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Middle Miocene assemblage of Rodents from Bonanza site near Devínska Nová Ves (Slovakia)

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Abstract. Eleven taxa of rodents (*Spermophilinus bredai*, Sciuridae gen. et spec. indet., *Eumyarion* sp., ?*Megacricetodon* sp., *Democricetodon vindobonensis*, ?Cricetidae gen. et spec. indet., *Neocometes brunonis*, *Bransatoglis astaracensis*, ?Gliridae gen. et spec. indet., ?Eomyidae gen. et spec. indet., and Rodentia gen. et spec. indet.) have been determined in the Middle Miocene micromammal assemblage from Devínska Nová Ves-Bonanza fossil site. Although this Late Badenian (MN 6) rodent assemblage is similar to that of Devínska Nová Ves-Fissures (Middle Badenian, early MN 6), it shows a decrease of the diversity, caused probably by environmental changes at the beginning of the Late Badenian in the Vienna Basin area. Found rodents inhabited forested insular region neighbouring with freshwater lagoon, marsh or delta.

Key words: Sciurids, Cricetids, Glirids, Eomyids, Late Badenian, MN 6, Devínska Nová Ves, Slovakia

1. Introduction

Records of fossil rodents are frequent in Miocene terrestrial deposits of Europe. However, only isolated teeth and bones are mostly found.

In Slovakia, only four of 13 sites with a record of Miocene mammals yielded also remains of rodents. The stratigraphically youngest record is known from the Late Miocene (MN 10) site of Pezinok, where Joniak (2005) recently found rodent assemblage with *Spermophilinus bredai*, ?*Albanensia* sp., *Trogontherium minutum*, *Microtocricetus mollasicus*, *Kowalskia* sp., *Progonomys* sp., Muridae gen. et spec. indet., *Anomalomys gaillardi*, *Graphiurops austriacus*, *Glirulus* (*Paraglirulus*) sp., and *Eomyops* sp.. He also mentions a fossil assemblage of micromammals from Borský Svätý Jur (MN 9) containing remains of *Spermophilinus bredai*, *Steneofiber* sp., *Trogontherium minutum*, *Eumyarion latior*, *Megacricetodon minutus*, *Democricetodon* sp., *Microtocricetus mollasicus*, *Glirulus* cf. *lissiensis*, *Muscardinus hispanicus*, Gliridae gen. et spec. indet., *Eomyops catalaunicus*, and *Keramidomys* sp.. Terrestrial deposits of Devínska Nová Ves-Fissures (also known as Neudorf-Spalte, MN 6) yielded thus far the richest insectivore assemblage, including *Spermophilinus bredai*, *Blackia miocaenica*, *Eumyarion latior*, *E. weinfurteri*, *Megacricetodon gregarius*, *M.* cf. *schaubi*, *Democricetodon vindobonensis*, *Lartetomys* cf. *zapfei*, *Neocometes brunonis*, *Anomalomys gaudryi*, *Bransatoglis astaracensis*, *Microdyromys* cf. *miocaenicus*, *Miodyromys hamadryas*, *Myoglis larteti*, *Muscardinus sansaniensis*, *Eomyops* sp., and *Keramidomys carpathicus* (Zapfe, 1949; Schaub & Zapfe, 1953; Fejfar, 1974; Sabol et al., 2004). However, only undetermined finds of rodent incisors are thus far known from the marine deposits of Devínska Nová Ves-Sandpit (also known as Neudorf-Sandberg; Thenius, 1952), dated to the late MN 6. Similarly, only *Eumyarion* sp. was known so far from nearby Bonanza site (Holec et al., 1987).

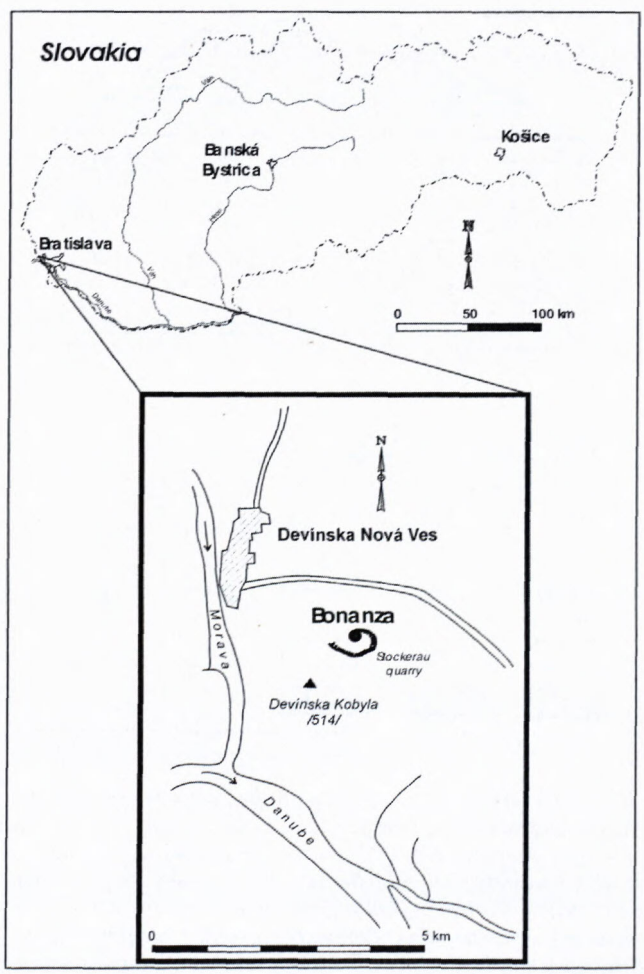


Fig. 1. Location of the Bonanza site on northern slopes of Devínska Kobyla Hill near Devínska Nová Ves (Neudorf) (according to Koretsky & Holec, 2002; partly modified).

The studied site is located at the eastern margin of the former Stockerau limestone quarry on the northern slope of the Devínska Kobyla hill near Devínska Nová Ves, a suburban part of Bratislava (a geographic co-ordinates of the site are 48° 12' N and 17° 01' E; Fig. 1). It is a broad fissure situated in the protective wall of Lower Jurassic limestone, oriented towards the railway line from Bratislava to Prague. Marine sands, sandstone, and large limestone boulders fill the fissure (Fig. 2). A detailed description of the site has been presented by Holec et al. (1987), who also mentioned rodent remains from marly to sandy deposits of layers Nr. 11 and 13 as well as from a vertical crevice of karsted debris on the left side of the exposed fissure (Fig. 2). The last research in 2001-2002 yielded fossils of eleven rodent taxa (*Spermophilinus bredai*, Sciuridae gen. et spec. indet., *Eumyarion* sp., ?*Megacricetodon* sp., *Democricetodon vindobonensis*, ?Cricetidae gen. et spec. indet., *Neocometes brunonis*, *Bransatoglis astaracensis*, ?Gliridae gen. et spec. indet., ?Eomyidae gen. et spec. indet., and Rodentia gen. et spec. indet.). Many of them represent the important finds from biostratigraphic viewpoint.

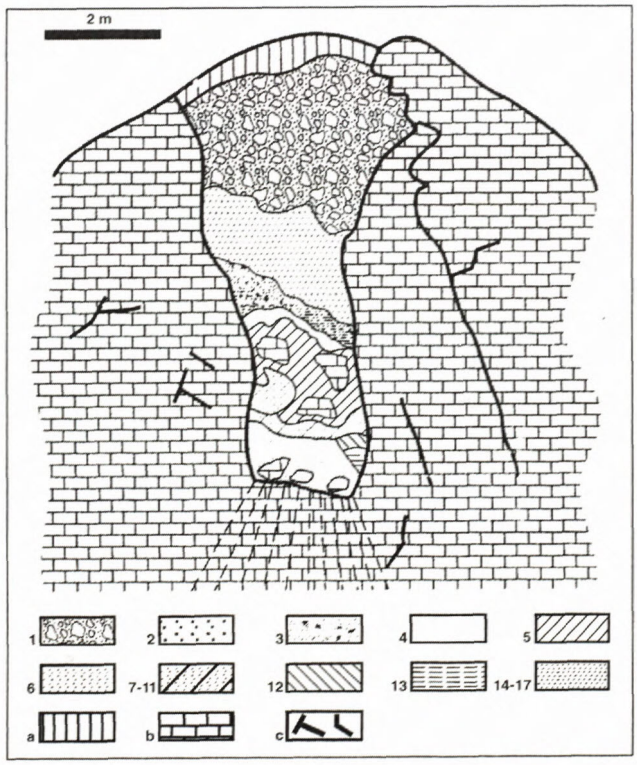


Fig. 2. Generalized section through the sediments of Bonanza (according to Ivanov, 1998).
1 – fine limestone debris; 2 – white lime sand; 3 – disaggregating sandstone with a higher content of muscovite; 4 – solid, light yellow marlstone with a great quantity of fossils; 5 – big boulders with white lime matter; 6 – greenish sand with interbeds of white lime matter; 7-11 – layers with coarse-grained, disaggregating sandstone without fossils to the fossiliferous marl, rich in fossils; 12 – white calciferous sandstone; 13 – yellowish-white sand with a large quantity of fauna; 14-17 – greenish to light sandstone, the biggest quantity of fossils are contained in the layer No. 17; a – Holocene humus-carbonate soil; b – Lias limestone; c – tectonic faults.

Apart from rodent remains, transgressive sandy sediments of the fissure also contain abundant marine and terrestrial vertebrates and invertebrates (Holec et al., 1987; Špinar et al., 1993; Ivanov, 1998; Koretsky & Holec, 2002; Sabol, *in press*). The fossil assemblage from the Bonanza site could be important in interregional correlations.

2. Material and methods

Former fossil remains of rodents were collected by amateur paleontologist Š. Meszároš in the 1980s. New material has been found by the screen washing of fossiliferous sediments in 2002. The studied material is a part of the fossil vertebrate collections of the Slovak National Museum - Natural History Museum (SNM-NHM; Meszároš 's collections), and of the Department of Geology and Paleontology, Comenius University (DGP; new finds) in Bratislava.

Fossils were documented by magnifying using Carl Zeiss Jena binocular, drawing apparatus Meopta, and camera Nikon F-70, as well as scanned by SEM Philips XL30CP. They were measured partly according to methods of Anděra & Horáček (1982) and Daams & Freudenthal (in Freudenthal, 1988). All measured data are given in millimetres.

