material and measurements

	Length			Width	
	range	**mean**	**N**	**range**	**mean**
M1	21.3-24.5	23.10	8	14.99	12.7-16.2
M2	16.2-18.4	17.20	13	14.45	12.8-16.2
M3	9.9-12.2	11.25	6	11.75	10.4-12.4
m1	17.1-19.8	18.65	8/9	12.62	11.7-13.7
m2	18.1-18.4	18.3	2/3	14.3	13.2-15.4
m3	13.4-15.3	14.48	7	12.42	11.7-13.6

Description

M1: The anterocone is wide and situated somewhat lingually of the paracone. The labial spur of the anterolophule is always present, but shows a great deal of variation in length. The protolophule II and the metaloph are directed posteriorly. The protolophule I, which seems to be a neoformation, is strong in some specimens, but weak in others. The posterior spur of the paracone is connected to the long mesoloph. The sinus is open lingually and not antero-posteriorly compressed.

M2: The lingual and labial branch of anteroloph are well developed and of about equal length. The protolophule I and II are equally well developed and enclose a triangular pit with the protocone as basis. The mesoloph is long in most specimens. The posterior spur of the paracone is well developed in some specimens, but absent in others. The connection of the posterior spur of the paracone and the mesoloph is, in contrast to the situation in the M1, not well established. The metalophule is usually transverse, rarely posteriorly directed. The sinus is rather wide and open lingally.

M3: The lingual and labial branch of the anteroloph are weak. The single protoloph is directed anteriorly. The original longitudinal crest is well developed although the new entoloph is complete. The mesoloph is long and reaches the labial outline of the occlusal surface. The metacone is unusually well developed for a cricetid M3 and is not incorporated into the posteroloph.

m1: The large blade-like anteroconid of the m1 is situated on the median axis of the occlusal surface. The forwards directed metalophid and the anterolophulid meet at the anteroconid. The mesolophid is long and reaches the lingual border of the occlusal surface. The ectomesolophid is well developed.

m2: The labial and lingual branch of the anterolophid are of about the same length. The metalophid and hypolophid are directed forwards. The mesolophid and the ectomesolophid are both long and reach the border of the occlusal surface.

m3: The labial branch of the anterolophid is longer than the lingual branch, but the latter is unusually well developed compared to the configuration in other democricetodontines. The metalophid is directed forwards. The hypolophid is in line with the posterior arm of the protoconid. The entoconid is incorporated into the complete ectolophid.

Remarks: *Karydomys dzerzhinkii* n. sp. is closer in size and tooth morphology to the type species *K. symeonidisi* THEOCHAROPOULOS 2000 than to the two other species allocated to this genus [*K. boskosi* THEOCHAROPOULOS 2000 from Karydia, Greece and *K. zapfei* (MEIN & FREUNDENTHAL 1981) from Vieux Collonges, France]. Comparison of our material with the type material of *K. symeonidisi* shows that the Kazakhstan specimens are in many details less specialized. The main differences between *K. dzerzhinskii* and *K. symeonidisi* are that the teeth (especially the upper cheek teeth) are not antero-posteriorly compressed and that the cusps are not inflated. Moreover, the metalophule of the M2 of *K. dzerzhinskii* is almost invariably transverse and the metacone of the M3 is well developed. In all these respects our species is clearly less derived than *K. symeonidisi*. *K. dzerzhinskii* is therefore, at least structurally, a perfect candidate for the ancestor of *K. symeonidisi*.

Tachyoryctoidinae SCHAUB 1957

The Tachyoryctoidinae, which are presumably the Central Asiatic counterpart of the West Asiatic Spalacidae, contain three genera: *Tachyoryctoides* BOHLIN 1937, *Aralomys* ARGYROPULO 1939 and *Eumysodon* ARGYROPULO 1939 only. SCHAUB (1957) also included *Argyromys* SCHAUB 1957, a genus that is based on a single lower dentition described as *Schaubeumys aralensis* by ARGYROPULO (1939). Since this toothrow does not show the characteristic Tachyoryctoidinae increase in depth of the labial sincline from m1 through m3, the allocation of *Argyromys* to this subfamily does not seem to be justified. The genera *Aralomys* (type species: *A. gigas* ARGYROPULO 1939) and *Tachyoryctoides* (type species: *T. obrutshewi* BOHLIN 1937) have very similar (lower) dentitions and are therefore tentatively considered congeneric. This lack of diversity of the family by no means reflects reality. *Tachyoryctoides kokonorensis* LI & QUI 1980 differs in our opinion sufficiently from *T. obrutschewi* to justify generic distinction. Material kindly shown to one of the authors (H. D. B.) by Dr. V. ZAZHIGIN in 1998 and the three teeth from the Chul'adyr Formation (pl. 3 figs 8-10) that will be described below make it clear that the Tachyoryctoidinae were a diverse group in Central Asia during the Oligo-Miocene. The reason that the material available in collections has remained largely unstudied probably is that there are no adequate samples available. LINDSAY (1994) in his review of the fossil record of the Asiatic Cricetidae mentions *Aralomys, Eumysodon* and *Argyromys* briefly and suggests that they might be zapodids rather than cricetids, omitting *Tachyoryctoides* and in particular *T. kokonorsis* LINDSAY 1994 in his discussion. This species is based on a partial skull and the lower dentition of one individual that shows unmistakably that we are dealing with a cricetid. The Oligo-Miocene Tachyoryctoidinae is a neglected, but diverse, subfamily of the cricetids that seems to have good potential for biostratigraphy. The three teeth from the Chul'adyr Formation represent a new genus and species that will not be formally named because the material is scanty and should be studied within the context of a revision of the Tachyoryctoidinae.

