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Plesiosminthus (Zapodidae, Mammalia) from China and Mongolia: migrations to Europe

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Plesiosminthus VIRET 1926 was recorded from China and Mongolia for the first time: *P. asiaticus* n.sp. from the Late Oligocene of China (Tiensihabahe), and *P. cf. asiaticus* and *P. promyaron* from the Late Oligocene (biozone C1) of Mongolia (RHN-A/7 and RHN-A/9). *P. barsboldi* n.sp. was recovered from the Oligocene-Miocene transition (biozone D) of Mongolia (UNCH-A/3, LOG-A/2 and RHN-A/12). There are some more undetermined occurrences: *Plesiosminthus* sp. A and *Plesiosminthus* sp. B from two Late Oligocene (biozones C and C1) deposits of Mongolia (TAR-A/2 and LOH-C/1), and *Plesiosminthus* sp.1 (large) and *Plesiosminthus* sp. 2 (small) from the Oligocene-Miocene transition of China (Locality 99005). *P. asiaticus* is so far the most primitive *Plesiosminthus*-species by having upper incisors with a shallow longitudinal groove. *P. promyaron*, the first zapodid to immigrate and disperse in Europe in the Late Oligocene (MP26-29), was identified from the Late Oligocene of Mongolia (biozone C1).

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INTRODUCTION

The first record of zapodids in Europe was *Plesiosminthus* VIRET 1926. Immigrating from eastern countries *P. promyaron* arrived, and almost simultaneously dispersed all over central and western Europe to the Iberian Peninsula (Hugueney & Vianey-Liaud 1980, Engesser & Mödden 1997, Hugueney 1997, Freudenthal 1997) in the Late Oligocene (PM 26-29). Locally two more species occurred: *P. conjunctus* ZIEGLER 1994 (MP 28) from Germany and *P. moralesi* ALVAREZ-SIERRA, DAAMS & LACOMBA ANDUEZA 1996 (MP 29) from Spain. All these species got extinct and were replaced by *P. schaubi* VIRET 1926 (MP

29-30) and *P. winistoerferi* ENGESSER 1987 (MP 30) at the end of the Late Oligocene. At the beginning of the Miocene (MN 1-2) only one species, *P. myarion* SCHAUB, 1930, lived in Europe; it is thought to be the direct descendant of *P. promyaron*.

Lopatin (1999) described *P. tereskentensis* from the Early Miocene of Altynshokysu (Northern Aral Region) in Kazakhstan to be the first *Plesiosminthus* from Asia. As no grooved upper incisor (which is most characteristic for the genus) was recovered from this area, it has to be demonstrated in future, whether or not "*P.*" *tereskentensis* is really a species of *Plesiosminthus*. Recently

Plesiosminthus-findings were recovered for the first time from China and Mongolia. They are described in the present paper.

DESCRIPTIONS

Plesiosminthus from China (Figs. 1-4)

Since 1995, a team from the Institute of Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences has been working on the Mid-Tertiary biostratigraphy in the Ulungur River Area of the

Northern Junggur Basin, Xinjiang Uygur Autonomous Region, China. Many localities and mammal fossils from several horizons have been found (Ye et al. 2000). Two localities yielded *Plesiosminthus*: Tieersihabahe and Locality 99005. From Tieersihabahe a rich fauna of Late Oligocene age was recovered. The second fauna is from the Locality 99005 of the Oligocene-Miocene transition. It is the first record of *Plesiosminthus* in China. For localization, see Figure 1.

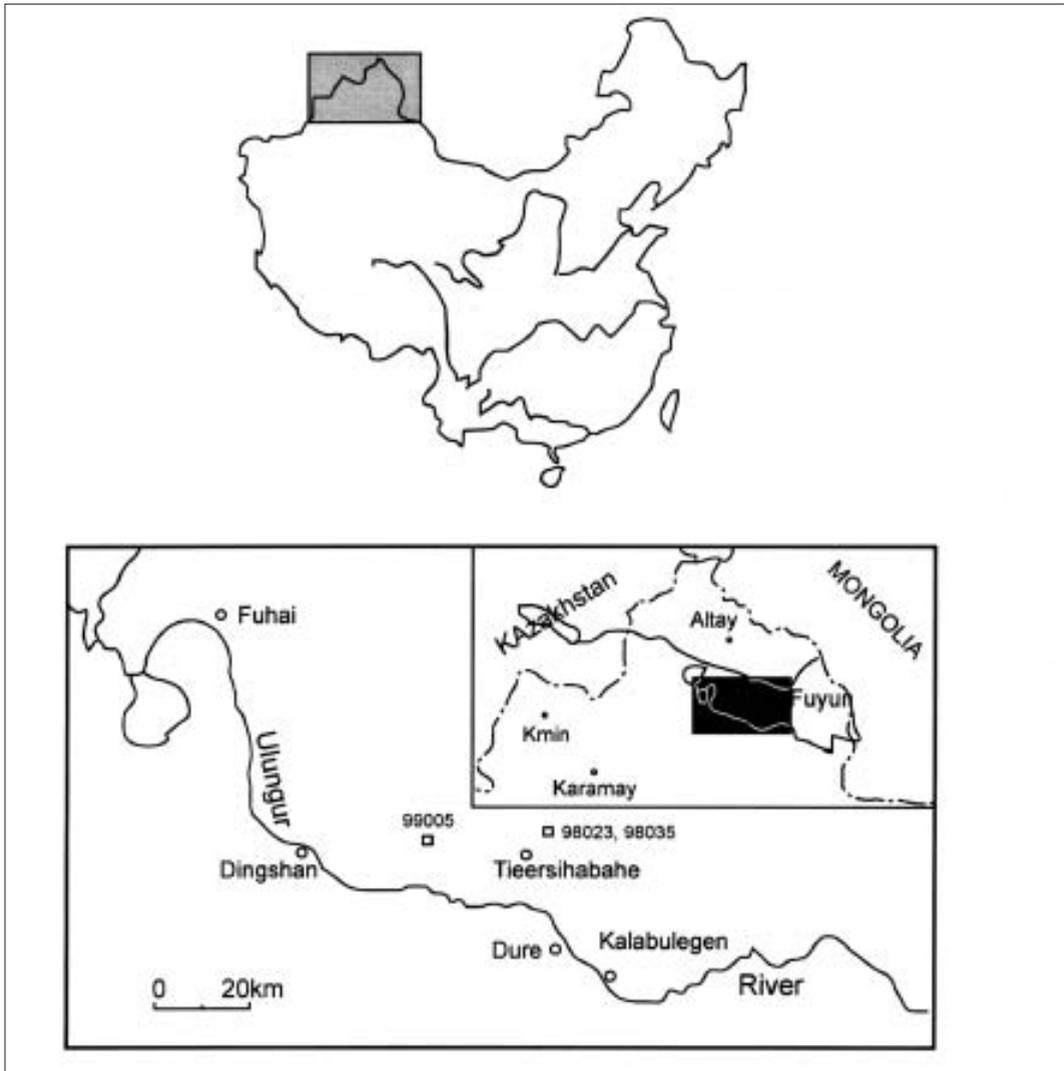


Figure 1 Sketch map showing the studied area in the North Junggur Basin of China and the localities Tieersihabahe and Locality 99005.

Order Rodentia BOWDICH, 1821
 Superfamily Dipodoidea FISCHER, 1817
 Family Zapodidae COUES, 1875
 Genus *Plesiosminthus* VIRET, 1926

***Plesiosminthus asiaticus* n. sp.**

(Fig. 2, 1-11; Fig. 3, 1-13)

Holotype Left M1 (Fig. 2, 1) V12724.6 from Locality 98035, Tiersihabahe, North Junggar Basin, China.

Paratypes 1 complete upper incisor and 14 fragments of upper incisors, 8 P4, 18 M1, 14 M2, 4 M3, 16 m1, 27 m2, 13 m3 from Locality 98035 (V12724.1-115).

Further referred material: 1 complete upper incisor and 3 fragments of upper incisors; 6 P4, 13 M1, 8 M2, 4 M3, 9 m1, 16 m2 and 8 m3 from Locality 98023 (V12723.1-68) Tiersihabahe, North Junggar Basin, China.

Diagnosis Large species of *Plesiosminthus*; upper incisors with shallow longitudinal groove; anterior cingulum of M1 often present; metaloph of M1 extends frequently to the hypocone; protoloph of M2 double; connection of protocone and protoloph II of M2 weak, sometimes interrupted; length ratio of M3/M1 (0.76) and m3/m1 (0.84); metalophid II of m2 frequently present (90%); mesoconid of m1 present, sometimes pronounced; ectolophid short; hypolophid-connection anterior to the hypoconid.

Derivatio nominis 'asiaticus' (latin) indicating the first record in Asia.

Type locality and stratigraphy Locality 98035 (N 46°40.416' E 88°28.958'), Tiersihabahe in the North Junggar Basin; Tiersihabahe Formation; Late Oligocene. Locality and stratigraphy of further referred materials: Locality 98023 (N 46°40.374'; E 88°28.278'), Tiersihabahe in the North Junggar Basin; Tiersihabahe Formation; Late Oligocene.

Measurements See Table 1.

Description

The two localities yielding *Plesiosminthus* are near from each other and at the same stratigraphic level, and all *Plesiosminthus* teeth are rather homologous both in morphology and size. Therefore, we treat all *Plesiosminthus* teeth collected from around the two localities as if they were from one fauna.

I (Fig. 2, 11): The upper incisor has very shallow longitudinal groove on the dorsal face, and an additional longitudinal, very fine groove medially on the dorsal face.

P4 (Fig. 2, 10) is peg-like with a single root. A main cusp is antero-medially situated and surrounded by a round ridge posteriorly. The upper molars are 3-rooted except for one M2 that is 4-rooted.

M1 (Fig. 2, 1-3) is round square in outline. Its anterior width is nearly equal to or slightly narrower or wider than the posterior one. An anterior cingulum is often present on M1 at the base of the anterior wall (23 out of 32 teeth). An anteroconule is more or less developed in the anterior arm of the protocone. The anterior arm of the protocone is usually long, extending near to the antero-labial base of the paracone and ending in a weak parastyle. In 3 specimens the anterior arm of the protocone interrupts labially before it reaches the parastyle. The protoloph connects lingually to the posterior arm of the protocone. The metaloph joins frequently the central part of the hypocone, occasionally the anterior corner of the hypocone. The mesoloph is complete, ending in a more or less developed mesostyle. The mesocone is developed. The posteroloph is low and merges in the posterior arm of the hypocone or thins down lingually so that a contraction is present at the postero-labial corner of the hypocone. The sinus stretches antero-externally.