For terminology of tooth crowns, the papers of Bolliger (1992) for sciurids, Mein & Freudenthal (1971) for cricetids, Fejfar (1999) for platacanthomyines, and Daams (1981) for glirids are followed.

Abbreviations for the dimensions of the teeth and mandibles are: HM – height of the mandible, L – max. length of the tooth, LM – medial length, LOID – length of the lower tooth-row, Lm1-m3 – length of m1 – m3, W - maximum width of the tooth, WM – medial width.

3. Systematic paleontology

Family Sciuridae Fischer de Waldheim, 1817
Subfamily Sciurinae Fischer de Waldheim, 1817
Tribe Marmotini Pocock, 1923
Subtribe Spermophilina Moore, 1959
Genus *Spermophilinus* de Bruijn & Mein, 1968

Spermophilinus bredai (VON MAYER, 1848)

Figs. 3 and 4

Material: m1 dext. (SNM-NHM, Z-14594, layer Nr. 13) and m2 sin. (SNM-NHM, Z-14593, layer Nr. 4).

Description: The unworn crown of right m1 is only slightly damaged. The metaconid is the largest cusp, with a distinct medio-anterior crest passing into the robust anterolophid. An antero-buccal syncline-like depression separates the damaged anteroconid from the conspicuous protoconid with the evident protolophid. Together with the anterolophid and a small crest between the protoconid and the anteroconid, it restricts a deep square-shaped depression. Between the protoconid and the distinct hypoconid, the small mesoconid with the tiny ectolophid is situated. The posterolophid consists of some small cusps, the largest of which is probably the entoconid(?). The mesostylid is not distinguishable. A deep dish-like basin

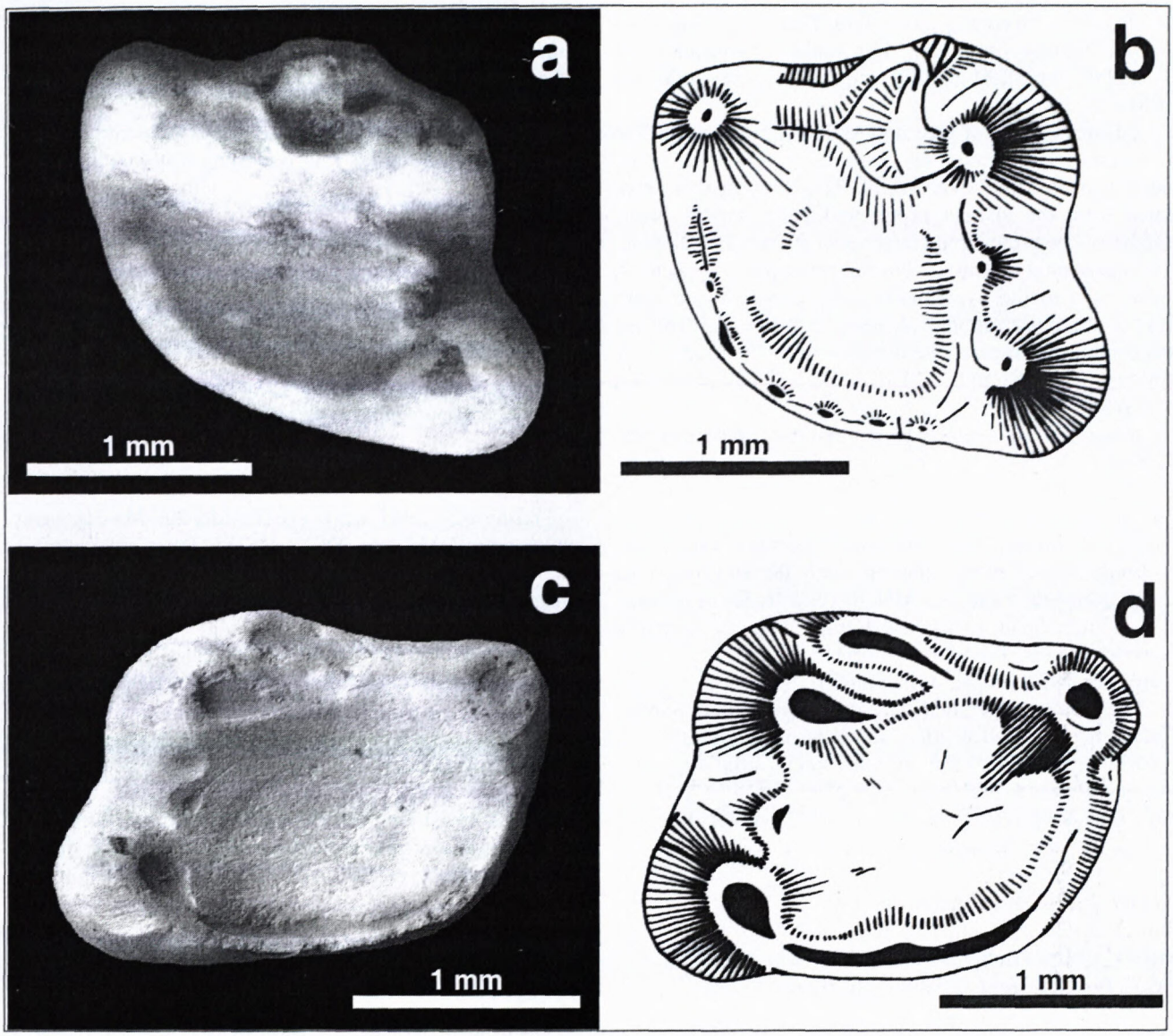
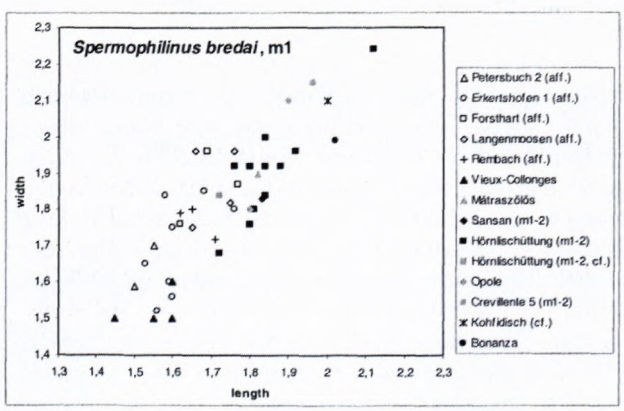


Fig. 3. Spermophilinus bredai (von Mayer, 1848), Late Badenian (MN 6), Bonanza. a-b) m1 dext. (Z-14594, occlusal view); c-d) m2 sin. (Z-14593, occlusal view).



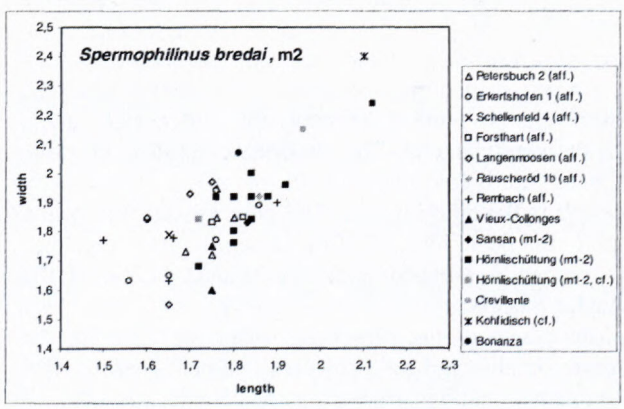


Fig. 4. Bivariate plot of molar (m1, m2) length/width of Spermophilinus bredai (used data: Bachmayer & Wilson, 1970; Baudelot, 1972; Bolliger, 1992; de Bruijn et al., 1975; Gál et al., 2000; Kowalski, 1967; Ziegler & Fahlbusch, 1986).

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is situated in the central crown part. From four roots, only one is entirely preserved. The molar dimensions are: L = 2.02 mm, LM = 1.76 mm, W = 1.99 mm, and WM = 1.73 mm.

All main cusps of the rootless left m2 are worn. The metaconid passes into the marginal anterolophid, connecting it with the anteroconid. This low cusp is separated from the distinct protoconid by a narrow basin. Medially, the protoconid connects to the tiny protolophid. The mesoconid is distinct, but the ectolophid is absent. A worn facet of the hypoconid nearly passes into a worn one of the posterolophid. A deep dish-like basin forms the central crown part. The dimensions of the tooth are as follows: L = 2.81 mm, LM = 1.58 mm, W = 2.07 mm, and WM = 2.03 mm.

Remarks: The genus *Spermophilinus*, described by Kretzoi (1951) as *Csakvaromys* and classified by de Bruijn (1999) to the tribe Tamiini, is one of the dominating ground squirrel genera in the European Neogene (MN 4 to MN 14; de Bruijn, 1999). From four species of this genus, *S. bredai* is the most common, with the stratigraphical range from MN 4 (aff.) to MN 10 (cf.). Its fossil records, known from Spain to Central Europe, show a relatively considerable variability in the morphology and size of teeth (Engesser, 1972; Ziegler & Fahlbusch, 1986).

The Bonanza specimens are rather larger than Sansan fossils, but they fall to the size-range of *Spermophilinus bredai*, showing also the morphological similarity with the fossil record of the Middle Miocene sites such as Anwil in Switzerland (Engesser, 1972) or localities in Hungary (Gál et al., 2000; Hír, 2001).

Family Cricetidae Rochebrune, 1883
Subfamily Cricetodontinae Schaub, 1925
Tribe Cricetini Fischer de Waldheim, 1817
Genus *Megacricetodon* Fahlbusch, 1964

?*Megacricetodon* sp.,
Fig. 5a, b, e, f

Material: Damaged left mandible with incisor (SNM-NHM, Z-14595, layer Nr. 17).

Description: The light-brown to brown hemimandible is slightly damaged in the posterior part. The hook-like coronoid process is tiny, whereas the condylar one is robust, with the broken posterior part and with a distinct blunt hump-shaped protuberance on the buccal side. The broken angular process probably formed a right angle with the condylar one. The masseteric fossa is shallow, extended up below the alveoli of m1 and distinctly bounded in the anterior part. The only mental foramen is close to the posterior part of the diastema. The mandibular foramen is situated over the ventral ramus of the condylar process.