Genus A, species 1

Pl. 3 figs 8-10

Material and measurements: Ml sin. (39,0 × 28,0), M3 sin (21,0 × 23,8), m3 dext (29,1 × 24,6).

Type locality: Aktau I, stratum N129 of KORDIKOVA & MAVRIN (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Description

Cheek teeth lophodont. Lophs predominantly transverse and separated by valleys that are approximately as wide as the lophs.

M1: The anteroloph is very strong and parallel to the other lophs. The metaloph is connected to the protocone and bifurcates lingually to connect with a strong mesocone. The longitudinal ridge is absent between the mesocone and the hypocone. The strong transverse metaloph forms lingually a continuous loop with the posteroloph. The labial end of the posteroloph is separated from the metacone by a narrow valley.

M3: The dental pattern of the M3 is very derived. The procone is incorporated into a strong anteroloph. The 'protoloph' is directed forwards and connects the paracone-metacone complex to the anteroloph. The rather weak longitudinal crest is complete and delimits a strongly forwards directed sinus. The metaloph is transverse and forms one lingually continuous loop with the posteroloph.

m3: The anterolophid is not connected to the protoconid, but touches the base of the metaconid. There is only one lingual sinus between the metalophid and the hypolophid that form a V-shaped ridge with the protoconid at the apex. The sinusid is very deep and has been extended at the expense of the posterior lingual sinus. This is the main characteristic of the Tachyoryctoidinae, separating this subfamily clearly from the West Asiatic Spalacidea (HOFMEIJER & DE BRUIJN 1985).

Discussion: The three teeth described above are similar to '*Tachyoryctoides' kokonorensis* in that they are lophodont and have a dental pattern that differs substantially from the basic cricetid arrangement. Other characteristics of the Kazakhstan specimens, such as the antero-posteriorly compressed configuration with narrow transverse valleys between the lophs, the strong mesocone in the M1 and the interrupted longitudinal ridge in the M1, seem to us of enough importance to consider these teeth generically different from *'T' kokonorensis*.

We suggest that the Tachyoryctoidinae as known in the literature contains four genera: *Eumysodon, Tachyoryctoides* (including *Aralomys*), an unnamed genus with the species *kokonorensis* as the type, and an unnamed genus A with species 1 as the type.

Dipodidae WATERHOUSE 1842

The recognition of the subfamilies of the Dipodidae as based on the extant representatives seems to lose all meaning when applied to pre-Miocene and dentally conservative fossil material. We therefore refrain from suggesting subfamily positions. A further problem with the primitive Asiatic Dipodidae is that they seem to be oversplit, at least for us who have not seen the rich Chinese and Mongolian material, and the generic differences seem in a number of cases trivial. This trend of oversplitting was set as early as 1946 by BOHLIN who distinguished *Parasminthus* from *Plesiosminthus* VIRET 1926 merely because his material did not show groved upper incisors. Since the work of BOHLIN material has been assigned to *Plesiosminthus* or *Parasminthus* without reference to the incisors, so a revision of the group is badly needed.

The number of genera of more-or-less primitive Dipodidae formally named is twelve: *Plesiosminthus* VIRET 1926, *Heterosminthus* SCHAUB 1930, *Parasminthus* BOHLIN 1946, *Aksyromys* SHEVYREVA 1984, *Allosminthus* WANG 1985, *Heosminthus* WANG 1985, *Sinosminthus* WANG 1985, *Shamosminthus* HUANG 1992, *Gobiosminthus* HUANG 1992, *Banyuesminthus* TONG 1997, *Primisminthus* TONG 1997 and *Bohlinosminthus* LOPATIN 1999.

?***Sinosminthus*** sp. indet.

Text-figs 3a, b

Material and measurements: M2 dext. (12,3 × 11,1), m1 dext. (13,3 × 9,1).