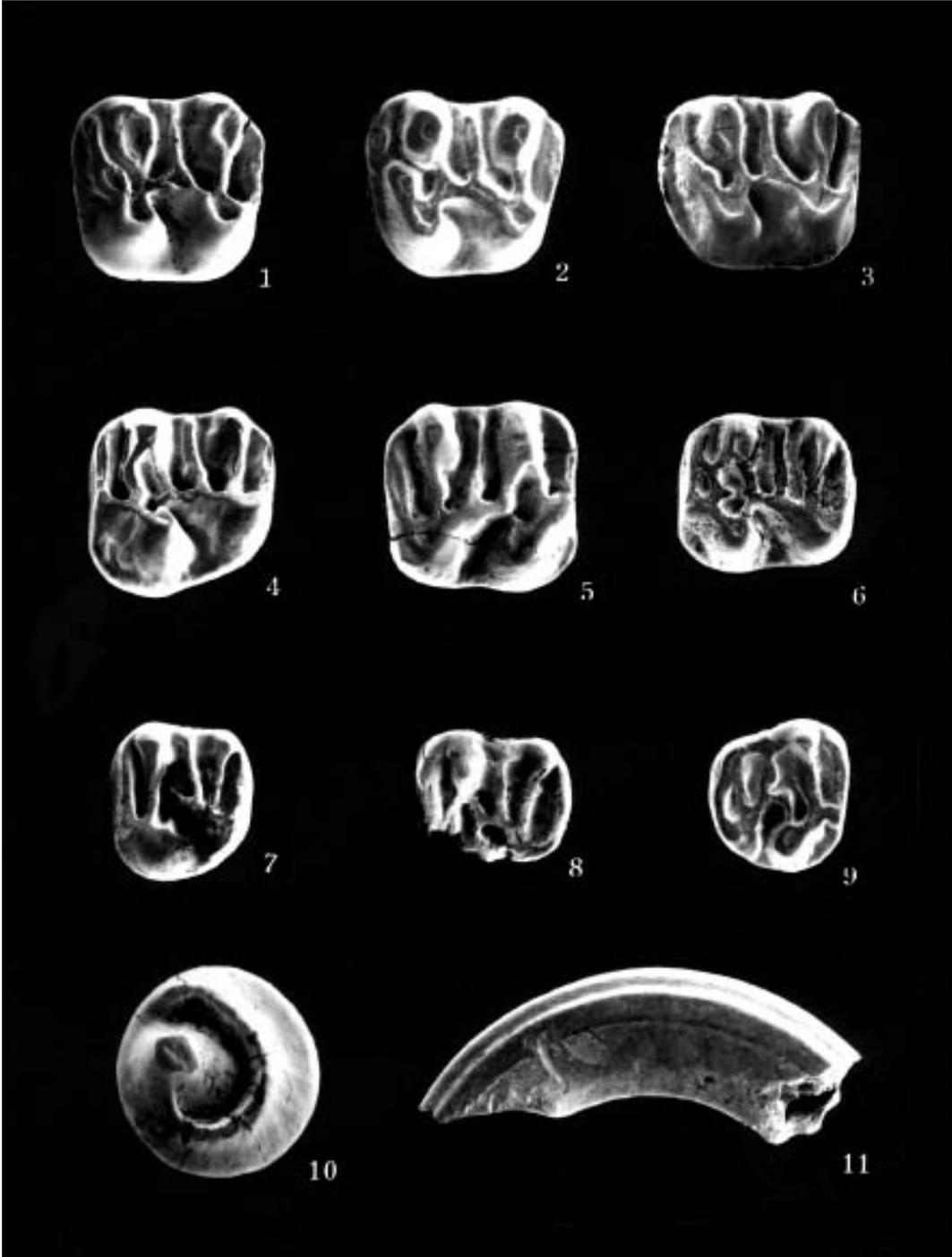


Figure 2 Upper dentition of *Plesiosminthus asiaticus* n. sp. from Tieersihabahe, localities 98023 (V 12723) and 98035 (V 12724), North Junggar Basin, China. Late Oligocene. Collection of the IVPP. The magnification is 20 times except for (Figs 2, 10-11). Fig. 2, **1** - M1l; V 12724.6. Fig. 2, **2** - M1r; V12724.15. Fig. 2, **3** - M1l; V12723.30. Fig. 2, **4** - M2l; V12723.10. Fig. 2, **5** - M2r; V12724.19. Fig. 2, **6** - M2l; V12724.63. Fig. 2, **7** - M3l; V12723.38. Fig. 2, **8** - M3l; V12724.20. Fig. 2, **9** - M3r; V12724.74. Fig. 2, **10** - P4l; V12724.4; x 40. Fig. 2, **11** - I sup. V12724.50; x13.

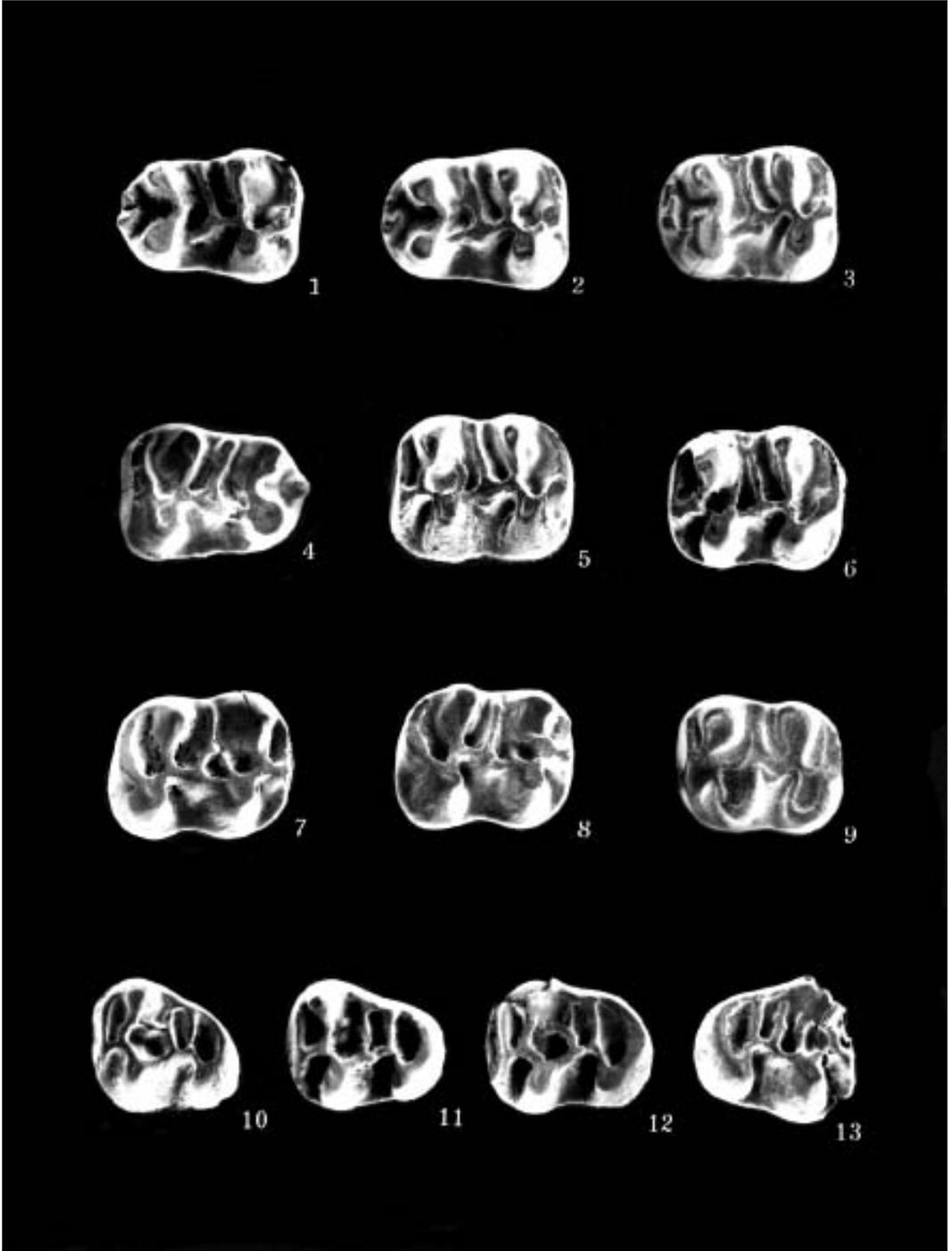


Figure 3 Lower dentition of *Plesiosminthus asiaticus* n. sp. from Tiejersihabahe, localities 98023 (V 12723) and 98035 (V 12724), North Junggar Basin, China. Late Oligocene. Collection of the IVPP. The magnification is 20 times. Fig. 3, **1** - m1l; V12724.21. Fig. 3, **2** - m1l; V12724.75. Fig. 3, **3** - m1l; V12724.77. Fig. 3, **4** - m1r; V12724.86. Fig. 3, **5** - m2l; V12724.90. Fig. 3, **6** - m2l; V12724.24. Fig. 3, **7** - m2r; V12724.29. Fig. 3, **8** - m2r; V12723.53. Fig. 3, **9** - m2l; V12723.49. Fig. 3, **10** - m3l; V12723.21. Fig. 3, **11** - m3l; V12723.60. Fig. 3, **12** - m3l; V12723.37. Fig. 3, **13** - m3r; V12724.112.

