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

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Abstract: Eight taxa of insectivores (*Lantanotherium* aff. *sansaniense*, Erinaceidae gen. et spec. indet., *Talpa minuta*, *Storchia meszaroshi* sp. nov., *Plesiodimylus chantrei*, *Dinosorex* cf. *zapfei*, Soricidae gen. et spec. indet., and ?Lipotyphla gen. et spec. indet.) have been determined in the Middle Miocene micromammal assemblage from Devínska Nová Ves — Bonanza fossil site. This Late Badenian (MN6) insectivore assemblage comprises several new faunal elements including a new form of water-mole (*Storchia meszaroshi* sp. nov.). These animals inhabitated a forested coast of an insular region neighbouring with freshwater lagoon, marsh or delta. Most of them belong to juvenile specimens.

Key words: Late Badenian, Slovakia, Devínska Nová Ves, MN6, erinaceids, talpids, dimylids, soricids.

Introduction

Records of Miocene fossil insectivores are relatively frequent in Europe. Mostly, only isolated teeth and bones are found, whereas finds of well preserved entire skeletons or larger parts of them are rather rare.

In Slovakia, only four of 13 sites with a record of Miocene mammals also yielded remains of insectivores. The stratigraphically youngest find is known from the Late Miocene (MN10?) site of Dubná skala, where Pipík & Sabol (in press) recorded only *Paenelimnoecus* sp. A recently found fossils assemblage of micromammals from Borský Svätý Jur (MN9) contains also *Schizogalerix* sp., *Heterosorex* sp., and undetermined talpids (Joniak 2005). The terrestrial deposits of Devínska Nová Ves-Fissures (also known as Neudorf-Spalte, MN6) yielded thus far the richest insectivore assemblage, including *Lantanotherium sansaniense*, *Amphechinus intermedius* (according to Mein & Ginsburg (2002), it is *Postpalerinaceus intermedius*), *Talpa minuta*, "*Scaptonyx*" *edwardsi*, ?*Urotrichus dolichochir*, Talpidae gen. et spec. indet. I & II, *Plesiodimylus chantrei*, *Dinosorex zapfei*, *Lartetium dehmi*, and "*Allosorex*" *gracilidens* (Zapfe 1951; Fejfar & Sabol in press). However, only undetermined fossils of insectivores were known so far from the nearby Bonanza site (Holec et al. 1987).

The site under study is located at the eastern margin of the former Stockerau limestone quarry on the northern slope of 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 insectivore remains from marly to sandy deposits of layers No. 11, 12, and 13 (Fig. 2). The last research in 2001–2002 yielded eight insectivore specimens (*Lantanotherium* aff. *sansaniense*, Erinaceidae gen. et spec. indet., *Talpa minuta*, *Storchia meszaroshi* sp. nov., *Plesiodimylus chantrei*, *Dinosorex* cf. *zapfei*, Soricidae gen. et spec. indet., and ?Lipotyphla gen. et spec. indet.). Many of them represent important finds from the paleobiological and taphonomic viewpoint (e.g. dimylid jaw with deciduous and permanent dentition or an insectivore forelimb in life-position).

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

Material and methods

Former fossil remains of insectivores were collected by amateur paleontologist Š. Meszároš in the 1980s. New material has been found by screen washing of fossiliferous sediments in 2002. The material under study 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 binocular magnifying Carl Zeiss Jena, drawing apparatus Meopta, and camera Nikon F-70, as well as scanned by SEM Philips XL30CP. They were measured partly according to the methods of Ziegler (1983), Reumer (1984), and de Jong (in Freudenthal 1988). All measured data are given in millimeters.

For terminology of tooth crowns, the papers of Ziegler (1983) for erinaceids, Engesser (1980) for talpids, Bolliger (1992) for dimylids, and Reumer (1984) for soricids are followed.