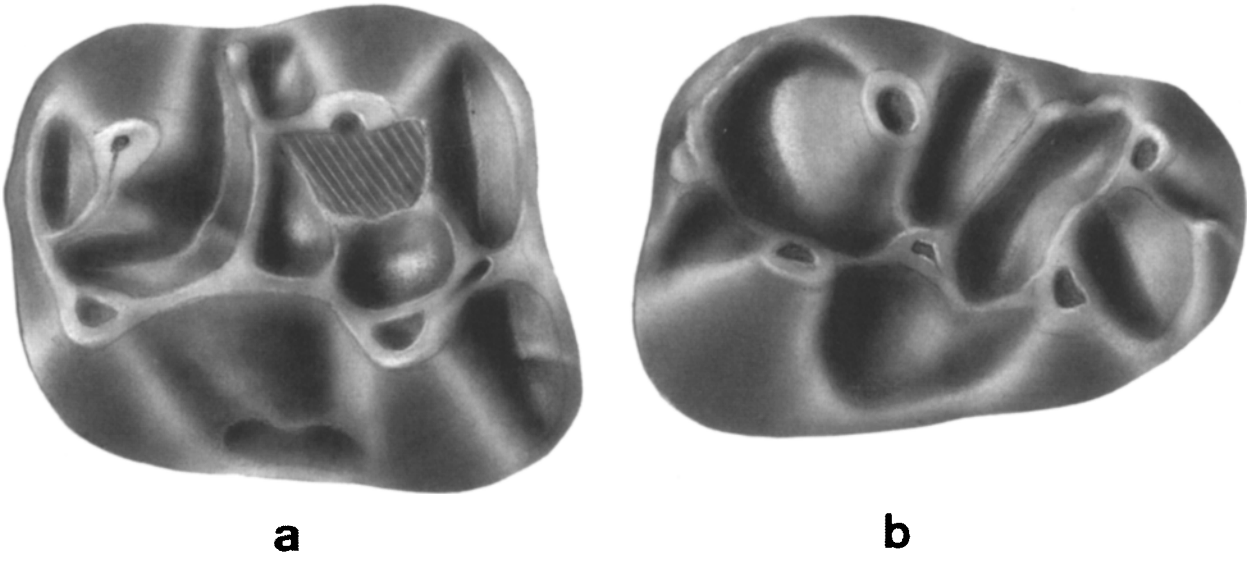
Locality: Aktau I, stratum N129 of KORDIKOVA & MAVRIN (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Description

M2: This tooth is not much longer than it is wide, as in some species from the Early Miocene of Anatolia. The lingual branch of the anteroloph is well developed which is uncommon in the family in general, but which is also seen in *Sinosminthus, Heosminthus* and *Allosminthus*. The protoloph is double, the metaloph directed posteriorly and the lingual sinus is rather shallow and open. In all these characteristics this specimen resembles *Sinosminthus inapertus* WANG 1985.

m1: The anteroconid is small and does not influence the anterior outline of the occlusal surface. The metalophid is complete and the mesolophid is long. The mesolophid and hypolophid meet the ectolophid at the small mesoconid. The hypoconulid is not well marked. All these dental characteristics may occur in almost any primitive dipodid and therefore do not contribute much to the generic identification of our material.



Text-fig. 3. Molars of ?*Sinosminthus* sp., Dipodidae: a) Right first lower molar; b) right second upper molar.

Ctenodactylidae ZITTEL 1893

Sayimys WOOD 1937

Sayimys as understood here includes *Prosayimys* BASKIN 1996 because the main characteristic of the latter genus is that the lower molars have retained the metalophulid II (= posterior arm of the protoconid). In other respects the teeth of *Prosayimys flynni* BASKIN 1996 (the type of *Prosayimys*) are very much as those of *Sayimys*. Since there is evidence that the metalophulid II, a character inherited from the ancestral stock, was gradually lost in different lineages that develop the *Sayimys* dental pattern we consider presence or absence of the metalophulid II unsuitable for generic distinction.

Sayimys* aff. *obliquidens BOHLIN 1946

Pl. 3 figs 1-6

Material and measurements: D4 (17,9 × 16,9), M2 (20,2 × 20,1), M3 (21,5 × 22,0), d4 (20,5 × 12,8), m1 (20,9 × 16,8), m2 (26,9 × 19,7).

Locality: Aktau I, stratum N129 of KORDIKOVA & MAVRIN (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Description

D4: The dental pattern of the D4 is very similar to the D4 in *S. intermedius* SEN & THOMAS 1979 (DE BRUIJN, BOON & HUSSAIN 1989) and *Prosayimys flynni* BASKIN 1996. The strong anteroloph is confluent with the anterior arm of the protocone, the protoloph is transverse, the metaloph curves posteriorly and connects with the posteroloph. The first labial re-entrant fold is wider and longer than the third labial re-entrant fold.

M2: The first and third labial re-entrant folds are of about equal length and reach further lingually than in teeth of other species of *Sayimys* showing a similar stage of wear.

M3: This tooth is very similar to its counterpart in *S. intermedius*. The second labial re-entrant fold is rather narrow and reaches far lingually. A peculiar feature is that the sinus and the second labial re-entrant fold are both almost transverse and in line.

d4: The anteroconid is isolated as in *Sayimys minor* DE BRUIJN, HUSSAIN & LEINDERS 1981 and in *S. intermedius*. The metalophulid II is connected to the metaconid as in *S. minor* and *P. flynni*.

m1: The metalophid and hypolophid are more-or-less transverse as in other early species of *Sayimys*. The metalophulid II is missing.

m2: The metalophid is transverse, but the hypolophid is directed anteriorly. The metalophid II is well developed and connected to the basis of the metaconid.