The crown of the preserved lower incisor with the blackish dentine and the brownish enamel is worn, with an indistinct shallow groove on the labial side merging into an indistinct ridge. The bone between oval to round alveoli of the single molars is "serrated". Dimensions of the hemimandible are: HM (from the base to the coronoid process) = 6.35 mm and LOID = 3.60 mm.

Remarks: Exact determination of the hemimandible under study is more or less impossible because of the absence of molars. However, its appearance and the incisor texture distinctively indicate a cricetid, showing a close similarity with the *Democricetodon* record (see below). In spite of it, this find is slightly different: it is relatively more slender and longer, with the more blunt humpy protuberance on the buccal side of the condylar process and the more marked anterior part of the masseteric fossa; and the mental foramen is smaller and placed more nearly the diastema posterior margin. Thus, the including of the found molar-less hemimandible to the similar and relative genus of *Megacricetodon* is assumed.

Genus *Democricetodon* Fahlbusch, 1964
Democricetodon vindobonensis (Schaub & Zapfe, 1953)
Figs. 5c, d, g-r and 6

Material: 2 M1 dext. (DGP, MS-29, MS-30, layer unknown); 1 M2 sin. (DGP, MS-31, layer unknown); 1 m2 sin. (SNM-NHM, Z-14598, layer Nr. 13); and damaged left mandible with incisor and m1 – m3 (SNM-NHM, Z-14597, layer Nr. 17).

Description: The teeth, with generally light-brown low crowns, are unworn to worn and two of them (MS-30 and Z-14598) are damaged. Their roots are mostly broken off.

The anterocone of M1s (if preserved) is simple, undivided, and arched mesially. The anteromesoloph is slightly conspicuous. Other main cusps (protocone, paracone, hypocone, and metacone) are also clearly distinguishable. The protolophule I is not developed, while the protolophule II and the entoloph are evident. The long mesoloph extends to the tiny mesostyle and the metalophule is connecting to the metacone, which is posteriorly bordered by the marked posteroloph. The dimensions of molars are as follows: L = 1.62 mm (MS-29), W = 1.00 mm (MS-29), and 1.02 mm (MS-30).

The distinct anteromesoloph of the only M2 anteriorly borders the conspicuous paracone with the meander-like protolophule on the medial side. The mesoloph is long and narrow, extending almost to the buccal crown margin. The metalophule forms only a short spur on the postero-medial side of the metacone, merging into the marked posteroloph. L = 1.22 mm and W = 1.14 mm.

The broad anteroconid of m1 at the hemimandible is simple, undivided, merging into the short anterolophulid without clearly distinguishable spurs. The lingual cusps (metaconid and entoconid) are lower than buccal, more conical ones (protoconid and hypoconid). Whereas the metalophulid is short and wide, the mesolophid is long and narrow, extending to the blunt mesostylid. Opposite the short and wide hypolophulid, a small ridge (ectomesolophid?) is situated in the sinusid between the protoconid and the hypoconid. The partly worn posterolophid forms the postero-lingual margin of the crown. The molar dimensions are: L = 1.27 mm and W = 0.90 mm.

The anterolophid is distinct, situated on the mesial side of the both m2s. The metalophulid and the hypolophulid are almost symmetric, curved forward to anterior crown margin. The long and narrow mesolophid extends

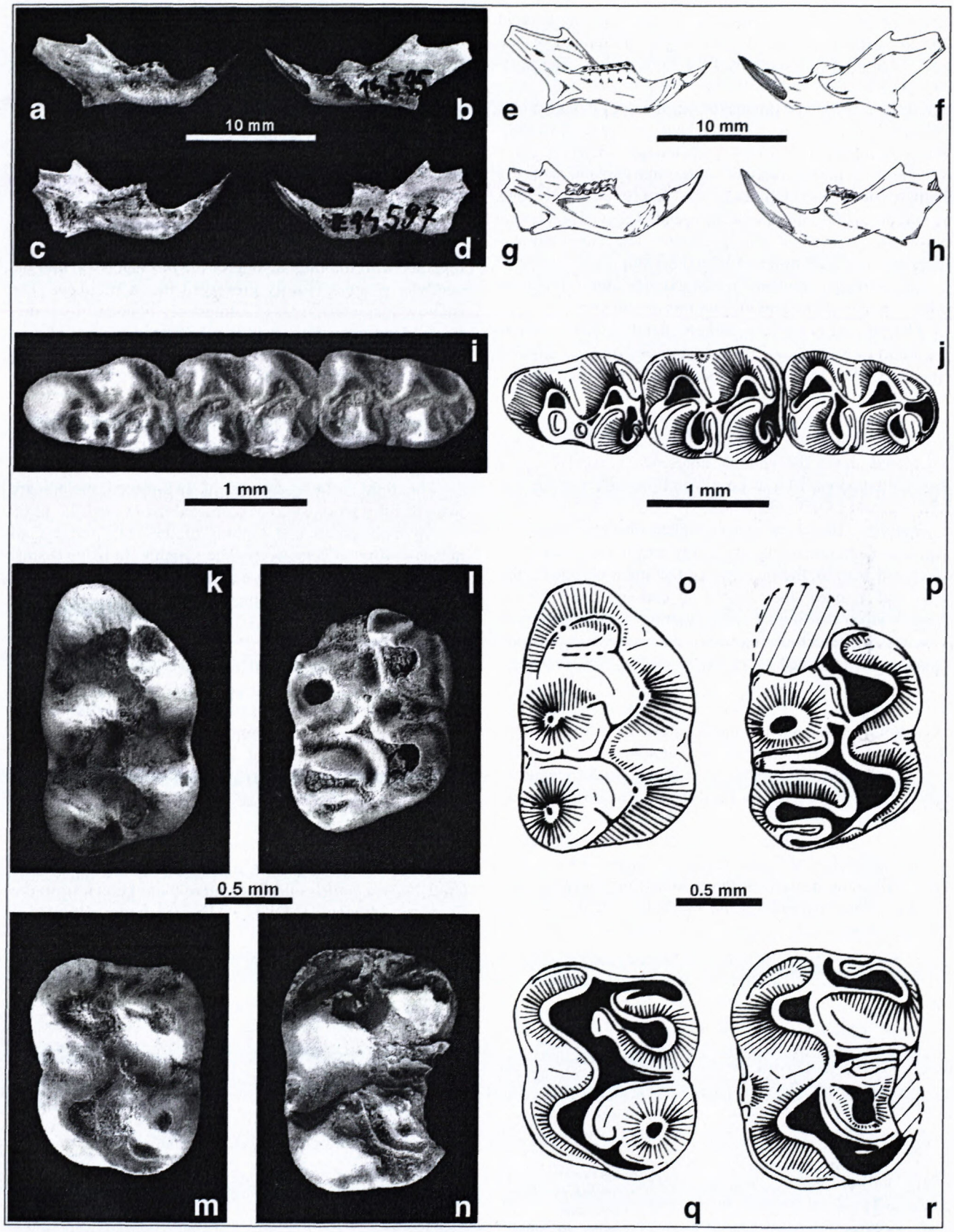

Fig. 5. ?Megacricetodon sp. and Democricetodon vindobonensis (Schaub & Zapfe, 1953), Late Badenian (MN 6), Bonanza.
?Megacricetodon sp.: a-b, e-f – left hemimandible (Z-14595, a, e – lingual view, b, f – buccal view).
Democricetodon vindobonensis (Schaub & Zapfe, 1953): c-d, g-h – left hemimandible (Z-14597, c, g – lingual view, d, h – buccal view); i-j – m1-m3 sin. (Z-14597, occlusal view); k, o – M1 dext. (MS-29, occlusal view); l, p – M1 dext. (MS-30, occlusal view); m, q – M2 sin. (MS-31, occlusal view); n, r – m2 sin. (Z-14598, occlusal view).

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up to the lingual crown margin. Between the protoconid and the hypoconid, the tiny ectostylid is situated on the buccal cingulid-like margin of the both molars. The posterolophid is conspicuous, forming the postero-lingual margin of the crown. The dimensions of the both molars are as follows: L = 1.18 mm (Z-14597) and 1.43 mm (Z-14598); W = 1.00 mm (Z-14597) and 1.12 mm (Z-14598).

The only m3 is relatively long and narrow, with the distinct short metalophulid, the faintly marked long mesolophid, and with the deep, rounded depression (posterosinusid) instead of the entoconid. The molar dimensions are: L = 1.22 mm and W = 0.86 mm.

An indistinct shallow groove extends along the labial side of the brown to grey-brown incisor enamel.

The light-brown damaged hemimandible has the short and blunt coronoid process, broken condylar and angular processes, and the shallow masseteric fossa, extending up below the anterior margin of m1, and with a blunt protuberance in the posterior part. The only mental foramen is situated below the diastema. The mandibular foramen is situated above the ventral ramus of the condylar process. Dimensions of the hemimandible are: Lm1-m3 = 3.72 mm and LOID ~ 3.80 mm.

Remarks: Based on morphological characteristics (the long mesoloph extending to the tiny mesostyle on the buccal crown margin; the presence of the anteromesoloph, the long and narrow mesolophid extending to the blunt mesostylid on the lingual crown margin; and the assumed presence of the ectomesolophid), the mentioned cricetids fossils are determined as *Democricetodon vindobonensis*, which mainly resemble *D. gaillardi* from the Sarmatian deposits (Fejfar, 1974). However, the type material, originally described by Schaub and Zapfe (1953) from Devínska Nová Ves-Fissures as *Cricetodon brevis vindobonensis*, is generally smaller than *D. gaillardi* (Schaub & Zapfe, 1953; Fejfar, 1974). Further, the Bonanza record is even smaller, when dimensions of found teeth fall into the range of *D. gracilis* (Fig. 6). Thus, it shows to the possibility of a wider metric variability of *D. vindobonensis*, indirectly validating a view on the assumed phylogenetic line *gracilis – vindobonensis – gaillardi* (Fejfar, 1974).

Subfamily Platacanthomyinae Alston, 1876
Tribe Platacanthomyini Stehlin & Schaub, 1951
Genus *Neocometes* Schaub & Zapfe, 1953

Neocometes brunonis Schaub & Zapfe, 1953

Figs. 7 and 8

Material: Fragment of right mandible with m1 – m3 (SNM-NHM, Z-14596/1, layer unknown); 1 m2 dext. (SNM-NHM, Z-14596/2, layer Nr. 13?).