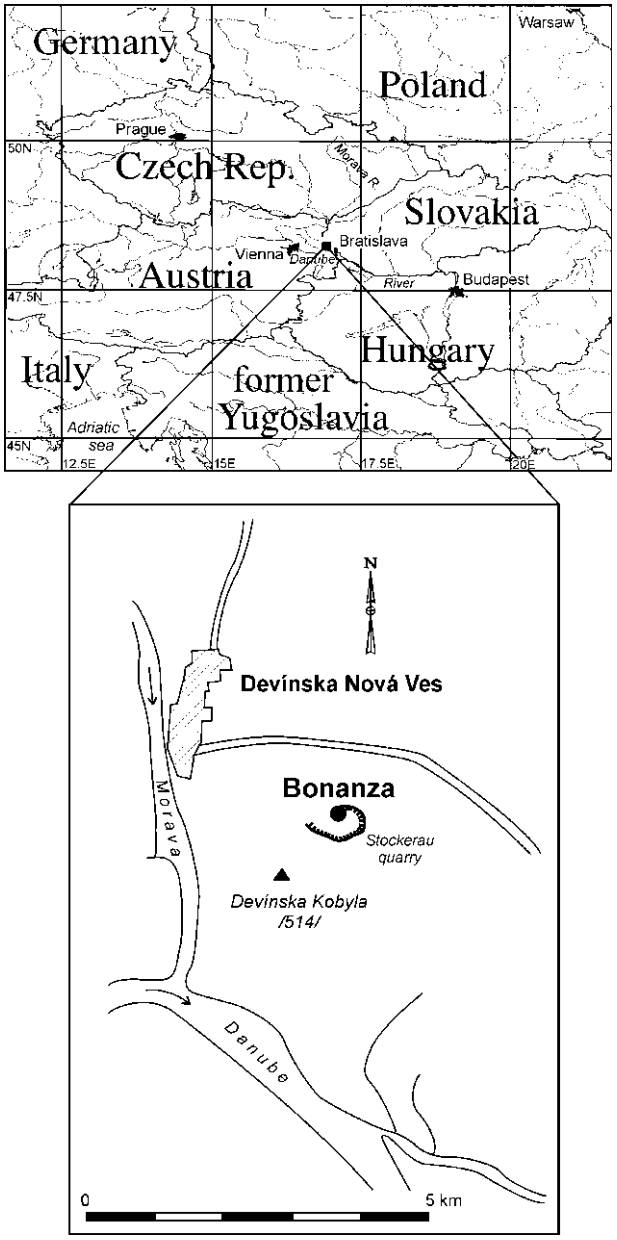

Fig. 1. Location of the Bonanza site on northern slopes of Devínska Kobyla Hill near Devínska Nová Ves (Neudorf) (according to Koretsky & Holec 2002, partly modified).

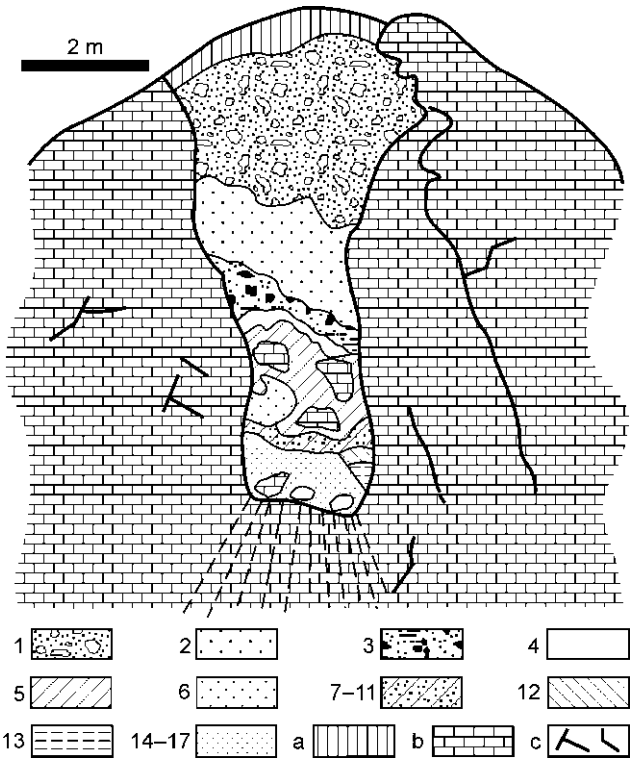

Fig. 2. Generalized section through the sediments of Bonanza (according to Ivanov 1998). **1** — fine limestone debris; **2** — white lime sand; **3** — disaggregating sandstone with a higher content of muscovite; **4** — solid, light yellow marlstone with a great quantity of fossils; **5** — big boulders 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 is contained in the layer No. 17. **a** — Holocene humus-carbonate soil, **b** — Lias limestone, **c** — tectonic faults.