Discussion: The *Sayimys* teeth described above show a stage of evolution that is intermediate between *P. flynni* from the Chitarwata Formation and *S. minor* from the Murree Formation of Pakistan (both Lower Miocene). The lack of a metalophulid II in the m1, but its presence in the m2 is exactly as in the type material of *S. obliquidens* BOHLIN 1946 from Taben Buluk, China. The only difference between the material from Kazakhstan and China is that our material is significantly smaller. Since we have not seen the Chinese material we cannot exclude the possibility that differences in measuring technique have influenced the values obtained. The difference seems, however, significant, so we list our material as *Sayimys* aff. *oliquidens*.

Castoridae GILL 1872

Asiacastor LYCHEV 1971

Asiacastor* aff. *baschanovi LYCHEV 1971 (in LYCHEV & AUBEKEROVA 1971)

Material: A fragment of a right lower jaw with broken incisor and P4 and with m1, m2.

Measurements: m1 (36,0 × 32,3), m2 (37,8 × 31,5).

Locality: Aktau III of KORDIKOVA & MAVRIN (1996), Aktau Mountains, Dzhungarian Alatau, South-Eastern Kazakhstan.

Stratigraphical range: Middle Member of the Chul'adyr Formation, MN4.

Description

The partial ? dentition presents a small castorid. The foramen mentale is situated below the anterior part of the m1.

I: The section of the lower incisor shows that the enamel band on its anterior side is concave.

m1: The occlusal surface shows five main flexids with an incomplete sixth flexid in the parastriid. The hypostriid and the metastriid are in line. The mesostriid and the poststriid are longer and reach further labially than the parastriid and the metastriid.

m2: The m2 shows five parallel flexids because the additional flexid in the parastriid is absent. The dental pattern is otherwise as that of the m1.

Discussion: The specimen from Aktau III differs from the type material of *A. baschanovi* from the Akmola area in having an additional flexid in the paraflexid of the m1. Our specimen is smaller than the type material of *A. major* LYCHEV 1971 and the labial outline of the protoconid and the hypoconid are more rounded in that species. Moreover, the hypoflexid and the metaflexid are in line in our specimen which is not the case in the lower molars of *A. major*.

Sciuridae GRAY 1821

The squirrels are represented in the association from the Middle Member of the Chul'adyr Formation by one rolled M3 only. Although this tooth is damaged its straight posterior outline, short posterior part and small size suggest that it represents a species of *Tamias* ILLIGER 1811.

The age of the assemblage

Biostratigraphical correlations over long distances based on rodent fauna are never very precise because of the limited geographical ranges of most species. In the case of the rodent faunule from the Chul'adyr Formation we are fortunate to have *Karydomys dzerzhinskii* showing a stage of evolution that is clearly less atranced than that of *K. symeonidisi* from the locality Karydia (MN4, Greece) and *Sayimys* sp. showing a stage of evolution similar to *S.* aff. *obliquidens* from Taben Buluk – a locality that was traditionally considered to be of Early Miocene age, but that has recently been placed in the latest Oligocene (RUSSELL & ZHAI 1987). Comparable *Sayimys* specimens have not yet been found on the Indian Subcontinent, but the stage of evolution of *Sayimys* sp. is clearly intermediate between the material from the Chitarwata Formation and the Murree Formation (both Early Miocene in age). *Aktaumys* resembles the primitive representatives of the megacricetodontines and myocricetodontines, two groups that have never been found in pre-Miocene deposits. The tachyoryctoidine is unique, but shows more similarity to *T. kokonorensis* from the Early Miocene of China than to the species from the Late Oligocene of the Aral Formation. Finally, the lower teeth of *Asiacastor* aff. *baschanovi* show characteristics that suggest that they are older than the material from the Mid Miocene age deposits of the Akmola and the Pavlodar Irtysh river areas (LYCHEV & AUBEKEROVA 1971).

Although the rodents from the middle members of the Chul'adyr Formation do not allow a precise correlation with either the Chinese or the European faunal sequences, there is good evidence that they are of Early Miocene age and possibly represent the MN4 in Kazakhstan, although this is somewhat older than biostratigraphical estimates based on the Insectivora and Carnivora from the same member (KORDIKOVA 2000, KORDIKOVA, HEIZMANN & MAVRIN 2000).

Acknowledgements

We are most grateful to Mr. A. MAVRIN of the Kazakh Technical University, Almaty for his support during many years of field work in the Aktau Mountains. Our colleagues and the director, Mr. A. V. DUBINKIN, of the Kapchagay Geological Expedition at the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan are gratefully acknowledged for their help in the organisation and implementation of the field work. We thank Profs Drs J. YE and W. WU for discussion on the stratigraphy of the Aktau Mountains during an joint Kazakhstan-Chinese field excursion (15-30, June, 1999).

The field assistance of M. R. DE BRUIJN and A. E. DE BRUIJN-DUDAK VAN HEEL is appreciated. Mr. W. A. DEN HARTOG made the S.E.M. photos, Mr. J. LUTEIJN retouched the photos and drew the dipodid teeth and Mrs. M. J. W. VAN WIJK (Institute of Earth Sciences, University of Utrecht) typed and edited the manuscript.

This study was partly supported by the DAAD grant.

References

ARGYROPULO, A. I. (1939): New Cricetidae (Glires, Mammalia) from the Oligocene of Middle Asia. – C. R. Acad. Sci. U.S.S.R., **23** (1): 11-114, 1 text-fig.; Moskva.

