©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

Ann. Naturhist. Mus. Wien	108 A	173–215	Wien, September 2007

Oligocene-Miocene Vertebrates from the Valley of Lakes (Central Mongolia): Morphology, phylogenetic and stratigraphic implications

Editor: Gudrun DAXNER-HÖCK

6. The Ctenodactylidae (Rodentia, Mamalia)

by Norbert SCHMIDT-KITTLER[1], Monique VIANEY-LIAUD[2] and Laurent MARIVAUX[2]

Manuscript submitted on March 25th 2006,
the revised manuscript on February 19th 2007

(With 2 plates and 103 figures)

Abstract

Oligocene ctenodactylid rodents of a rich mammalian fauna gathered by the Austrian expeditions to the Valley of Lakes (Central Mongolia) in 1996 and 1997 are described. The species recognized are already known from earlier fossil collections in the same area or from localities in Gansu (Shargaltein, Tabenbuluk) and Inner Mongolia (St. Jaques, Ulantatal) in China. A species only unformally described from Ulantatal (VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX 2006) is erected as new taxon *Huangomys frequens* nov. gen. nov. sp. Thanks to the stratigraphically controlled gathering of fossils in the sections more precise biostratiographical correlations can be established with the well studied faunal succession of Ulantatal. Comparison based on *Karakoromys*, *Huangomys* nov. gen. and *Yindirtemys* reveal that the levels A and B of the Valley of Lakes correspond to the lower part of the Ulantatal sequence. Most of the middle part of the Ulantatal section has no representation in the Valley of Lakes series because of a sedimentary gap. Level C and C1 can be correlated with the upper part of the Ulantatal section. As to the phylogenetic results, *Tataromys*, *Alashania* VIANEY-LIAUD et al. and *Huangomys* nov. gen. are most probably members of one and the same branch of specialization from which *Yindirtemys* probably diverged more early. *Karakoromys* seems to be very close to the bifurcation point of the two developmental directions. It shows the most ancestral status of all Tataromyinae.

Zusammenfassung

Aus der reichen Säugetierfauna, die durch eine österreichische Expedition in den Jahren 1996 und 1997 im Valley of Lakes (Zentrale Mongolei) geborgen wurde, sind hier die oligozänen Ctenodactyliden beschrieben. Die vorgefundenen Arten sind schon von früheren Aufsammlungen im gleichen Gebiet oder chinesischen Fundstellen in Gansu (Shargaltein, Tabenbuluk) und der Inneren Mongolei (St. Jaques, Ulantatal) bekannt. Für eine schon in Ulantatal nachgewiesene, aber zunächst nur informell charakterisierte, neue Art (VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX 2006) wird ein neues Taxon *Huangomys frequens* nov. gen. nov sp. aufgestellt. Dank der stratigraphisch kontrollierten Gewinnung der Fossilien aus geologischen Profilen sind genauere biostratigraphische Korrelationen mit der inzwischen gut untersuchten Artenabfolge in Ulantatal möglich. Die Vergleiche, basierend auf *Karakoromys*, *Huangomys* nov. gen. und *Yindirtemys* zeigen, dass die stratigraphischen Abschnitte A und B im Valley of Lakes mit dem

---

[1] Institut für Geowissenschaften, Paläontologie, Universität Mainz, Becherweg 21, 55099, Germany.

[2] Institut des Sciences de l'Evolution, Université Montpellier II, Place Eugène Bataillon, 34095 Montpellier Cedex 5, France.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

unteren Teil der Ulantatal-Sequenz korrespondieren. Der größte Teil der mittleren Folge in Ulantatal hat im Valley of Lakes aufgrund einer Sedimentationslücke kein Äquivalent. Die dortigen Abschnitte C und C1 entsprechen dem oberen Teil der Ulantatal-Folge. Phylogenetisch gesehen, sind *Tataromys*, *Alashania* Vianey-Liaud et al. und *Huangomys* nov. gen. wahrscheinlich Abkömmlinge eines und desselben Spezialisierungszweigs, von dem sich die *Yindirtemys*-Linie schon etwas früher abgetrennt hat. Der Ursprung von *Karakoromys* scheint dem Aufspaltungspunkt der beiden Entwicklungsrichtungen sehr nahe zu liegen. Die Gattung weist unter allen Tataromyinae den ursprünglichsten Merkmalsstatus auf.

Key words: Ctenodactylids, Oligocene, Central Mongolia, taxonomy, biostratigraphy, phylogeny

Introduction

The fossil vertebrate faunas collected from different areas of the Mongolian part of Central Asia since the early last century up to its end were for the most considered as Oligocene in age, some being Miocene in age (Matthew & Granger 1923, Bohlin 1946, Kowalski 1974, Huang 1985). However, due to the fact that the faunas are highly endemic no more detailed correlation with the well known European faunal successions was possible. Also attempts of correlation of fossil localities from different areas within Central Asia based on the usually stratigraphically very informative rodents were affected by much uncertainty, because of the lack of knowledge about common species (Wang 1997). Major progress in defining the biostratigraphic position could finally be attained by extensive geological field investigations and lithostratigraphically controlled collecting of vertebrate faunas combined with datations of basalts in the Valley of Lakes (Mongolia) brought forward by an Austrian project in 1996 and 1997 (Daxner-Höck et al. 1997, Höck et al. 1999). As one of its results radiometric dating of basalt flows intercalated in the sections provided a reliable chronostratigraphic frame for the fossil assemblages of the area. An important element leading to a more complete knowledge of Central Asian faunal successions could be added independently by field activities in the Western part of Inner Mongolia (Ulantatal area north of Alxa Zuoqi, China). Surface collection in this area was undertaken by Huang (1982) and part of the material decribed, among it also the rodent family Ctenodactylidae (Huang 1985). Two years later (1987), the high fossil potential of the Ulantatal became the subject of a Chinese/German expedition during which an abundant material of micromammals was recovered by washing and screening in defined stratigraphic horizons. Of this material the stratigraphically relevant ctenodactylids were published recently by Vianey-Liaud et al. (2006). In this article first insights concerning the correlation of Oligocene faunas in Central Asian could already be developped owing to the comparison with the ctenodactylid findings gathered during the Austrian expedition. This up to now unpublished material is now decribed in the present paper. As shown by the evidence of the radiometric data (Höck et al. 1997) it roughly covers the whole Oligocene. Based on the chronostratigraphic markers and the results obtained from the study of the Ulantatal ctenodactylids it becomes clear that major changes of the picture of faunal correlations in Central Asia at that time are necessary.

Since the ctenodactylid material was gathered by washing sediments of particular levels of the geologic sections, the names of the localities are derived from the identification symbols of the sections and the lithostratigraphic position within them. For the localities and their assignment to the distinguished biostratigraphical levels see Höck et al. (1999) and Daxner-Höck & Badamgarav (2007: tab. 2, fig 1).

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

The dental material studied is housed in the collection of the Naturhistorisches Museum Wien under the catalogue symbol 2006z together with running numbers. For more shortness in the following text only the latter are indicated.

Taxonomy

For ctenodactylid cheek teeth in which the roots are not preserved, the discrimination of first, second or third molars is sometimes difficult. This is the reason why for some species they are not distinguished in the diagrams representing the measurements.

Besides the diagnostic dental characters of species and also beyond the individual variations within the species populations, general morphological trends depending on the position of the teeth in the jaw can be stated. As these are found in all species studied here they are discussed prior to the more detailed description of the taxa. In the upper molars the shape of the mesosyncline being more triangular in M1, becomes somewhat quadrangular in M2 and even more in M3. The endoloph and also the short crest connecting the metaloph and the posteroloph, are most weakly developped in M1, more strengthened in M2 and reach about the same hight as the protocone and the hypocone in M3. Correspondingly, of the molar patterns distinguished in fig. 1b type D can most frequently be found in M1 (only to a lesser extent there is also type E). Passing from M2 to M3 there is an increasing tendency of fusion of the buccal portions of the metaloph and posteroloph. As a result, in M2 pattern, types B and C are frequent, whereas C is predominant in M3. Related to the described trend, in M1 the buccal sinus is mostly confluent with the posterosyncline. And in case the buccal sinus is delimited it enters rather deeply into the toothcrown. In M2 the buccal sinus is less profound and in M3 it is very shallow or even absent. As another trend the length of the posteroloph decreases in the tooth row gradually in posterior direction and in some species even supplementary crests become frequent. In the lower tooth row in bunodont species the connective crests of cones become stronger and higher in posterior direction. In the non-bunodont species with tendency of developing a connection between the hypoconulid and the entoconid, this is most frequently found in m1, to a lesser extent in m2 and even less in m3.

Family Ctenodactylidae ZITTEL, 1893

Subfamily Tataromyinae LAVOCAT, 1961

Karakoromys MATTHEW & GRANGER, 1923

Type species: *Karakoromys decessus* MATTHEW & GRANGER, 1923

***Karakoromys decessus* MATTHEW & GRANGER, 1923**

Synonymy: see VIANEY-LIAUD et al. 2006.

Stratigraphic range: Early Oligocene, Level Ulan I in the Ulantatal area; level A and B in the Valley of Lakes.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

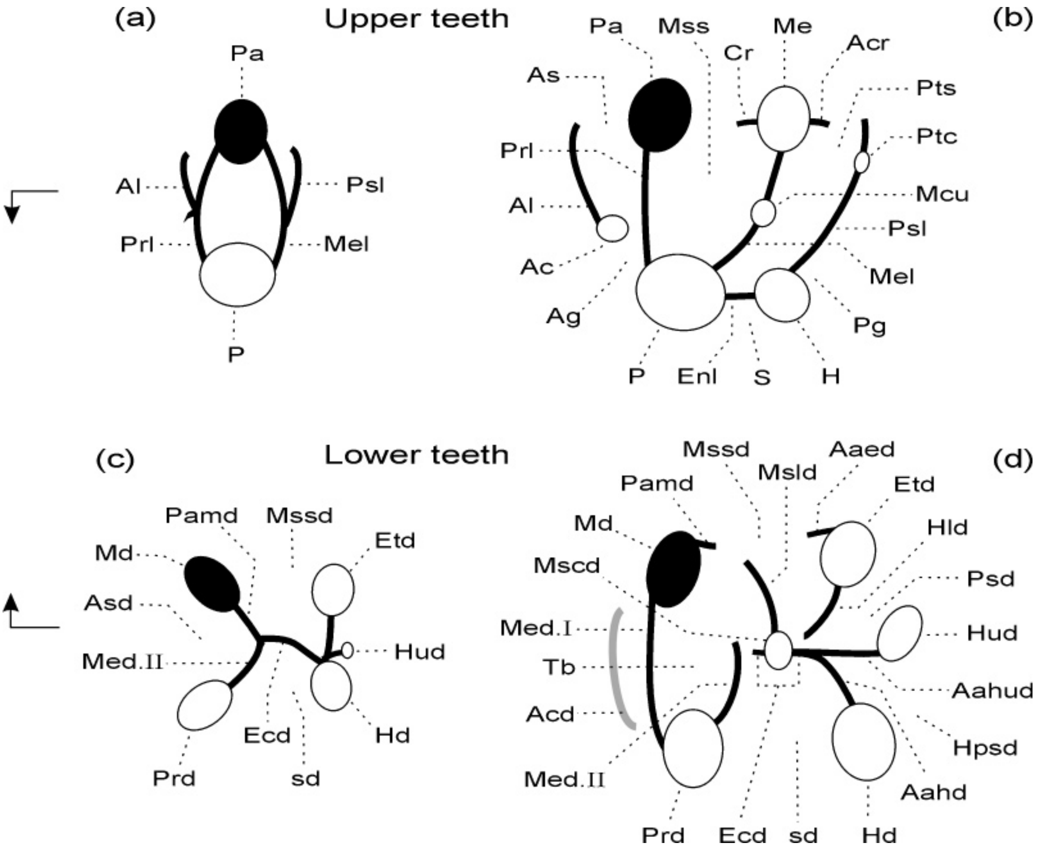


Fig. 1a: Schematic drawings showing the occlusal dental morphology of the upper and lower cheek teeth of primitive ctenodactyline rodents (modified after WOOD & WILSON 1936 and WANG 1997); a) upper left premolar, b) upper left molar, c) lower left premolar, d) lower left molar.
Upper teeth: **Ac**: anterocone, **Acr**: anticrochet, **Ag**: anterior groove, **Al**: anteroloph (=anterior cingulum), **As**: anterior syncline, **Cr**: crochet, **Enl**: endoloph, **H**: hypcone, **Mcu**: metaconule, **Me**: metacone, **Mel**: metaloph, **Mss**: meosocyncline, **P**: protocone, **Pa**: paracone, **Pg**: posterior groove, **Prl**: protoloph, **Psl**: posteroloph, **Ptc**: postrerocone, **Pts**: posterior syncline, **S**: sinus.
Lower teeth: Aaed: anterior arm of entoconid, **Aahd**: anterior arm of hypoconid, **Aahud**: anterior arm of hypoconulid, **Acd**: anterior cingulid, **Asd**: anterior sinusid, **Ecd**: ectolophid, **Etd**: entoconid, **Hd**: hypoconid, **Hld**: hypolophid (= anterior arm of entoconid), **Hpsd**: hyposinusid, **Hud**: hypoconulid, **Md**: metaconid, **Med I**: metalophid I, **Med II**: metalophid II (= posterior arm of protoconid), **Mscd**: mesoconid, **Msld**: mesolophid, **Mssd**: mesosynclinid, **Pamd**: posterior arm of metaconid, **Prd**: protoconid, **Psd**: posterior synclinid, **Sd**: sinusid, **Tb**: trigonoid basin.

Geographic range: Central Mongolia, Western Inner Mongolia (China), Kazakhstan.

Material: Taatsiin Gol, TGL-A/1, fig. 5, TGR-A/13, fig. 6-13; TGR-A/14, fig. 4 ; TGR-AB (surface collection), fig. 2 and 3; Tatal Gol, TAT-D/1, pl. 1 fig. G-J; Hsanda Gol, SHG-surface collection, SHG-A/6 and 9, SHG-C/1;

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

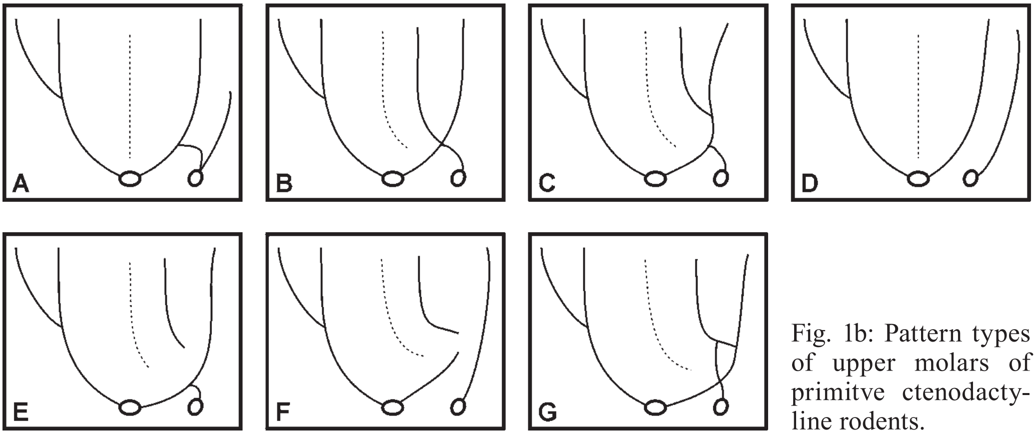


Fig. 1b: Pattern types of upper molars of primitve ctenodactyline rodents.

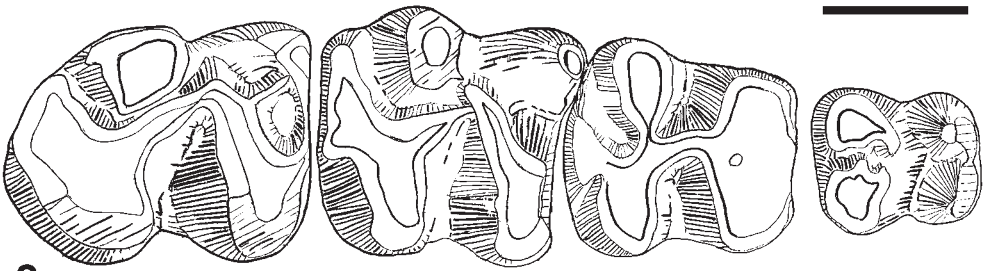
Measurements: see fig. 14 and 15

Original diagnosis: see VIANEY-LIAUD et al. 2006.

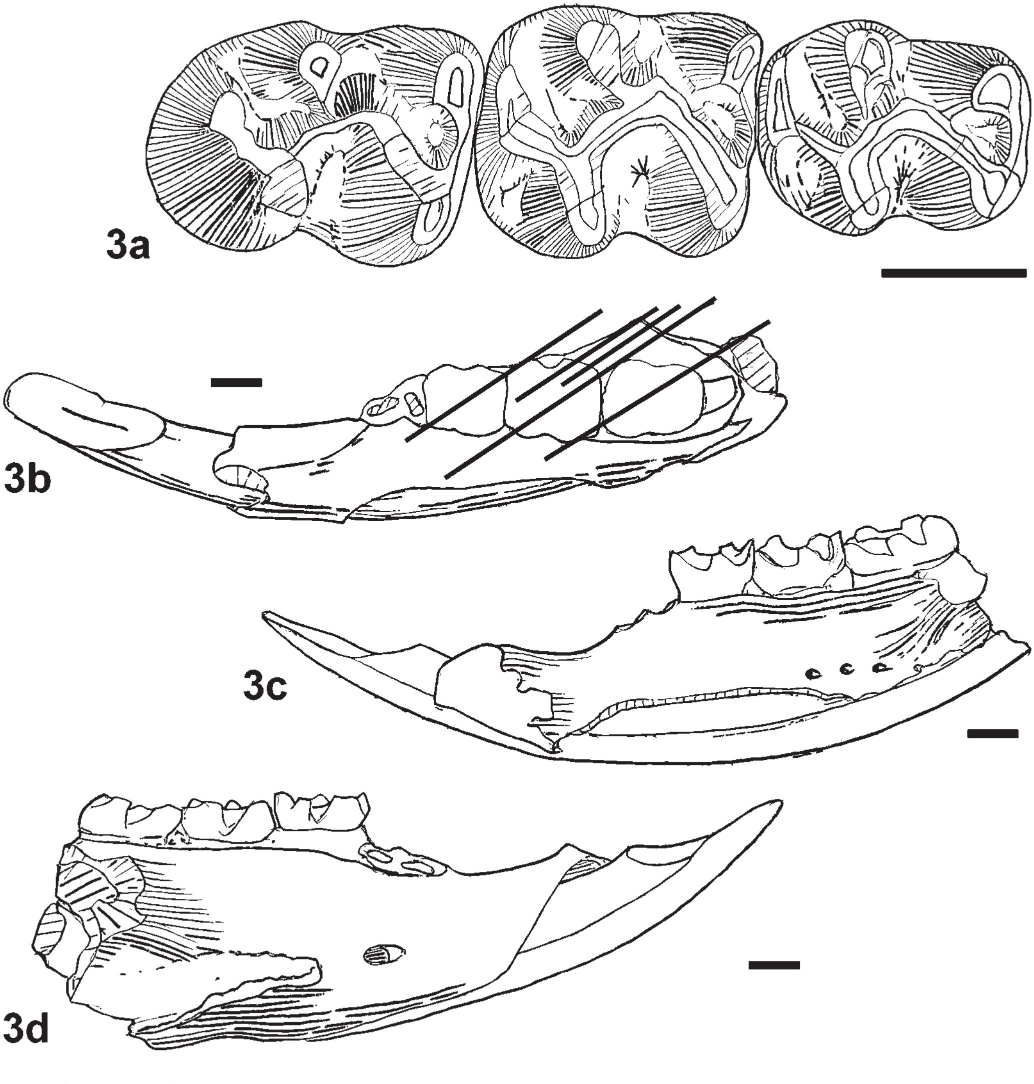
Emended diagnosis (VIANEY-LIAUD et al. 2006): Cheek teeth brachydont; endoloph of upper molars low; metacone only weakly connected to the posteroloph; lower premolar with well developped hypoconid; lower molars and forth decidous molar with ectolophid forming a lingually protruding angle; no connection between ectolophid and metaconid.