Description: The tawny hemimandible is very damaged – the coronoid and angular processes are broken off together with the lingual side of the *pars incisiva*, and the condylar process is only preserved like a fragment. The shallow masseteric fossa is anteriorly bounded by a distinct edge, extending below m1. The posterior of two mental foramens is larger. The distinct mandibular foramen is situated above the ventral ramus of the condylar process. LOID is approximately 5.10 mm.

Only exposed posterior crown part of the lower incisor with blackish dentine and grey enamel is preserved. Its lingual side is nearly flat.

The light yellow crowns of two-rooted molars are worn to fully worn, such as damaged m1 (W = 1.23 mm).

All main cusps and lophids of the both undamaged m2s are worn to very worn. The syncline Ia is not distinguished. Other synclines are either deep or shallow; some of them (the syncline I in one case and the syncline IV of the both molars) are closed for the reason of deeper wear. Two roots of the loose m2 are posteriorly curved; the anterior root is longer and narrower than posterior one. The dimensions of the both m2s are as follows: L = 1.71 mm (Z-14596/1) and 1.81 mm (Z-14596/2), W = 1.24 mm (Z-14596/1) and 1.56 mm (Z-14596/2).

The triangular crown of m3 is damaged (a part of the posterior side is broken off) and very worn. Thus, all synclines (with the exception of the syncline III) are closed. The mesial margin is posteriorly arched. The dimensions of the molar: L = 1.36 mm and W = 1.16 mm.

Remarks: Two species of platacanthomyine rodents (*Neocometes similis* and *N. brunonis*) are known from the European Miocene (MN 3? – MN 7/8; Fejfar, 1999) to-

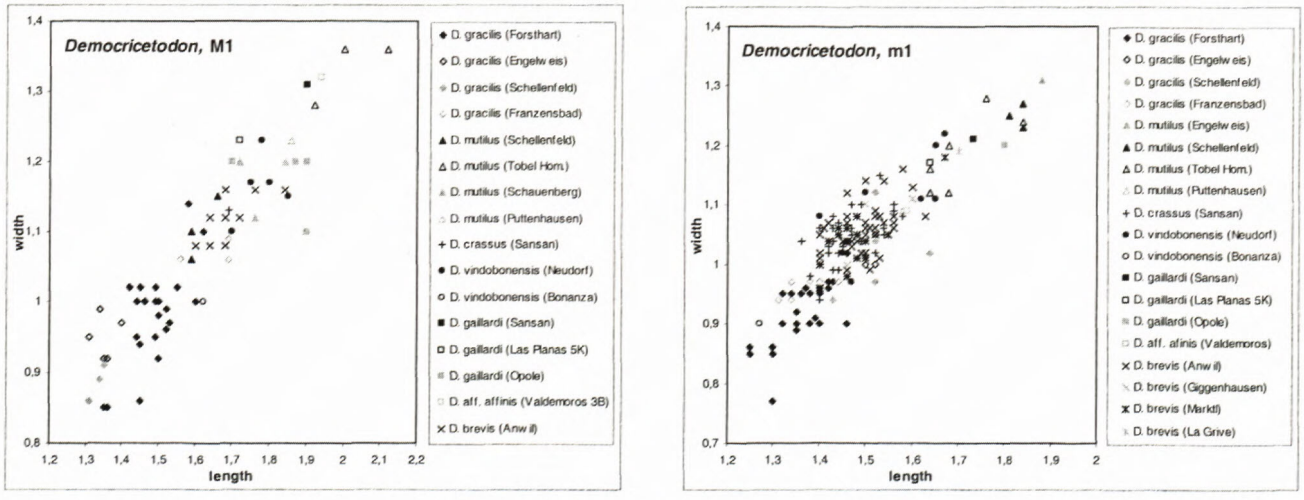

Fig. 6. Bivariate plot of molar (M1, m1) length/width of *Democricetodon*-species from the Miocene of Europe (used data: Baudelot, 1972; Bolliger, 1992; Engesser, 1972; Fejfar, 1974; Freudenthal & Daams, 1988; Kowalski, 1967; Schaub & Zapfe, 1953; Ziegler, 1995; Ziegler & Fahlbusch, 1986).

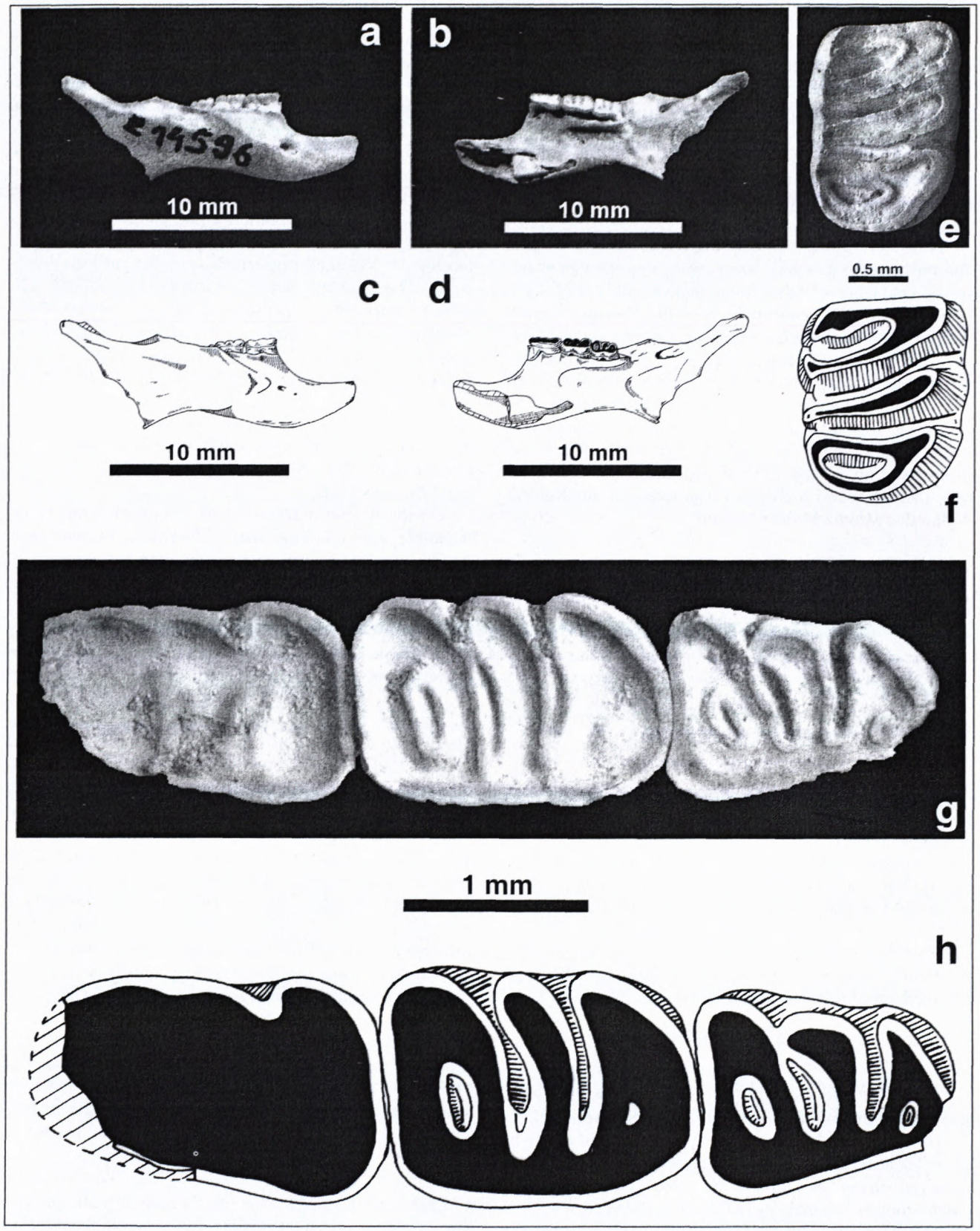

Fig. 7. *Neocometes brunonis* Schaub & Zapfe, 1953, Late Badenian (MN 6), Bonanza.
a-d: right hemimandible (Z-14596/1; a, c – buccal view, b, d – lingual view); e-f: m2 dext. (Z-14596/2; occlusal view); g-h: m1-m3 dext. (Z-14596/1; occlusal view).

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gether with some close relative forms (e.g. *N.* cf. *similis* or *N.* aff. *brunonis*) from MN 5 sites of Czech Republic, Germany, or Switzerland (Ziegler, 1995; Fejfar, 1999). Although the sequence of these taxa does not display significant changes in the molar pattern, there is possible to detect some evolution trends in dental morphology, especially in the diagnostic anterior parts of the first both lower and upper molars (Fejfar, 1999), when two morphotypes (A and B) are distinguishable (Fejfar, 1974).

Found m1, however, is damaged in its anterior part and furthermore it is very worn. Thus, morphological and metric characters of other found teeth (mainly m2s) have been used for the determination of the Bonanza record. According to Fahlbusch (1966), none fundamental differences in the dental morphology are known between *N. similis* and *N. brunonis*. The both species only differ each other by the dimensions of their teeth, when molars of *N. similis* are smaller than these of *N. brunonis*. The dimensions of the found m2s fall to the size-range of *N. brunonis* (Fig. 8) and furthermore, they can reflect not only the metric variability but also a sexual dimorphism within this Middle Miocene species.

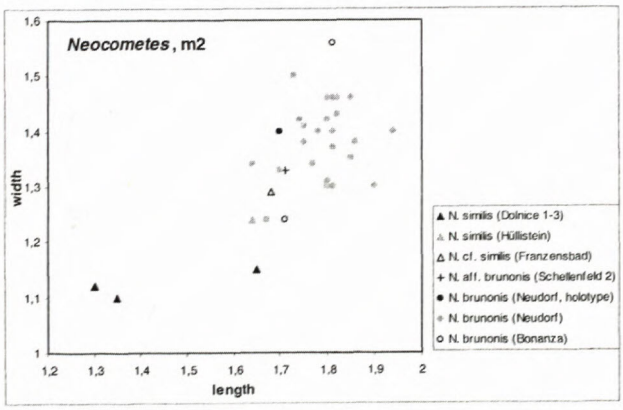

Fig. 8. Bivariate plot of m2 length/width of *Neocometes* - species from the Miocene of Europe (used data: Bolliger, 1992; Fejfar, 1974; Schaub & Zapfe, 1953; Ziegler, 1995).