Abbreviations for the dimensions of the teeth and mandibles are:

H — maximum height of the tooth, HCo — height of the coronoid process, Hm1 — mandible height below m1 on the buccal side, Hm3 — mandible height below m3 on the buccal side, HEND — height of the entoconid, HHY — height of the hypocone, HHYD — height of the hypoconid, HM — maximum height of the mandible, HME — height of the metacone, HMED — height of the metaconid, HPA — height of the paracone, HPAD — height of the paraconid, HPR — height of the protocone, HPRD — height of the protoconid, L — length of the tooth or mandible, LL — length on the lingual side, LM — medial length, LT — length of the talon, Lm1-m2 — length of m1-m2, Lm1-m3 — length of m1-m3, TAL — length of the talonid, TAW — width of the talonid, TRL — length of the trigonid, TRW — width of the trigonid, W — maximum width of the tooth, WM — medial width.

Systematic Paleontology

Family: **Erinaceidae** Fischer de Waldheim, 1817
Subfamily: **Galericinae** Pomel, 1848
Tribe: **Galericini** Pomel, 1848
Genus: *Lantanotherium* Filhol, 1888

Lantanotherium aff. *sansaniense* (Lartet, 1851)
Figs. 3, 4

Material: m1 dext. (SNM-NHM, Z-14664/1, layer NO. 13).

Description: The molar is partly damaged and slightly worn. The protoconid posterior crest extends behind the metaconid, which is almost as tall as the former cusp. The trigonid basin is narrow, relatively deep, restricted from all sides, when a small cristid between the paraconid and the

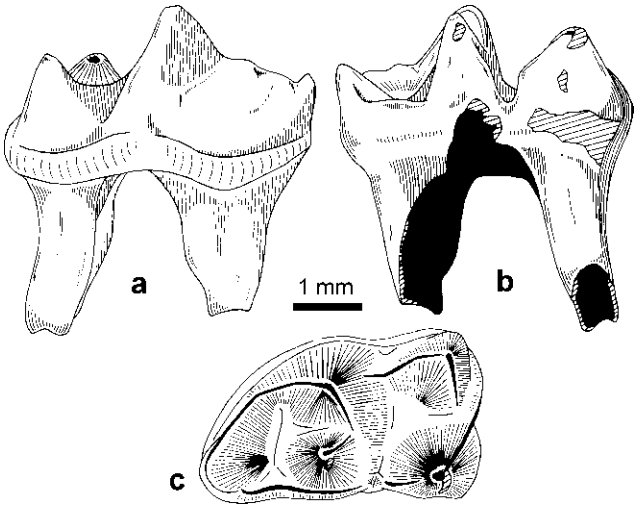

Fig. 3. *Lantanotherium* aff. *sansaniense* (Lartet, 1851), m1 dext. (Z-14664/1), Late Badenian (MN6), Bonanza. **a** — buccal view, **b** — lingual view, **c** — occlusal view.

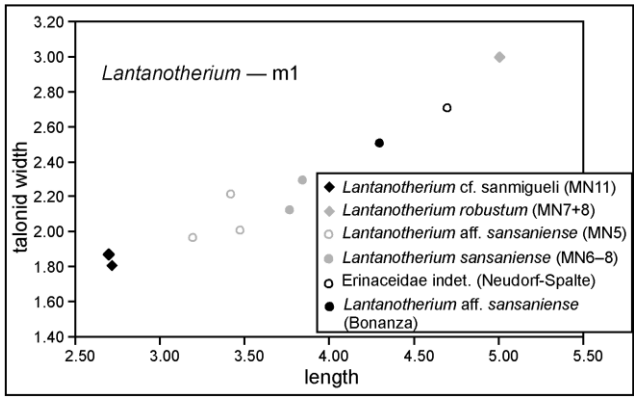

Fig. 4. Bivariate plot of m1 length/talonid width of *Lantanotherium*-species from Europe (used data: Baudelot 1972; Bolliger 1992; Rabeder 1973; Viret 1940; Zapfe 1951; Ziegler & Mörs 2000).

metaconid bounded it on the lingual side too. The oblique crest extends anteriorly from hypoconid top and the entoconid crest extends towards a narrow, deep, U-like depression. The posterior cingulid forms the entoconid. The talonid basin is shallow. The molar dimensions are: L = 4.30 mm, TRW = 2.40 mm, and TAW = 2.50 mm.