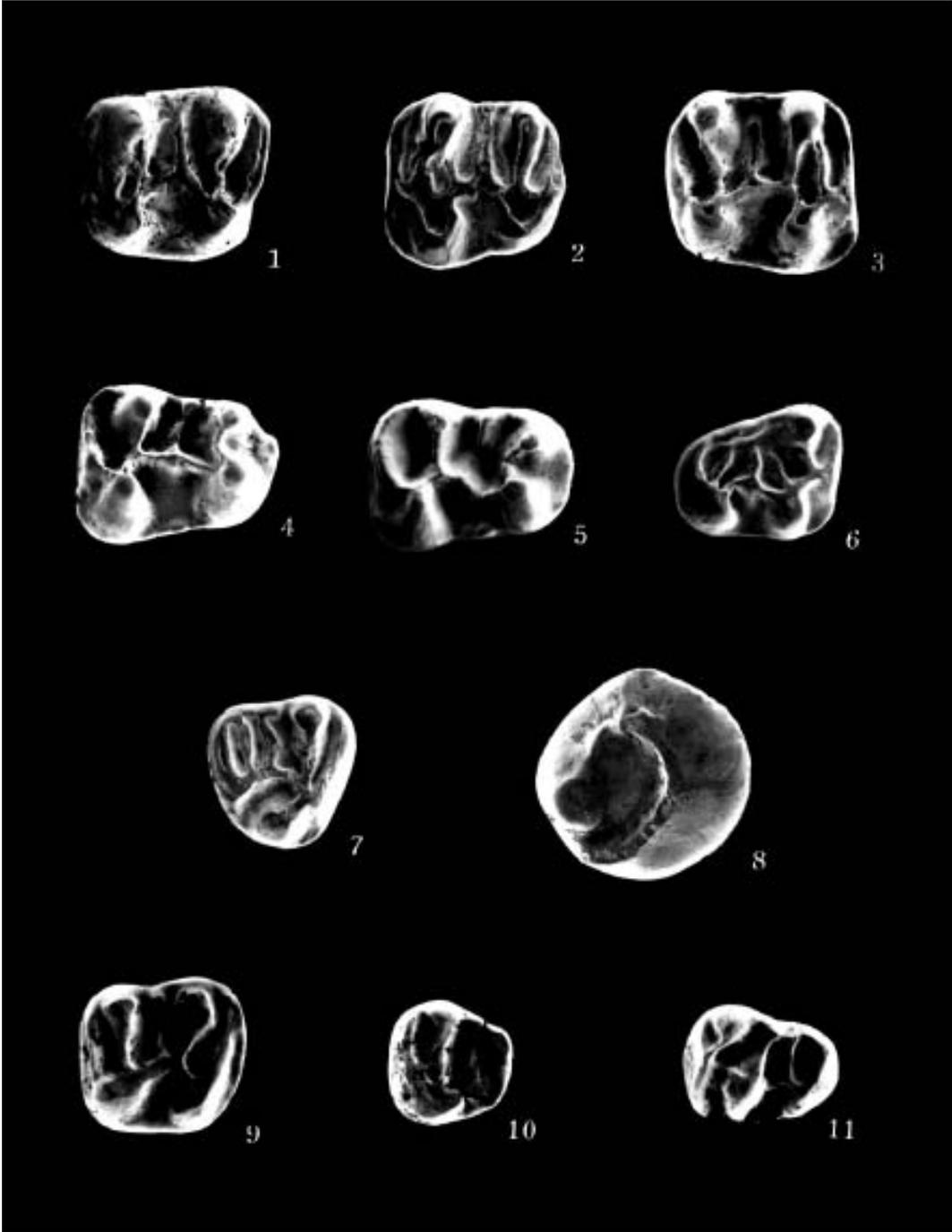


Figure 4 Dentition of *Plesiosminthus* sp. 1 (large) from locality 99005 (V12725), North Junggar Basin, China. Oligocene-Miocene transition. Collection of the IVPP. The magnification is 20 times, except for Figure 4, 8. Fig. 4, **1** - M1l; V12725.1. Fig. 4, **2** - M2l; V12725.6. Fig. 4, **3** - M2r; V12725.3. Fig. 4, **4** - m1r; V12725.9. Fig. 4, **5** - m1r; V12725.10. Fig. 4, **6** - m3r; V12725.11. Fig. 4, **7** - M3r; V12725.9. Fig. 4, **8** - P4; V12725.1; x40. Dentition of *Plesiosminthus* sp. 2 (small) from locality 99005 (V12726), North Junggar Basin, China. Oligocene-Miocene transition. Collection of the IVPP. The magnification is 20 times. Fig. 4, **9** - M1r; V12726.1. Fig. 4, **10** - M3l; V12726.3. Fig. 4, **11** - m3l; V12726.4.

M2 (Fig. 2, 4-6) is round rectangle in shape. It is wider anteriorly than posteriorly. A labial anteroloph is developed but the lingual one is weak or absent. The protoloph I and II are present and almost equally developed on all M2. The connection between the protocone and the protoloph II is usually weak but complete, it interrupts slightly as a shallow notch in 7 out of 19 specimens. The metaloph extends to the central part or to the anterior corner of the hypocone. The mesoloph is complete, ending in a mesostyle. The posteroloph is well developed. The sinus stretches anteroexternally.

M3 (Fig. 2, 7-9) is nearly a duplication of M2 but smaller and reduced posteriorly. The protoloph is double on 6 out of 7 observable teeth and is single on one tooth. The mesoloph is complete but a bit shorter in few cases. The entoloph is complete or interrupted. The protocone contacts the hypocone on most teeth, and closes the sinus lingually with few exceptions in which the sinus is open.

m1 (Fig. 3, 1-4): The anteroconid is always present but low and variable: single(12), double(6) or ridge-like(6), it is usually lingually situated. In most cases, the ridge-like anteroconid extends lingually to the metaconid. The metaconid and protoconid are waterdrop-shaped, connecting medially, forming an angular or round arc. The mesolophid is lower than the metalophid and hypolophid. It extends parallel with the hypolophid, and joins the ectolophid in the more or less developed mesoconid. The mesostylid is more or less developed. An ectostylid (sometimes ridge-like) is present in a few cases. The hypoconulid is more or less developed.

m2 (Fig. 3, 5-9) is stable in morphology but the metalophid II is variable. The metalophid II is usually present but absent in 4 out of 42 cases. It extends from the lingual side of the protoconid centrally or posteriorly as a posterior arm of the protoconid. Usually it extends to the postero-external corner of the metacon-

id, it stops midway in 11 out of 42 cases (on one tooth the half-long metalophid II joins the mesolophid). In 2 out of 42 cases, it forms a (pseudo) mesolophid in place of mesolophid. The mesolophid is usually long (40 out of 42 teeth), ending in a mesostylid, half-long in 2 cases. The m2 is similar to m1 in other respects.

m3 (Fig. 3, 10-13) is similar to m2 in morphology but narrowed posteriorly with the entoconid strongly reduced. The metalophid II is present in 18 out of 24 cases and usually longitudinally stretched between the postero-external corner of the metaconid and the mesolophid. The posterolophid is thin and with no hypoconulid.

Differential diagnosis *P. asiaticus* is larger than "*P.*" *terekentensis*, *P. promyarion*, *P. myarion*, and *P. moralesi*, however, smaller than *P. winistoerferi* and *P. schaubi*. From all known species *P. asiaticus* is morphologically closest to '*P.*' *terekentensis* from the Aral Formation of Kazakstan. As stated above, no grooved upper incisor of '*P.*' *tereskentensis* was found so far. Therefore, the generic position is still unclear. Besides that, the lack of M3 and m3 makes comparison of the length ratio of M3/M1 and m3/m1 impossible. The length ratio of M3/M1 (0.76) and m3/m1 (0.84) is lower than of *P. winistoerferi*, slightly higher than *P. promyarion*, much higher than of *P. myarion*, *P. schaubi* and *P. moralesi*.

P. asiaticus differs from '*P.*' *tereskentensis* in: the larger size; the interruption between protocone and protoloph II on M2 is not frequently present, and usually as a shallow notch.

From *P. promyarion* it differs in: the larger size; the shallower groove of the upper incisor; having protoloph II consistently on M2; the interruption between protocone and protoloph II is shallower and present on only few M2; the higher length ratio of M3/M1 and m3/m1 (the length ratio of M3/M1 and m3/m1 of *P. promyarion* from Pech Desse is 0.71 and 0.81 respectively).

From *P. myarion* it differs in: the larger size; the interruption between protocone and protoloph II is shallower and present on only few M2; the rather higher length ratio of M3/M1 and m3/m1 (the length ratio of M3/M1 and m3/m1 by *P. myarion* from Charvroche is 0.65 and 0.74 respectively).

From *P. schaubi* it differs in: having the shallower groove on the upper incisor; the double protoloph on all M2; the double metalophid on most m2; the much higher length ratio of M3/M1 and m3/m1 (the length ratio of M3/M1 and m3/m1 of *P. schaubi* from Coderet is 0.60 and 0.66 respectively).

From *P. winistoerferi* it differs in: the shallower groove of the upper incisor; the lacking long and strong posterior arm of protoconid (=metalophid II) which contacts with the mesolophid or mesostylid; the absence of the secondary ridges between the metalophid and mesolophid on m1; the lower length ratio of M3/M1 and m3/m1 (the length ratio of M3/M1 and m3/m1 of *P. winistoerferi* from late Oligocene of Brochene Fluh 53 is 0.78 and 0.92 respectively). As Engesser analyzed *P. winistoerferi* represents a separate evolutionary line from the other European species of *Plesiosminthus*.

From *P. moralesi* it differs in: not having the developed antero-lingual cingulum ridge on M1-2; having the more or less developed anteroconule on M1; having double protoloph on M2; having double metalophid on m2; having the usually complete mesolophid on lower molars; and the higher length ratio of M3/M1 and m3/m1 (the length ratio of M3/M1 and m3/m1 of *P. moralesi* from late Oligocene of Sayaton 1 is 0.60 and 0.62 respectively). In some respect *P. moralesi* is more similar to *Litodonomys* than to *Plesiosminthus* in morphology. Furthermore, it is unknown whether its upper incisor is grooved because no finding of upper incisors have been reported. It is quite probably that *P. moralesi* is not in the same phylogenetic lineage with the other species.

Discussion The described form belongs

undoubtedly to *Plesiosminthus*. It has grooved upper incisor; 3-rooted upper molars. The M1 has a more or less developed anteroconule in the anterior arm of the protocone; an anterior cingulum is often present on M1 at the base of the anterior wall. The metalophid II of m3 is usually present as a longitudinal ridge between the metalophid I and the mesolophid. *P. asiaticus* has obviously more primitive features than the European species: the shallower longitudinal groove on the upper incisor; the double protoloph of M2 and double metalophid of m2 and the higher length ratio of M3/M1 and m3/m1 (except for *P. winistoerferi*). Furthermore the anterior arm of the protocone on M1 is short in a few cases, it stops before it reaches the parastyle, and the anterior cingulum at the base of the anterior wall is frequently present on M1. These two latter features are in common with *Heosminthus* WANG, 1985 from the Late Eocene of Yunnan, China. Therefore the Tiersihabahe form is more primitive than all related European species. The European *Plesiosminthus* immigrated from Asia in the Late Oligocene. The similarity between the M1s of *Heosminthus* and *Plesiosminthus* of Tiersihabahe confirms Wang's predication that "*Heosminthus* may represent an ancestor-form of *Plesiosminthus*."

In the Tiersihabahe fauna *P. asiaticus* is associated with *Amphechinus kansuensis*, *A. minimus*, *A. cf. A. rectus*, Talpidae gen. et sp. indet., Heterosoricinae gen. et sp. indet., Chiroptera incertae familiae, *Desmatolagus* sp., *D. gobiensis*, *Desmatolagus* sp. nov., *Sinologomys major*, *S. kansuensis*, *S. gracilis?*, *Yindirtemys* cf. *Y. deflexus*, *Y. ambiguus*, *Tachyoryctoides obrutschewi*, *Parasminthus asiae-centralis*, *P. tangingoli*, *Bohlinosminthus parvulus*, *Litodonomys* sp., *Ansomyinae* gen. et sp. nov., *Eutamias* sp., Sciuridae gen. et sp. indet., *Eucricetodon* sp. nov., *Pseudotheridomys asiaticus*, *Vasseuromys* sp., Carnivora 3 genera, Bovidae gen. et sp. indet., *Eumeryx* sp.(large), *Eumeryx* sp.(small), *Didymoconus* sp. The fauna can be compared with the

Taben-buluk and Xiagou faunas from Gansu China. It is undoubtedly of Late Oligocene age.