BASKIN, J. A. (1996): Systematic revision of Ctenodactylidae (Mammalia, Rodentia) from the Miocene of Pakistan. – Palaeovertebrata, **25** (1): 1-49, 8 text-figs, 1 pl.; Montpellier.

BOHLIN, B. (1937): Oberoligozäne Säugetiere aus dem Shargal-tein-Tal (Western Kansu). – Palaeont. Sinica, N. S., (C) **3**: 1-66, 136 text-figs, 2 pls; Nanking.

BOHLIN, B. (1946): The fossil mammals from the Tertiary deposits of Taben-Buluk, Western Kansu. Part II. Simplicidentata, Carnivora, Artiodactyla, Perissodactyla, and Primates. – Sino-Swedish Exp. Publ., **28**: 1-259, 90 text-figs, 9 pls; Stockholm.

BRUIJN, H. DE, BOON, E. & HUSSAIN, S. T. (1989): Evolutionary trends in Sayimys (Ctenodactylidae, Rodentia) from the Lower Manchar Formation (Sind, Pakistan). – Proc. Kon. Nederl. Akad. Wet., (B) **92** (3): 191-214, 6 text-figs, 4 pls; Amsterdam.

BRUIJN, H. DE, HUSSAIN, S. T. & LEINDERS, J. J. M. (1981): Fossil rodents from the Murree formation near Banda Daud Shah, Kohat, Pakistan. – Proc. Kon. Nederl. Akad. Wet., (B) **84**: 71-99; Amsterdam.

FAHLBUSCH, V. (1964): Die Cricetiden (Mammalia) der Oberen Süßwassermolasse Bayerns. – Abh. Bayer. Akad. Wiss., **118**: 1-136, 7 pls; München.

HOFMEIJER, G. K. & BRUIJN, H. DE (1985): The mammals from the Lower Miocene of Aliveri (Island of Evia, Greece). Part 4: The Spalacidae and Anomalomyidae. – Proc. Kon. Nederl. Akad. Wet., (B) **88** (2): 185-198, 3 text-figs, 3 pls; Amsterdam.

HUANG, X. (1992): Zapodidae (Rodentia, Mammalia) from the Middle Oligocene of Ulantatal, Nei Mongol. – Vertebrata PalAsiatica, **10**: 249-286, 3 text-figs, 4 pls; Beijing.

KORDIKOVA, E. G. (2000): Insectivora (Mammalia) from the Lower Miocene of the Aktau Mountains, South-Eastern Kazakhstan. – Senckenbergiana lethaea, **80** (1): 67-80, 4 text-figs, 3 tabs, 2 pls; Frankfurt am Main.

KORDIKOVA, E. G., HEIZMANN, E. & MAVRIN, A. V. (2000): Early Middle Miocene Carnivora of Aktau Mountains, South-Eastern Kazakhstan. – Paläont. Z., **74** (1/2): 195-204, 5 text-figs, 2 tabs; Stuttgart.

KORDIKOVA, E. G. & MAVRIN, A. V. (1996): Stratigraphy and Oligocene-Miocene mammalian biochronology of the Aktau Mountains, Dzhungarian Alatau Range, Kazakhstan. – Palaeovertebrata, **25** (2-4): 141-174, 5 text-figs, 4 tabs, 1 pl.; Montpellier.

LI, CH. & QUI, ZH. (1980): Early Miocene mammalian fossils of Xiniing Basin, Qinghai. – Vertebrata PalAsiatica, **18** (3): 198-214, 7 text-figs; Beijing.

LINDSAY, E. H. (1994): The fossil record of Asian Cricetidae with emphasis on Siwalik cricetids. – In: Y. TOMIDA, C. k. LI & SETOGUCHI [Eds], Rodent and Lagomorph families of Asian origins and diversification, **8**: 131-147; Tokyo.

LOPATIN, A. (1999): New Early Miocene Zapodidae (Rodentia, Mammalia) from the Aral Formation of the Altynshokysu locality (North Aral region). – Paleont. Zhurn., **33** (4): 429-438, 3 text-figs, 3 tabs; Moskva.

LUCAS, S. G., BAYSHASHOV, B. U., TYUTKOVA, L. A., ZHAMANGARA,

A. K. & Aubekerov, B. Z. (1997): Mammalian biochronology of the Paleogene-Neogene boundary at Aktau Mountain, eastern Kazakhstan. – Paläont. Z., **71** (3/4): 305-314, 6 text-figs, 1 tab.; Stuttgart.

Lychev, G. F. & Aubekerova, P. A. (1971): Iskopayemyye bobry Kazakhstana [Fossil beavers of Kazakhstan]. – In: Materialy po istorii fauny i flory Kazakhstana, **5**: 12-33, 10 text-figs, 2 tabs; Alma-Ata (Kazakh Acad. Sci.).

Mein, P. & Freudenthal, M. (1981): Les Cricetidae (Mammalia, Rodentia) du Néogène moyen de Vieux-Collonges. Partie 2; Cricetodontinae incertae sedis, Melissiodontinae, Platacanthomyinae et Anomalomyinae. – Scripta geol., **60**: 1-11, 2 pls; Leiden.