Family Gliridae Thomas, 1897
Subfamily Bransatoglirinae Daams & De Bruijn, 1995
Genus *Bransatoglis* Hugueney, 1967

***Bransatoglis astaracensis* (Baudelot, 1970)**
Figs. 9, 10 and 11

Material: Damaged left hemimandible with broken incisor, m1 and m3 (SNM-NHM, Z-14599, layer Nr. 13).

Description: The broken lower incisor with the light tawny dentine and the black enamel is exposed on the damaged lingual side of the mandible ramus. Its buccal side is convex, whereas its inner one is flattened.

The rounded crown of m1 with concave occlusal surface is faintly worn and damaged on the lingual side. The narrow anterolophid turns posteriorly in its buccal part. Other main dental ridges are straight (metalophid and mesolophid) or arched posteriorly (posterolophid), with expanded their buccal terminations (protoconid, mesoconid, and hypoconid). The centrolophid is isolated, whereas the both anterior and posterior extra ridges were probably connected with the ridge on the lingual crown side. Also, the metalophid was probably connected with the broken metaconid in the anterior crown part. The ridges are separated by the deep and narrow, buccally opened valleys. The dimensions of the molar are as follows: L = 1.74 mm, LM = 1.71 mm, and W = 1.84 mm.

The faintly worn and damaged rounded crown of m3 is tapering posteriorly. Whereas the anterolophid, metalophid, and mesolophid are narrow and straight, the posterolophid is arched posteriorly, passing into the hypoconid. The relatively short centrolophid is isolated. The anterior extra ridge was probably not connected with the metaconid and the posterior extra ridge is divided to two small isolated cusp-like parts. The entoconid is a small indistinct cusp on the postero-lingual border of the crown. The ridges are separated by relatively shallow valleys, opened on the buccal side (the valley between the metalophid and mesolophid is also opened on the lingual side). The molar dimensions are: L = 1.54 mm and W = 1.54 mm.

On the damaged fragment of the massive left hemimandible, only one large mental foramen, situated below the diastema, is preserved together with anterior part of the shallow masseteric fossa. Lm1-m3 is 5.07 mm.

Remarks: Individual species of *Bransatoglis* differ by dimensions of teeth and their morphology, especially of M1-2 (de Bruijn, 1998). The find under study corresponds most of all to the Miocene species *B. astaracensis*, known from Sansan, Anwil or La Grive, and also supposed in Devínska Nová Ves (Neudorf) by Engesser (1972). However, the Bonanza record differs from Anwil and Sansan specimens by both, the bigger measurements of m1 and lesser morphological differences, such as isolated centrolophid. On the other hand, the occlusal morphology of lower molars is very variable (Engesser, 1972) and various occlusal patterns of the main ridges and extra ones are noted depending on the stage of wear. For that reason, the find of dormice hemimandible with the dentition is determined as fossil remains of *B. astaracensis* in spite of the bigger molar dimensions, indicating probably a more robust specimen only.

Apart from aforementioned fossil record, 24 loose rodent incisors of various measurements and different morphological characters have been found too (Figs. 12 and 13). They were compared with found incisors situated in above-mentioned finds of mandible fragments and with specimens from the collection of Prof. O. Fejfar in Prague. Based on this comparison, some taxa can be distinguishable:

Sciuridae gen. et spec. indet. – four large incisors (3 upper and 1 lower) with mostly smooth dark enamel, smooth or striated light dentine and with elliptical cross-section (the cross-section of one upper incisor (deciduous?), is rhombic). They cannot be assigned to found sciurid species *Spermophilinus* (*Csakvaromys*) *bredai* because the anterior surface of its incisors is striated (Fejfar & Kretzoi, *in press*). Remains of this species were also found together with fossils of *Blackia miocaenica* in near

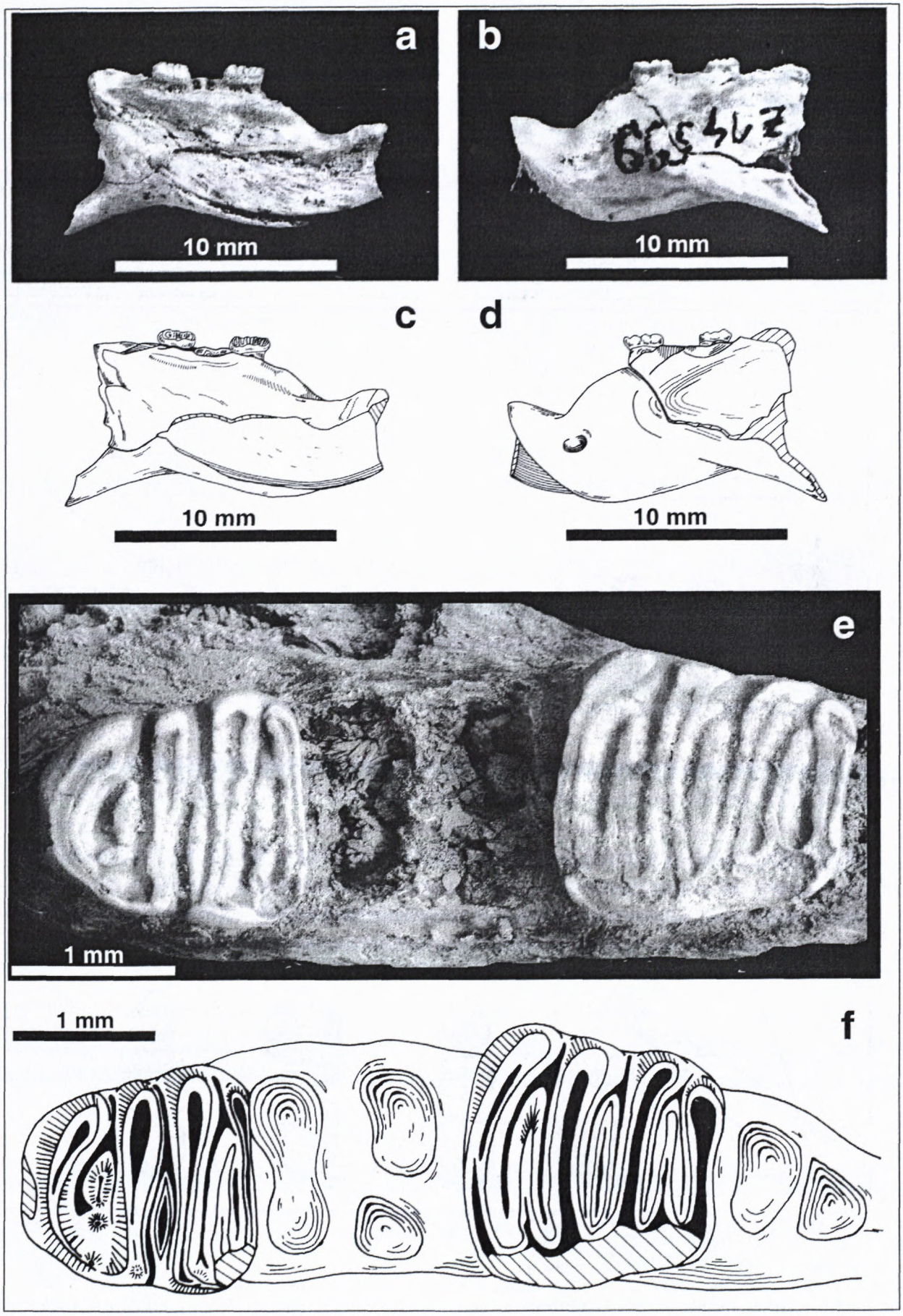

Fig. 9. *Bransatoglis astaracensis* (Baudelot, 1970), left hemimandible with broken incisor, m1 and m3 (Z-14599) from Late Badenian deposits of Bonanza. a, c: lingual view; b, d: buccal view; e-f: detail view to the occlusal surface of preserved molars.

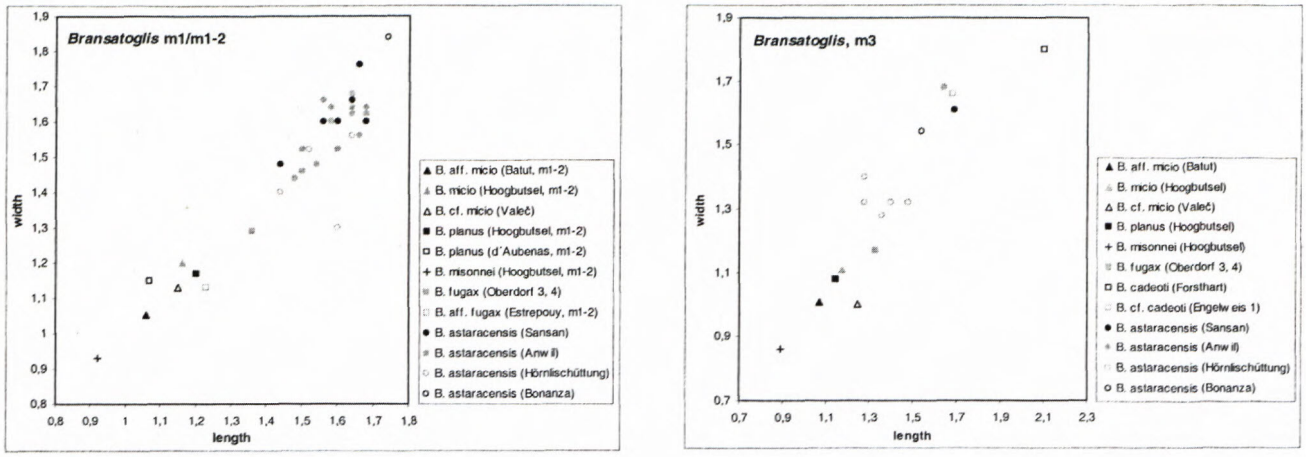

Fig. 10. Bivariate plot of molar (m1, m1-2, m3) length/width of *Bransatoglis*-species from the Tertiary of Europe (used data: Bolliger, 1992; de Bruijn, 1998; Bulot, 1980; Engesser, 1972; Fejfar et al., 1994; Vianey-Liaud, 1994; Ziegler, 1995; Ziegler & Fahlbusch, 1986).