There are two species of *Plesiosminthus* from Locality 99005, a large one and a small one. Both have deep-grooved upper incisors.

***Plesiosminthus* sp. 1 (large)**

(Fig. 4, 1-8)

Specimens An upper incisor, 1P4, 1M1, 4M2, 2M3, 2m1 and 2m3 (V12725.1-13)

Occurrence and stratigraphy Locality 99005 (N 46°39.415', E 88°20.623'), North Junggar Basin; lowermost level of Suosuoquan Formation. Earliest Miocene or Oligocene-Miocene transition.

Measurements P4 0.64 x 0.62. M1 1.19 x 1.05. M2 1.12 x 1.07; 1.05 x 1.04; 1.08 x 1.03; 1.07 x 1.03. M3 0.88 x 0.93; ~0.78 x 0.73. m1 1.22 x 0.93; 1.28 x 0.88. m3 1.03 x 0.80; 1.07 x 0.79.

Brief description In principle the molars (M1, M2, M3 and m1) of *P. sp.1* (large) are identical with those of *P. asiaticus* of Tiersihabahe in size and morphology. *P. sp.1* (large) differs from the latter in having deeper-grooved upper incisors. The protoloph is doubled and the connection between protoloph II and protocone is never interrupted on the M2. The M3 has a single protoloph, a developed mesoloph and a metaloph. The sinus is closed or open. One specimen of m1 has a single anteroconid situated lingually. The other one has a very low and double anteroconid. A low ectoconid is present on both m1.

***Plesiosminthus* sp. 2 (small)**

(Fig. 4, 9-11)

Specimens An upper incisor, 2 M1, 1 M3, 1 m3 (V12726.1-5)

Occurrence and stratigraphy Locality 99005 (N 46°39.415' E 88°20.623'), North Junggar Basin; lowermost level of the Suosuoquan Formation. Earliest Miocene or Oligocene-Miocene transition.

Measurements M1 1.00 x 0.94; 1.02 x 0.96. M3 0.78 x 0.73; 0.73 x 0.70. m3 0.94 x 0.77

Brief description All teeth are small. The upper incisor has a deeper longitudinal groove than *P. asiaticus*. from Tiersihabahe. The M1 has 3 roots, a more or less developed anteroconule (= protoconule) and the anterior cingulum at the base of the front wall. The mesoloph is interrupted on one out of the 2 teeth, but there is an obvious mesostyle. The M3 has double protoloph, an undeveloped mesoloph, a developed protocone and hypocone, and an extremely reduced metacone. On m3 the metalophid I is developed but the metalophid II is extremely short and thin. This species is characterized by the small size and deeper grooved incisor. It is rather smaller than *P. asiaticus* from Tiersihabahe.

Plesiosminthus sp.1 and sp. 2 are associated with *Amphelchinus* sp., *Sinolagomys* cf. *S. kansuensis*, *Litodonomys lajeensis*, *Heterosminthus* sp. (large), *Heterosminthus* sp. (small), *Pseudotheridomys* sp., *Democricetodon* sp., Tachyoryctoididae gen. et sp. nov., Sciuridae gen. et sp. 1, Sciuridae gen. et sp. 2, *Palaeogale* sp.

***Plesiosminthus* from Mongolia (Figs. 5-11)**

In the Valley of Lakes (Central Mongolia) *Plesiosminthus*-fossils were collected from seven horizons along five profiles of the localities Tavan Ovoony Deng (RHN-A/7, 9, 12), Unkheltseg (UNCH-A/3), Luugar Khudag (LOG-A/1), Tarimalyn Churem (TAR-A/2) and Loh (LOH-C/1). It is the first record of *Plesiosminthus* in Mongolia (for localization see Figure 5).

In three field campaigns (1995-1997) in cooperation of the Mongolian Paleontological

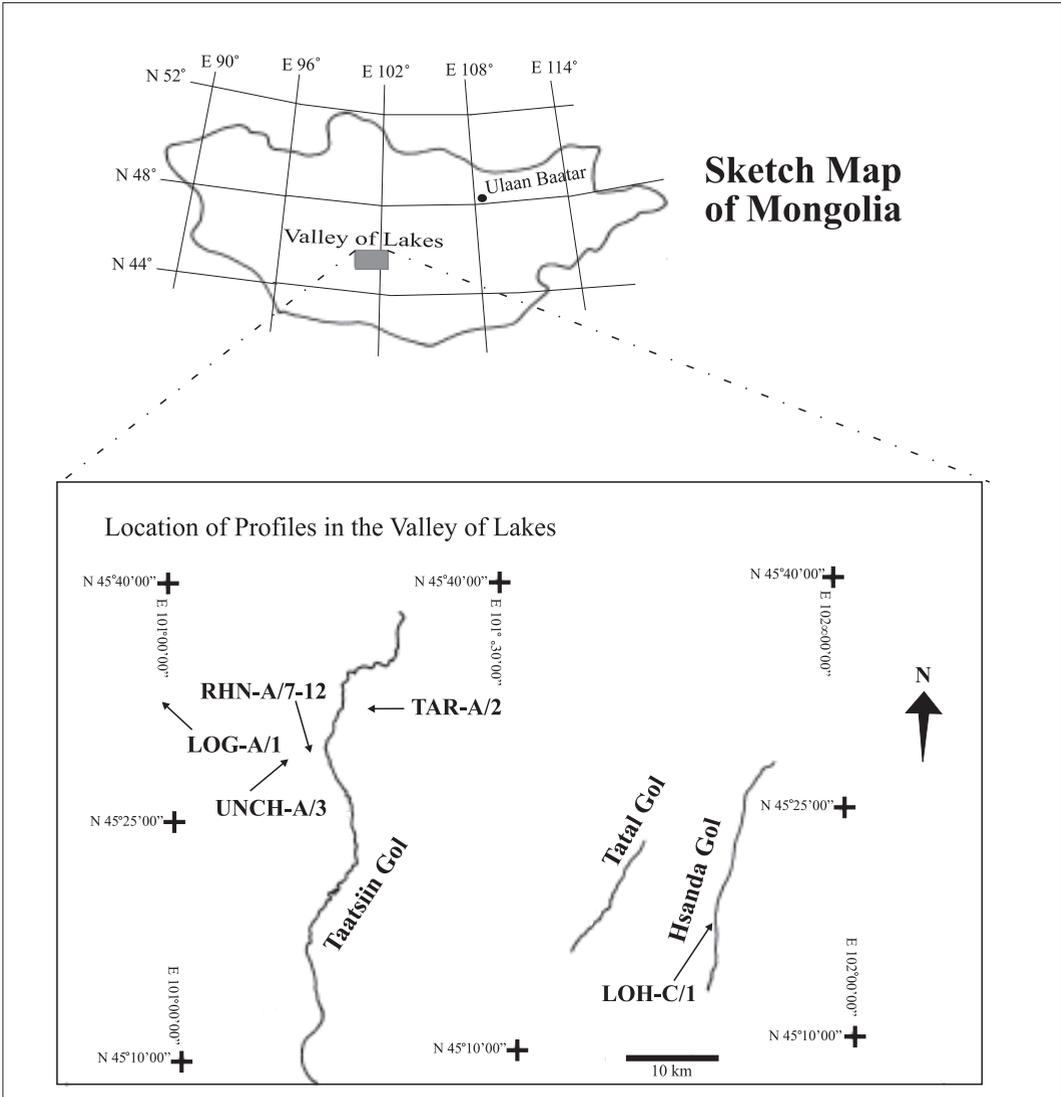


Figure 5 Sketch map of Mongolia showing the location of profiles and fossil sites in the Valley of Lakes, Central Mongolia: Luugar Khudag (**LOG-A**), Unkheltseg (**UNCH-A**), Tavan Ovoony Deng (**RHN-A**), Tarimalyn Khurem (**TAR-A**) and Loh (**LOH-**

Center of the Mongolian Academy of Sciences, of the Museum of Natural History Vienna, and the Austrian Science Fund an interdisciplinary study was carried out in Central Mongolia. The study included paleontological investigations, sedimentology, geological mapping, petrological-geochemical studies of basalts and the accompanying age dating (Daxner-Höck *et al.* 1997, Höck *et al.* 1999). The aim was to establish a strati-

graphic concept by means of lithostratigraphy, biostratigraphy and geochronological data. The study area was chosen in an approximately NW-SE to NNW-SSE striking corridor in which Paleogene and Neogene basalts, serving as stratigraphic markers, are interlayered with continental sediments. Three basalt layers were dated. $^{40}\text{Ar}/^{39}\text{Ar}$ whole rock data showed that basalt I erupted around 31.1 Ma, i. e. Early Oligocene, basalt

II erupted in the early Late Oligocene between 27 and 28 Ma, and basalt III, finally, was emplaced in the Middle Miocene between 12.5 and 13 Ma. Throughout the whole sediment sequence seven informal biozones (A, B, C, C1, D, D1 and E) were established. They are characterized by certain rodent species, and represent from A to E a chronological sequence (Höck *et al.* 1999; Fig. 22).

The presently described fossils were recovered from sediments of the Loh Formation immediately above basalt II (TAR-A/2), and from other profiles without any basalt-contact. Three horizons of the profile RHN-A (RHN-A/7, 9 and 12) yielded three different species of *Plesiosminthus* (Fig. 6).

Methods The method of collecting was wet screening of large sediment samples. Sieves with mesh sizes of 0.5, 2.5, and 5.0 mm were used. A GPS was used to locate profiles and fossil sites. The precision of the GPS measurements is in the range of 50 to 100 m horizontally. SEM-photos of the fossils were taken by a JEOL 6400 scanning electron microscope of the Geocenter/University of Vienna. For measurements, a Leica WILD M8 stereomicroscope was used.

Plesiosminthus cf. asiaticus n. sp.

(Fig. 7, 1-9)

1999 - *Plesiosminthus* sp.1 - Höck *et al.*: p. 118

Specimens 1 P4, 2 M1, 2 M2, 1 m1, 1 m2, fragmentary jaw with m2-3. Inv. Nr. NHMW2001z 0064/0001/1-9.

Occurrence and stratigraphy Tavan Ovoony Deng (RHN-A/7), N 45°29'37" E 101°12'17", Valley of Lakes, Central Mongolia; brown silt of the Loh Formation; Late Oligocene, biozone C1.

Measurements P4 0.65 x 0.65. M1 1.35 x 1.30; 1.30 x 1.30. M2 1.30 x 1.25; 1.15 x

1.20. m1 1.25 x 0.90. m2 1.30 x 1.10; 1.20 x 1.00. m3 1.05 x 0.90.

Description

I (Fig. 7, 5) The upper incisor has a very shallow longitudinal groove. An additional shallow longitudinal notch is visible close to the median edge of the incisor.

P4 (Fig. 7, 1) is peg-like with a single root. The main cusp is antero-medial. A posterior ridge surrounds it. The upper molars have three roots.