Remarks: Four genera of erinaceids are known from European Middle Miocene (MN5 to MN8) — *Galerix*, *Lantanotherium* (not *Lanthanotherium*, according to McKenna & Bell 1997), *Mioechinus* (according to McKenna & Bell (1997), this genus is synonymous with the genus *Hemiechinus* Fitzinger, 1866), and *Amphechinus* (Ziegler 1999). The extending protoconid posterior crest and posterior cingulid forming the entoconid of m1 indicate *Lantanotherium*, differing thus from other genera as follows:

— from *Galerix* by the shape and larger dimensions of the trigonid;

— from *Mioechinus* by the longer trigonid than talonid;

— from *Amphechinus* by smaller dimensions and proportionally by the wider trigonid.

So far, six valid species of *Lantanotherium* are known from the European Miocene (Ziegler & Mörs 2000). However, only three of them — *L. longirostre* Thenius, 1949, *L. sansaniense* (Lartet, 1851), and *L. robustum* Viret, 1940 — have been found in Middle Miocene sediments (MN5–8) (Ziegler 1999). Because the tooth morphology of these species is very similar, only the dimensions of teeth are relevant for the exact determination. Whereas teeth of *L. robustum* are usually the largest (Fig. 4), molars of *L. longirostre* are smaller than those of *L. sansaniense* (Ziegler & Mörs 2000). From this point of view, the erinaceid m1 from Bonanza is the closest to the Sansan species (*L. sansaniense*), though it is somewhat larger. For that reason, the find is determined as *L.* aff. *sansaniense* only.

Erinaceidae gen. et spec. indet.
Fig. 5

Material: Left juvenile tibia with fragment of fibula (DGP, MS-9, layer unknown).

Description: The missing proximal head of the slightly S-like curved tibia was not joined with diaphysis yet. The *margo cranialis* is conspicuous, but narrow. Only distal part of the probably slender fibula is preserved, grown into the shinbone. Both bones are separated from each other by the *spatium interosseum cruris*. The dimensions are as follows: length of the tibia is 22.75 mm, length from point of the tibia-fibula symphysis to the shinbone distal epiphysis is 8.35 mm, proximal width is 2.60 mm, width of the tibia diaphysis is 0.75 mm, and the distal width is 1.85 mm.

Remarks: Compared with tibiofibulae of extant insectivores (*Erinaceus concolor*, *Talpa europaea*, *Sorex araneus*, and *Crocidura suaveolens*), the Bonanza find most

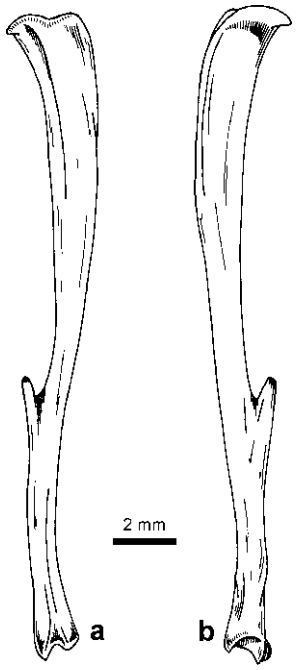

Fig. 5. Erinaceidae gen. et spec. indet., left juvenile tibia with fragment of fibula (MS-9), Late Badenian (MN6), Bonanza. **a** — medial view, **b** — lateral view.

morphologically corresponds to the erinaceids, when talpid tibiofibula is more S-like curved with mainly different morphology of the proximal part and the tibia-fibula symphysis of soricids is situated in the upper part of their straighter tibiofibulae. However, the tibiofibula under study is smaller than in the extant *Erinaceus*, due to its juvenile character. Although it does not display larger morphological differences, more exact determination is not possible, because no other comparative material (especially fossil one) has been seen, yet.

Family: **Talpidae** Fischer de Waldheim, 1817
Subfamily: **Talpinae** Fischer de Waldheim, 1817
Tribe: **Talpini** Fischer de Waldheim, 1817
Genus: *Talpa* Linnaeus, 1758

Talpa minuta Blainville, 1838
Fig. 6

Material: Damaged right ulna (DGP, MS-10, layer unknown).