Mörs, T., Hocht, F. von der & Wutzler, B. (2000): Die erste Wirbeltierfauna aus der miozänen Braunkohle der Niederrheinischen Bucht (Ville-Schichten, Tagebau Hambach). – Paläont. Z., **74** (1/2): 145-170, 9 text-figs, 1 tab.; Stuttgart.

Qui, Zh. (1996): Middle Miocene micromammalian fauna from Tunggur, Nei Mongol. – 1-216, 25 text-figs, 8 pls; Beijing.

Russell, D. E. & Zhai, R. (1987): The Paleogene of Asia: mammals and stratigraphy. – Mém. Mus. Nat. Hist. Natur., (C) **52**: 1-400, 232 text-figs; Paris.

Schaub, S. (1930): Fossile Sicistinae. – Eclogae Geol. Helvetiae, **23** (2): 616-637, 17 text-figs; Basel.

Schaub, S. (1958): Rodentia. – In: J. Piveteau, Traité de Paléontologie, **6** (2): 659-818, 283 text-figs; Paris.

Shevyreva, N. S. (1984): Novyye ranneeotsenovyye gryzuny Zaysanskoy vpadiny [New early Eocene rodents from the Zaysan Basin]. – In: L. K. Gabunia [Ed.], Flora and fauna of the Zaysan Basin: 77-114; Tbilisi.

Theocharopoulos, K. D. (2000): Late Oligocene-Middle Miocene Democricetodon, Spanocricetodon and Karydomys. n. gen. from the eastern Mediterranean area. – GAIA Kapodistrian University of Athens, **8**: 1-98, 11pls; Athens.

Tong, Y. (1997): Middle Eocene small mammals from Liguanqiao Basin of Henan Province and Yuanqu Basin of Shanxi Province, central China. – Palaeont. Sinica, 18, N. S., (C) **26**: 189-256; Beijing.

Viret, J. (1926): Nouvelles observations relatives à la faune de rongeurs de St. Gerand-le-Puy. – C. R. Acad. Sci., **183**: 71-72, 2 text-figs; Paris.

Wang, B. (1985): Zapodidae (Rodentia, Mammalia) from the Lower Oligocene of Qujing, Yunnan, China. – Mainzer geowiss. Mitt., **14**: 345-367; Mainz.

Wessels, W. (1996): Myocricetodontinae from the Miocene of Pakistan. – Proc. Kon. Nederl. Akad. Wet., **99** (3-4): 253-312; Amsterdam.

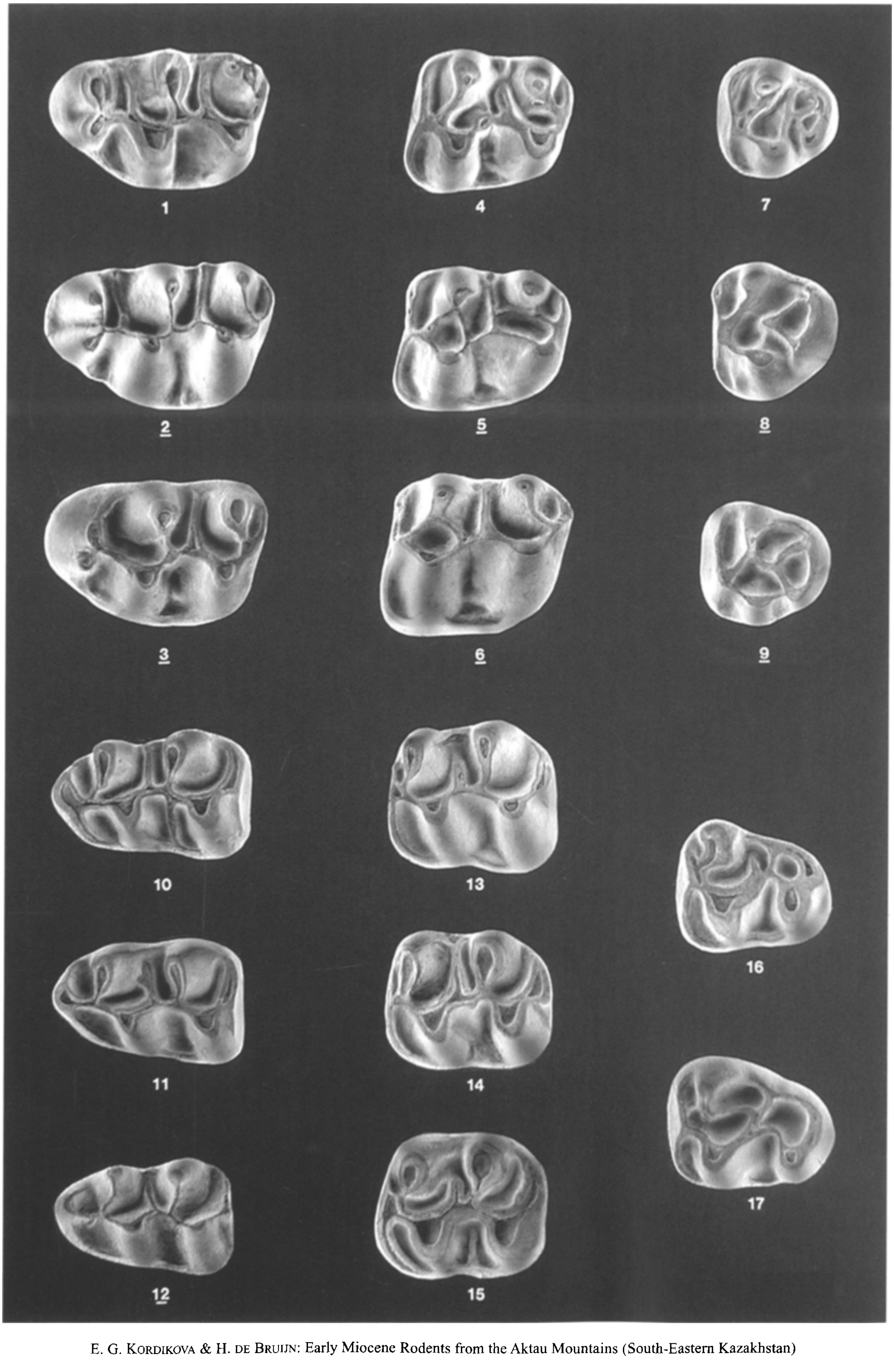
Wood, A. E. (1937): Fossil rodents from the Siwalik beds of India. – Amer. J. Science, **36**: 64-76, 14 text-figs; New Haven.