M1 (Fig. 7, 2-3) is round-square in outline, anterior wider than posterior. A weak anterior cingulum is present at the base of the anterior wall. The anterior arm of the protocone is long. It extends to the antero-labial edge of M1, and ends in a weak parastyle. The anterocone (=protoconule) on the anterior arm of the protocone is pronounced in one specimen, it is weak in the second M1. The protoloph II connects with the posterior arm of the protocone. The metaloph extends to the anterior arm of the hypocone. The mesoloph is long. The contact between posteroloph and the posterior arm of the hypocone is weak, it is almost interrupted. The sinus is directed forwards.

M2 (Fig. 7, 4 & 6) is round-square in outline. It is anterior wider than posterior. The labial anteroloph is pronounced, the lingual one is weak. The protoloph is double. There is a weak connection of the protoloph II and the posterior arm of the protocone. The metaloph extends to the anterior arm of the hypocone. The mesoloph is long. The hypocone-posteroloph connection is weak. The sinus is directed forwards.

m1 (Fig. 7, 7) The anteroconid is pronounced. The metalophid is V-shaped. The ectolophid is long, oblique and curved, and extends from the postero-labial edge of the protoconid to the connection of the hypolophid and the anterior arm of the hypoconid. The mesolop-

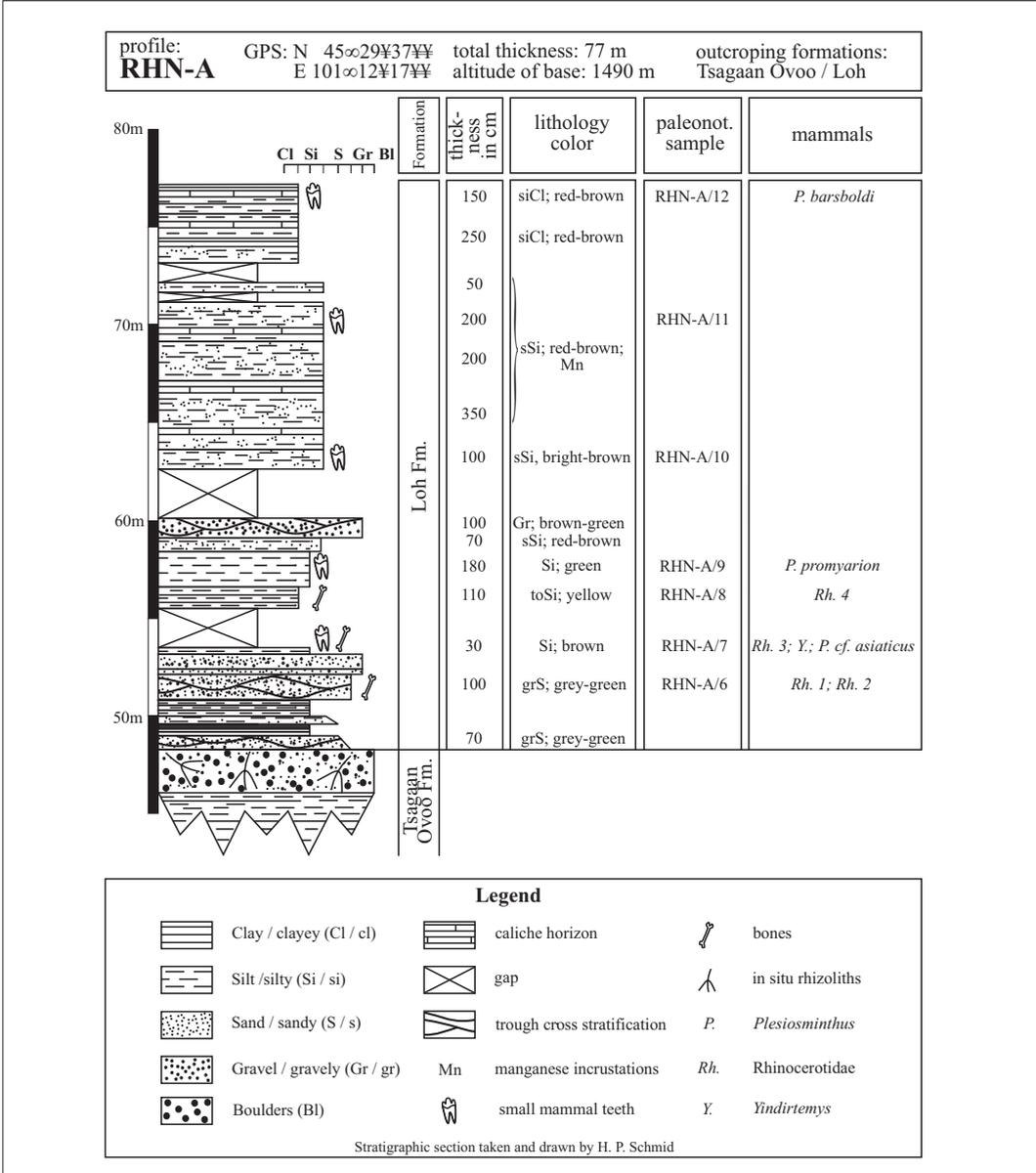


Figure 6 The profile of Tavan Ovoony Deng (RHN-A) from the Valley of Lakes in Central Mongolia.

hid is long, oblique, and has a right-angled connection with the ectolophid. The mesoconid is weak. The posterolophid is pronounced.

m2 (Fig. 7, 8-9) has a lingual and a labial anterolophid. The mesolophid is long and connects with the ectolophid right-angled.

The metalophid I connects with the anterior arm of the protoconid. The metalophid II is weak or almost absent. In one specimen there is a pronounced mesostylid. The hypolophid attaches the connection of the ectolophid and the anterior arm of the hypoconid. There is a strong posterolophid and a posteroconid.

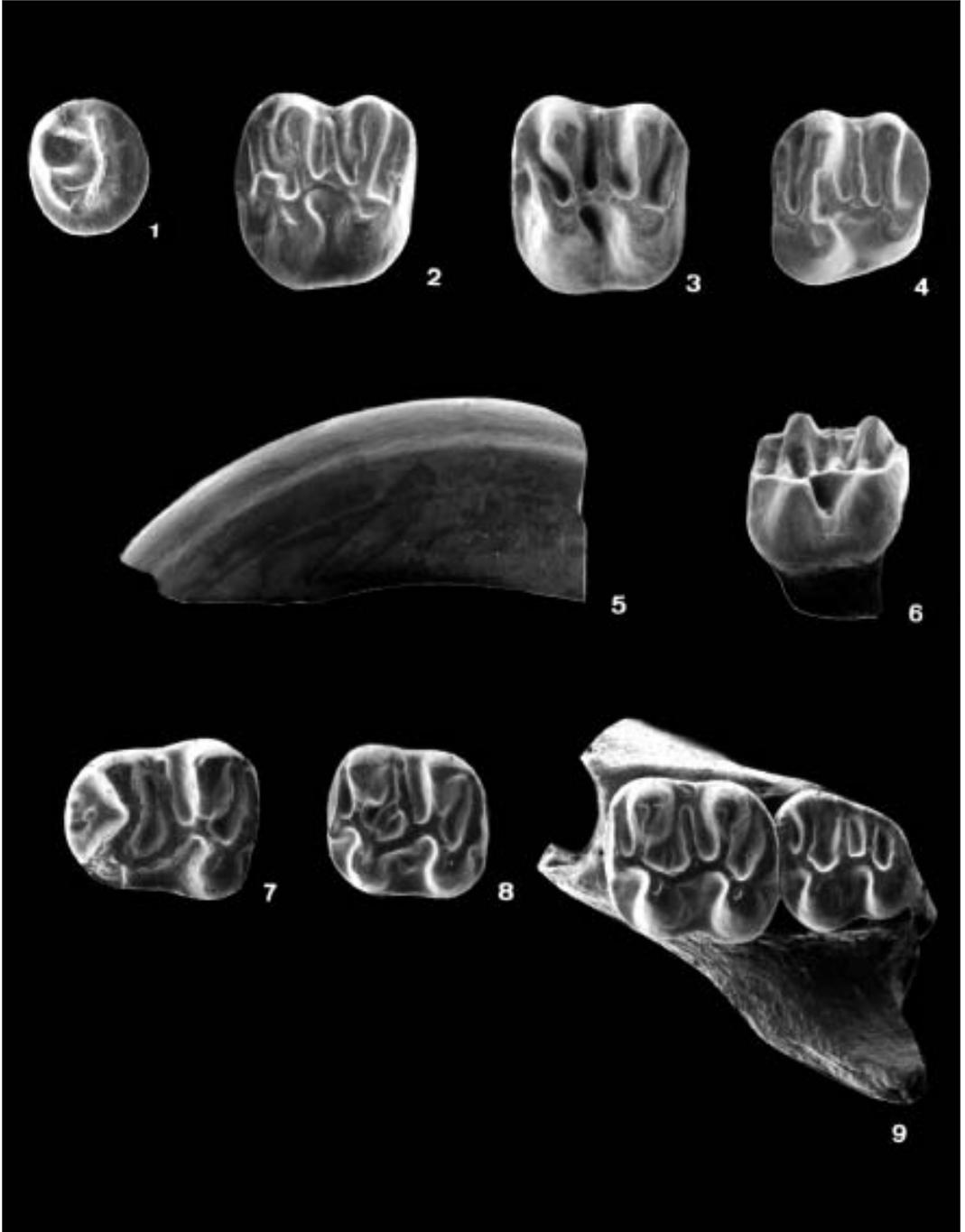


Figure 7 Dentition of *Plesiosminthus* cf. *asiaticus* n.sp. from Tavan Ovoony Deng (RHN-A/7), Valley of Lakes, Mongolia. Late Oligocene (biozone C1). Collection of the Natural History Museum, Department of geology and paleontology, Vienna. All right side (r) molars are figured as if they were from the left side (l). The magnification is 20 times. Fig. 7, **1** - P4; 2001z0064/0001/1. Fig. 7, **2** - M1l; 2001z0064/0001/2. Fig. 7, **3** - M1r; 2001z0064/0001/3. Fig. 7, **4** - M2l; 2001z0064/0001/4. Fig. 7, **5** - I sup.; 2001z0064/0001/5. Fig. 7, **6** - M2l (lingual); 2001z0064/0001/6. Fig. 7, **7** - m1r; 2001z0064/0001/7. Fig. 7, **8** - m2r; 2001z0064/0001/8. Fig. 7, **9** - m2-3r; 2001z0064/0001/9.

m3 (Fig.7, 9) is similar to the m2, but narrowed in its posterior part. There is no metalophid II in m3. The mesolophid is long.