Description: The incisive foramen reaches backward to the posterior border of P4 (pl. 1, fig. G); cones of upper molars low; protoloph and metaloph varying between rounded and more sharpened; metaloph mostly only weakly connected to the posteroloph; no anterocone or posterocone present; DP4 without anteroloph; at its place a low cingulum is developed; the plesiomorphic trigon structure formed by the protocone, paracone and metacone and typical of very primitive rodents is clearly visible; hypocone separated from the trigon by a deep valley (fig. 9 and 12); position of the mental foramen of the mandible below p4; lower molars and lower deciduous molar with angular ectolophid; lingualmost point of the angle representing frequently provided with a short spur extending in lingual direction; no connection to the metaconid developped; only in one observed case [nr. MgM-III/15/10 of KOWALSKI's material (1974)] the spur continues more in anterolingual direction and nearly reaches the metaconid, to the effect that something like a "trigonoid structure" is formed; hypoconid and hypoconulid varying between blunt and rather acute; crest connecting them varying between very strong (pl. 1, fig. J) and very weak (fig. 4 and 5); in the former case the outer wall between hypoconid and hypoconulid shows a shallow depression, in the latter case a spacy hyposinusid is developped; hypoconid and hypoconulid of dp4 acute, without anterior arm and not connected to the ectolophid (fig. 10 and 13). No connective crest between protoconid and metaconid developed. From the striation of the wear facets the movement of the jaws during the power stroke can be inferred (fig. 3).

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

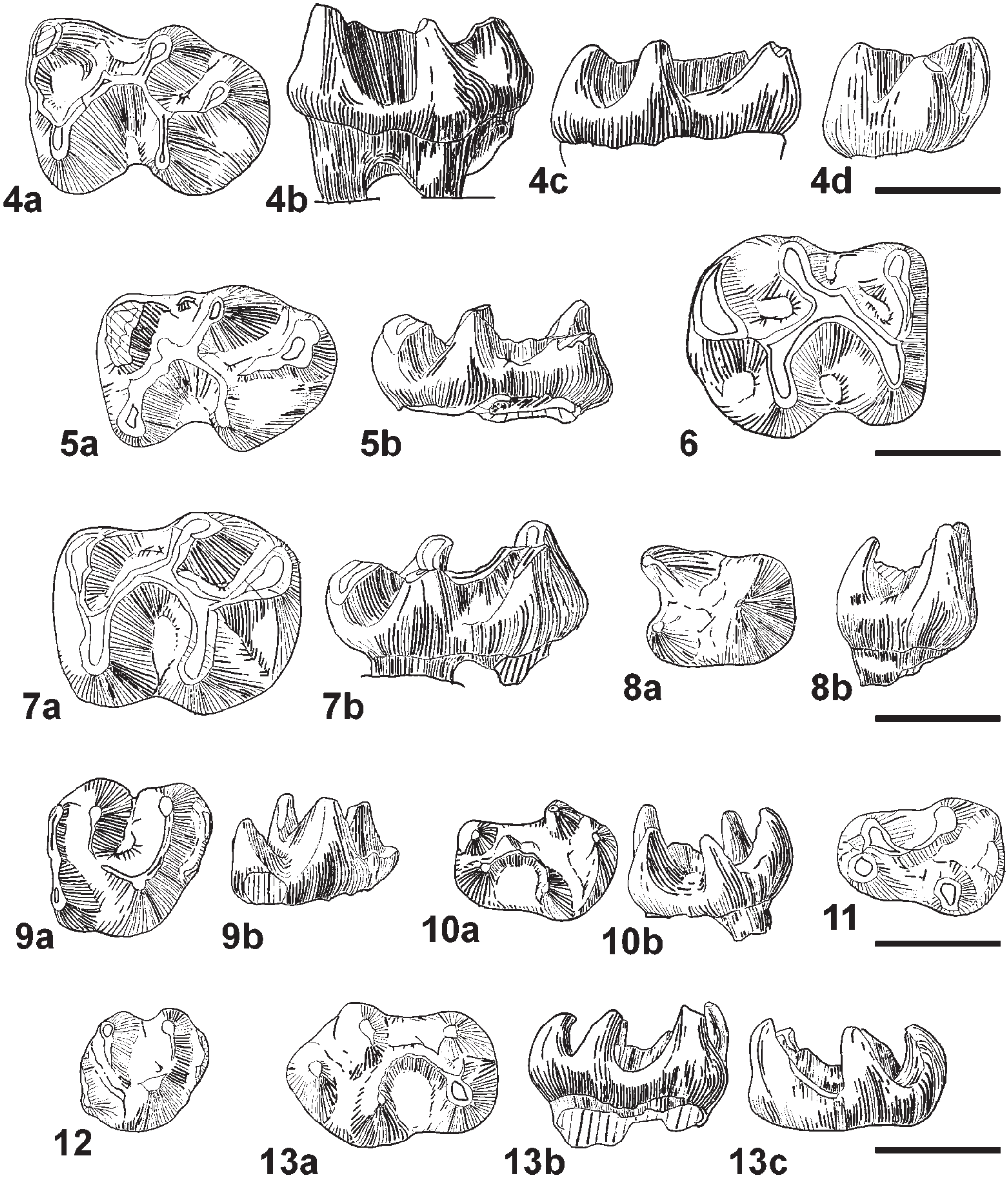


2



Karakoromys decessus MATTHEW & GRANGER, 1923
Fig. 2: right mandible fragment with m1-m3, TGR-AB, surface collection, 112/0001; fig. 3: right mandible fragment with p4-m3, TGR-AB, surface collection, 112/0002, a) dentition in occlusal view, b) mandible in occlusal view, c) labial side of the mandible, d) buccal side of the mandible.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



Karakoromys decessus MATTHEW & GRANGER, 1923
Fig. 4: left m2, TGR-A/14, 110/0001, a) occlusal view, b) buccal view, c) lingual view, d) caudal view; fig. 5: left m2, TGL-A/1, 113/0001, a) occlusal view, b) lingual view; fig. 6: right m2, TGR-A/13, 111/0001, occlusal view; fig. 7: left m2, TGR-A/13, 111/0002, a) occlusal view, b) lingual view; fig. 8: TGR-A/13, right p4, 111/0006, a) occlusal view, b) buccal view; fig. 9: right DP4, TGR-A/13, 111/0007, a) occlusal view, b) lingual view; fig. 10: left dp4, TGR-A/13, 111/0004, a) occlusal view, b) buccal view; fig. 11: right dp4, 111/0005, occlusal view; fig.12: right DP4, 111/0008, occlusal view; fig. 13: left dp4, TGR-A/13, 111/0003, a) occlusal view (figured inversely), b) lingual view, c) buccal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

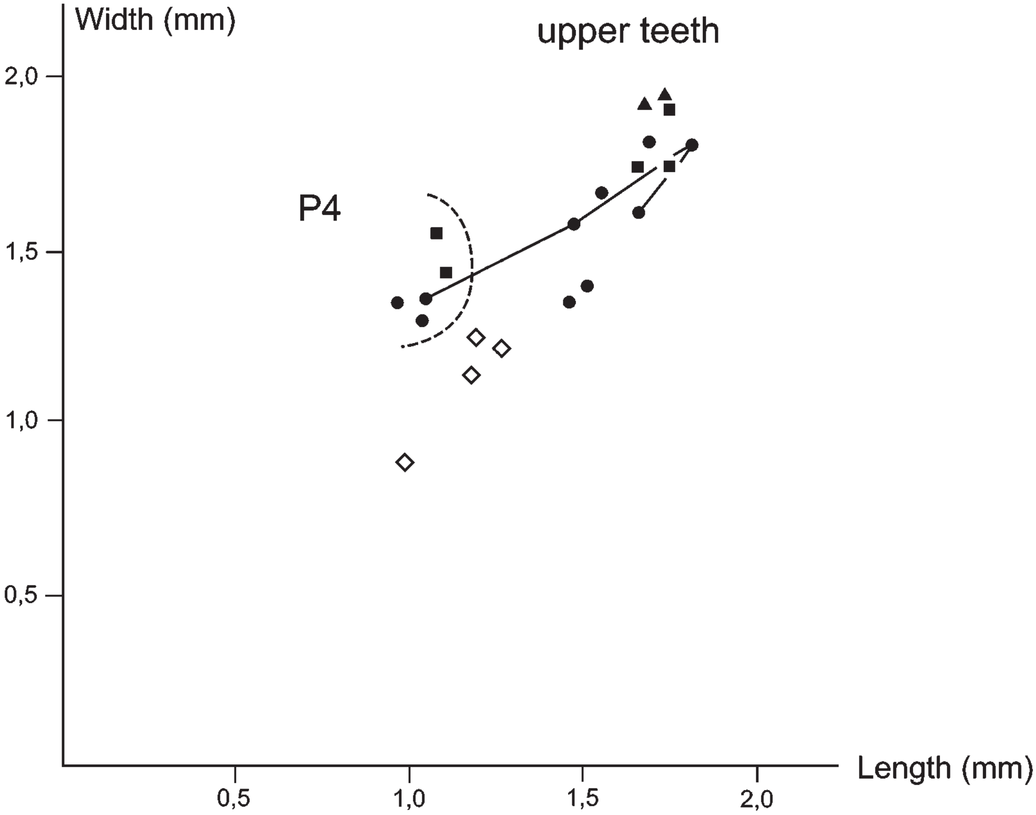


Fig 14: Upper cheek teeth of *Karakoromys decessus* MATTHEW & GRANGER, 1923. ■ SHG-A/9, permanent cheek teeth; ▲ SHG-A/6, permanent cheek teeth; * SHG-C/1, P4; ● TAT-D/1, permanent cheek teeth; ◊ TGR-A/13, PD4; + TGL-A/2, P4. measurements connected by straight lines: upper jaw shown in pl. 1 fig. G.

Tataromys MATTHEW & GRANGER, 1923

For the distinction of this genus from the other ctenodactylid genera present in Central Asia see VIANEY-LIAUD et al. (2006). The most important particularity of *Tataromys* mentioned there is found in the lower cheek teeth, where a connection of the anterior arm of the hypoconulid to the anterior arm of the hypoconid is present in all molars. The distinction between the three species of this genus described up to now is mainly based on size differences. All three are represented in the sections of the Valley of Lakes. However, two of them, the bigger sized and the medium one, are only represented by few isolated teeth. From the third species a more abundant dental material has been collected. It is of the size of *Tataromys minor* but differs from this by some minor morphological features.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

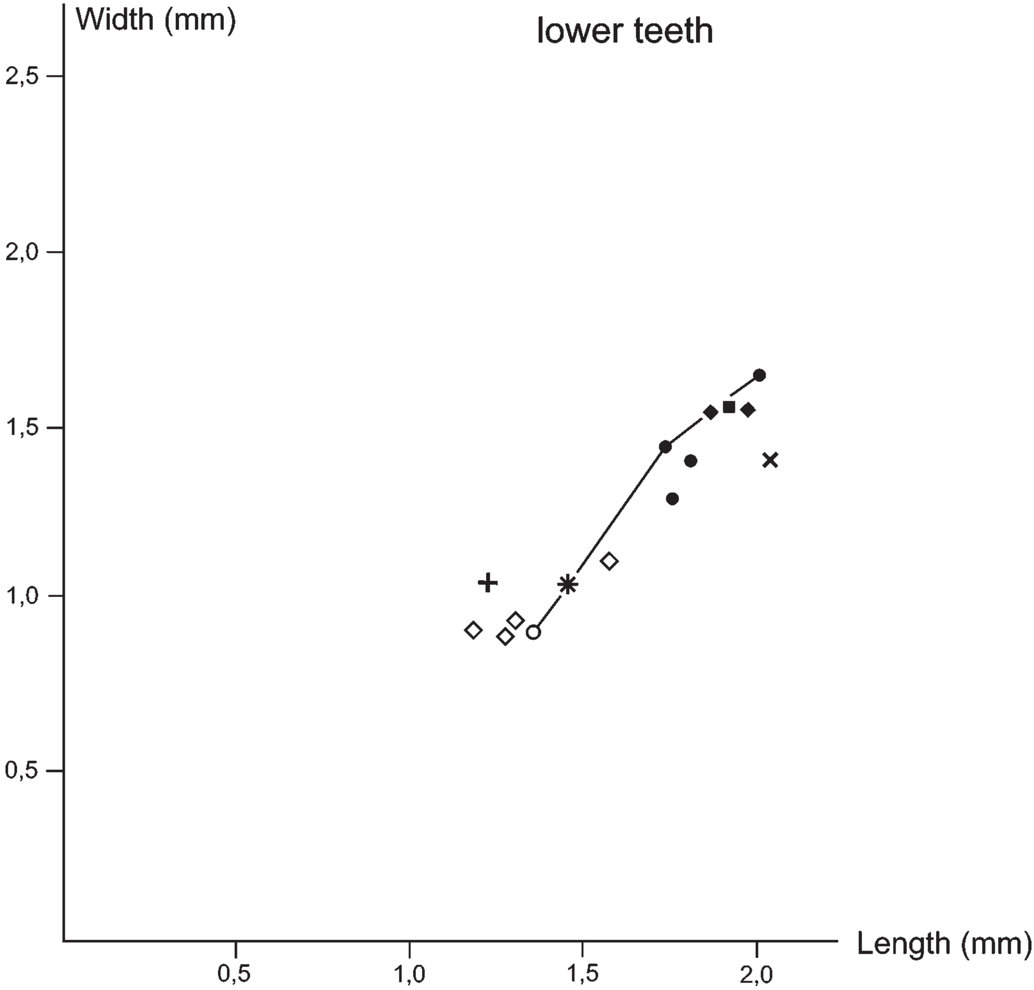


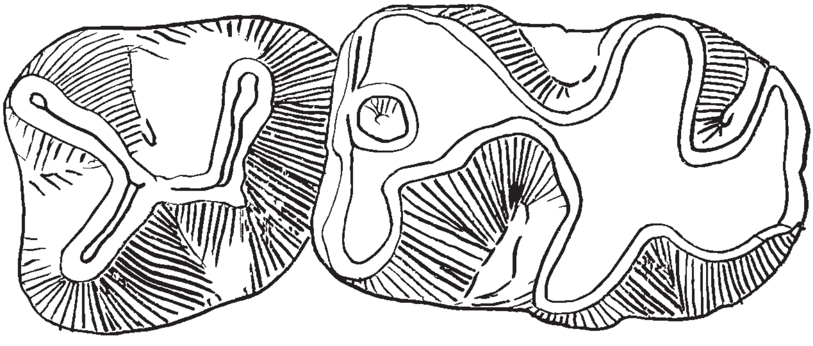
Fig. 15: Lower cheek teeth of *Karakoromys decessus* MATTHEW & GRANGER, 1923. ■ SHG-A/9, permanent cheek teeth; ● TAT-D/1, permanent cheek teeth; ○ TAT-D/1, pd4; * SHG-C/1, p4; + TGL-A/2, p4; **x** TGR-A/14, permanent cheek teeth; ♦ TGR-A/13, permanent cheek teeth; ◊ TGR-A/13, pd4; measurements connected by straight lines: lower jaw of fig. 3.

Tataromys plicidens **MATTHEW & GRANGER 1923**

Synonymy: see VIANEY-LIAUD et al. 2006.

Material: left mandibular fragment with m1 and p4, section DEL - B/12 (highest part of the red silt of the Hsanda Gol Formation), fig. 16, m1: length 4.84 mm width 3.15 mm, p4: length 3.27 mm, width 3.05 mm.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



16

Fig. 16: *Tataromys plicidens* Matthew & Granger, 1923. Left mandibular fragment with p4-m1, DEL-B/12, 108/0001, occlusal view.

Description: On the mandibular fragment a strongly worn m1 and a weakly worn p4 are preserved; though the characters of m1 are somewhat concealed by wear some of the typical features of *Tataromys* can still be recognized. These are the non-selenodont shape of the cones, the moderately developped trigonoid and the absence of a mesoconid. p4 is tricuspid due to the fact that the hypoconid is completely lacking. Related to the reduction of the latter the posterobuccal outline of the tooth is smoothly rounded. With this the tooth is somewhat different from the *plicidens* material known up to now (which, however, is still rather limited) but enters perfectly within the p4 variation of *Tataromys* as a whole.

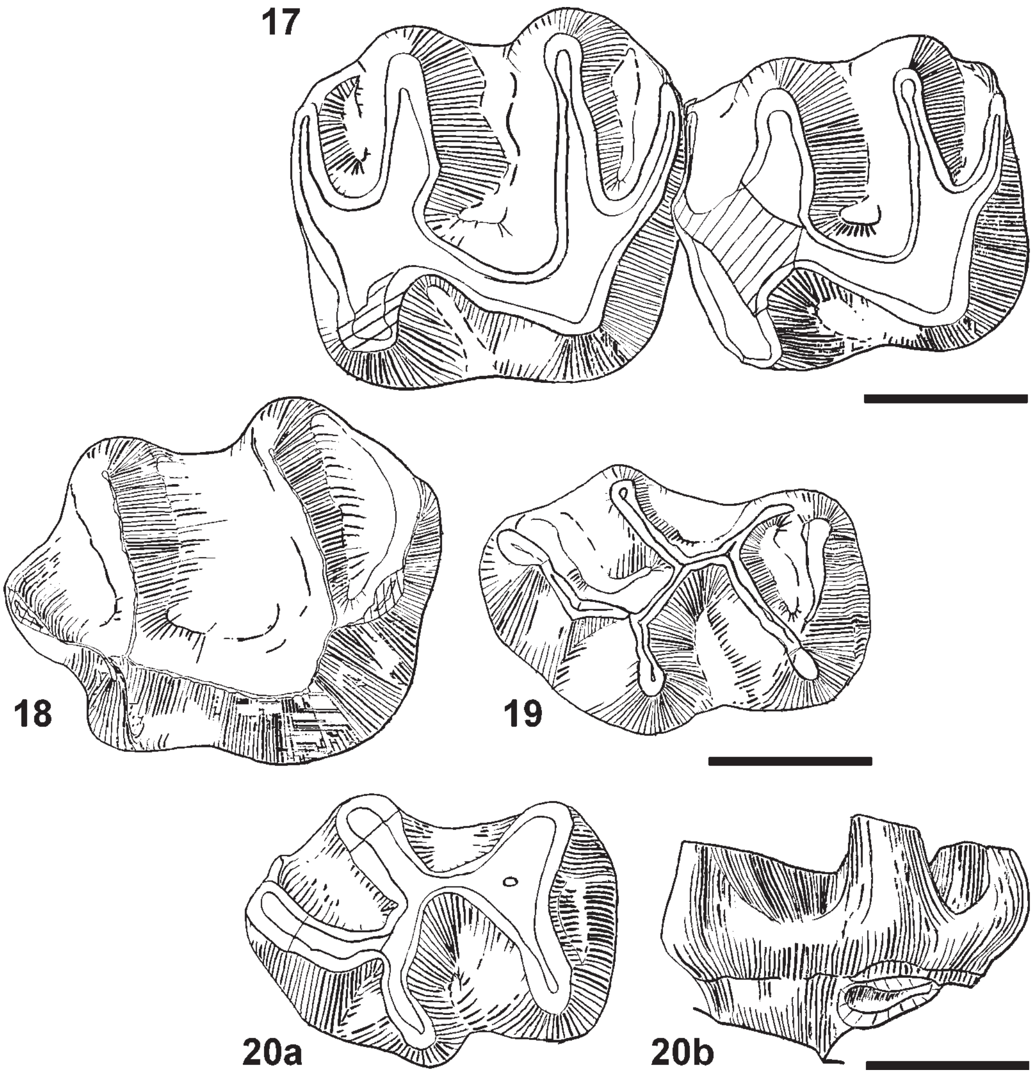
Tataromys sigmodon Matthew & Granger, 1923

Synonymy: see Vianey-Liaud et al. 2006.