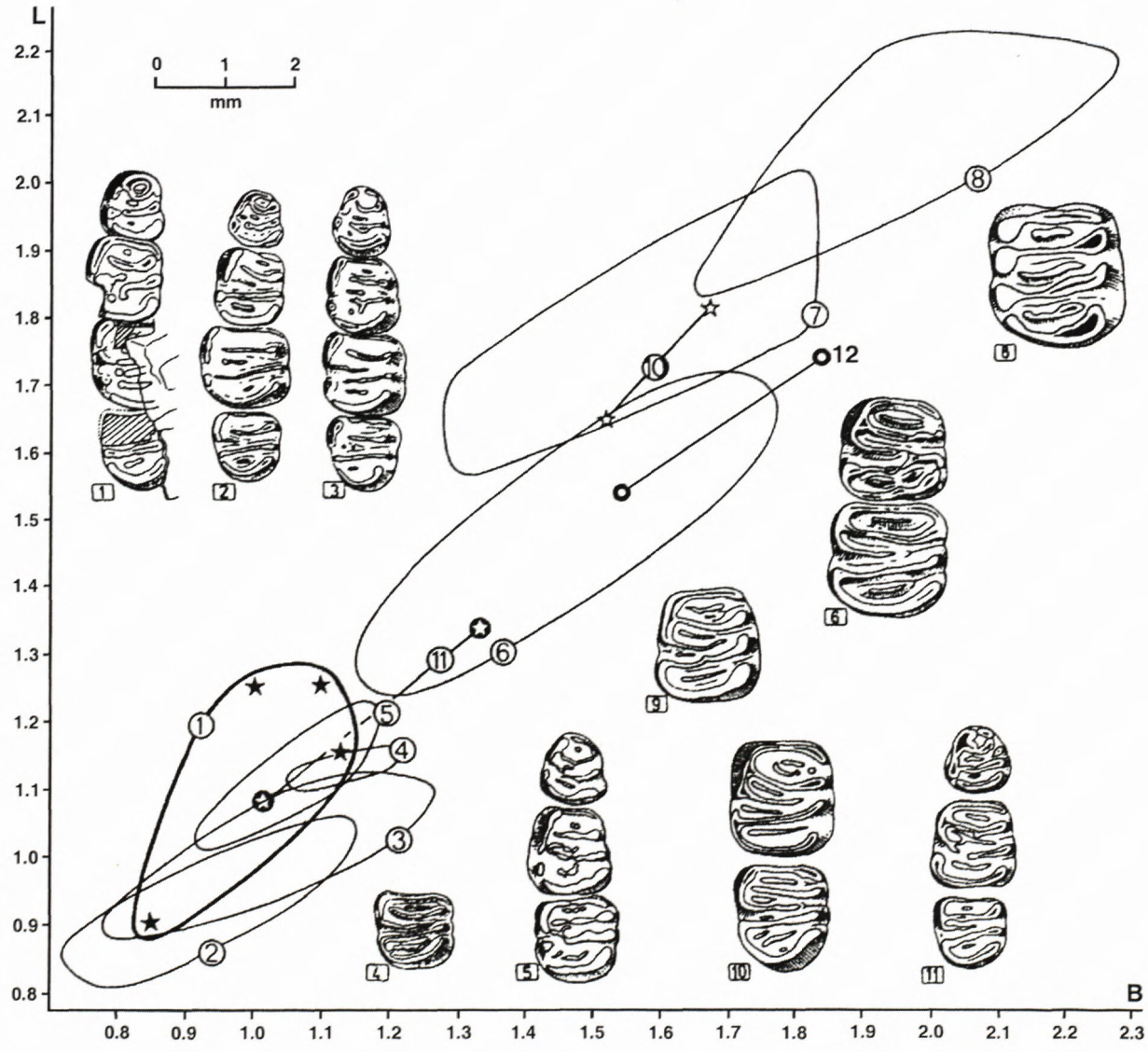

Fig. 11. Measurements of lower dentition of various species of *Bransatoglis* from the European Oligocene and Miocene (in mm; according to Fejfar et al., 1994; modified). 1 – *Bransatoglis* cf. *micio* from Valeč-Waltsch; 2 – *B. bahloi* from Isle of Wight; 3 – *B. micio* from Hoogbutsel; 4 – *B. planus* from Heimersheim; 5 – *B.*cf. *micio* from Charbon; 6 – *B. astaracensis* from Sansan and Anwil; 7 – *B. spectabilis* from Wintershof-West; 8 – *B. cadeoti* from Bézian and La Romieu; 9 – *B. concavidens* from Paulhiac; 10 – *B. concavidens* from Coderet-Bransat; 1 – *B. fugax* from Coderet-Bransat; 12 – *B. astaracensis* from Devínska Nová Ves-Bonanza.

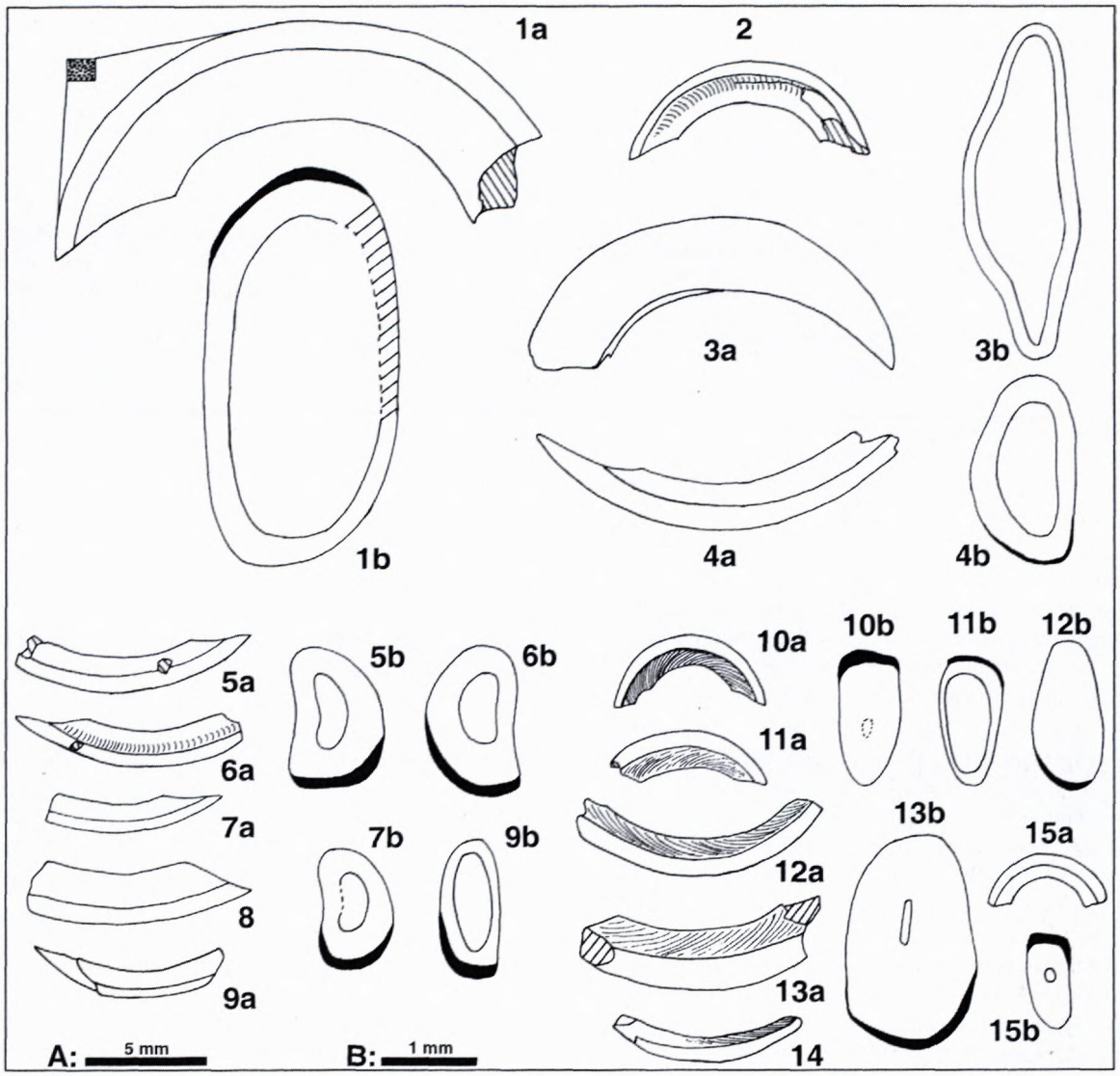

Fig. 12. Upper and lower incisors of rodents from the Late Badenian deposits of Bonanza.
1-4: Sciuridae gen. et spec. indet. (3 – incisor of a juvenile); 5-8: *Eumyarion* sp.; 9: Cricetidae gen. et spec. indet.; 10-14: Gliridae gen. et spec. indet.; 15: Eomyidae gen. et spec. indet.
a – lateral views, b – cross-sections; scales: A for incisors in lateral view, B for cross-sections of incisors.

Devínska Nová Ves-Fissures. However, no incisors of the latter sciurid have been seen, and so, finds of loose sciurid incisors from Bonanza are thus so far determined to the family level only. Furthermore, their metric differences probably indicate the occurrence of 2 to 3 taxa of squirrels on the site.

Eumyarion sp. – five lower incisors with characteristic two distinct longitudinal "grooves" on the anterior surface determine this large cricetid. Two species (*E. weinfurteri* and *E. latior*) of the genus are known from the nearby type-site Devínska Nová Ves-Fissures (Fejfar, 1974), but no molars have been found in Bonanza so far.

?Cricetidae gen. et spec. indet. – besides of five *Eumyarion* incisors, also one smaller damaged lower incisor with the only distinct longitudinal "groove" on the anterior surface followed by a marginal one was found in sample from Bonanza. It probably belongs to some of lesser cricetids (*Democricetodon*?, *Megacricetodon*?).

?Gliridae gen. et spec. indet. – the enamel of two upper and three lower incisors is smooth, whereas a texture of oblique lines is situated on the surface of their light dentine and its origin is probably connected with the growth of the incisor(-s). This texture is observed in incisors of glirids, but also in incisors of *Neocometes*. A difference among incisors of the both taxa could be seen in cross-sections of these teeth – the cross-sections of dormice incisors are more elliptical than those of platacanthomyine ones. However, findings of unbroken incisors in toothed jaws (or in their fragments) are necessary for more exact determination.

?Eomyidae gen. et spec. indet. – one upper incisor, the smallest of all, with smooth enamel and elliptical cross-section probably belongs to unknown eomyid.