Description: The proximal part consists of wide olecranon with a mediolateral fan-like tubercle. The beak-like anconeous process is distinct, protruding forward. The semicircular trochlear notch is smooth, with indistinct coronoid processes. The bone body is laterally flattened, with robust damaged caudal ridge. The dimensions of the bone are as follows: mediolateral width of the proximal part is 3.5 mm, craniocaudal width of the proximal part is 1.00 mm, minimum width of the bone body is 0.75 mm, height of trochlea notch is 1.20 mm, and the width of trochlea notch in its central part is 0.75 mm.

Remarks: Although the found ulna is evidently smaller than in the extant *Talpa europaea*, it does not display any morphological differences. Furthermore, its assumed greatest length (12–13 mm) corresponds to finds of *T. minuta* from Petersbuch (especially from Petersbuch 10). Despite larger dimensions of German samples, they do not differ from specimens of *T. minuta* from the Sansan type locality and so, the delineation of a new species or subspecies was not justified (Ziegler 2003).

In Slovakia, fossils of *T. minuta* were thus far known from Devínska Nová Ves-Fissures only (Zapfe 1951). Together with this locality, the Bonanza forms one of the easternmost sites of this Miocene talpid species in Europe.

Subfamily: **Desmaninae** Mivart, 1871

Storchia meszaroshi sp. nov.
Figs. 7, 8

Derivatio nominis: In honour of Mr. Štefan Meszároš from Bratislava, discoverer of the paleontological site Bonanza and its fossils.

Holotype: Right hemimandible of a juvenile with still fully unerupted p2, p3 and with m2 and m3 (SNM–NHM, Z-14662, layer No. 13).

Type locality: Bonanza (details see in "Introduction").

Age: Middle Miocene, Late Badenian (MN6, level of Sansan).

Diagnosis: A small species of *Storchia*. Lower premolars are double-rooted; p2<p3. Lower molars are very narrow, m2>m3. Oblique crest extends lingually to the metaconid; a short metacristid is present in m2. The entostylid is distinctly developed in m2 and m3.

Description of the holotype: The hemimandible anterior part and angular process are broken off. The masseteric fossa is wide and shallow. The coronoid process is tall and pointed posteriorly, whereas the condylar process is situated on the elongated ramus high above the dentary level. Two mental foramens are situated between the posterior alveolus of p1 and the anterior one of p2, and below the anterior alveolus of m1. The mandibular foramen is situated high, on the level of m3. Dimensions of the mandible are as follows: HM = 6.00 mm, HCo = 4.87 mm, and Hm1 = 1.30 mm.

The dominant main cusp (protoconid?) is situated in the anterior crown part of the still fully unerupted p2 with relatively distinct lingual and posterior cingulids. The tooth is oval in occlusal outline. The morphology of larger p3 corresponds to that of p2.

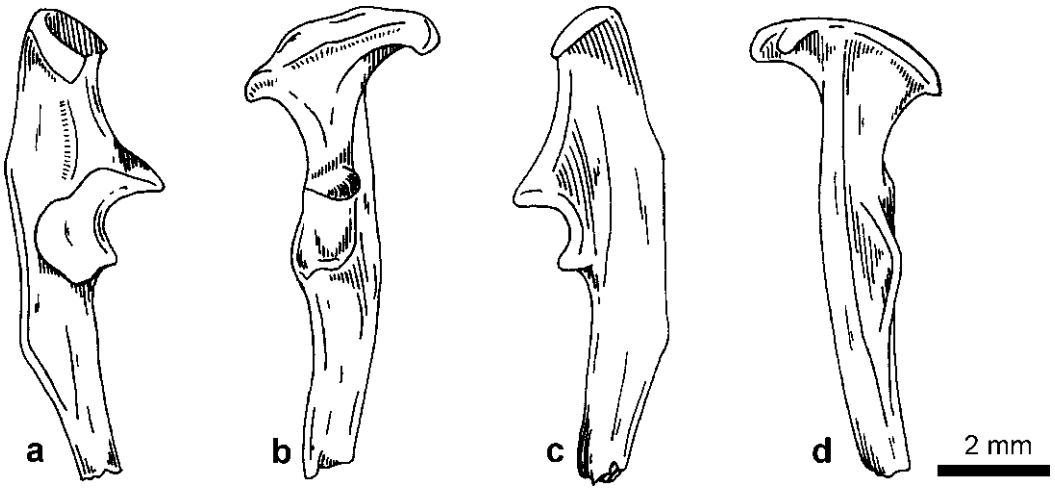

Fig. 6. *Talpa minuta* Blainville, 1838, proximal part of the right ulna (MS-10), Bonanza. **a** — lateral view, **b** — anterior view, **c** — medial view, **d** — posterior view.