Material and measurements: right maxillary fragm. with M1 and M2, section TGW-A/2, Taatsiin Gol, fig. 17; M1: length 1,96 mm, width 1,84 mm, M2: length 2,25 width 2,16; rigth M3, section TGW-A/2b, Taatsin Gol, fig. 18, length 2,55 mm, width 2,1 mm; right m3, section TGR-AB/22, Taatsin Gol, fig. 19, length 2,45 mm, width 1,57 mm; right m2, section TAR-A/2, Tarimalyn Khurem, fig. 20, length 2,53 mm, width 1,77 mm.

Description: This species is of the same size as *Alashania tengkoliensis* Vianey-Liaud et al. (2006) but is clearly distinguished from the latter by the connection between the anterior arm of the hypconulid and the anterior arm of the hypoconid present in all lower molars. In the well preserved unworn m3 of fig. 19 the trigonoid-structure is particularly large and the mesolophid is not really connected to the metaconid. The documented upper molars do not show specific morphological particularities beyond the features characteristic of the genus *Tataromys*.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



Tataromys sigmodon MATTHEW & GRANGER, 1923.
Fig. 17: right maxillary fragment with M1-M2, TGW-A/2, 105/0001, occlusal view; fig. 18: right M3, TGW-A/2b, 106/0001, occlusal view; fig. 19: right m3, TGR-AB/22, 107/0001, occlusal view; fig 20: right m2, TAR-A/2, 104/0001, a) occlusal view, b) lingual view.

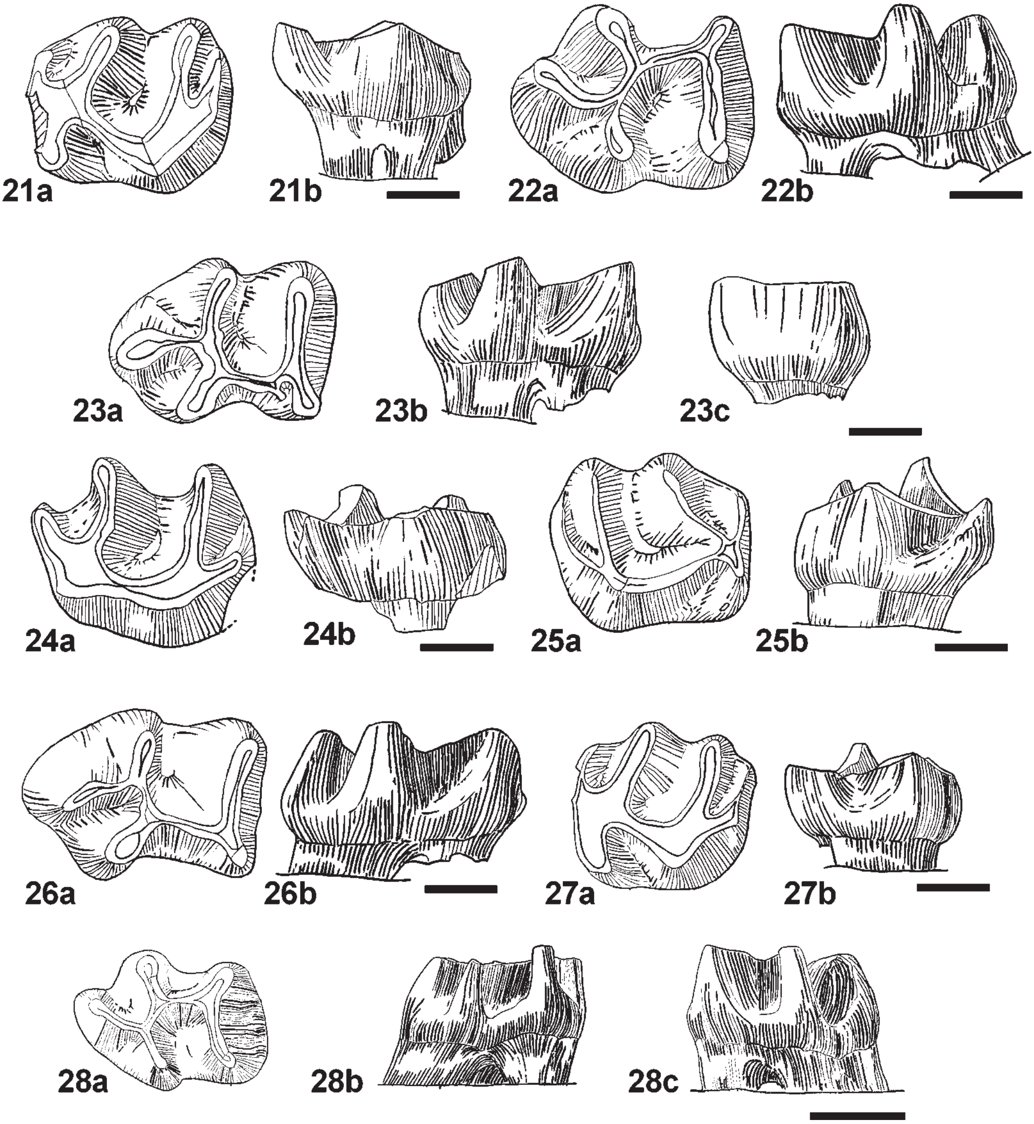
Tataromys minor (HUANG, 1985)

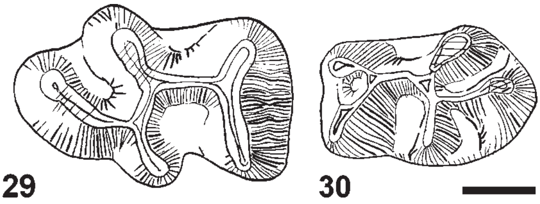
Tataromys minor longidens **nov. subsp.**

1999 *Tataromys parvus* – HÖCK et al.: fig. 20/10.

Derivatio nominis: The name refers to the length-width ratio of the teeth as a particularity of the subspecies.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at





Tataromys minor longidens n. ssp.
Fig. 21: right M2, TAR-A/2, 101/0003, a) occlusal view, b) lingual view; fig. 22: right m2, TAR-A/2, 101/0001, a) occlusal view, b) lingual view; fig. 23: left m2, TAR-A/2, 101/0002, a) occlusal view, b) lingual view, c) mesial view; fig. 24: right M3, TGR-C/2, 102/0003, a) occlusal view. B) lingual view; fig. 25: left M3, TGR-C/2, 102/0002, a) occlusal view, b) lingual view; fig. 26: left m2, TGR-C/2, 102/0004, a) occlusal view, b) lingual view; fig. 27: right M1, TGR-C/2, 102/0001, a) occlusal view, b) lingual view; fig. 28: right m3, DEL-B/12, 103/0001, a) occlusal view, b) buccal view, c) lingual view; fig. 29: right m3, DEL-B/12, 103/0002, occlusal view; fig 30: left m1, TGW-A/2b, 100/0004, occlusal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

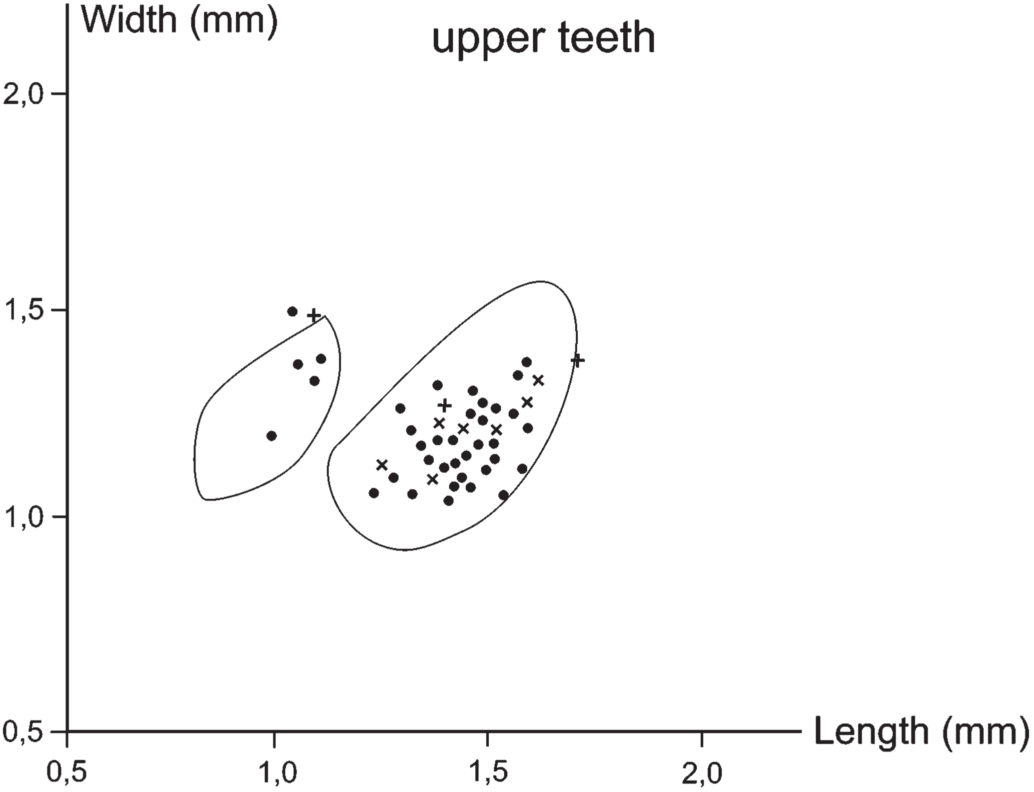


Fig. 31: Upper cheek teeth of *Tataromys minor longidens* n. ssp. Point distributions of the molars and the shorter premolars well separated. ■ TAR-A/2, permanent cheek teeth; ● TGW-A/2b, permanent cheek teeth; + DEL-B/12, permanent cheek teeth; x TGR-C/2, molars. The outlines correspond to the plots of *Tataromys minor* of the locality Ulantatal UTL4 (see VIANEY-LIAUD et al. 2006).

Type locality: Loh Formation, Khunug Valley, section TGW–A/ 2b; topographical position N 45° 22' 19", E 101° 06' 01".

Stratigraphic level: Late Early Oligocene to Early Late Oligocene

Geographic range: Valley of Lakes, Central Mongolia.

Holotype: right maxillar fragment with M1 and P4, invnr. 2006z0100/0001, pl. 1, fig. A, M1: length 1.33 mm, width 1.05 mm; P4: length 1.06 mm, width 1.36 mm.

Other localities: section TGR – C/ 1 and 2, highest part of red silt of the Hsanda Gol Formation; section DEL - B/12, and section TAR – A/2, Loh Formation.

Diagnosis: Of the size of *Tataromys minor minor* but molars more elongated, which is particulary discernable in the upper teeth; P4 larger transversally than the M1; trigonoid of the lower molars more frequently reduced.

Material and measurements: see fig. 31 and 32.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

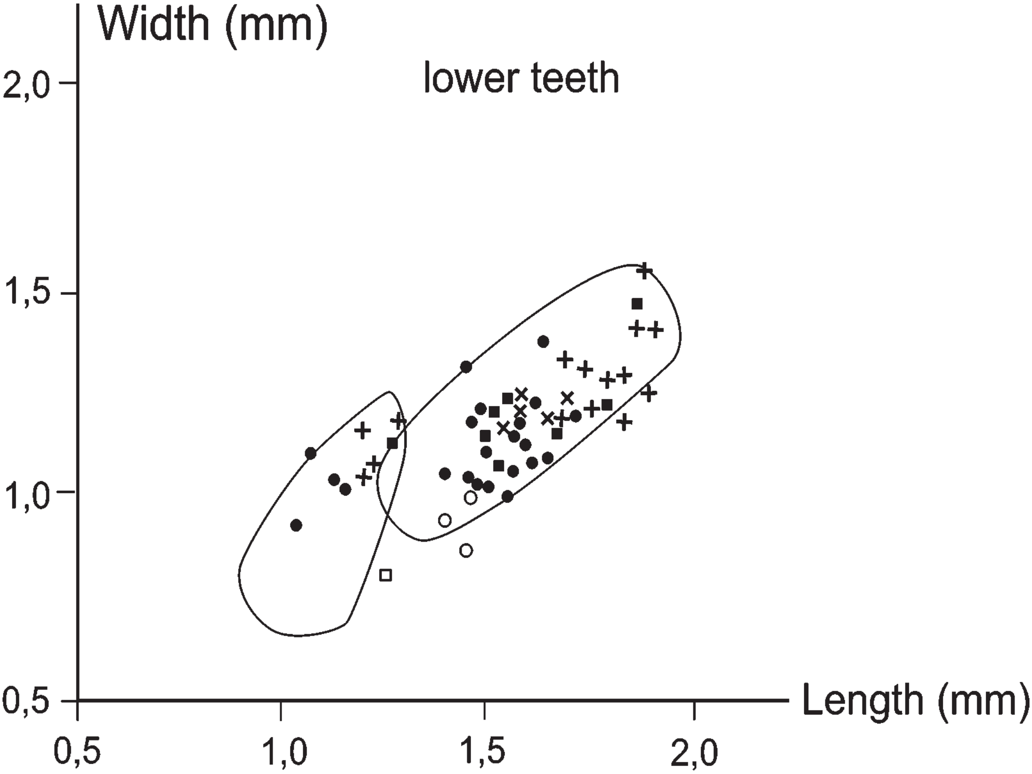


Fig. 32: Lower cheek teeth of *Tataromys minor longidens* n. ssp. Point distributions of the molars and the shorter premolars well separated. ■ TAR-A/2, permanent cheek teeth; □ TAR-A/2, dp4; ● TGW-A/2b, permanent cheek teeth; ○ TGW-A/2b, pd4; + DEL-B/12, permanent cheek teeth; x TGR-C/2, molars. The outlines correspond to the plots of *Tataromys minor* of the locality Ulantatal UTL4 (see VIANEY-LIAUD et al. 2006).

Description of the holotype: Posterior margin of the incisive foramen extended posteriorly to the anterior border of the upper premolar; tooth pattern of M1 corresponds to pattern type C (see fig. 1); anteroloph and posteroloph steeply inclined towards the buccal base of the tooth; anterocone weak, sinus strongly asymmetrical, bending to the posterolingual direction. P4 corresponding well to the typical morphology of this tooth in *Tataromys minor minor*, but relatively larger; no anterior or posterior cingulum developped.

Description of the additional material: As fig. 31 and 32 show the size of *Tataromys minor longidens* nov. subsp. is equivalent to that of the type subspecies but its molars are slightly more elongated. From the point distribution of the lower teeth it can be seen that the newly distinguished supspecies possesses a relatively broader lower p4. Of the 14 only slightly worn lower second and third molars preserved from the type locality only one exhibits a trace of a small trigonoid. One of the three preserved m1 lacks a trigonoid structure, the other two are distinguished by an angular connection between the metaconid and protoconid which is open to the anterior side (fig. 30). The

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

p4 is morphologically not distinguished from that of *Tataromys minor minor* (HUANG, 1985). As to the variation of the crown hight, beginning hypsodonty is found in many teeth of the new supspecies in locality DEL-B/12 (pl. 1, fig. B).

Yindirtemys BOHLIN, 1946

Type species: *Yindirtemys grangeri* BOHLIN, 1946

Included species: *Yindirtemys deflexus* (TEILHARD DE CHARDIN, 1926), *Yindirtemys ulantatalensis* (HUANG, 1985), *Yindirtemys bohlini* (HUANG, 1985), *Yindirtemys shevyrevae* VIANEY-LIAUD et al., 2006.

***Yindirtemys shevyrevae* VIANEY-LIAUD et al., 2006**

Stratigraphic range: Upper Oligocene, Level Ulantatal I and Ulantatal II, Level B in the sections of the Tsagan Noor basin (Valley of Lakes).

Geographic range: Valley of Lakes, Central Mongolia; Ulantatal area, western part of Inner Mongolia (China)

Diagnosis: Comparable to *Tataromys minor* and *Yindirtemys grangeri* in its size; in the lower molars, mesoconid present but less voluminous than in the species *grangeri*; no vertical groove on the posterior wall of the protoconid separating it from the mesoconid developped; cones more rounded than in *Tataromys minor* but without selonodont tendency as in *Yindirtemys grangeri*; metaloph of upper molars mostly connected to the hypocone, corresponding to pattern type B.

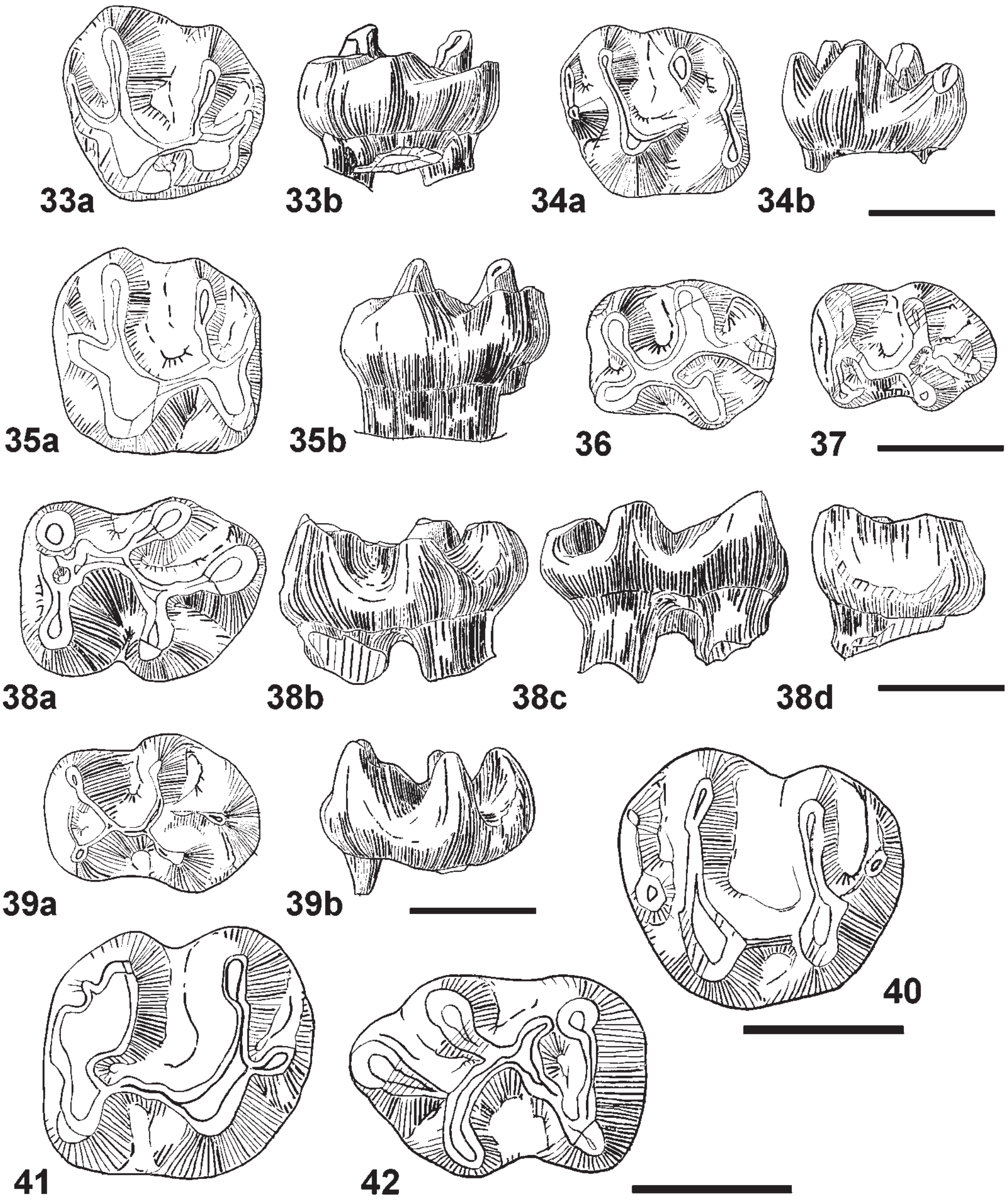
Material: TGR-AB/21, TGR-B/1, Taatsin Gol; SHG-A/15+20, SHG-A/20, SHG-AB/21, SHG-AB/22, Hsanda Gol.