The remaining 8 loose incisors are only determined as Rodentia gen. et spec. indet. because of their fragmentary.

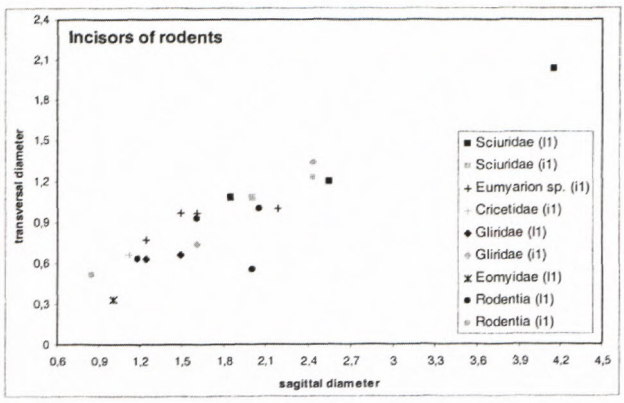

Fig. 13. Bivariate plot of incisor sagittal diamater/transversal diameter of rodents found in Devínska Nová Ves-Bonanza.

4. Biostratigraphic considerations

Rodents have a good stratigraphic value and they serve for biostratigraphic correlations over the world. The stratigraphic ranges of four species found in Bonanza are outlined in order according to de Bruijn (1999), Kälin (1999), Fejfar (1999) and Daams (1999).

The stratigraphic range of *Spermophilinus bredai* is mainly from MN 6 to MN 8, though slightly smaller *S.* aff. *bredai* is also known from MN 4 (e. g. Petersbuch 2 or Erkertshofen 1) and MN 5 sites (e.g. Forsthart, Langenmoosen, Rauscheröd 1b, Rembach or Schellenfeld 4; Ziegler & Fahlbusch, 1986). Also, slightly larger form is known from later periods (e.g. *S.* cf. *bredai* from MN 10 site of Kohfidisch; Bachmayer & Wilson, 1970). The lesser form probably represents an ancestor for *S. bredai*, whereas larger one can represent a descendant of the Middle Miocene populations. The Bonanza finds represent a typical form from the Middle Miocene.

Democricetodon vindobonensis is only known so far from the type-site Devínska Nová Ves-Fissures, dated to lower part of MN 6 zone.

The genus *Neocometes*, as an Ottnangian immigrant (Fejfar, 1974), is known in European Miocene from MN 3 to MN 7/8 in two species. Fossils of the stratigraphically younger of them, *N. brunonis*, come from deposits dated from MN 6 to MN 7/8, though close relative form (*N.* aff. *brunonis*) is known already from MN 5 sites (e.g. Schellenfeld 2; Ziegler, 1995), representing probably an ancestor of the Astaracian species.

The stratigraphic range of *Bransatoglis astaracensis* is from the Early Miocene (MN 4) to the Late Miocene (the last occurrence of this species is known from MN 9 in Spain; Daams & de Bruijn, 1995).

Based on the stratigraphic range of the determined rodent species from Bonanza, the age of this found assemblage can be correlated with MN 6 zone, what it also supported by record of insectivores from the same site (Sabol, *in press*). However, on the basis of lithological circumstances, the Bonanza represents a site from later period than a nearby locality Devínska Nová Ves-Fissures (Holec et al., 1987), whose faunal assemblage is dated to the lower part of MN 6 zone (upper part of the Middle Badenian; Fejfar, 1990, 1997).

5. Paleoenvironmental aspects

Besides their biostratigraphic value, rodents can also serve as relatively good indicator of paleoenvironmental conditions.

The squirrel *Spermophilinus* was probably a ground dweller (de Bruijn, 1999) of forested environments, preferring closed, relatively humid biotopes (van Dam & Weltje, 1999). However, Bolliger (1992) also do not exclude the arboreal mode of life for this Miocene genus. Extant close relatives of *Spermophilinus* are adapted to more cool environmental conditions.

The family Cricetidae represents relatively heterogeneous group, preferring both open and closer habitats (van Dam & Weltje, 1999). From found genera, *Eumyarion* is assumed to have preferred wet habitats and probably it was a dweller of proximal areas of alluvial fans (Kälin, 1999), whereas some *Megacricetodon* species probably preferred wet biotopes and others were indifferent (Daams et al., 1988). In the case of Bonanza, where aquatic vertebrates have been found together with terrestrial ones (see below), determined cricetids (*Democricetodon vindobonensis*, *?Megacricetodon*, and *Eumyarion*) probably lived in the humid and warm habitat.

The genus *Neocometes* is the only Miocene representative of rodents with living close relatives (*Platacanthomys* and *Typhlomys*). The both extant genera are arboreal, living either in the rocky forests of Southern India (*Platacanthomys*) or in forested slopes of mountains with dwarfed, moss-laden deciduous trees and small bamboos in undergrowth in SE China (*Typhlomys*; Walker et al., 1968). The paleoecology of *N. brunonis* was probably similar – it was an arboreal rodent with frugivorous and granivorous diet, living probably in drier conditions (frequent records in karstic areas). However, the Spanish record of *N. similis* indicates also a humid habitat (Fejfar, 1999).

Representatives of the extinct subfamily Bransatoglirinae (*Bransatoglis astaracensis*) belong among arboreal/scansorial glirids, dwelling in sub-canopy to canopy of humid forests. Also, a preference for cool-warm seasonality is ascribed to this group of dormouses (van Dam & Weltje, 1999).

The eomyids are considered to have been gliding dwellers of humid forest biotope with high trees. However, the interpretation of all eomyids as gliders could be erroneous (Engesser, 1999). On the other hand, the simultaneous occurrence with *Spermophilinus* can confirm the hypothesis on their preference of close vegetation habitat (van Dam & Weltje, 1999).

The rodent assemblage under study generally indicates a forested environment. However, in detailed paleoenvironmental reconstruction, the whole fossil assemblage should be analysed. Besides rodents, representatives of Erinaceidae, Talpidae (including Desmaninae), Dimylidae, Soricidae, Viverridae, Phocidae, Mustelidae, Chiroptera, Cervidae, and Mammutidae are known from the site. Reptiles, frogs, fishes, sharks, and marine bivalves belong among relatively frequent fossil finds as well. Thus, the composition of the whole Bonanza assemblage refers to a mixed one living in an insular or peninsular area, covered by a subtropical forest with freshwater lagoons or marshes

in near vicinity of a prograding sea. The record of terrestrial (reptiles and land mammals), freshwater (frogs) and semi-marine (seals) to marine (sharks and fishes) vertebrates could serve as a good evidence of this assumption.

Site	Number of rodent taxa							Reference
	Sciuridae	Petauristidae	Cricetidae	Anomalo-myidae	Gliridae	Eomyidae	Castoridae	Index of similarity	
Faluns Pont Levoy	1	1	5	–	1	–	1	0.57	de Bruijn et al., 1992
Hambach 6C	4	3	8	–	10	3	3	0.39	Mörs et al., 2000
Sansan	3	2	6	–	5	1	2	0.44	de Bruijn et al., 1992
Neudorf-Spalte	1	1	8	1	5	2	–	0.55	Sabol et al., 2004
La Grive	2	4	9	1	6	2	–	0.31	de Bruijn et al., 1992
Anwil	2	4	9	1	11	3	1	0.43	Engesser, 1972
Bonanza	2	–	5	–	2	1	–	–	

Tab. 1. The number of rodent taxa from some Middle Miocene European sites and the comparison of similarity of individual assemblages with Bonanza sample on the basis of calculated Sorensen Index (2B/(F1+F2)).
B – number of common genera; F1 – number of genera from the first compared site; F2 – number of genera from the second compared site (Bonanza).

6. Composition of rodent assemblage

The European Miocene rodent assemblages display the larger diversity than extant rodent fauna, which is impoverished of some extinct and/or exotic taxa (e.g. eomyids, anomalomyids or flying squirrels) in comparison with the fossil record. However, the number of rodent taxa and the composition of individual fossil assemblages frequently vary both in space and time. Despite the incompleteness of fossil record, this compositional variability can be evoked by various factors, mainly by environmental and climatic changes.

From the viewpoint of the similarity of assemblages from some important European sites dated from MN 5 to MN 8 (Tab. 1) on the level of rodent genera, the Bonanza rodent assemblage displays the largest analogy especially with that of Devínska Nová Ves-Fissures (the high similarity of Bonanza rodent assemblage with the rodent assemblage of Faluns Pont Levoy – Thenay (MN 5) is probably caused by the lower diversity of the both sites). The difference is only observed in the larger number of both the cricetid and glirid taxa in the Devínska Nová Ves-Fissures locality and in the absence of anomalomids in deposits of Bonanza. This decrease of diversity in Bonanza rodent assemblage can probably be related to the paleoecological changes caused by the Late Badenian transgression in the territory of Devínska Kobyla hill.

The rodent assemblages of Sansan (MN 6) and Anwil (MN 8) display also relatively great index of similarity with the Bonanza sample. However, detailed comparisons are more or less limited, as the rodent fossil record from the site under study is very scarce.

7. Conclusions

The eleven taxa of rodents (*Spermophilinus bredai*, Sciuridae gen. et spec. indet., *Eumyarion* sp., ?*Megacricetodon* sp., *Democricetodon vindobonensis*, ?Cricetidae gen. et spec. indet., *Neocometes brunonis*, *Bransatoglis astaracensis*, ?Gliridae gen. et spec. indet., ?Eomyidae gen. et spec. indet., and Rodentia gen. et spec. indet.) were found in the Bonanza site. This rodent assemblage comprises several faunal elements known also from nearby Devínska Nová Ves-Fissures site, dated to the Middle Badenian (early MN 6 zone).

The composition of the Bonanza rodent assemblage, supported by the record of the whole mammalian assemblage, validated the assumed Late Badenian age of the site (MN 6).

Found rodents indicate a forested subtropical environment with neighbouring freshwater lagoon, marsh or delta, situated in insular or peninsular area on the eastern side of the Vienna Basin.

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References

Anděra, M. & Horáček, I., 1982: Poznáváme naše savce. Mladá fronta, Praha, 256 p.

Bachmayer, R. & Wilson, R. E., 1970: Die Fauna der altpliozänen Höhlen- und Spaltenfüllung bei Kohfidisch, Burgenland (Österreich). *Annales des Naturhistorische Museum Wien*, 74, Wien, 533-587.