Comparison and discussion The shallow grooved upper incisor, the molar morphology and the m3/m1 ratio (0.84) confirm *Plesiosminthus* from Tavan Ovoony Deng (RHN-A/7) to be close to, but not really identical with *P. asiaticus* from the locality Tieersihabahe in China. The small differences from *P. asiaticus* are: larger molar sizes of M1-2; metaloph of M1-2 connects with the anterior arm of the hypocone; no metalophid II of the m3; ectolophid of m1-2 pronounced, oblique; labial connection of the ectolophid with the protoconid.

Despite of these differences we determine the few teeth from RHN-A/7 as *P. cf. asiaticus*, because the material is too small to make clear whether or not it represents a different species.

In Mongolia, RHN-A/7 (Fig.6) *P. cf. asiaticus* is associated with a rhinocerotid indet. (= Rh.3), and the rodents *Yindirtemys deflexus*, *Bohlinosminthus parvulus* and *Parasminthus cf. tangingoli*. It is the first occurrence of *Plesiosminthus* in Mongolia. Biostratigraphically *Y. deflexus* marks the level of biozone C1, and *B. parvulus* was recorded for the last time in biozone C1 (Höck *et al.* 1999; 116-118; Fig. 22). The age is Late Oligocene (see Figure 11).

***Plesiosminthus promyarion* SCHAUB 1930**

(Fig. 8, 1-9)

1999 - *Plesiosminthus* sp. 2 - Höck, V. *et al.*: p. 118.

Specimens 12 fragmentary I sup., 15 fragmentary I inf., 1 M1, 3 m1, 2 m2. Inv. Nr. NHMW2001z 0065/0001/1.

Occurrence and stratigraphy Tavan Ovoony Deng (RHN-A/9), N 45°29'37" E 101°12'17", Valley of Lakes, Central

Mongolia; green silt of the Loh Formation; about 3 meters above level RHN-A/7 (with *P. cf. asiaticus*); Late Oligocene, biozone C1.

Measurements M1 1.05 x 1.00. m1 1.12 x 0.75; 1.20 x 0.80; 1.20 x 0.85. m2 1.15 x 0.90; 1.10 x 0.80.

Description

I sup. (Fig. 8,1-3) has a deep longitudinal groove that is U- shaped in cross section. There is no longitudinal notch close to the median edge of the upper incisor. All twelve incisor-fragments have very similar pattern. The I inf. have a flat anterior enamel surface.

M1 (Fig. 8, 4) is round-square in outline, anterior slightly wider than posterior. The anterior arm of the protocone is long. It extends to the antero-labial edge of the M1. It touches the anterior wall of the paracone, and ends in a weak parastyle. The protoloph II connects with the posterior arm of the protocone. The mesoloph is long and ends in a weak mesostyle. The metaloph extends to the anterior arm of the hypocone. The posteroloph is low. Its connection with the hypocone is almost interrupted. The sinus is almost symmetrical.

m1 Three first lower molars (Fig. 8, 5-7) are very similar in molar pattern. The anteroconid (=a conulid or a crest) contacts the protoconid. The metalophid is curved or weakly V-shaped. The ectolophid is long, oblique and curved. It extends from the postero-labial base of the protoconid to the connection of hypolophid and the anterior arm of the hypoconid. The mesolophid is long, oblique, and has a right-angled connection with the ectolophid. There is no mesoconid but a weak mesostylid. The posterolophid is pronounced and extends to the postero-lingual edge of m1.

m2 There are two almost identical m2 (Fig.8, 8-9). The lingual and labial arms of the anterolophid are equal. The mesolophid is long



Figure 8 Dentition of *Plesiosminthus promyarion* Schaub 1930 from Tavan Ovoony Deng (RHN-A/9), Valley of Lakes, Mongolia. Late Oligocene (biozone C1). Collection of the Natural History Museum, Department of geology and paleontology, Vienna. All right side (r) molars are figured as if they were from the left side (l). The magnification is 20 times. Fig. 8, **1** - I sup.; 2001z0065/0001/1. Fig. 8, **2** - I sup.; 2001z0065/0001/2. Fig. 8, **3** - I sup.; 2001z0065/0001/3. Fig. 8, **4** - M1r; 2001z0065/0001/4. Fig. 8, **5** - m1l; 2001z0065/0001/5. Fig. 8, **6** - m1l; 2001z0065/0001/6. Fig. 8, **7** - m1r; 2001z0065/0001/7. Fig. 8, **8** - m2l; 2001z0065/0001/8. Fig. 8, **9** - m2l; 2001z0065/0001/9.

and connects with the ectolophid right-angled. The metalophid I connects with the anterior arm of the protoconid. The metalophid II is short. The ectolophid is oblique. The hypolophid attaches the connection of the ectolophid and anterior arm of the hypoconid. Comparable to the m1 the posterolophid is long.

Comparison and discussion The pronouncedly grooved upper incisors, the small size, and the unique molar morphology confirm the small fossil material from RHN-A/9 to be *P. promyarion*. The molar measurements of the latter are smaller than any other *Plesiosminthus*-species. Level 9 of the profile RHN-A from the locality Tavan Ovoony Deng yielded remains of only two different rodents of completely different sizes. The very small sized zapodid *P. promyarion* with grooved upper incisors, plane lower incisors, and the according small molars of *P. promyarion*-pattern. The large ctenodactylid ?*Yindirtemys* sp. which is represented by a few large tooth-fragments (upper incisor and a molar). So far *P. promyarion* is known all over Europe (Germany, Switzerland, France and Spain) ranging from MP26 to MP29 (Engesser 1987, Huguene 1997, Freudenthal 1997, Kristkoiz 1992, Huguene & Vianey-Liaud 1980, and others). Proceeding on the assumption that *P. promyarion* migrated from Central Asia to Europe the first appearance in Europe in MP 26 (Mümliswil-Hardberg/Switzerland; Engesser 1987) requires a minimum age of MP26 for *P. promyarion* in Central Asia.

***Plesiosminthus barsboldi* n. sp.**

(Fig. 9, 1-7; Fig. 10, 1-12)

1997 - *Plesiosminthus* ? sp. - Daxner-Höck *et al.*: p. 173

1999 - *Plesiosminthus* sp.3 - Höck *et al.*: p. 118

Holotype Right maxilla (frag.) with P4-M1 (Fig. 9,1); Inv. Nr. NHMW2001z 0066/0002/1; from Unkheltseg, Mongolia.

Paratypes Fragmentary left maxilla with M2, 2 M1, 4 M2, 1 M3, 3 left mandibles (frag.) with m2-3, 1 right mandible (frag.) with m2-3, 4 m1, 1 m2 (Fig. 9,2-5; Fig. 10,1-8, 10-12). Inv. Nr. NHMW2001z 0066/0002/2.

Dagnosis One of the largest species of *Plesiosminthus* with lophodont molar pattern. Upper incisors with a pronounced longitudinal groove, which is V-shaped in cross section, and a longitudinal notch close to the median edge of the incisor. Upper molars extremely wide; cusps situated close to the four corners of the tooth; narrow and deep valleys between high cusps and lophs; three rooted upper molars square, sometimes wider than long; no anterior cingulum of M1; double protoloph of M2; weak connection of protoloph II and protocone; metaloph-connection anterior to hypocone; rectangular two rooted lower molars; alternating cusps transversally compressed; ectolophid short with median connection to protoconid; mesoconid strong; hypolophid-connection anterior to hypoconid; M3/m3 large; M3/M1 ratio 0.83, m3/m1 ratio 0.86.

Derivatio nominis Dedicated to Dr. R. Barsbold (Director of the Paleontological Center, Academy of Sciences, Ulan Bator).

Type locality and stratigraphy Unkheltseg (UNCH-A/3), N 45°27'41" E 101°12'05', Valley of Lakes, Central Mongolia; rose-red silt of the Loh Formation; Oligocene-Miocene transition, biozone D.

Measurements See Table 2.

Description of the holotype Fragmentary right maxilla with P4-M1 (Fig. 9,1/1). The P4 is peg-like with a single root. The single cusp is in anterior position. Posterior and lingual surrounded by a cingulum. M1 has three roots. It is almost square in occlusal outline, even a little wider than long. The four cusps



Figure 9 Dentition of *Plesiosminthus barsboldi* n. sp. from Unkheltseg (UNCH-A/3) and Tavan Ovoony Deng (RHN-A/12), Valley of Lakes, Mongolia. Oligocene-Miocene transition (biozone D). Collection of the Natural History Museum, Department of geology and paleontology, Vienna. All right side (r) molars are figured as if they were from the left side (l). The magnification is 20 times. (Figures 9, 1-5 = UNCH-A/3, Figures 9, 6-7 = RHN-A/12). Fig. 9, **1** - P4-M1r (Holotype); 2001z0066/0002/1. Fig. 9, **2** - I sup; 2001z0066/0002/2. Fig. 9, **3** - I sup; 2001z0066/0002/3. Fig. 9, **4** - left maxilla with M2; 2001z0066/0002/4. Fig. 9, **5** - left mandible with m2-3; 2001z0066/0002/5. Fig. 9, **6** - I sup; 2001z0066/0001/1. Fig. 9, **7** - m1-3; 2001z0066/0001/2.

are connected by pronounced lophes, which are almost as high as the cusps. The enclosed valleys are narrow and deep. There is no anterior cingulum. The anterior arm of the protocone is long. It extends to the anterolabial edge of the M1. There is no parastyle, but an anterocone (=protoconule) on the anterior arm of the protocone. The connection of the protocone and the protoloph is weak. The mesoloph is long. The metaloph connects with the anterior arm of the hypocone. The connection of the hypocone and the posteroloph is weak. The sinus is directed forwards.

Description of the paratypes (Fig. 9, 2-4, Fig. 10, 1-8, 10-12) According to the holotype the cusps are situated close to the four corners of the tooth. Cusps and lophes are pronounced and high. The enclosed valleys are narrow and deep. The tooth has a lophodont character. The upper molars are almost square in occlusal outline, sometimes wider than long. They have three roots. The lower molars are rectangular in occlusal outline. They have two roots. The alternating labial and lingual cusps are transversally compressed.

I (Fig. 9, 2-3) The upper incisors have a pronounced longitudinal groove, which is V-shaped in cross section. A longitudinal notch is close to the median edge of the incisor.

M1 (Fig. 10, 1-2) Are almost identical with the holotype, except for one M1 with a parastyle.

M2 (Fig. 9, 2; Fig. 10, 3-5) The anterior cingulum is labial. The protoloph is double. The connection of the protoloph II and protocone is weak or interrupted. The mesoloph is long. The metaloph connects with the anterior arm of the hypocone. The posteroloph is the weakest loph. The sinus is directed forwards.