Measurements: see fig. 45 and 46

Description: Of the size of *Tataromys minor*; cones less compressed, weakely bunodont; upper molars with low endoloph; anteroloph low and more cingulum-like; anterocone not or only weakely connected to the protoloph, which can best be seen in unworn or slightly worn teeth (fig. 34, 40 and 41); mesosyncline mostly more or less rectangular, sometimes turned backwards, producing an embayment in the metaloph between metacone and hypocone (fig. 41); posterocone mostly absent, occasionally present (fig. 40); lower molars with considerable variation in the position of the ectolophid and, in connection with this, the size of the trigonoid structure.

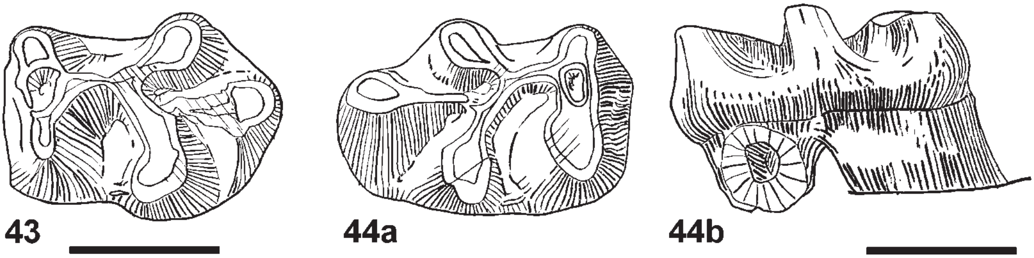
There are teeth possessing an ectolophid more removed in lingual direction which is accompanied by a very deep sinusid and a rather reduced trigonoid (fig. 38 and 43). And there are morphotypes with ectolophid penetrating no further than to the middle long axis of the tooth, consequently exhibiting a less extended sinusid. They at the same time have a very spacy trigonoid (fig. 42). As a difference to *Yindirtemys bohlini* no or only a weak mesoconid is developed on the trigonoid structure. And there is no groove on the posterior protoconid wall. The metalophid is nearly always present, only sometimes it is weak (fig. 39) or even absent (fig. 36). Additional structural elements

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



Yindirtemys shevyrevae Vianey-Liaud, Schmidt-Kittler & Marivaux, 2006
Fig. 33: left M3, TGR-AB/21, a) occlusal view, b) lingual view; 96/0003, fig. 34: left M1, TGR-AB/21, 96/0001, a) occlusal view, b) lingual view; fig 35: left M2, TGR-AB/21, 96/0002, a) occlusal view, b) lingual view; fig. 36: right m2, TGR-AB/21, 96/0006, occlusal view; fig. 37: right m2, SHG-AB/17-18, 95/0001, occlusal view (see pl. 2 fig. G); fig. 38: left m2, TGR-AB/21, 96/0005, a) occlusal view, b) buccal view, c) mesial view, d) lingual view; fig. 39: right m1, TGR-AB/21, 96/0004, a) occlusal view, b) lingual view; fig. 40: left M3, SHG-A/20, 93/0001, occlusal view; fig. 41: right M2, TGR-B/1, 98/0001, occlusal view; fig. 42: right m2, SHG-A/15+20, 92/0001, occlusal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



Yindirtemys shevyrevae VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX, 2006
Fig. 43: left ?m2, TGR-AB22, 97/0002, occlusal view; fig. 44: right m3, TGR-AB/22, 97/0001, a) occlusal view, b) lingual view.

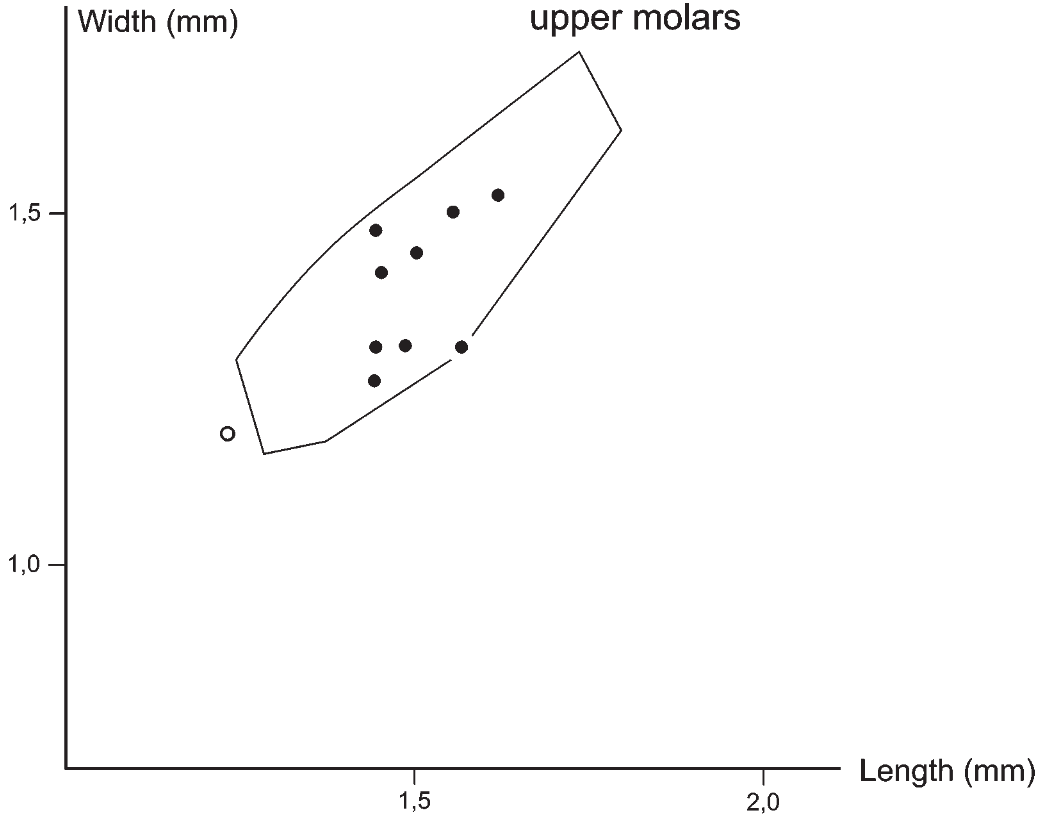


Fig. 45: Upper molars of *Yindirtemys shevyrevae* VIANEY-LIAUD SCHMIDT-KITTLER & MARIVAUX, 2006. ● TGR-AB/21; ○ SHG-AB/17-20. The outlines correspond to the plots of *Yindirtemys shevyrevae* of the locality Ulantatal UTL4 (see VIANEY-LIAUD et al. 2006).

are only occasionally developed: in the m2 of fig. 38 the trigonoid is divided into two pits; there is the incipient formation of an additional connection between the anterior arm of the hypoconid and the anterior arm of the hypoconulid so that a pit cut off from the the posterior synclinid is the result (m2 of fig. 37 and pl. 2, fig. G and also in the

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

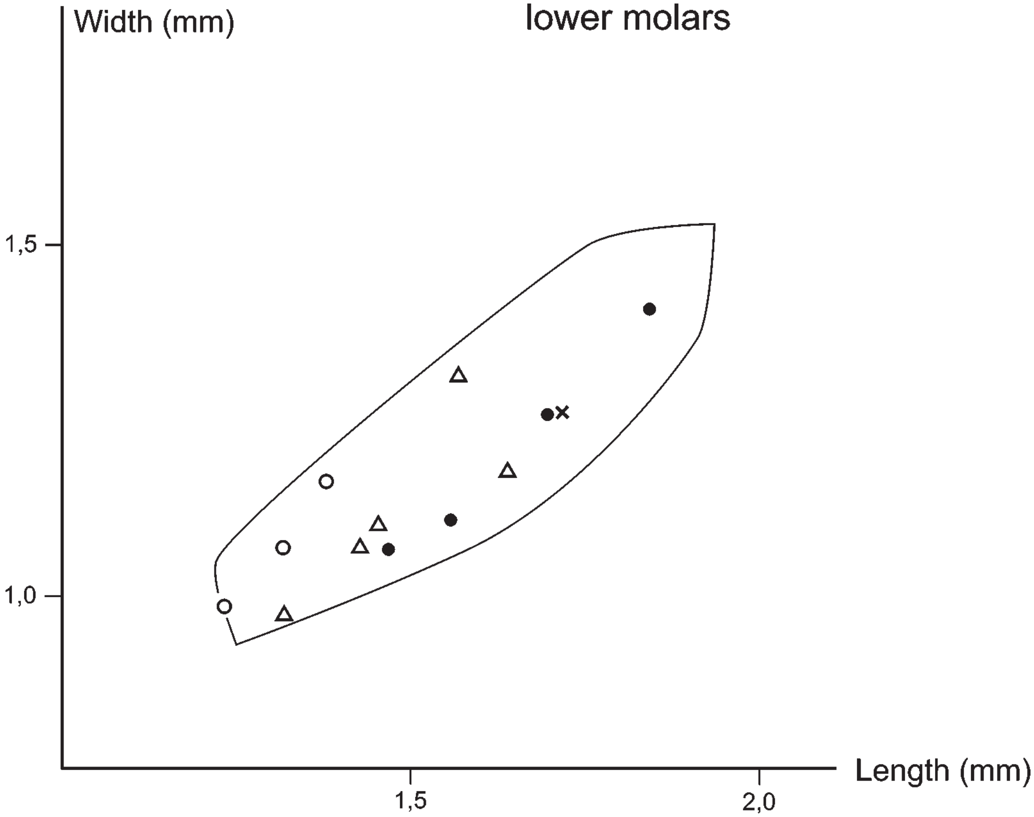


Fig. 46: Lower molars of *Yindirtemys shevyrevae* VIANEY-LIAUD SCHMIDT-KITTLER & MARIVAUX, 2006. ● TGR-AB/21; ○ SHG-AB/17-20; Δ SHG-AB/17-18; x SHG-AB/15+20. The outlines correspond to the plots of *Yindirtemys shevyrevae* of the locality Ulantatal UTL4 (see VIANEY-LIAUD et al. 2006).

m1 of pl. 2 fig. F). In some tooth specimens the striations of tooth wear are well visible. The wear facets are less inclined than in the other *Yindirtemys* species. There is still no tendency towards selenodonty.

Yindirtemys aff. *ulantatalensis* (HUANG, 1985)

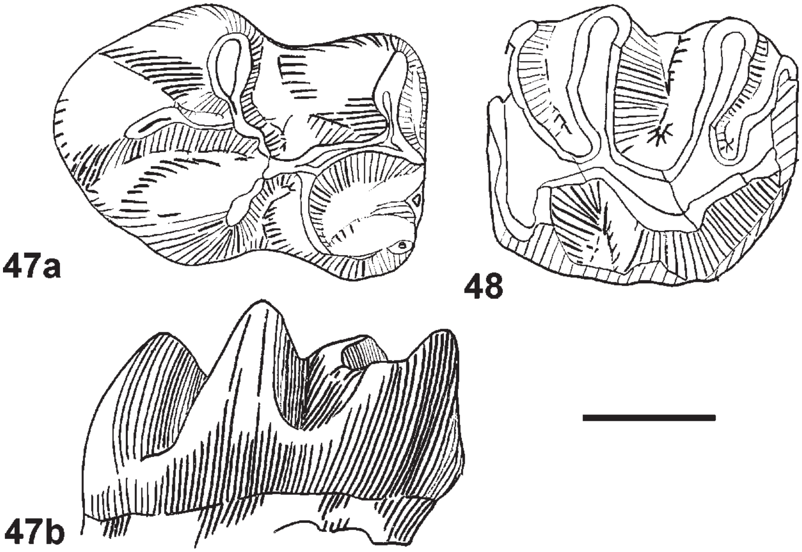
Synonymy: see VIANEY-LIAUD et al. 2006

Stratigraphic range: Late Oligocene; unit C in the Valley of Lakes; Level UTL I and UTL II in the Ulantatal area.

Geographic distribution: Valley of Lakes (Central Mongolia); Ulantatal area, Inner Mongolia (China)

Material and measurements: right mandible with m2, length 2,76 mm, width 2,07 mm; left m3, length 2,23 mm, width 2,23 mm; right M1, length 2,23 mm, width 1,91 mm; Loh Formation, Unzing Khurem, section and horizon TAR-A/2.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



Yindirtemys ulantatalensis (Huang, 1985). Fig. 47: left m3, TAR-A/2, 91/0001, a) occlusal view, b) lingual view, fig 48: right M2, TAR-A/2, 91/0002, occlusal view.

Description: The three isolated teeth range within the inferior part of the size variation of *Yindirtemys ulantatalensis* from the type locality Ulantatal (Vianey-Liaud et al. 2006) but their morphological characters are identical to this species. The unworn left m3 exhibits a small basal anterior cingulum on the anterior wall of the tooth; the trigonoid is relatively large. Its two parts formed by the mesolophid and the ectolophid together produce a regularly curved crest as is the case in the lower molars found in the type area. Also the worn m2 on the preserved mandible exhibits the characteristic dental pattern found in the type material from the Ulantatal localities. The moderately worn upper first molar ranges within the morphologic variation of the type material as well. The three tooth specimens in their evolutionary stage correspond to the stratigraphic levels UTL I and UTL II of the type arae (see p. ...).

Yindirtemys deflexus (Teilhard de Chardin, 1926)

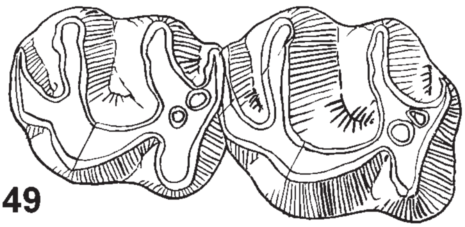
1926 *Tataromys deflexus* n. sp. – Teilhard de Chardin: 28.
1946 *Tataromys*, Material of larger species (pars) – Bohlin: 95.
1951 *Tataromys sp.* – Stehlin & Schaub: Abb. 181.
1974 *Tataromys gobiensis* n. sp. – Kowalski 1974: 162.
1997 *Yindirtems deflexus* (Theilhard de Chardin, 1926) – Wang: 30.
1997 *Yindirtemys gobiensis* (Kowalski, 1974) – Wang: 34.

Stratigraphic range: Late Oligocene, level UTL I and UTL II in the Ulantatal area, Level C1 in the sections of the Valley of Lakes.

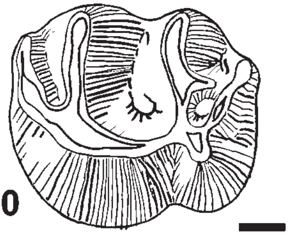
Geographic distribution: Western part of Inner Mongolia, Gansu province China, Tsagan Noor basin (Valley of Lakes).

Emended diagnosis: large *Yindirtemys* species with advanced selenodonty in the lower molars and strong tendency of developing additional crests in the upper molars.

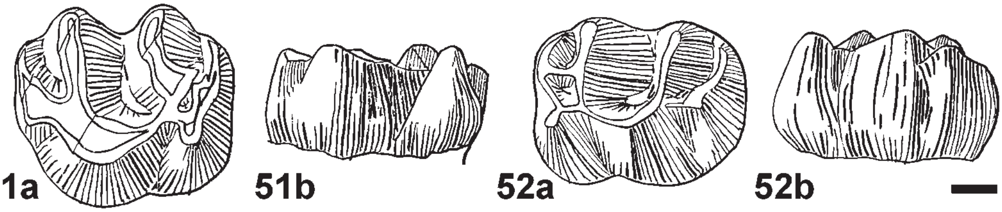
©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