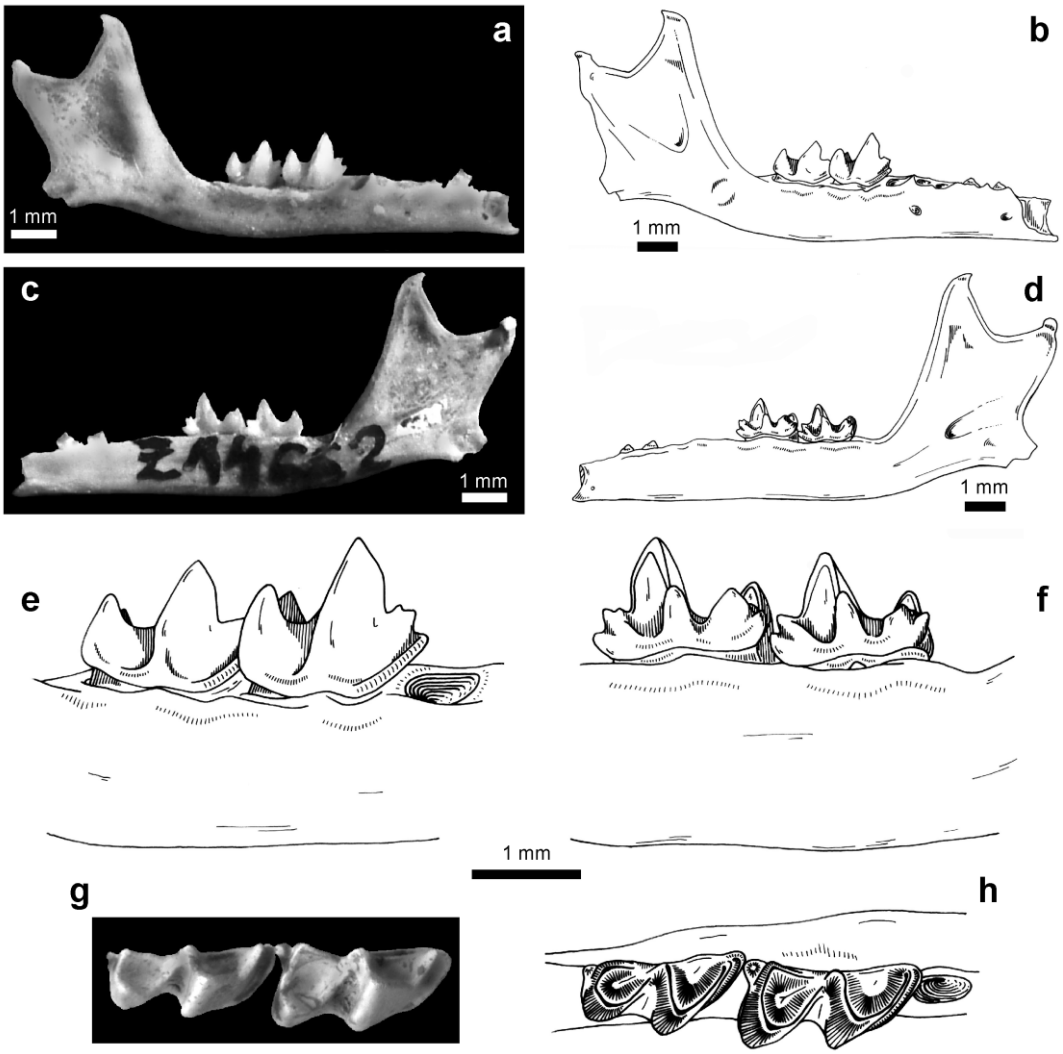

Fig. 7. *Storchia meszaroshi* nov. sp. (Z-14662), a new species of water-mole from Upper Badenian deposits of Bonanza. **a–d** — right hemimandible of a juvenile with still fully unerupted p2, p3 and with m2 and m3 (Z-14662; a, b — buccal views; c, d — lingual views). **e–h** — detail view on preserved molars (e — buccal view; f — lingual view; g, h — occlusal views).