M3 (Fig. 10, 6) is very similar with the M2, but smaller. The sinus is lingually closed.

m1 (Fig. 10, 7-8 & 10) has an anteroconid which can be isolated or connected with the protoconid or/and the metaconid. The metalophid is pronounced and V-shaped. The mesolophid is long and oblique. The hypolophid connects with the anterior arm of the hypoconid. The posterolophid is strong and has a posteroconid. There is a pronounced mesoconid, but a short ectolophid. The ectolophid is median and connects with the posteroligular part of the protoconid.

m2 (Fig. 9, 5; Fig. 10, 11) The anteroconid and the lingual anterolophid are strong, the labial anterolophid is weak. The labial cusps are posterior to the lingual ones. The metalophid I connects with the anteroconid. The metalophid II is strong, it is of medium length and connects with the posterior wall of the metaconid. The anterior fossettid is narrow. The mesolophid is long. The hypolophid connects with the anterior arm of the hypoconid. The posterolophid is strong. There is almost no ectolophid, but a pronounced mesoconid.

m3 (Fig. 9, 5; Fig. 10, 12) It is very similar to the m2 but narrowed in its posterior part. In m3 the metalophid II is partly stronger and longer than the mesolophid. The metalophid I can be reduced. The anterior fossettid is smallest.

Differential diagnosis *P. barsboldi* n. sp. differs from *P. asiaticus* n. sp. by: larger size; deeper longitudinal groove of I sup.; lophodont molar pattern; high cusps and crests, narrow and deep valleys; no anterior cingulum of M1; connection of metaloph anterior to the hypocone in M1-3. It differs from *P. promyarrion*, *P. mayrion* and *P. conjunctus* by: much larger sizes; lophodont molar pattern; high cusps and crests, narrow and deep valleys. It differs from *P. schaubi* and *P. moralesi* by: larger sizes; double protoloph of M2-3; double metalophid of m2-3; lophodont molar pattern; high cusps and crests, narrow and deep valleys. Among all known species it comes

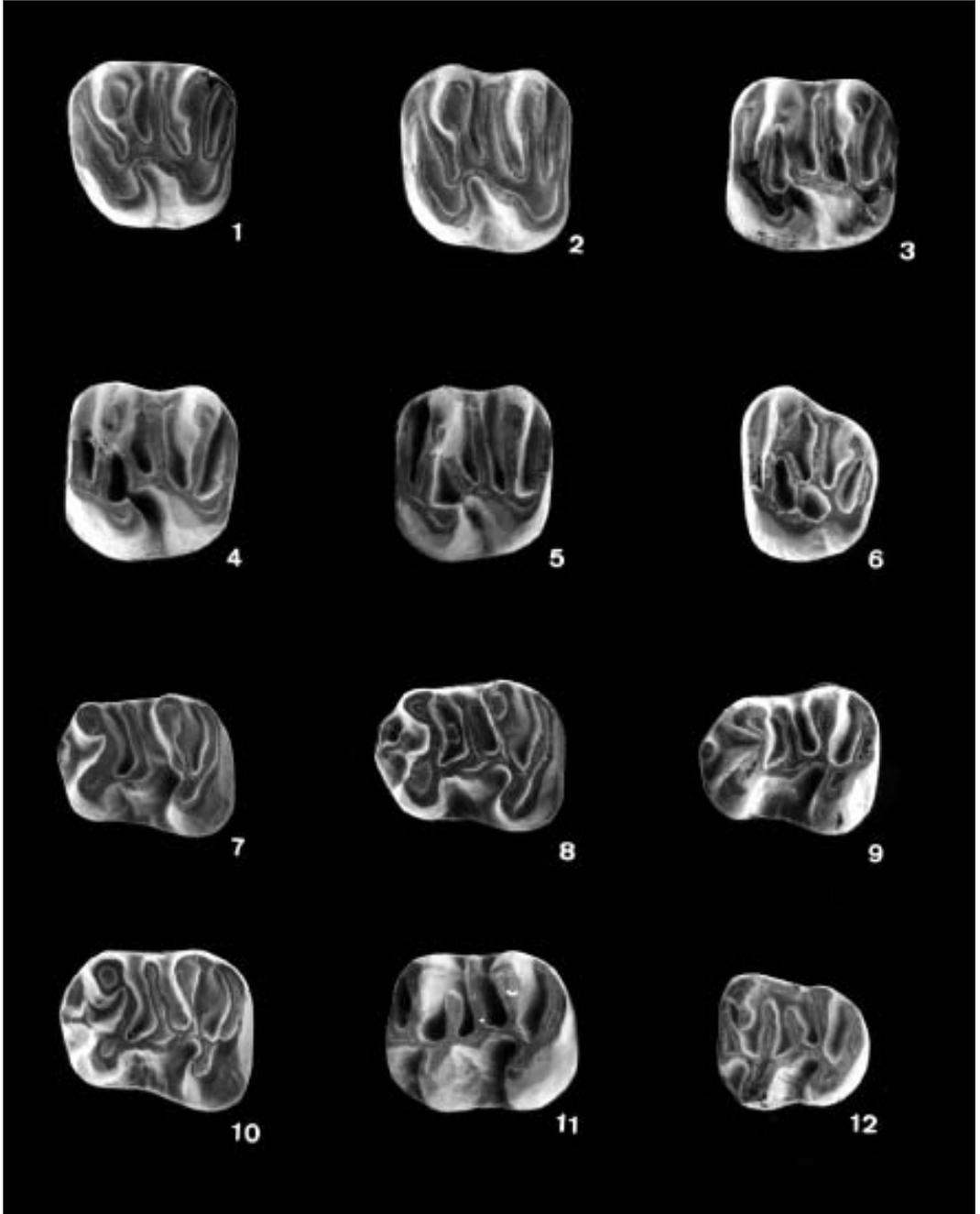


Figure 10 Dentition of *Plesiosminthus barsboldi* n. sp. from Unkheltseg (UNCH-A/3) and Tavan Oovoony Deng (RHN-A/12), Valley of Lakes, Mongolia. Oligocene-Miocene transition (biozone D). Collection of the Natural History Museum, Department of geology and paleontology, Vienna. All right side (r) molars are figured as if they were from the left side (l). The magnification is 20 times. (Figures 10, 1-8 & 10-12 = UNCH-A/3, Figure 10, 9 = RHN-A/12). Fig. 10, **1** - M1r; 2001z0066/0002/6. Fig. 10, **2** - M1r; 2001z0066/0002/7. Fig. 10, **3** - M2r; 2001z0066/0002/8. Fig. 10, **4** - M2r; 2001z0066/0002/9. Fig. 10, **5** - M2l; 2001z0066/0002/10. Fig. 10, **6** - M3r; 2001z0066/0002, 11. Fig. 10, **7** - m1r; 2001z0066/0002, 12. Fig. 10, **8** - m1r; 2001z0066/0002, 13. Fig. 10, **9** - m1l; 2001z0066/0001, 3. Fig. 10, **10** - m1r; 2001z0066/0002, 14. Fig. 10, **11** - m2l; 2001z0066/0002, 15. Fig. 10, **12** - m3l; 2001z0066/0002/16.

closest to *P. winistoerferi* but differs in: wider M1-2; smaller m3; shorter posterior arm of protoconid (=metalophid II); no additional conules or ridges in the valleys. *P. barsboldi* n. sp. differs from '*P. tereskentensis*' by: larger size; lophodont molar pattern; high cusps and crests, narrow and deep valleys.

Other occurrences of *P. barsboldi* n. sp. in Mongolia

(A) Tavan Ovoony Deng (RHN-A/12), N 45°29'37" E 101°12'17", Valley of Lakes; red silt of the Loh Formation; about 17 meters above level RHN-A/9 (with *P. promyarion*); Oligocene-Miocene transition, biozone D (see Figure 6).

Specimens 4 fragmentary upper incisors with longitudinal groove; left lower jaw with m1-3 (Fig. 9, 6-7), 1 m1 (Fig. 10, 9). Inv. Nr. NHMW2001z 0066/0001/1-6.

Measurements (m1-3 from one tooth row)
m1 1.20 x 0.95; 1.30 x 0.95. m2 1.25 x 1.00. m3 1.15 x 0.95.

Remarks The specimens do not differ from the type material in molar morphology and dimensions. The associated rodents are undetermined species of: *Prodistylomys*, *Distylomys*, *Litodonomys*, *Heosminthus*, *Heterosminthus* cf. *firmus* and an undetermined aplodontid, which are indicative for biozone D.

(B) Luugar Khudag (LOG-A/1), N 45°32'18" E 101°00'48", Valley of Lakes; red silt of the Loh Formation; Oligocene-Miocene transition, biozone D.

Specimens 1 fragmentary upper incisor with longitudinal groove, 1 m1, 2 m2. Inv. Nr. NHMW2001z 0066/0003/1-4.

Measurements m1 1.40 x 0.95. m2 1.40 x 1.10.

Remarks The specimens are rather larger

but do not differ significantly from the type material in molar morphology. The associated rodents are undetermined species of: *Prodistylomys*, *Litodonomys* and *Heterosminthus* cf. *firmus* which indicate biozone D.

Discussion *P. barsboldi*, *P.* cf. *asiaticus* from Asia and *P. winistoerferi* from Europe are large sized species of *Plesiosminthus*.

However, the shallow longitudinal groove of the upper incisors, the bunodont cusps, the wide valleys and the low lophs and the anterior part of the M1 demonstrate a more primitive stage of evolution of *P.* cf. *asiaticus* versus *P. barsboldi*. Besides differences in morphology there are differences in age. *P.* cf. *asiaticus* was recovered from a 20 meters lower level of the Tavan Ovoony Deng-profile (RHN-A/7). The fauna indicates biozone C1 / Late Oligocene. Whereas *P. barsboldi* was recovered from fossil horizons of the Oligocene-Miocene transition (RHN-A/12, UNCH-A/3 and LOG-A/1) (see Figure 6 and 11).

As demonstrated above *P. winistoerferi* and *P. barsboldi* are closest in molar morphology and dimensions. However, the European species *P. winistoerferi*, known from the Late Oligocene (MP30) of Switzerland could have descended from an Asian species close to *P. barsboldi*.

The associated rodents are: *Tachyoryctoides kokonorensis*, *Heterosminthus firmus*, and undetermined species of *Democricetodon*, *Distylomys*, *Litodonomys* 2 sp., *Pseudotheridomys*, *Heosminthus*, aplodontids and sciurids. They represent biozone D and indicate an age around the Oligocene-Miocene transition (Fig. 11).

From Mongolia, two more localities yielded fragments of grooved upper incisors or/and a few isolated molars, which resemble *Plesiosminthus*. Because of the poor material, no species was determined.