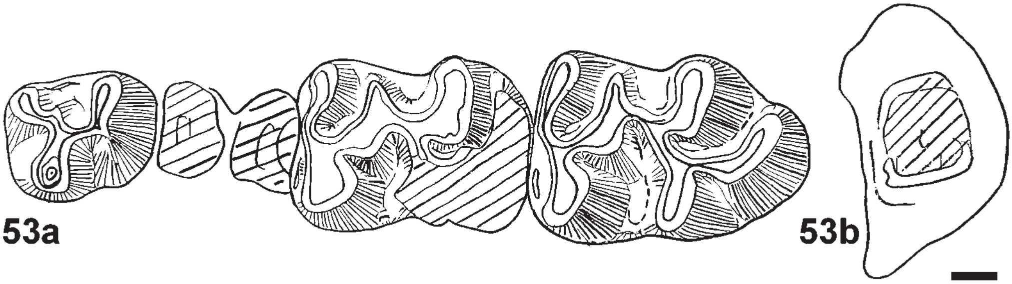
49



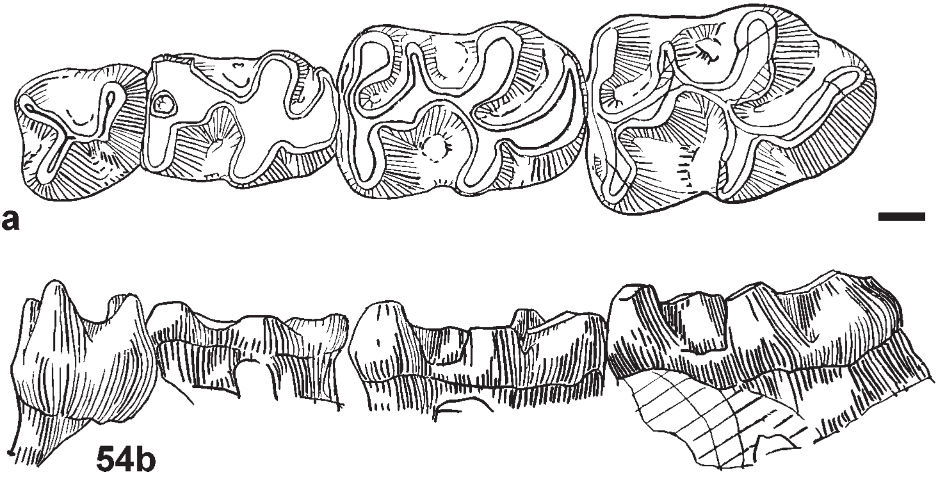
50



51a 51b 52a 52b



53a 53b

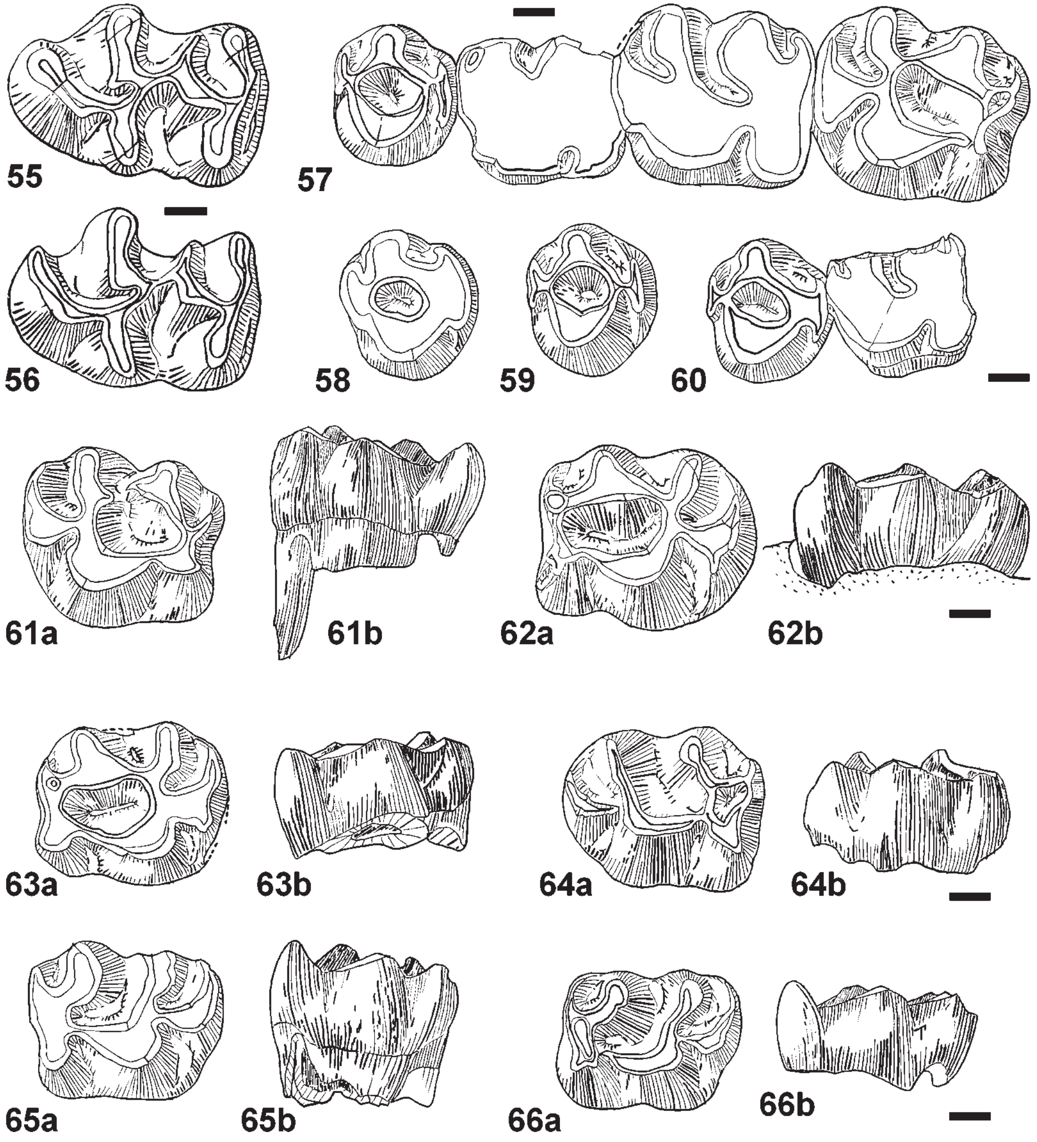


54a

54b

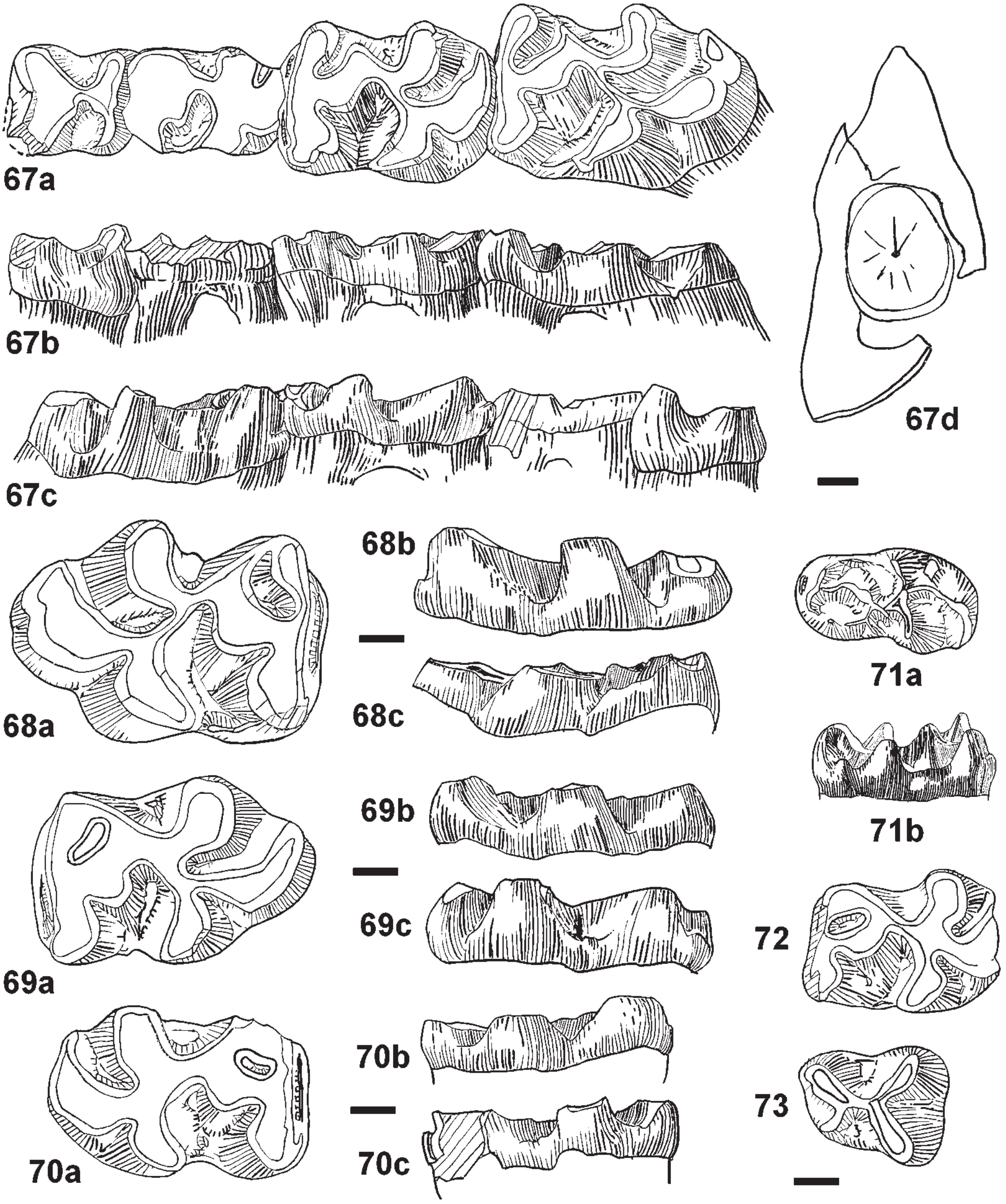
Yindirtemys deflexus (TEILHARD DE CHARDIN, 1926).
Fig. 49: maxillary fragment with M2-M3, DEL-B/12, 89/0004, occlusal view; fig. 50: left M3, DEL-B/12, 89/0005, occlusal view; fig. 51: left M3, DEL-B/12, 89/0007, a) occlusal view, b) lingual view; fig. 52: right M2, DEL, B/12, 89/0006, a) occlusal view, b) lingual view; fig. 53: left mandible with p4 and m2-m3, DEL-B/12, 89/0008, a) occlusal view, b) section of incisor; fig. 54: left mandible with p4-m3, DEL-B/12, 89/0001, a) occlusal view, b) buccal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



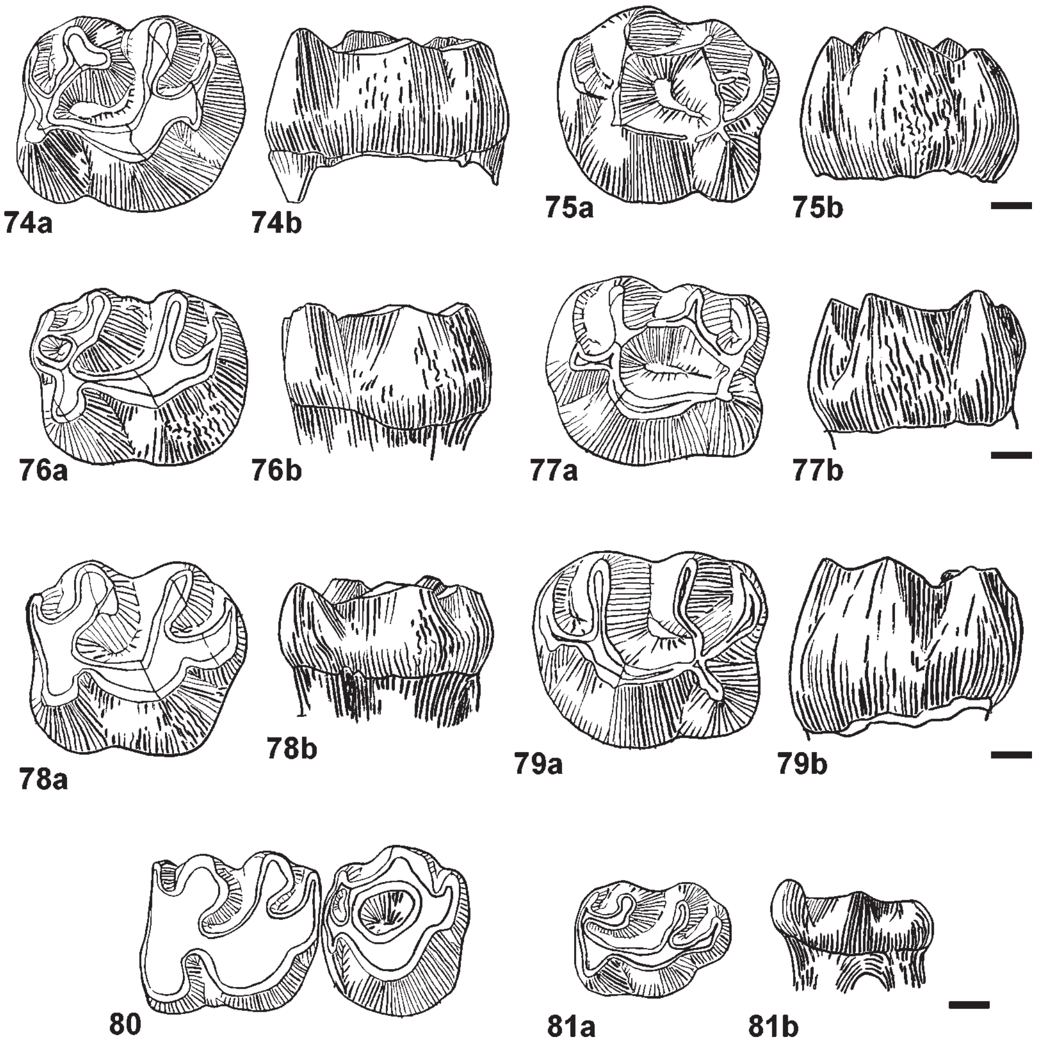
Yindirtemys deflexus (TEILHARD DE CHARDIN, 1926).
Fig. 55: right m3, DEL-B/12, 89/0002, occlusal view; fig. 56: left m3, DEL-B/12, 89/0003, occlusal view; fig. 57: left maxilla with P4-M3, LOH-C/1β, 83/0002, occlusal view; fig. 58: left P4, LOH-C/1β, 83/0006, occlusal view; fig. 59: left P4, LOH-C/1β, 83/0005, occlusal view; fig 60: maxillary fragment with P4-M1, LOH-C/1α, 83/0011, occlusal view; fig. 61, left M3, LOH-C/1β, 83/0003, a) occlusal view, b) lingual view; fig. 62: right M3, LOH-C/1α, 83/0007, a) occlusal view, b) lingual view; fig. 63: right M3, LOH-C/1α, 83/0008, a) occlusal view, b) lingual view; fig. 64: right M2, LOH-C/1α, 83/0009, a) occlusal view, b) lingual view; fig. 65: right M1, LOH-C/1β, 83/0004, a) occlusal view, b) lingual view; fig. 66: right M2, LOH-C/1α, 83/0010, a) occlusal view, b) lingual view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



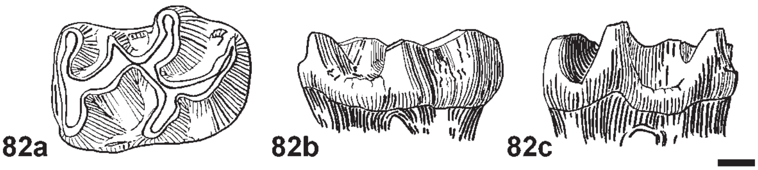
Yindirtemys deflexus (Teilhard de Chardin, 1926).
Fig. 67: left mandible with p4-m3, LOH-C/1β, 83/0001, a) occlusal view, b) buccal view, c) lingual view, d) section of incisor; fig. 68: right m3, LOH-C/1β, 83/0012, a) occlusal view, b) lingual view, c) buccal view; fig. 69: left m2, LOH-C/1β, 83/0014, a) occlusal view, b) buccal view, c) lingual view; fig. 70: right pd4, LOH-C/1α, 83/0015, a) occlusal view, b) buccal view; fig. 71: right m2, LOH-C/1α, 83/0013, a) occlusal view, b) buccal view, c) lingual view; fig. 72: left m1, LOH-C/1α, 83/0017, occlusal view; fig. 73: right p4, LOH-C/1α, 83/0016, occlusal view.

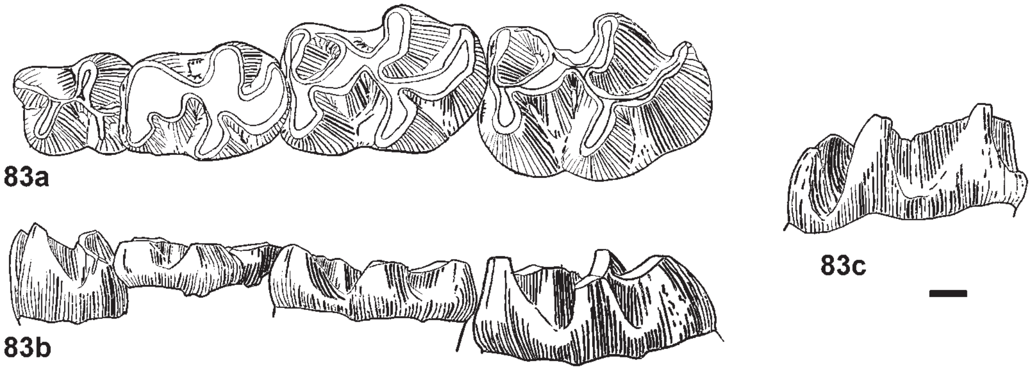
©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

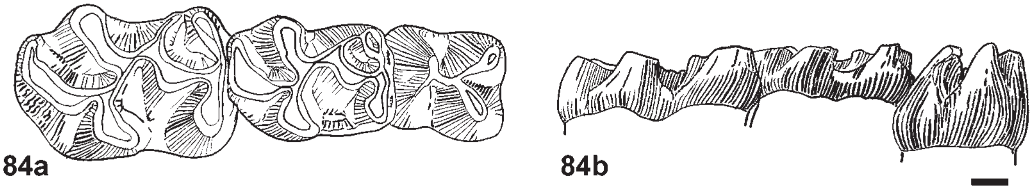


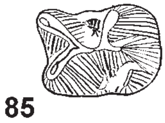
Yindirtemys deflexus (TEILHARD DE CHARDIN, 1926).
Fig. 74: right M3, RHN-A/7, 90/0009, a) occlusal view, b) lingual view; fig 75: left M3, RHN-A/7, 90/0010, a) occlusal view, b) lingual view; fig. 76: right M2, RHN-A/7, 90/0011, a) occlusal view, b) lingual view; fig. 77: left M3, RHN-A/7, 90/0012, a) occlusal view, b) lingual view; fig. 78: right M2, RHN-A/7, 90/0016, a) occlusal view, b) lingual view; fig. 79: Left ?M2, RHN-A/7, 90/0013, a) occlusal view, b) lingual view; fig. 80: right maxillary fragm. with P4-M1, RHN-A/7, 90/0014, occlusal view; fig. 81: right PD4, RHN-A/7, 90/0015, a) occlusal view, b) lingual view.

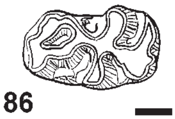
©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

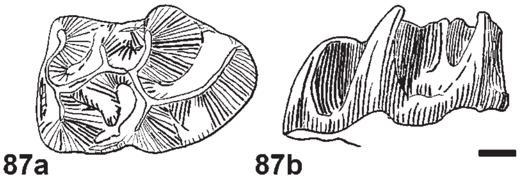


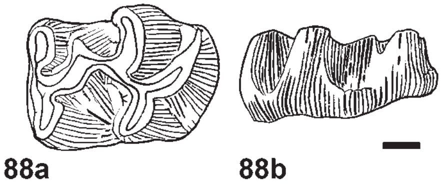


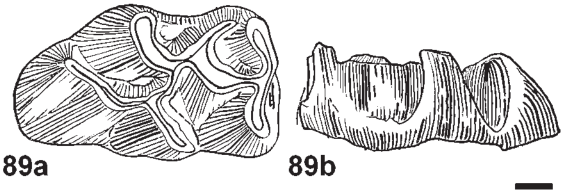






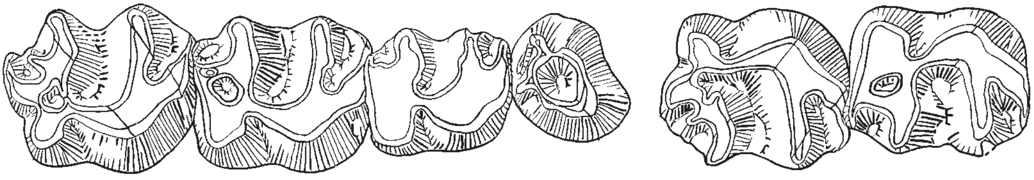




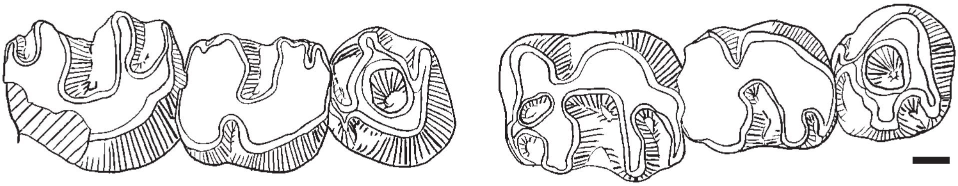


Yindirtemys deflexus (Teilhard de Chardin, 1926).
Fig. 82: left m2, RHN-A/7, 90/0002, a) occlusal view, b) buccal view, c) lingual view; fig. 83: left mandible with p4-m3, RHN-A/7, 90/0001, a) occlusal view, b) buccal view, c) m3 in lingual view; fig. 84: right mandibular fragm. with p4-m2, RHN-A/7, 90/0003, a) occlusal view, b) buccal view; fig. 85: left p4, RHN-A/7, 90/0005, occlusal view; fig. 86: left pd4, RHN-A/7, 90/0004, occlusal view; fig. 87: left m3, RHN-A/7, 90/0006, a) occlusal view, b) lingual view; fig. 88: left m2, RHN-A/7, 90/0007, a) occlusal view, b) lingual view; fig. 89: right m3, RHN-A/7, 90/0008, a) occlusal view, b) lingual view.

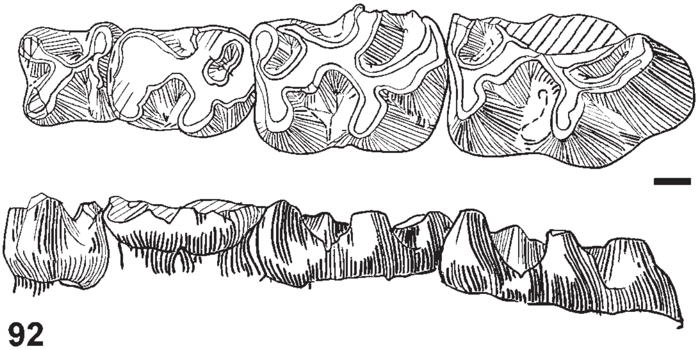
©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



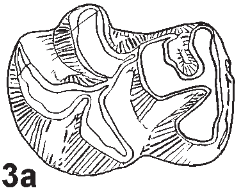
90



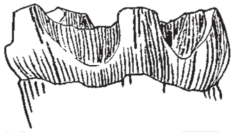
91



92



93a



93b

Yindirtemys deflexus (TEILHARD DE CHARDIN, 1926).
Fig. 90: palate with right P4-M3 and left M2-M3, TGW-A surface collection, 86/0002; fig. 91: palate with right and left P4-M2, TGW-A surface collection, 86/0003; fig 92: left mandible with p4-m3, TGW-A surface collection, 86/0001, a) occlusal view, b) buccal view; fig. 93: right m2, TGW-A/5, 87/0001, a) occlusal view, b) lingual view.