Lower molars are very narrow with two massive roots. A tiny accessory cusp is situated at the paracristid of m2. The narrow and tall metaconid is smaller than distinct protoconid. The two cusps are connected by the short protocristid. Thus, the trigonid basin is opened on the lingual side only. The distinct hypoconid is smaller than protoconid. The oblique crest extends lingually to the metaconid with a faint metacristid. Between the protoconid and hypoconid, a deep hypoflexid without the ectostylid is situated. The short entocristid is well developed and the postcristid connects the entoconid with the hypoconid. Unlike the trigonid basin, the dish-like talonid one is relatively shallow. The distinct entostylid is present behind the entoconid. A cingulid is well developed on the anterobuccal side. More marked lingual cingulid is absent. Dimensions of m2 are as follows: L = 1.41 mm, TRW = 0.71 mm, and TAW = 0.72 mm.

The protocristid of m3 extends from the protoconid towards the metaconid. Trigonid basin is widely opened on the lingual side. The oblique crest extends from the hypoconid towards the metaconid, forming a distinct border between the deep hypoflexid and shallow talonid basin. The entocristid and postcristid are distinctly developed. The small entostylid is evident. A cingulid is markedly developed on the anterobuccal side only. Dimensions of m3 are as follows: L = 1.33 mm, TRW = 0.63 mm, and TAW = 0.50 mm.

Only alveoli for roots of p1, p4, and m1 are preserved. All these missing teeth were double-rooted.

Remarks: The fossil under study represents a species of the Desmaninae subfamily, for representatives of which the following characters of lower molars can be generally observed: oblique crest extends more lingually, frequently joining the metaconid; teeth are mesiodistally compressed (inflated aspect); and a distinct anterobuccal cingulid extending to the protoconid (or to the hypoflexid resp.) is mostly present.

The Bonanza find differs from most extinct and extant desmans (*Mygatalpa*, *Asthenoscapter*, *Mygalea*, *Theratiskos*, *Lemoynea*, *Archaeodesmana*, *Mygalinia*, *Desmana*,