Plesiosminthus sp. A

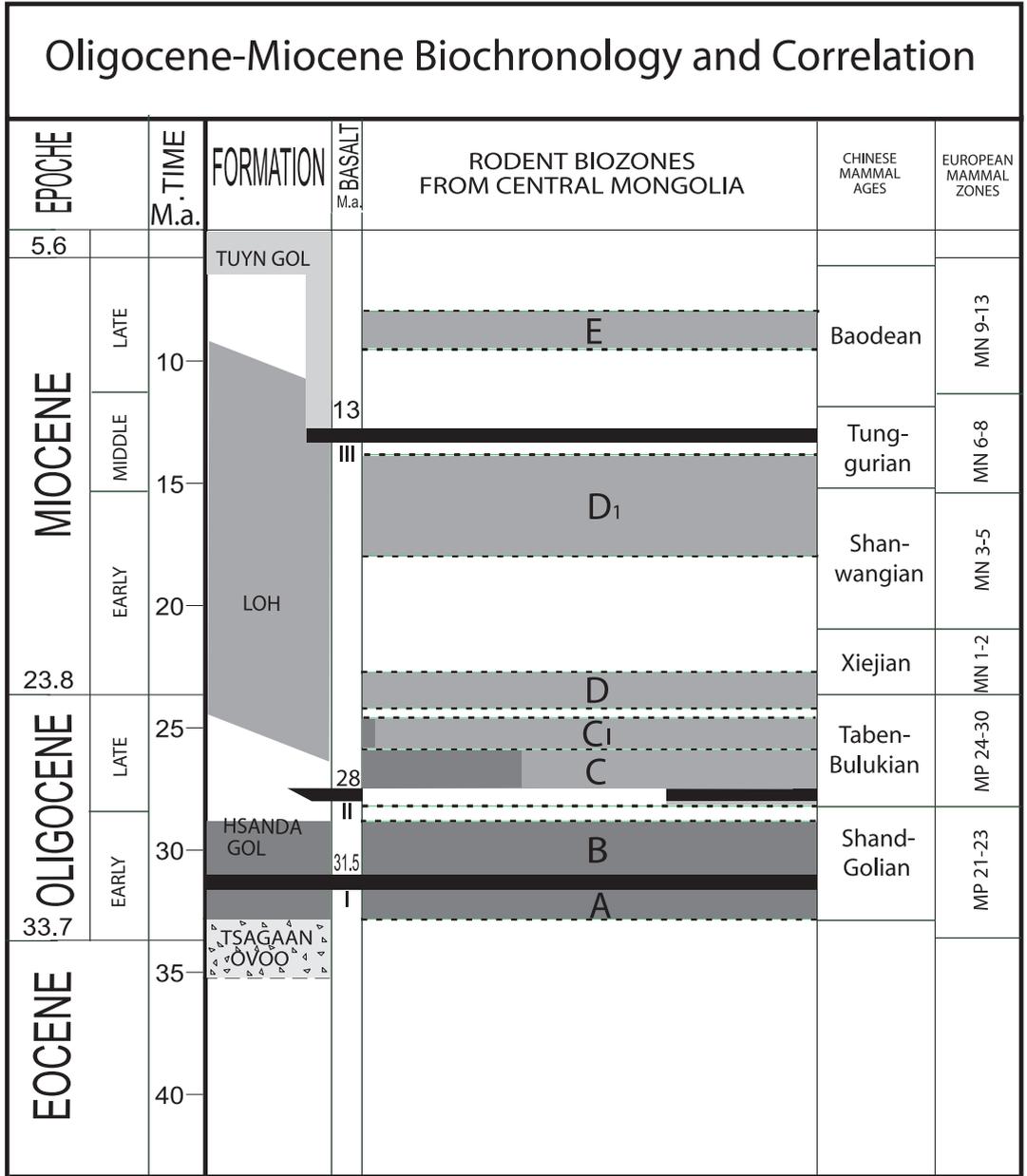


Figure 11 Correlation chart for continental Paleogene-Neogene biochronology of Asia (after Höck, V. *et al.* 1999 and Daxner-Höck, G. 2001) based on informal biozones (A-E) and on basalt datings. Tentative correlation with Chinese and European biochronologies.

Table 1 Dental measurements (in mm) of *Plesiosminthus asiaticus* n. sp.

	Length			N	Width		
	Range	mean	s		Range	Mean	s
P4	0.63-0.70	0.66	0.02	14/14	0.63-0.68	0.66	0.02
M1	1.11-1.29	1.19	0.04	30/31	0.98-1.18	1.11	0.06
M2	1.03-1.20	1.13	0.05	21/19	0.98-1.17	1.08	0.05
M3	0.88-0.93	0.90	0.02	8/6	0.88-0.98	0.93	0.04
m1	1.13-1.34	1.26	0.06	24/23	0.84-0.99	0.92	0.04
m2	1.17-1.34	1.24	0.05	40/40	0.88-1.07	0.97	0.04
m3	0.95-1.17	1.06	0.05	23/17	0.80-0.96	0.88	0.04

Occurrences and stratigraphy Tarimalyn Churem (TAR-A/2), N 45°31'06" E 101°18'23", Valley of Lakes, Central Mongolia; red silt of the Loh Formation, immediately above basalt II (40Ar/39Ar-dating: 27-28 Ma); Late Oligocene, biozone C (Fig. 11).

Specimens 2 grooved upper incisors (frag.), 1 M1, 1 m1, 2 m2. Inv. Nr. NHMW2001z 0067/0004/1-6.

Measurements M1 1.30 x 1.20. m1 1.50 x 1.05. m2 1.35 x 1.05.

Remarks The *Plesiosminthus*-material is very scarce and not homogenous, therefore for the time being we do not give any further determinations. The associated rodents are undetermined species of *Yindirtemys*, *Tataromys*, *Bohlinosminthus*, *Parasminthus*, *Heosminthus*, *Aralocricetodon*, *Eucricetodon*, *Tsaganomyidae*. They indicate biozone C.

***Plesiosminthus* sp. B**

Occurrences and stratigraphy Loh (LOH-C/1), N 45°15'44" E 101°43'03", Valley of Lakes, Central Mongolia; red silt of the Loh Formation, biozone C1 (Fig. 11).

Specimens 2 fragments of grooved upper incisors. Inv. Nr. NHMW2001z 0068/0005/1-

2.

Remarks In LOH-C/1 *Plesiosminthus* sp.3 is associated with the rodents *Yindirtemys deflexus*, *Heterosminthus* cf. *firmus* and *Litodonomys* sp. *Y. deflexus* indicates biozone C1.

THE ORIGIN AND MIGRATIONS OF PLESIOSMINTHUS

The oldest *Asian zapodids* were recovered from the Middle-Late Eocene of China and described by Tong (1997) as *Primismynthus* and *Banyuesminthus*. Wang (1985) described three genera from the Late Eocene of China, *Sinosminthus*, *Allosminthus* and *Heosminthus*, *Primismynthus*, *Banyuesminthus* and *Allosminthus* so far are restricted to the Chinese Eocene, but descendants of *Heosminthus* developed in Asia during the Oligocene to the Oligocene-Miocene transition. Through the Late Eocene and Oligocene times, the diversity and abundance of zapodids increased. Thus, *Shamosminthus* HUANG 1992, *Parasminthus* BOHLIN 1946, *Heterosminthus* SCHAUB 1930), *Gobiosminthus* HUANG 1992, *Litodonomys* WANG & QIU 2000, *Tatalsminthus* DAXNER-HÖCK 2001, *Bohlinosminthus* LOPATIN 1999 and *Heosminthus* WANG 1985 were recorded from many Oligocene localities from China, Mongolia and Kazakhstan. All these Oligocene zapodids, with primitive, low

Table 2 Dental measurements (in mm) of *Plesiosminthus barsboldi* n. sp.

	Length				Width		
	Range	mean	s	N	Range	Mean	s
P4	0.40			1	0.50		
M1	1.15-1.25	1.20	0.05	3	1.25-1.30	1.27	0.03
M2	1.15-1.25	1.20	0.05	5	1.20-1.30	1.23	0.04
M3	1.00			1	1.00		
m1	1.25-1.40	1.33	0.06	4	0.95-1.00	0.99	0.02
m2	1.30-1.40	1.36	0.04	5	1.00-1.10	1.05	0.04
m3	1.05-1.25	1.14	0.09	4	0.95-1.00	0.99	0.02

crowned cheek teeth of bunolo-phodont molar pattern and ungrooved upper incisors, originated, radiated and remained in Asia. The one exception is *Plesiosminthus* VIRET 1926 (narrow sense), which had a grooved enamel surface on the upper incisors, a dominant feature that can be traced through all of its species. Contrary to Li & Qiu (1980), we agree with Wang (1985) to exclude all zapodid species which have ungrooved upper incisors and more than 3 roots in the upper molars from the genus *Plesiosminthus*.

Plesiosminthus migrated to Europe in the Late Oligocene, where it first appeared in MP 26 (*P. promyaron*), and to North America, where a close relative, *Schaubeumys grangeri* WOOD 1935, was described from the Early Miocene. There is a long discussion whether or not *S. grangeri* is synonymous with *Plesiosminthus* (Engesser 1979; 35). The assumed Asian origin of *Plesiosminthus* was not confirmed so far, although Wang (1985; 361-362) stated that *Plesiosminthus* could have descended from *Heosminthus* in keeping the *Heosminthus*-like molar pattern but successively developed grooved upper incisors and a long anterior arm of the protocone of M1. *Heosminthus* is one of the most conservative and long-living Asian zapodids, known to have survived from the Late Eocene to the Oligocene-Miocene transition. Its molar pattern is very similar to the European *Plesiosminthus*, but the upper incisors have a flat anterior enamel surface.

The above-described findings confirm the existence of *Plesiosminthus* in Asia. The occurrences from the Late Oligocene and from the Oligocene-Miocene transition of China and Mongolia are summarized here:

- *P. asiaticus* - from the Late Oligocene of the northern Junggur Basin in China, and *P. cf. asiaticus* from the Valley of Lakes in Central Mongolia (RHN-A/7; Late Oligocene, biozone C1). *P. asiaticus* has a very shallow longitudinal groove of the upper incisors and is thought to be the most primitive species.
- *P. promyaron* - from the Late Oligocene (RHN-A/9; biozone C1) of Mongolia. It has a pronounced longitudinal groove of the upper incisors. The size and pattern of molars and incisors is identical with *P. promyaron* known from European localities of the Late Oligocene (MP 26-29).
- *P. barsboldi* - from the Oligocene-Miocene transition of Mongolia (biozone D). Localities: RHN-A/12, UNCH-A/3, LOG-A/1 (Fig. 5). It is the most advanced Asian species with deeply grooved incisors and bunolo-phodont molar pattern. The M3/m3 are relatively long. Among all known species it comes closest to *P. winistoerferi* (MP 30) from Europe.
- *P. sp. A* and *P. sp. B* - from the Late Oligocene of Mongolia (TAR-A/2; biozone C and LOH-C/1; biozone C1).
- *P. sp. 1* (large) and *P. sp. 2* (small) from the Oligocene-Miocene transition of China

(Locality 99005).

As demonstrated above, *Plesiosminthus* derived in Asia from *Heosminthus* and migrated to the west. *P. promyaron* - known from the Late Oligocene of Mongolia - was the first zapodid species to arrive in Europe in the Late Oligocene. *P. winistoerferi* could have originated from an Asian relative of *P. barsboldi* which migrated to Europe end of the Oligocene.

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