Manuscript submitted: 2000-09-26; accepted: 2001-09-12.

Plate 1

Figs 1-17. *Aktaumys dzhungaricus* n. gen. n. sp.

1-3: M1 sin.
4-6: M2 sin
7-9: M3 sin.
10-12: m1 sin.
13-15: m2 sin.
16, 17: m3 sin.

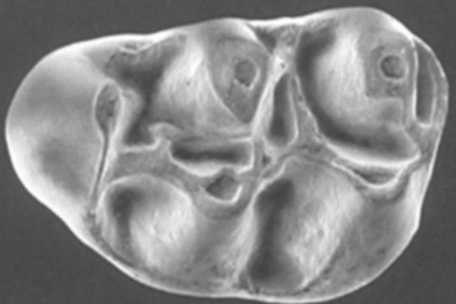


E. G. KORDIKOVA & H. DE BRUIJN: Early Miocene Rodents from the Aktau Mountains (South-Eastern Kazakhstan)

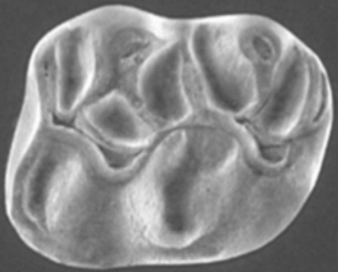
Plate 2

Figs 1-13. *Karydomys dzerzhinskii* n. sp.

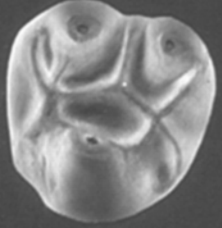
1-3: M1 sin.
4-6: M2 sin.
7, 8: M3 sin.
9, 10: m1 sin.
11: m2 sin.
12, 13: m3 sin.