Material and measurements:

DEL-B/12

category	number	length			breadth		
		minimum	maximum	average	minimum	maximum	average
P4	2	2.6	2.62		3.32	3.48	
M1	2	3.64	3.84		2.6	2.62	
M2	2	4.14	4.2		3.54	3.58	
M3	5	4.58	4.84	4.69	3.94	4.28	4.03
p4	9	2.52	3.0	2.78	2.32	2.82	2.53
m1	2	3.64	3.84		2.6	2.62	
m2	5	4.54	5.02	4.81	3.02	3.44	3.26
m3	7	5.24	6.02	5.59	3.42	3.76	3.602

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

LOH-C/1

category	number	length			breadth		
		minimum	maximum	average	minimum	maximum	average
P4	4	3.08	3.4	3.27	3.56	3.84	3.6
M1	1			4.56			3.26
M2	2	5.1	5.14		4.36	4.44	
M3	5	4.86	5.64	5.161	4.1	4.62	4.31
p4	3	2.94	3.7	3.27	2.54	2.98	2.7
m2	3	4.8	5.6	5.28	3.44	3.92	3.68
m3	6	5.6	6.64	6.19	3.8	4.82	4.31

RHN-A/7

category	number	length			breadth		
		minimum	maximum	average	minimum	maximum	average
DP4	1			3.26			2.56
P4	7	2.94	3.38	3.15	2.84	3.96	3.52
M1	1			4.2			3.8
M2	6	4.2	5.36	4.39	4.0	4.64	4.24
M3	4	4.86	5.4	5.17	4.12	4.84	4.42
dp4	2	3.26	3.52		1.98	2.2	
p4	8	2.8	3.3	3.07	2.38	3.56	2.86
m1	6	3.58	4.3	3.96	2.48	3.04	2.81
m2	8	4.6	5.4	5.1	3.44	3.84	3.7
m3	7	5.76	6.76	6.21	3.4	4.28	3.88

Description: The size of the molars increases sensibly from the front to the end of the tooth range. In the same direction in the upper teeth additional crests occur more frequently. Two different accessory structures can be distinguished: 1) a short crest connecting the metaloph with the posteroloph, 2) a crest connecting the metacone with the paracone. The metaloph-posteroloph connection (structure 1) nearly always appears in the upper M2 and frequently also in M3. Together with the fusion of the metaloph and posteroloph buccally of the hypocone a pit of varying size is produced. Only sometimes the metaloph-posteroloph-connection is replaced by a more or less vestigial spur descending from the metacone posteriorly (fig. 50, 51, 75). The metacone-paracone connection (structure 2) mainly occurs on the M3. In more advanced wear stages of the teeth together with the endoloph it produces a large central basin. It was first described by TEILHARD DE CHARDIN (1926) on the M3 of the type specimen of the species *Tataromys deflexus* newly erected by him. Later, KOWALSKI (1974) considered this character of diagnostic value. This is why it must be discussed more extensively (see below). For more convenience it is named "deflexus structure" here. It now reveals that it does not represent a constant feature of the M3. For instance, it can be found in only two of the nine last upper molars from locality RHN-A/7 (Valley of Lakes). In the material from Shargaltein (BOHLIN 1937) the character is present in two specimens among eight M3. Furthermore it must be stated that the deflexus structure occasionally also occurs in *Yindirtemys grangeri* (non *woodi*, BOHLIN 1946: fig. 29) and *Yindirtemys ulantatalensis*

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

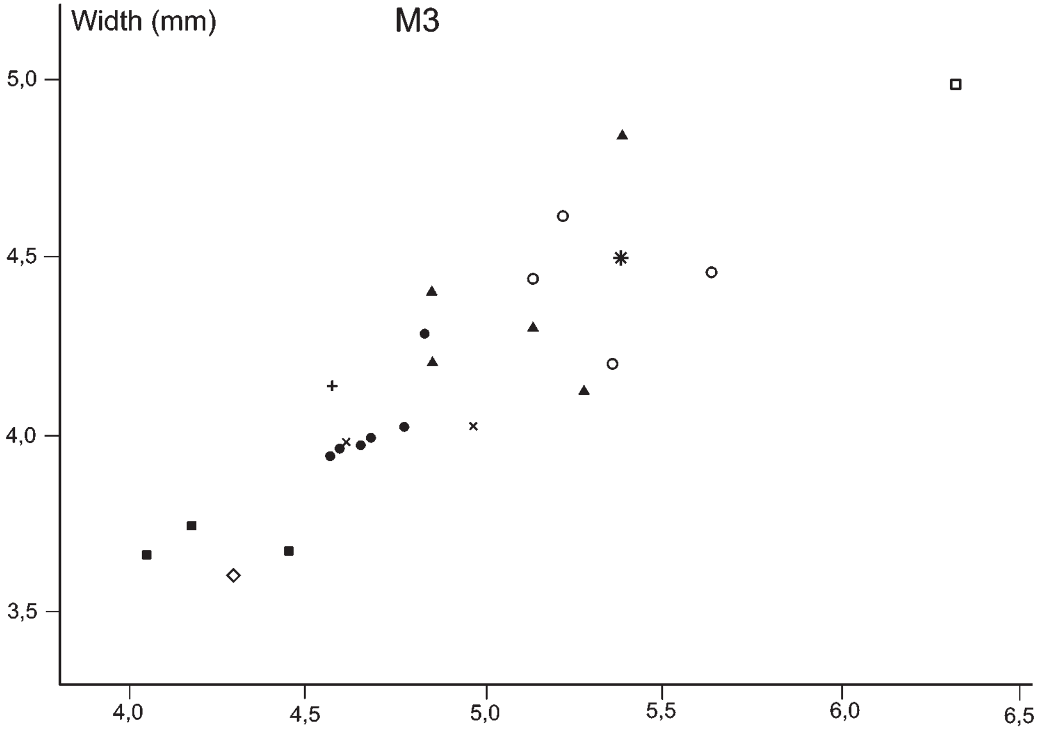


Fig. 94: Third upper molars of *Yindirtemys deflexus* TEILHARD DE CHARDIN, 1926. ■ Ulantatal, UTL8 (see VIANEY-LIAUD et al. 2006); ● DEL-B/12; □ *Yindirtemys suni*, type (see LI & QIU 1980); ○ LOH-C/1; ▲ RHN-A/7; * *Yindirtemys deflexus*, type (see TEILHARD DE CHARDIN 1926); + *Yindirtemys deflexus*, Tabenmbuluk (see BOHLIN 1946); x *Yindirtemys deflexus*, Shargaltein (see BOHLIN 1937); ◊ *Yindirtemys deflexus* (*non gobiensis*), Hsanda Gol (see KOWALSKI 1974).

(VIANEY-LIAUD et al. 2006). In the P4, in addition to the posterior cingulum, an anterior cingulum is quite well developed (fig. 58 and 59). The structure of the upper deciduous molar is comparable to the pattern type C shown in fig. 1b. The anterior wall of the tooth is inflated to form an anterior lobe delimited anteriorly by a curved, obliquely oriented anteroloph (fig. 81). The teeth show the dental pattern common to the more evolved species of the genus, e. g. *Yindirtemys grangeri* and *Yindirtemys ulantatalensis* of level Ulantatal III. The p4 is quadrangular and lacks a hypoconid. At its place sometimes a vertical crest descending towards the posterobuccal corner of the tooth can be developped. The lower deciduous molar mostly ressemble the permanent molars but are more slender (fig. 86). Sometimes additional crests are developed as seen in fig.70.

Discussion: Already very early the question arose as to whether the dental material of large Tataromyinae found in different localities of the Hsanda Gol area (Central Mongolia) represents one single or two different species. MELLET (1966) assigned all the large teeth of the classical localities to the species *deflexus* but mentioned that eventually a second taxon should be distinguished. KOWALSKI (1974), faced with the same problem, proceeded in favour of the second option. The reason for this was that

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

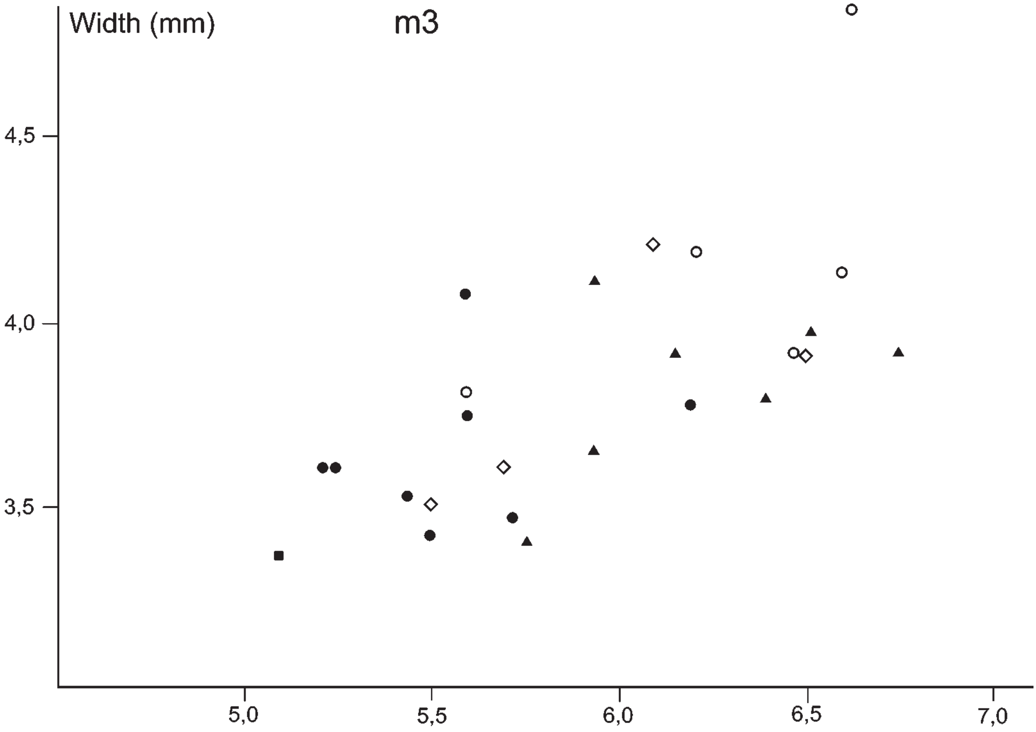


Fig. 95: Third lower molars of *Yindirtemys deflexus* Teilhard de Chardin, 1926. ■ Ulantatal, UTL8 (see Vianey-Liaud et al. 2006); ● DEL-B/12; ○ LOH-C/1; ▲ RHN-A/7; ◊ *Yindirtemys deflexus* (*non gobiensis*), Hsanda Gol /see Kowalski 1974).

a maxillary fragment of corresponding size comprised in his material did not exhibit the metacone-paracone connection generally thought by him to be diagnostic of the species *deflexus*. In order to solve the persisting uncertainty a more abundant material was necessary which would allow to circumscribe the individual variation of the characters within the populations. Thanks to the relatively rich dental material of the large *Yindirtemys* at disposal for the present study the problem could be reconsidered. It resulted that the *deflexus* feature in the M3 is ubiquitous: it can be found in all populations of large *Yindirtemys*. However, it appeared as well that it is not developed in all M3. Hence, its absence in some specimens cannot be taken as an argument in favour of the existence of a second contemporaneous species of about the same size. By the way, as shown in Vianey-Liaud et al. (2006), the deflexus feature is also found in the M3 of the independent lineage *Yindirtemys grangeri*. From this it can be concluded that the developpement of accessory crests in the last molars, and in particular of the metacone-paracone connection in M3, is a general feature of the more evolved species of *Yindirtemys*. Remains the question of whether the species *Tataromys gobiensis* distinguished by Kowalski could eventually represent an earlier evolutionary stage of the large *Yindirtemys*, which still did not develop the deflexus feature. This, however, cannot be the case because the deflexus feature can already be found in an M3 of the UTL 8 locality and, hence, represents a character which evidently occured

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

in a stratigraphically lower level. As a consequence the species name *gobiensis* has to be considered a junior synonym of TEILHARD's species *deflexus*. Independently, a slight size difference can be found when comparing the material of the Ulantatal area and the horizon DEL-B/12 on the one hand and the horizons LOH-C/1 and RHN-A/7 on the other hand. From independent biostratigraphic evidence (see below) it can be inferred that it is an evolutionary difference. The difference is, however, not important enough for justifying a subspecific distinction.

The question whether *Tataromys suni* described by LI & QIU 1980 from the Xiejia formation (Qinghai Province) represents a seperate species must be left open here. WANG (1997) redescribed it and also inclosed Later Oligocene material of the Yikebulage formation. From the morphological characterization no convincing argument arises to be sure about the taxonomic validity of the species. Most recently, however, some *Yindirtemys* teeth were found from the new locality Hotulin Teeg (level D of the Valley of Lakes), exceeding the size of the largest *Yindirtemys deflexus* (communication by HÖCK).

***Huangomys* nov. gen.**

Type species: *Huangomys frequens* nov. sp.

Derivatio nominis: In honor of the Chinese vertebrate paleontologist HUANG Xueshi and his meritorious work made in the Ulantatal area.

Stratigraphical range: Late Early Oligocene to Late Oligocene, Level A, B and C in the Valley of Lakes, Level UTL I and UTL II in the Ulantatal area..

Diagnosis: The same as the type-species.

***Huangomys frequens* nov. sp.**

1999 *Tataromys minor* – HÖCK et al.: fig. 20/7.
2007 Tataromyinae nov. gen. nov. sp. – VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX. (in press).

Derivatio nominis: From the frequency of the species in the localities of respective age in the Valley of Lakes (Mongolia) and in the Ulantatal area (China).

Type locality: Taatsiin Gol, section TGR-B, horizon B/1, topographical position N 45° 24' 53", E 101° 15' 44".

Stratigraphic level: as indicated for the genus.

Geographic range: Central Mongolia to western part of Inner Mongolia (PR China).

Holotype: left mandibel with p4 – m3, invnr. NHMW 2006z0068/0001, plate2, fig. A; measurements see diagram fig. 95.

Other localities: Valley of Lakes TGR-B AB/21, TGR-B AB 22, TGR-C1 and 2, SHG A/15, SHG-A/20; Ulantatal-area UTL1, 2, 3, 4b, 5, 7a, 8.

Diagnosis: Small ctenodactylid of the size of *Tataromys minor* with elongated molars. Upper premolar distinctly more extended in transversal direction than first

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

upper molar. Lower premolar triangular in shape due to the lack of a hypoconid; metaconid-protoconid ridge more elongated in transversal direction than the metaconid-protoconid ridge in the first lower molar. Upper molars with well accentuated anterocone and prominent posteroloph; posterocone removed buccalwards or located at the end of the posteroloph. In the lower molars the anterior arm of the hypoconulid bends to the lingual side and meets the entoconid; corresponding to this the hyposinusid reaches far lingually; metalophid crest-like; no trace of a trigonoid basin.

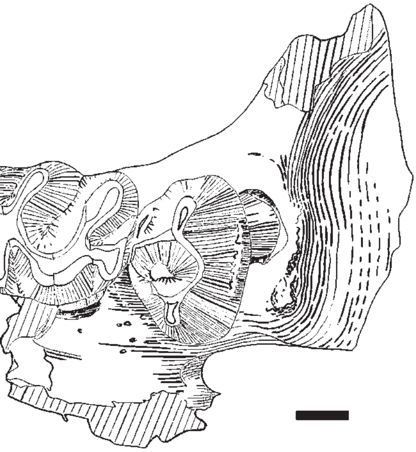
Differential diagnosis: New genus of the Tataromyinae differing from the other brachydont genera of the family in its elongated molars; distinguished from *Tataromys* and *Yindirtemys* by the hypoconid-entoconid connection on all lower molars, and furthermore distinct from *Yindirtemys* by the complete lack of a trigonoid structure.

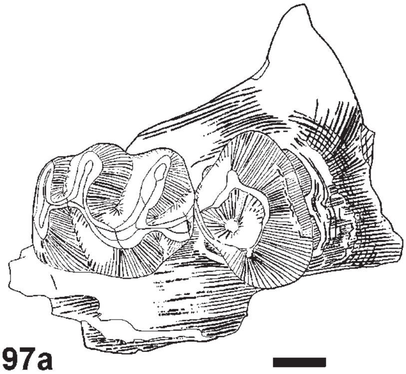
Material and measurements: See fig. 94 and 95.

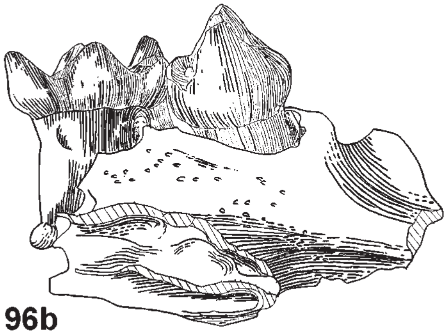
Description of the holotype: The type specimen is a well preserved unworn left mandible with complete dentition and an incisor broken at its base. Mental foramen situated below the posterior root of the premolar; p4 of triangular shape with its maximum diameter on its anterior end due to the transversal elongation of the protoconid-metaconid crest; entoconid sitting closer to the lingual than the buccal wall; on its buccal side no vestige of a hypoconid developed; m1 less broad than p4, with its greatest diameter at the hypoconid; metalophid I crest-like; ectolophid running to the metaconid; no trace of a trigonoid basin present; anterior arm of the hypoconulid strongly curved, meeting the anterior arm of the entoconid; related to this, hyposinusid penetrating far lingually into the tooth. m2 and m3 exhibiting the same occlusal pattern as m1 but somewhat larger transversally.

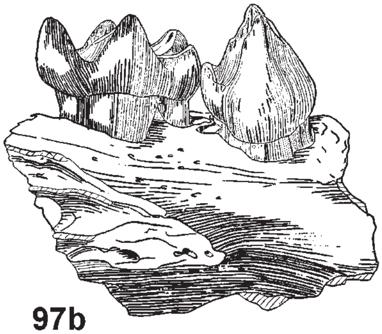
Description of additional material: Incisive foramen reaching backwards to the premolar (fig. 96 and 97); P4: broader than the first molar (fig. 96 , 97 and pl. 2 fig. B); metaloph angular; its connection with the posterolph sometimes strengthened to form a small cusp. (pl. 2 fig. B); upper molars with very prominent anterocone, connected with the protoloph by a short but strong ridge; anterior syncline deep and comparably large; anterior groove well developed in nearly all upper molars, forming an anterior sinus; posteroloph very prominent; M1: considerably longer than broad; trigon clearly developed; posteroloph well apart from it; sometimes separated by a continuous deep transversal valley (pattern type D in fig. 1) so that the sinus and the posterosyncline are confluent (pl. 2 fig. B); M2: sinus and posterosyncline not confluent; configuration of crests corresponding to pattern type A (fig. 99), type B (pl. 2 fig. C) and type C (pl. 2 fig. B); M3: mesosyncline very large and square-like; posteroloph short, with posterocone located at its lingual end; connection to the metaloph very prominent; anterosinus not penetrating into the tooth very deeply, varying between spacious (pl. 2 fig. C) and shallow (fig. 99); DP4 with very strong trigone crests; buccal half of the anterior wall with strong anterior cingulum; hypocone separated from the trigone by a deep and broad valley; in the lower molars continuous ridge formed by the anterior arm of the entoconid and the ectolophid not very close to the lingual wall of the tooth (pl. 2 fig. A) or very close to it (pl. 2 fig. E); m1 slightly smaller (pl. 2fig. A) or conspicuously smaller than m2 (pl. 2 fig. E); in p4 buccal wall of the entoconid sometimes with a weak vertical crest;

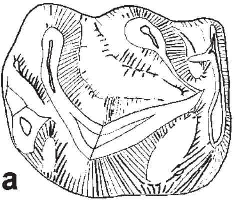
©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

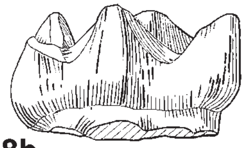

96a

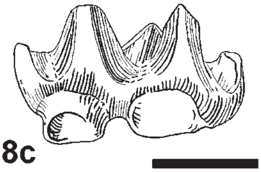

97a

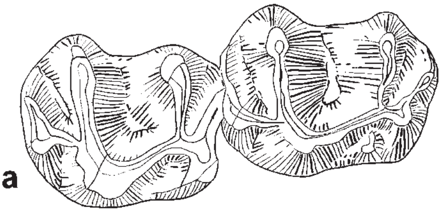

96b

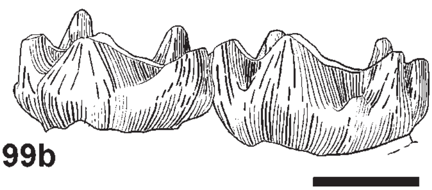

97b


98a


98b


98c


99a


99b

Huangomys frequens nov. gen. nov. sp.
Fig. 96: right maxillary fragm. With P4-M1, TGR-B/1, 68/0004, a) occlusal view, b) lingual view; fig. 97: right maxillary fragm. With P4-M1, TGR-B/1, 68/0005, a) occlusal view, b) lingual view; fig. 98: right M2, TGR-AB/21, 74/0002, a) occlusal view, b) lingual view; fig. 99: left maxillary fragm. With M2-M3, TGR-B/1, 68/0002, a) occlusal view, b) lingual view (see pl.2 fig. C).