Baudelot, S., 1972: Etudes des Chiropteres, Insectivores et Rongeurs du Miocene de Sansan (Gers). Manuscript, Toulouse, 364 p.

Bolliger, T., 1992: Kleinsäugerstratigraphie in der miozänen Hörnlischüttung (Ostschweiz). *Documenta naturae*, 75, München, 296 p.

Bruijn, de H., 1998: Vertebrates from the Early Miocene lignite deposits of the opencast mine Oberdorf (Western Styrian Basin, Austria): 6. Rodentia 1 (Mammalia). Annalen des Naturhistorischen Museums in Wien, 99A, Wien, 99-137.

Bruijn, de H., 1999: Superfamily Sciuroidea. In: Rössner G. E. & Heissig K. (eds.), 1999: The Miocene land mammals of Europe. Verlag Dr. Friedrich Pfeil, München, 271-280.

Bruijn, de H., Daams, R., Daxner-Höck, G., Fahlbusch, V., Ginsburg, L., Mein, P. & Morales, J., 1992: Report of the RCMNS working group on fossil mammals, Reisenburg 1990. *Newsl. Stratigr.*, 26 (2/3), Berlin - Stuttgart, 65-118.

Bruijn, de H., Mein, P., Montenat, C. & Weerd, van de A., 1975: Correlations entre les gisements de rongeurs et les formations marines du miocene terminal d´Espagne meridionale I (provices d´Alicante et de Murcia). *Koninkl. Nederl. Akademie van Wetenschppen*, Series B, 78 (4), Amsterdam, 1-32.

Bulot, Ch., 1980: Découverte de nouveaux Rongeurs dans le gisement d´Estrepouy (Gers). *Bull. Mus. natn. Hist. nat.*, 4 (2), Paris, 397-406.

Daams, R., 1981: The dental pattern of the dormice *Dryomys, Myomimus, Microdyromys* and *Peridyromys*. *Utrecht Micropaleontological Bulletins*, Special Publication, 3, Utrecht, 1-115.

Daams, R., 1999: Family Gliridae. In: Rössner G. E. & Heissig K. (eds.), 1999: The Miocene land mammals of Europe. Verlag Dr. Friedrich Pfeil, München, 301-318.

Daams, R. & Bruijn, de H., 1995: A classification of the Gliridae (Rodentia) on the basis of dental morphology. *Hystrix*, 6 (1-2), 3-50.

Daams, R. & Freudenthal, M., 1988: Cricetidae (Rodentia) from the type-Aragonian; the genus *Megacricetodon*. In: Freudenthal M. (ed.): Biostratigraphy and paleoecology of the Neogene micromammalian faunas from the Calatayud-Teruel Basin, *Scripta Geologica*, Special Issue 1, Leiden, 39-132.

Daams, R., Freudenthal, M. & Meulen, van der A. J., 1988: Ecostratigraphy of micromammal faunas from the Neogene of Spain. In: Freudenthal M. (ed.): Biostratigraphy and paleoecology of the Neogene micromammalian faunas from the Calatayud-Teruel Basin, *Scripta Geologica*, Special Issue 1, Leiden, 287-302.

Dam, van J. A. & Weltje, G. J., 1999: Reconstruction of the Late Miocene climate of Spain using rodent paleocommunity successions: An application of end-member modelling. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 151, Amsterdam, 267-305.

Engesser, B., 1972: Die obermiozäne Säugetierfauna von Anwil (Baselland). *Tätigheitsberichte der Naturforschenden Gesellschaft Baselland*, Band 28 (1969-1970), Basel, 37-363.

Engesser, B., 1999: Family Eomyidae. In: Rössner G. E. & Heissig K. (eds.), 1999: The Miocene land mammals of Europe. Verlag Dr. Friedrich Pfeil, München, 319-335.

Fahlbusch, V., 1966: Cricetidae (Rodentia, Mammalia) aus der mittelmiozänen Spaltenfüllung Erkertshofen bei Eichstätt. *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie*, 6, München, 109-131.

Fejfar, O., 1974: Die Eomyiden und Cricetiden (Rodentia, Mammalia) des Miozäns der Tschechodlowakei. *Palaeontographica*, Abt. A, 146, Stuttgart, 100-180.

Fejfar, O., 1999: Subfamily Platacanthomyinae. In: Rössner G. E. & Heissig K. (eds.): The Miocene land mammals of Europe, Verlag Dr. Friedrich Pfeil, München, 389-394.

Fejfar, O. & Kretzoi, M., (2005): The Mammalian Fauna of Rudabánya. Rodentia Bowdich, 1821. *Bolletino della Società Paleontologica*, Modena, *in press*.

Fejfar, O., Storch, G. & Koenigswald, von W., 1994: Das Magetier von Valeč-Waltsch in Böhmen – ein historischer fossiler Säugertierfund – (Rodentia: Myoxidae). *Müncher Geowiss. Abhandlungen*, 26 (A), München, 5-34.

Freudenthal, M. & Daams, R., 1988: *Democricetodon, Fahlbuschia, Pseudofahlbuschia* nov. gen., and *Renzimys* from the Aragonian and the lower Vallesian of the Calatayud-Teruel Basin. In: Freudenthal M. (ed.): Biostratigraphy and paleoecology of the Neogene micromammalian faunas from the Calatayud-Teruel Basin, *Scripta Geologica*, Special Issue 1, Leiden, 133-252.

Gál, E., Hír, J., Kessler, E., Kókay J. & Venczel, M., 2000: Középsőmiocén ősmaradványok a Mátraszőlős, Rákóczi-kopalna alatti útbevágásból II. A Mátraszőlős 2. lelőhely. *Folia Historico Naturalia Musei Matraensis*, 24, 39-75.

Hír, J., 2001: Új középső miocén rágcsálófaunák Észak-Magyarországról. *A Nógrád Megyei Múzeumok Évkönyve, Természettudomány – Natural History*, XXV. Kötet, Nógrád, 219-248.

Holec, P., Klembara, J. & Meszároš, Š., 1987: Discovery of new fauna of marine and terrestrial vertebrates in Devínska Nová Ves. *Geologica Carpathica*, 38, 3, Bratislava 349-356.

Ivanov, M., 1998: The snake fauna of Devínska Nová Ves (Slovak Republic) in relation to the evolution of snake assemblages of the European Middle Miocene. *Acta Musei Moraviae, Sci. geol.*, LXXXIII, Brno, 159-172.

Joniak, P., 2005: New rodent assemblage from Upper Miocene deposits of the Vienna and Danube Basins. *Manuscript*, Bratislava, 130 p.

Kälin, D., 1999: Tribe Cricetini. In: Rössner G. E. & Heissig K. (eds.), 1999: The Miocene land mammals of Europe. Verlag Dr. Friedrich Pfeil, München, 373-387.

Koretsky, I. A. & Holec, P., 2002: A Primitive seal (Mammalia: Phocidae) from the Early Middle Miocene of Central Paratethys. In: Emry R. J. (ed.): Cenozoic mammals of land and sea: Tributes to the Career of Clayton E. Ray, *Smithsonian Contributions to Paleobiology*, 93, Washington, 163-178.

Kowalski, K., 1967: Rodents from the Miocene of Opole. *Acta Zoologica Cracoviensis*, Tom XII, 1, Kraków, 1-18.

Kretzoi, M., 1951: The Hipparion-fauna from Csákvár. *Földtáni Közlöny*, 81, Budapest, 384-417.

Mein, P. & Freudenthal, M., 1971: Les Cricetidae (Mammalia, Rodentia) du Néogène Moyen du Vieux-Collonges. Parte 1: Le genre *Cricetodon* Lartet, 1851. *Scripta Geologica*, 5, Leiden, 1-51.

Mörs, T., Hocht, von der F. & Wutzler, B., 2000: Die erste Wirbeltierfauna aus der miozänen Braunkohle der Niederrheinischen Bucht (Ville-Schichten, Tagebau Hambach). *Paläontologische Zeitschrift*, 74 (1/2), Stuttgart, 145-170.

Sabol, M., (2005): Middle Miocene Assemblage of Insectivores from Bonanza site near Devínska Nová Ves (Slovakia). *Geologica Carpathica*, Bratislava, *in press*.

Sabol, M., Joniak, P. & Holec, P., 2004: Succession(-s) of mammalian assemblages during the Neogene: A case study from the Slovak part of the Western Carpathians. *Scripta Fac. Sci. Nat. Univ. Masaryk. Brunensis*, Geology, Vol. 31-32, Brno, 65-84.

Schaub, S. & Zapfe, H., 1953: Die fauna der miozänen Spaltenfüllung von Neudorf an der March (ČSR). Simplicidentata. *Sitz. Österr. Akad. Wiss. Wien*, Math.-Natw. Klasse 1, 162, 3, Wien, 181-215.

Špinar, Z. V., Klembara, J. & Meszároš, Š., 1993: A new toad from the Miocene at Devínska Nová Ves (Slovakia). *Západné Karpaty, séria paleontológia*, 17, Bratislava, 135-160.

Thenius, E., 1952: Die Säugetierfauna aus dem Torton von Neudorf an der March (ČSR). *Neues Jahrbuch für Geologie und Paläontologie*, Abhandlung 96, 1, Stuttgart, 27-136.

Vianey-Liaud, M., 1994: La radiation des Gliridae (Rodentia) à l´Eocène supérieur en Europe Occidentale, et sa descendance Oligocène. *Müncher Geowiss. Abhandlungen*, 26 (A), München, 117-160.

Walker, E. P. et al., 1968: Mammals of the World, 2. Ed., Vol. 2, Baltimore, 647-1500.

Zapfe, H., 1949: Eine mittelmiozäne Säugetierfauna aus einer Spaltenfüllung bei Neudorf an der March (ČSR). *Anz. Österr. Akad. Wiss.*, Math. Natturwiss. Klasse, 86, 7, Wien, 173-181.

Ziegler, R., 1995: Die untermiozänen Kleinsäugerfaunen aus den Süßwassekalken von Engelsweis und Schellenfeld bei Sigmaringen (Baden-Württemberg). *Stuttgarter Beiträge zur Naturkunde*, Serie B (Geologie und Paläontologie), 228, Stuttgart, 1-53.

Ziegler, R. & Fahlbusch, V., 1986: Kleinsäuger-Faunen aus der basalen Oberen Süßwasser-Molasse Niederbayerns. *Zitteliana*, 14, München, 3-58.