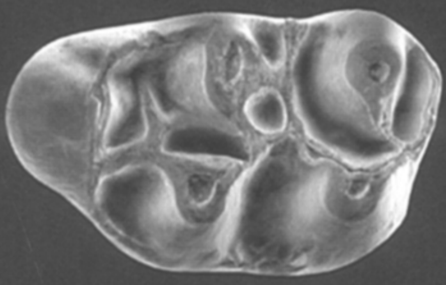
1



4

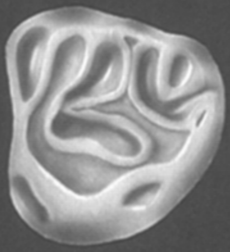


7

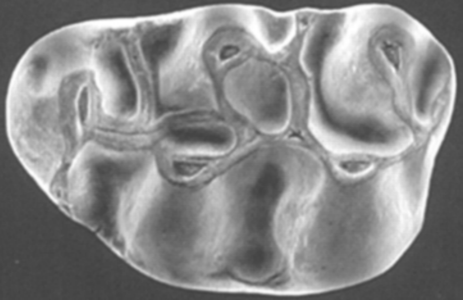


2

5

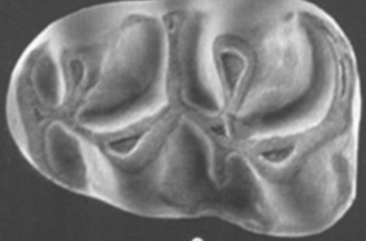


8



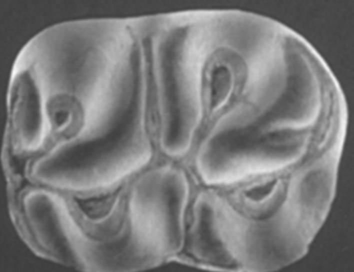
3

6

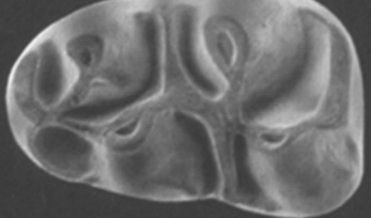


9

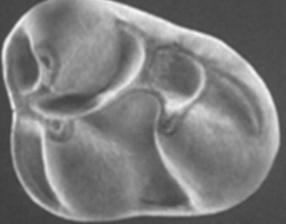
12



11



10



13

E. G. KORDIKOVA & H. DE BRUIJN: Early Miocene Rodents from the Aktau Mountains (South-Eastern Kazakhstan)

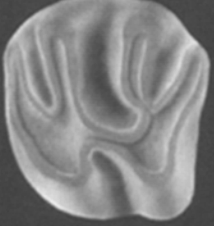
Plate 3

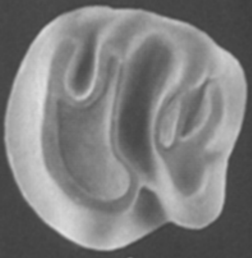
Figs 1-6. *Sayimys* aff. *obliquidens* Bohlin 1946.
1: D4 sin.
2: M1 sin.
3: M3 sin.
4: d4 sin.
5: m1 sin.
6: m2 sin.

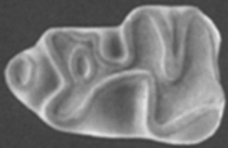
Figs 7a, b. *Asiacastor* aff. *baschanovi* Lychev 1971.
7a: A fragment of right mandible with p4-m2.
7b: m1, m2 sin. of same specimen reversed.

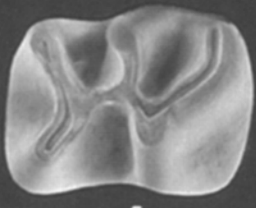
Figs 8-10. *Tachyoryctoides* gen. A, sp. 1.
8: M1 sin.
9: M3 sin.
10: m3 sin.

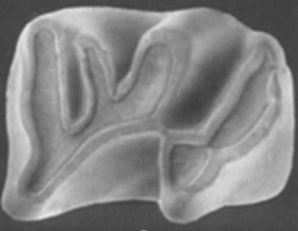

1

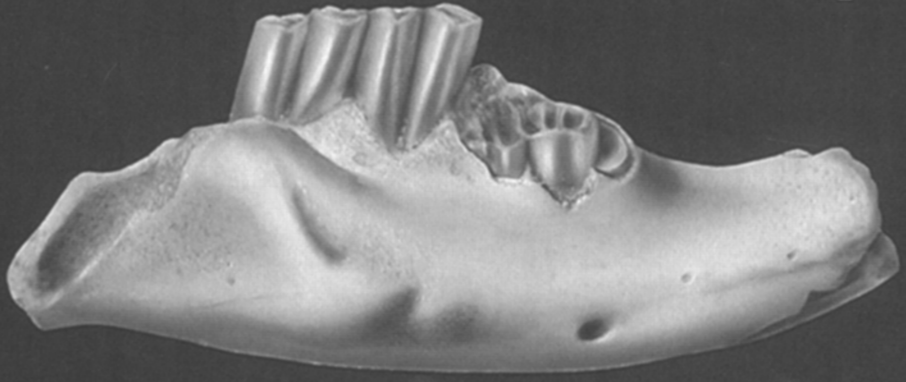

2

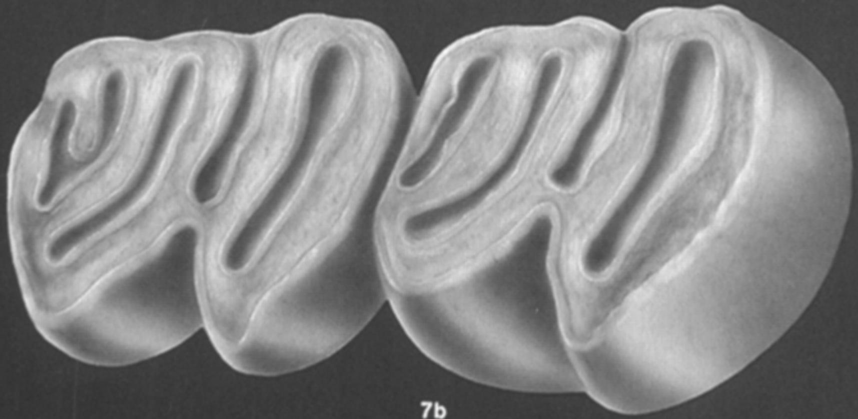

3


4


5

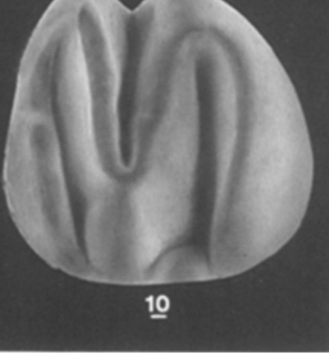

6


7a


7b


8


9


10

E. G. KORDIKOVA & H. DE BRUIJN: Early Miocene Rodents from the Aktau Mountains (South-Eastern Kazakhstan)