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

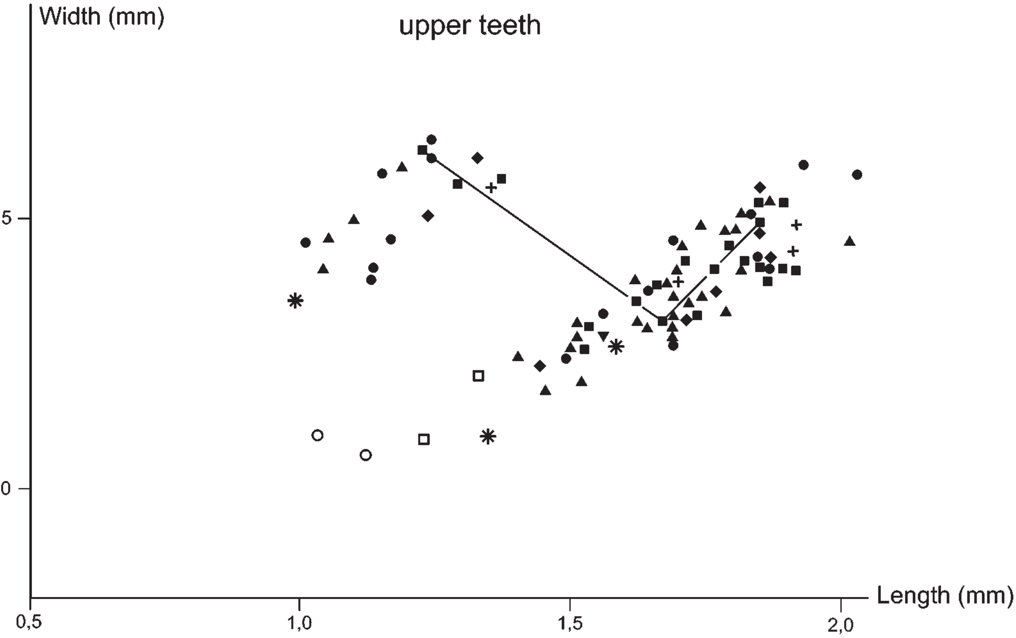


Fig. 100: Upper cheek teeth of *Huangomys frequens* nov. gen. nov. sp. Point distributions of the molars and the shorter premolars well separated. ○ TGR-B/1; ● TGR-B/1; ■ TGR-AB/22; □ TGR-AB/22; ▲ TGR-AB/21; * SHG-A/15; + SHG-A/20; x SHG-A/15-20; ▼ SHG-C/2. The measurements connected by straight lines correspond to the upper jaw of pl. 2 fig. B.

Discussion: *Huangomys frequens* described here as a new genus and species is abundant in the area of the Valley of Lakes and, if not really frequent so at least ubiquitous in the Ulantatal area. Therefore the question arises why this rodent has not already been discovered at the time of the first surface collecting made by HUANG in the early eightieth of the last century. The explanation for this is that in HUANG's material the small ctenodactylids are highly underrepresented as a whole. In fact, the type mandible of *Tataromys minor* created by HUANG represented the only specimen of the small size class of ctenodactylids at that time. Thanks to the extensive washing and screening during the second Ulantatal expedition also the smaller species could be well represented.

The existence of the new taxon and its presence both in the Valley of Lakes and in Ulantatal has already been recognized because the material collected from these areas was available for study at the same time. However, from the point of view of completeness of the specimens it seemed preferable to define it on the basis of the material from the Valley of Lakes. On the other side, on organisational grounds, the study of the Ulantatal area had to go to publication earlier (VIANEY-LIAUD et al. 2006). Because of this, the material of the Ulantatal localities attributable to the new taxon was only informally described and discussed in that article.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

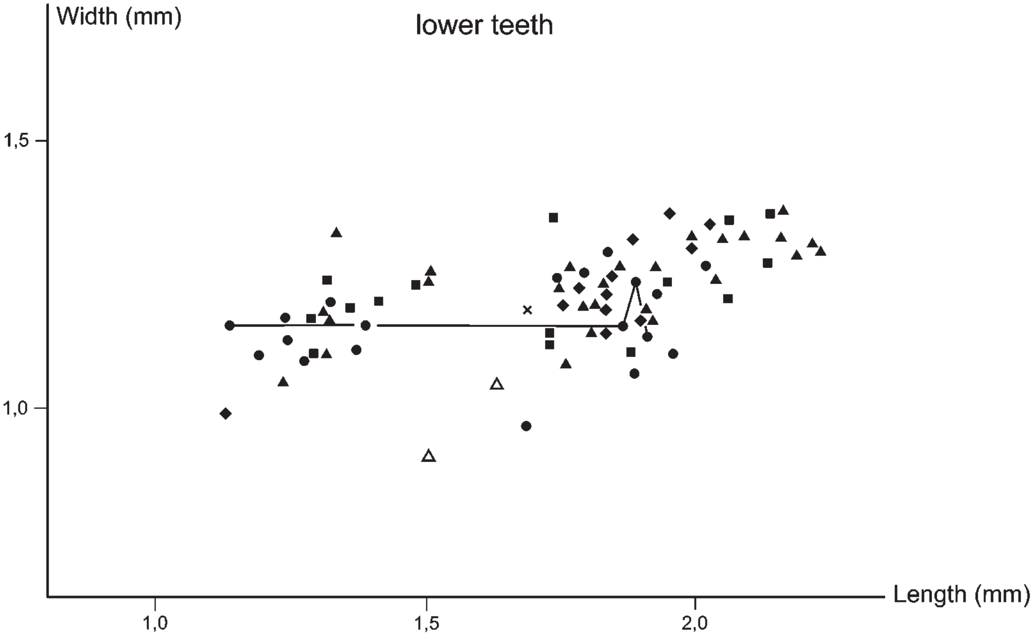


Fig. 101: Lower cheek teeth of *Huangomys frequens* nov. gen. nov. sp. Point distributions of the molars and the shorter premolars well separated. ○ TGR-B/1; ● TGR-B/1; ■ TGR-AB/22; □ TGR-AB/22; ▲ TGR-AB/21; x SHG-A/15-20. The measurements connected by straight lines correspond to the holotype pl. 2, fig. A.

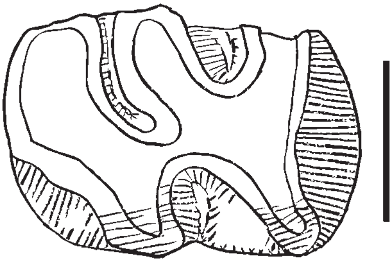


Fig. 102: *Sayimys* cf. *intermedius* SEN & THOMAS, 1979, right m2, UTO-A/3, 99/0001, occlusal view.

Subfamily Ctenodactylinae HINTON, 1933

Sayimys cf. *intermedius* (SEN & THOMAS, 1979)

Material: One single tooth specimen from the Ulaan Tolgoi section UTO-A/3, location N 45° 20' 49'', E 101° 50' 16''.

One single lower right molar of ctenodactylinae is recorded from level D1. Although this tooth is strongly worn and heavily damaged, it can be determined without difficulty and attributed to the genus *Sayimys*. However, as to its specific identification some uncertainties remain. Non of the existing species diagnoses can be verified without doubt. It seems, however, that the tooth resembles more closely the lower molars of *Sayimys intermedius*.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

Biostratigraphy

Up to now the studies of the Oligocene rodents of Central Asia were predominantly published without a detailed documentation of the lithostratigraphical setting of the area where they were found. A major problem hindering precise assessments was the badland character of many of the interesting areas. Due to the scarceness of easily recognizable topographic markers the main difficulty was to define precisely the geographic position of collecting places of fossil material and local field observations. The Austrian group of geologists and paleontologists working in the continental series of the Valley of Lakes in 1996 and 1997 for the first time could overcome this hinderances by using GPS data during mapping and for locating the measured sections. Thanks to this, the fossil content of the beds could be connected to the lithostratigraphic context over the whole area (Höck et al. 1999). And as a result of the present study it is now possible to delimit the vertical distribution of the ctenodactylid species in the subsequent horizons. Similar attempts were made during the Chinese/German expedition to the Ulantatal area in Western Inner Mongolia in 1987. Though mapping covered only a restricted surface and GPS facilities were still not at hand (see geological map and location of fossil sites in Vianey-Liaud et al. 2006), the superposition of the fossil localities could be ascertained. Combined with the fossil information, three informal stratigraphic units were distinguished. It reveals that the two geographically rather distant areas have several species or lineages in common. This is why for the first time a more detailed interregional biostratigraphic correlation can be made (fig. 103).

Karakoromys decessus has originally been described from the Hsanda Gol Formation of Central Mongolia (Matthew & Granger 1923). It is also present in the Oligocene of Kazakhstan (Shevyreva 1994, Wang 1997) and is mentioned from the Wulanbulage formation (Wang 1997) of Inner Mongolia. As to the Ulantatal area, Huang found there a mandible fragment which he determined as *Karakoromys* with question mark (1985). Recent reexamination of the specimen proved that it undoubtedly belongs to this taxon (Vianey-Liaud et al. 2006). In the material gathered during the Chinese/German expedition to the Ulantatal area in 1987, the species reappeared in the lower part of the section. This means that the *Karakoromys* lineage persisted up to the lowermost beds of the Ulantatal series distinguished as lower sedimentary unit (Ulan I). In the sections of the Valley of Lakes the lineage is characteristic of the levels A and B. Hence, there is a biostratigraphic overlap of the base of the Ulantatal series with at least the top of level B or even a larger part of the A/B sedimentary complex. However, since between level B and C a sedimentary gap was recognized (Höck et al. 1999) it can not be excluded that the deposition of B ended prior to the extinction of *Karakoromys* and level Ulan I in part also occupies the time span of non-sedimentation in the sequence of the Valley of Lakes. Because of this in any case the period of sedimentation of Ulan II must be comprised in the gap between B and C. Altogether it can be stated that the period of non-sedimentation between B and C recognized by Höck et al. (1999) minimally corresponds to the depositon of unit Ulan II only and maximally corresponds to the time span of deposition of both the units Ulan I and Ulan II.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

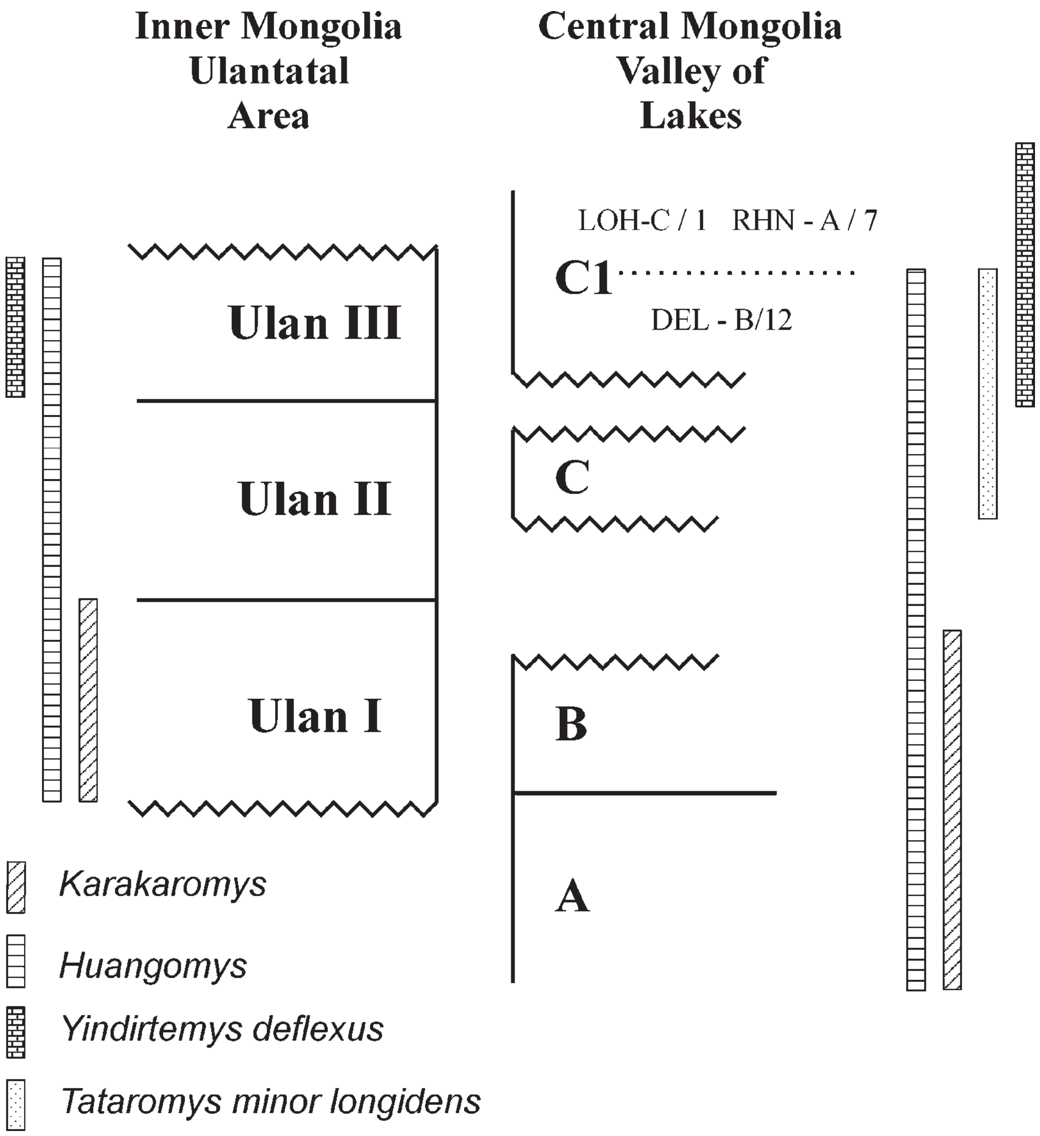


Fig. 103: Biostratigraphical correlation of the sedimentary series of the Ulantatal area (Inner Mongolia, China) and the sections of the Valley of Lakes (Central Mongolia).
Localities comprised in faunal complex A: TGL-A/1-2; TRG-A/13-14; TAT-C/1-3; SHG-C/1-2;
Localities comprised in faunal complex B: TGL-/A11,15; TGR-B/1; TGR-AB/21-22; TAT-C/6-7; SHG-A/1; SHG-AB/12-20.
Localities comprised in faunal complex C: TGR-C/1-6; TGW-A/1-2; TAR-A/2;
Localities comprised in faunal complex C1: RHN-A/7; TGW-A/5; LOH-C/1; LOH-B/3; DEL-B/12.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

In the Ulantatal area the lineage of the newly described *Huangomys frequens* nov. gen nov. sp. persisted from level Ulan I till Ulan III. In the Valley of Lakes this very characteristic species is represented in the levels A, B and C but not known from the localities of C1. As these sites are quite rich ctenodactlid remains, the absence of *Huangomys* there can most probability be explained as extinction of that lineage prior to the deposition of C1. This means that most likely there is no biostratigraphical overlap of C1 with the Ulantatal series. This seems to be confirmed by the *Yindirtemys deflexus* lineage. This species has its first appearance in the level Ulan III of the Ulantatal area and in level C1 of the section of the Valley of Lakes and there is an increase of size of the teeth with time. As it can be seen in the diagrams presented in fig. 94 and 95, the specimens of level Ulan III (locality UTL8) in their dimensions can best be compared to locality DEL-B/12 of the Valley of Lakes, but are clearly smaller than those of the localities LOH-C/1 and RHN-A7 belonging to level C1. An additional argument in support of this correlation is the persistence of the lineage *Tataromys minor longidens* nov. ssp. only up to DEL-B/12. It is no longer present in the two other localities. With this in level C1 two ages can be distinguished.

As to the correlation with other Central Asian areas, the evidence of the diagrams fig. 94 and 95 indicates that the upper level of C1 can be correlated with Shargaltein and Tabenbuluk in the Gansu province and the section of St. Jacques in the Ordos area. Beyond this, no very precise further indications can be given up to now. In the Oligocene of the Zaysan Basin in East Kazakhstan (Emry et al. 1998), the record in the Buran sedimentary series of *Karakoromys decessus*, *Tataromys plicidens*, *Tataromys sigmodon*, *Tataromys minor* and a *Yindirtemys* smaller than the species *deflexus* (determined as *Bounomys* sp. by the authors) means that part of the sequence is contemporaneous with the Ulantatal series of Inner Mongolia and the levels A – C of the sections of the Valley of Lakes. From the composition of the ctenodactylid fauna in the new material of the Valley of Lakes it is evident that the non-stratified fossils decribed from Central Asia by Matthew & Granger (1923) and Kowalski (1974) were collected from all levels.

Paleobiogeography

From the present study it results that several tataromyine species of the Oligocene extended from the southern part of the Gobi desert to Central Mongolia and Eastern Kazhakstan. At the same time also endemisms existed. The most striking regional difference can be seen in the early Upper Oligocene when small *Yindirtemys* species were dominant in the Ulantatal area but very rare in Central Mongolia. Only later the large descendant *Yindirtemys deflexus* became frequent also in the North (Valley of Lakes). But at the same time the small contemporaneous *Yindirtemys grangeri* represented an endemic element of the south (the presence of this species in the Hsanda Gol area in Central Mongolia, as signaled by Kowalski 1974 plate XLVIII, fig. 5, could not be confirmed). Also *Alashania tengkoliensis* as another characteristic element of the Ulantatal fauna could not be found in Central Mongolia. *Tataromys minor* of the Ulantatal area is replaced by a closely related form described above as *Tataromys minor longidens* nov. subsp.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

At least some of the species extended also more to the west to Kazakhstan. This did not become apparent immediately because they first were described by SHEVYREVA (1971, 1994) under various different names. Following the synonymization given by WANG (1997), *Karakoromys decessus*, *Tataromys plicidens* and *Tataromys sigmodon* are to be reported from there. EMRY et al. (1998) mentioned from the site K15 of the Buran series southwest of Lake Zaysan (East Kazakhstan) the presence of *Tataromys plicidens*, *Tataromys sigmodon*, *Tataromys minor*, *Karakoromys decessus* and "*Bounomys*" sp. which latter is a synonym of *Yindirtemys* (VIANEY-LIAUD et al. 2006). Wether also other species typical of Central and Inner Mongolia extended to the area of Kazakhstan cannot be answered at the moment. It is possible that within the determination of *Tataromys minor* from there also other small species (including *Huangomys*) are comprised.

There are no indications for effective paleogeographical barriers between Central Mongolia and Inner Mongolia in the Oligocene. So it seems more likely that there were some climatic differences. 1000 km distance in North-South direction does not make an important difference. But it could already be reflected in somewhat modified climatic parameters.

Evolutionary trends

Thanks to the fact that the Oligocene rodents of Central Asia for the first time are documented from geologically well studied continuous sections evolutionary trends become visible. These largely confirm what up to now has been considered plesiomorphic or apomorphic features within the group of Tataromyinae. Beyond this also more detailed observations can be made. So, it appears that the "trigonoid structure" characteristic of so many tataromyine species is derived from an ectolophid and ectolophid spur of the type found in *Karakoromys* and, hence, is not a trigonid. The ectolophid spur occurs in many *Karakoromys* dentitions and basically can be considered equivalent to a mesolophid. However, due to the displacement of the ectolophid to the lingual direction no space for a better development of that loph as a transversal crest was available. This is why it bends anteriorly and by this way approaches the metaconid so that a structure comparable to a trigonid results. In *Yindirtemys* this structure becomes more clearly developped and the point of departure of the ectolophid spur from the ectolophid becomes moderately strengthened to form a weak mesoconid. But nevertheless the connection of the ectolophid spur to the metaconid remains weak or uncomplete in many cases. And this is even true for the most evolved species *Yindirtemys deflexus*. The mesoconid becomes further developped in the more derived *Yindirtemys* species and submitted, like some of the other cones, to an increasingly selenodont pattern formation. It, hence, can be concluded that the trigonoid structure is formed through modification of the ectolophid structure found in *Karakoromys*. And this means that *Yindirtemys* most probably shares an immediate common ancestor with *Karakoromys*.

In the stratigraphically youngest species *Yindirtemys deflexus* and *Yindirtemys grangeri*, a quite conspicuous tendency to selenodonty can be observed. Parallel to this, supplementary crest structures became more frequent in the upper molars. They already sometimes appear in *Yindirtemys bohlini* and *Yindirtemys ulantatalensis* of the uppermost levels of the Ulantatal series (UTL 8). The variation of these structures in *Yindirtemy deflexus* is discussed on p. 200.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

A quite different structural development is found in the genera *Tataromys*, *Alashania* and *Huangomys*. In these the cusps become less voluminous, partly even compressed and crest-like. Correspondingly, the trigonoid structure did not develop a mesoconid. In all three genera there is a tendency of reduction of the trigonoid structure which indicates a derived state of development. In the genus *Alashania* it disappears in pd4 and m1 and in *Huangomys* it is lacking on all lower molars. Also in the posterior half of the lower molar passing from *Tataromys* to *Alashania* and *Huangomys* gradual pattern modification is attained. In *Tataromys* the anterior arm of the hypoconulid meets the anterior arm of the hypoconid and the hyposinusid between them is moderately developped. In *Alashania* in pd4, m1 and sometimes also in m2, the anterior arm of the hypoconulid is not fused with the anterior arm of the hypoconid but bends lingually to meet the anterior arm of the entoconid (hypolophid). In connection with this, the hyposinusid extends very far in lingual direction. *Huangomys* is even more derived in this feature because the described pattern is present in all lower molars and the deciduous molar. The structural differences altogether show that the three genera are more closely related to each other than to *Yindirtemys*. It is interesting to note that nonwithstanding the divergent dental specialization in *Yindirtemys* and the *Tataromys-Alashania-Huangomys*-group the direction of jaw movement remained the same as in *Karakoromys* (fig. 3).

Acknowledgements

We are very grateful to Gudrun DAXNER-HÖCK who gave to us the ctenodactylid material for study and helped us with field informations. Thanks also to Mrs. Petra KOPPENHÖFER, Mainz, for her assistance in producing the diagrams. The field work was funded in the frame of FWF-projects P-10505-GEO and P-15724-N06.

References

BOHLIN, B. (1937): Oberoligozäne Säugetiere aus dem Shargaltein-Tal (Western Kansu). – Palaeontol. Sinica, New Ser. C, **3**: 1-66.

––– (1946): The Fossil Mammals from the Tertiary Deposit of Taben-Buluk, Western Kansu. Part II: Simplicidentata, Carnivora, Artiodactyla, Perissodactyla, and Primates. – Reports Sci. Exped. Northwestern Prov. China: 1-259.

DAXNER-HÖCK, G., V. HÖCK, D. BADAMGARAV, G. FURTMÜLLER, W. FRANK, O. MONTAG, & H.P. SCHMID (1997): Cenozoic Stratigraphy based on a sediment-basalt association in Cenral Mongolia as Requirement for Correlation across Central Asia. – In: AGUILAR, J. P., S. LEGENDRE & J. MICHAUX (eds): Biochronologie mammalienne du Cénozoique en Europe et domaines reliés. – Mém Trav. E.P.H.E. Inst. Montpellier, **21**: 163-176.

––– & D. BADAMGARAV (2007): Geological and stratigraphic settings. – In: DAXNER-HÖCK, G. (ed.): Oligocene-Miocene Vertebrates from the Valley of Lakes (Central Mongolia): Morphology, phylogenetic and stratigraphic implications. – Ann. Naturhist. Mus. Wien, **108**A: 1-24.

EMRY, R.J., L.G. SPENCER, L. TYUTKOVA & B.-Y. WANG (1998): The Ergilian-Shandgolian (Eocene-Oligocene) Transition in the Zaisan Basin, Kazakhstan. – Bull. Carneegie Mus. Nat. Hist., **34**: 298-312.

HINTON, M. (1933): Diagnosis of new genera and species of rodents from Indian Tertiary deposits. – Annals and Magazine Nat. Hist., Ser. 10, **12**: 620-622.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

HÖCK, V., G. DAXNER-HÖCK, H.P. SCHMID, D. BADAMGARAV, W. FRANK, G. FURTMÜLLER, O. MONTAG, R. BARSBOLD, Y. KHAND & J. SODOV (1999): Oligocene-Miocene sediments, fossils and basalts from the Valley of Lakes (Central Mongolia) – An integrated Study. – Mitt. Österr. Geol. Ges., **90**: 83-125.

HUANG, X.-S. (1982): Preliminary observations on the Oligocene deposits and mammalian fauna from Alashan Zuoqi, Nei Mongol. – Vertebr. Palasiat. **20**/4: 337-349.

——— (1985): Middle Oligocene ctenodactylids (Rodentia, Mammalia) of Ulantatal, Nei Mongol. – Vertebr. Palasiat., **23**/1: 27-38.

KOWALSKI, K. (1974): Results of the Polish-Mongolian paleontological expeditions. Part V. Middle Oligocene rodents from Mongolia. – Palaoeont. Polon., **30** : 147-178.

LAVOCAT, R. (1961): Le gisement de vertébrés Miocène de Beni Mellal Maroc) Etude systématique de la faune de mammifères et conclusions générales. – Notes et Mém. Serv. Géol., **155**: 29-94.

LI, C.-K & Z.-D. QIU (1980): Early Miocene mammalian fossils of Yining Basin,Qinghai. – Vertebrat. Palasiat., **18**/3: 198-214.

MATTHEW, W.D. & W. GRANGER (1923): Nine new rodents from the Oligocene of Mongolia. – Amer. Mus Novitates, **102**: 1-10.

MELLET, J.S. (1966): Fossil mammals from the Oligocene Hsanda Gol Formation, Mongolia. Part I. Insectivora, Rodentia and Delatheridia, with notes on the paleobiology of *Cricetops dormitor*. – Ph. D, diss. manuscr., Columbia Univ. New York: 1- 224.

SEN, S. & H. THOMAS (1979): Découverte de Rongeurs dans le Miocène moyen de la Formation Hofuf (Province du Hasa, Arabie saoudite). – C. R. Somm. Séances Soc. Géol. France, 1979/fasc. 1 : 34-37. – Paris.

SHEVYREVA, N.S. (1971): New Middle Oligocene Rodents of Kazakhstan and Mongolia. – Trans. Paleontol. Inst. Acad. Sci. USSR, **130**: 70-86.

——— (1994): New Rodents (Rodentia, Mammalia) from the Lower Oligocene of the Zaisan depression (Eastern Kazakhstan). – Paleontologicheskyi Zhurnal, **28**/4: 111-126

STEHLIN, H.G. & S. SCHAUB (1951): Die Trigonodontie der simplicidenten Nager. – Schweizer Paläont. Abh., **67** : 1-385.

TEILHARD DE CHARDIN, P. (1926): Description de Mammifères Tertiaires de la Chine et de Mongolie. – Annales de Paléont., **15**: 665-727.

VIANEY-LIAUD, M., N. SCHMIDT-KITTLER & L. MARIVAUX (2007): The Tataromyinae (Ctenodactylidae, Rodentia) from the Oligocene of Ulantatal (Inner Mongolia, China). – Palaeovertebrata, **34:** in press.

WANG B.-Y. (1991): Discovery of *Yindirtemys* (Ctenodactylidae, Rodentia, Mammalia) from late Oligocene of Nei Mongol, China. – Vertebrata Palasiat., **29**/4: 296-302.

——— (1997): The Mid-Tertiary Ctenodactylidae (Rodentia, Mammalia) of Eastern and Central Asia. – Bull. Amer. Mus Nat. Hist., **234**: 1-88.

WOOD, A.E. & R.W. WILSON (1936): Suggested Nomenclature for the cusps of the Cheek Teeth of Rodents. – Journ. Paleontol., **10**: 388-391.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

Plate 1

Fig. A: *Tataromys minor longidens* nov. ssp., right maxilla fragment with P4-M1, TGW-A/2b, NHMW 2006z0100/0001, holotype, occlusal view.

Fig. B: *Tataromys minor longidens* nov. ssp., right M3, DEL-B/12, NHMW 2006z0103/0003, lingual view.

Fig. C: *Tataromys minor longidens* nov. ssp., right M3, DEL-B/12, NHMW 2006z0103/0003, occlusal view.

Fig. D: *Tataromys minor longidens* nov. ssp., right maxilla fragment with M2-M3, TGW-A/b2, NHMW 2006z0100/0002, occlusal view.

Fig. E: *Tataromys minor longidens* nov. ssp., right mandibular fragment with m1-m2, TGW-A/2b, NHMW 2006z0100/0003, occlusal view.

Fig. F: *Tataromys minor longidens* nov. ssp., left m3, TGW-A/2b, NHMW 2006z0100/0005, occlusal view.

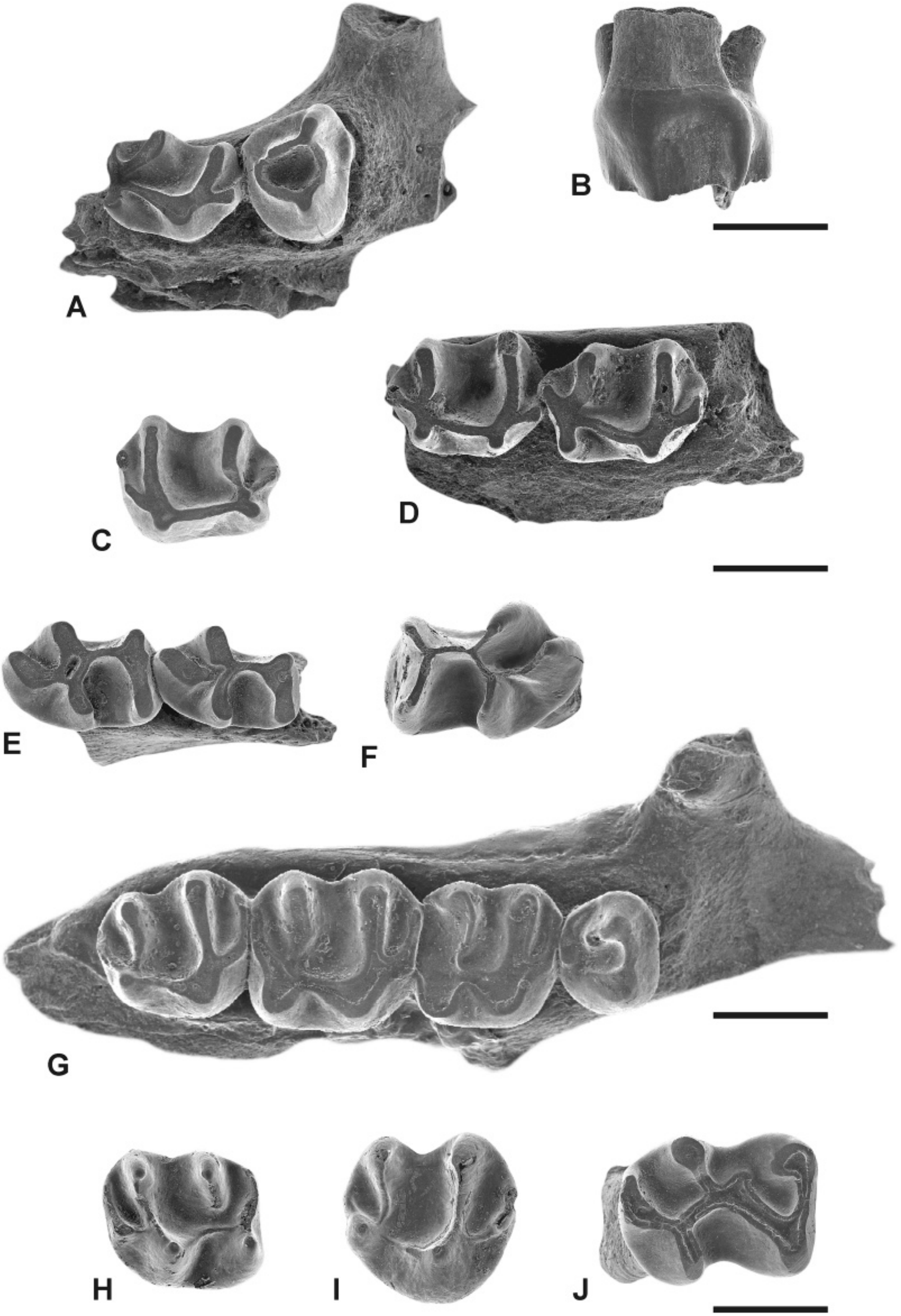
Fig. G: *Karakoromys decessus* Matthew & Granger, 1923, right maxilla with P4-M3, TAT-D/1, NHMW 2006z0109/0001, occlusal view.

Fig. H: *Karakoromys decessus* Matthew & Granger, 1923, left M2, TAT-D/1, NHMW 2006z0109/0002, occlusal view.

Fig. I: *Karakoromys decessus* Matthew & Granger, 1923, right M3, TAT-D/1, NHMW 2006z0109/0003, occlusal view.

Fig. J: *Karakoromys decessus* Matthew & Granger, 1923, right m2, TAT-D/1, NHMW 2006z0109/0004, occlusal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at

Plate 2

Fig. A: *Huangomys frequens* nov. gen. nov. sp., left mandible with p4-m3, TGR-B/1, NHMW 2006z0068/0001, holotype, occlusal view.

Fig. B: *Huangomys frequens* nov. gen. nov. sp., left maxilla fragment with P4-M2, TGR-AB/22, NHMW 2006z0075/0001, occlusal view.

Fig. C: *Huangomys frequens* nov. gen. nov. sp., left maxilla fragment with M2-M3, TGR-B/1, NHMW 2006z0068/0002, occlusal view.

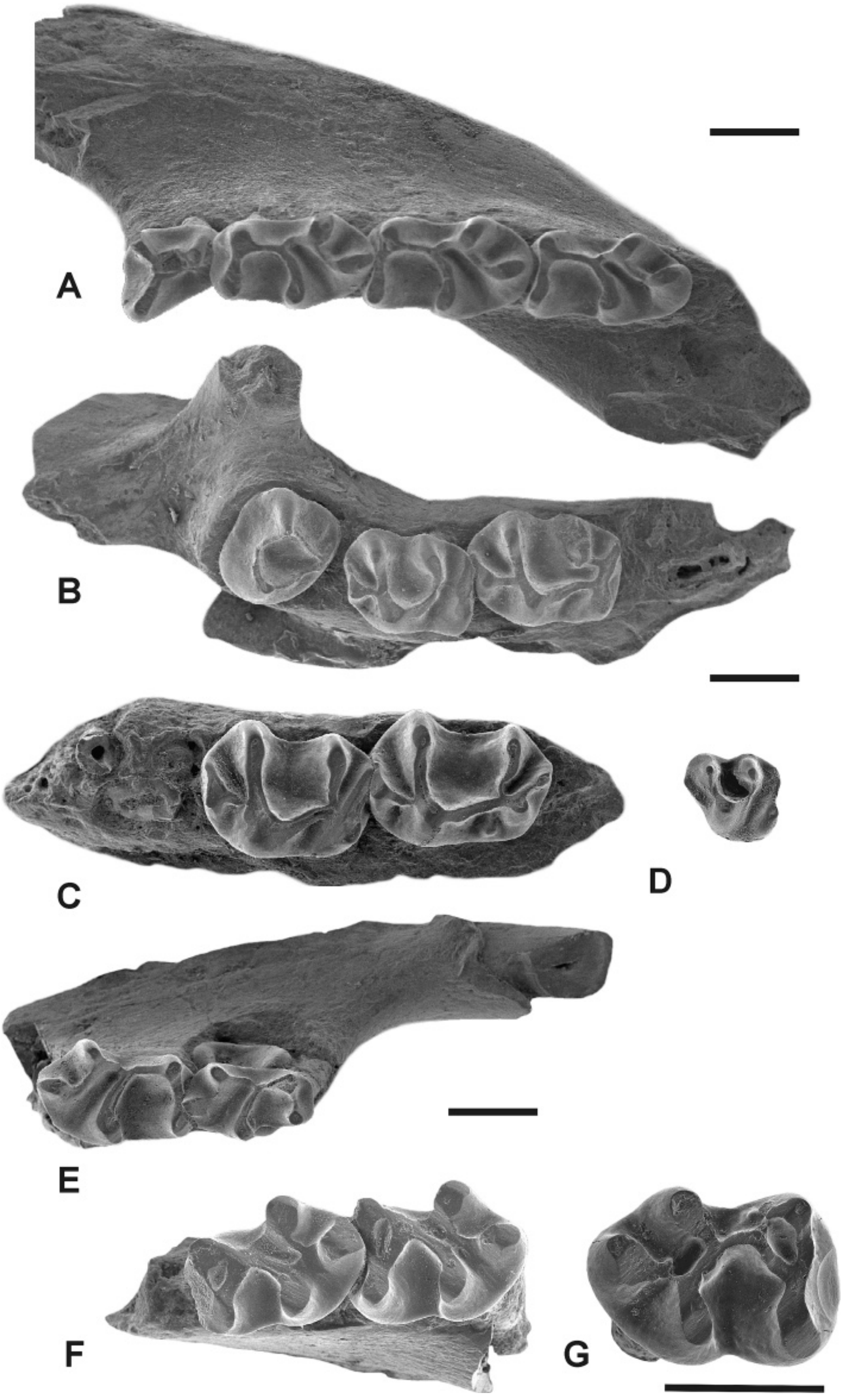
Fig. D: *Huangomys frequens* nov. gen. nov. sp., left PD4, TGR-B/1, NHMW 2006z0068/0003, occlusal view.

Fig. E: *Huangomys frequens* nov. gen. nov. sp., right mandibular fragment with pd4-m1, TGR-AB/21, NHMW 2006z0074/0001, occlusal view.

Fig. F: *Yindirtemys shevyrevae* VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX, 2006, left mandibular fragment with m1-m2, SHG-AB/17-20, NHMW 2006z0094/0001, occlusal view.

Fig. G: *Yindirtemys shevyrevae* VIANEY-LIAUD, SCHMIDT-KITTLER & MARIVAUX, 2006, right m2, SHG-A/17-18, NHMW 2006z0095/0001, occlusal view.

©Naturhistorisches Museum Wien, download unter www.biologiezentrum.at



ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: Annalen des Naturhistorischen Museums in Wien

Jahr/Year: 2007

Band/Volume: 108A

Autor(en)/Author(s): Schmidt-Kittler Norbert, Vianey-Liaud Monique, Marivaux Laurent

Artikel/Article: 6. Ctenodactylidae (Rodentia, Mammalia) In: Daxner-Höck, Gudrun ed. Oligocene-Miocene Vertebrates from the Valley of Lakes (Central Mongolia): Morphology, phylogenetic and stratigraphic implications 173-215