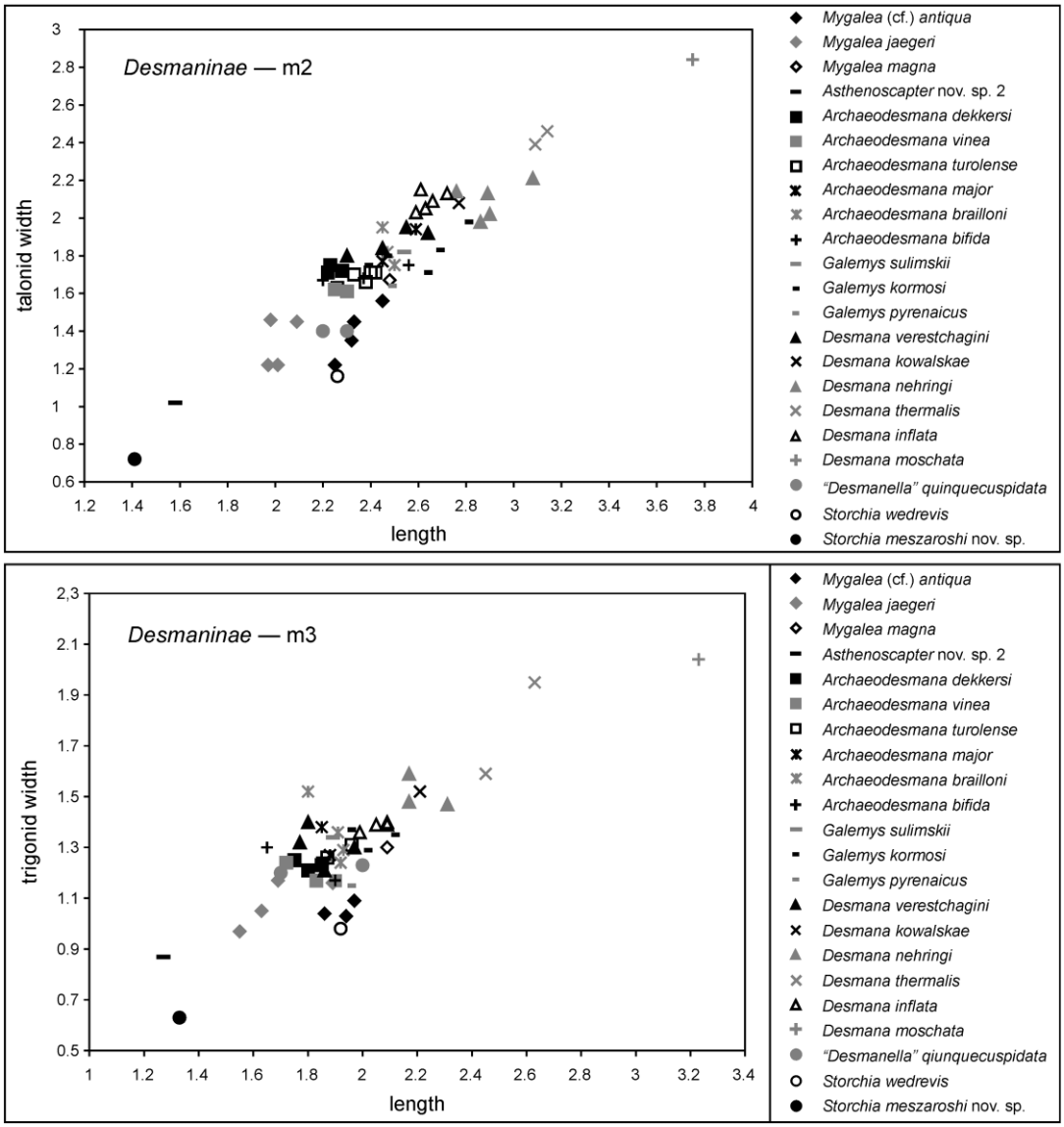

Fig. 8. Bivariate plot of m2 length/talonid width and m3 length/trigonid width of water-mole taxa from various Cenozoic sites of Europe and Asia (used data: Dahlmann 2001; Engesser 1980; Mayr & Fahlbusch 1975; Rümke 1985; Ziegler 1990b, 2003; Ziegler & Mörs 2000).

and *Galemys*) by smaller dimensions and the slenderness of its lower molars. Thus, it comes closest to *Storchia*, a small water-mole with narrow lower molars described by Dahlmann (2001) from Late Neogene deposits of Germany. There are only *Storchia wedrevis* from Wölfersheim (MN15) and *Storchia* sp. from Dorn-Dürkheim-1 (MN11) known thus far. Besides these two taxa, "*Desmanella*" *quinquecuspidata* Mayr et Fahlbusch, 1975 from Hammerschniede 1 (MN9) is also known. Dahlmann (2001) argues about this problematic taxon as a potential primitive species of *Storchia*, representing an ancestor of *S. wedrevis*.

However, the Bonanza specimen also shows some differences from aforementioned taxa.

It differs from *Storchia wedrevis* in:

— the taller and more slender paraconid, more anteriorly situated protoconid, the presence of the metacristid, and the presence of a small trigonid basin on m2;

— the presence of the distinct entostylid, the absence of a cingulid under the lingual opening of the trigonid basin, and generally more slender crown shape of m3;

— and smaller molars.

It differs from Dorn-Dürkheim-1 specimen designed as *Storchia* sp. in:

— the distinct entostylid and anterobuccal cingulid of m2.

It differs from "*Desmanella*" *quinquecuspidata* in:

— the presence of more faint metacristid and shallow talonid basin of m2;

— the smaller and less mesiodistally compressed molars.

Storchia meszaroshi is one of the smallest desmans. Because the species are known only from fragmentary material, it is difficult to find any phylogenetic relationship. However, it is not excluded that they represent a separate group within Desmaninae with distinct narrow lower molars, where the increase in tooth dimensions was probably

connected with the reduction of the trigonid basin and the loss of the metacristid during evolution. On the other hand, the problem of the phylogenetic and taxonomical position of "*Desmanella*" *quinquecuspidata* remains still unsolved. Thus, much more material and more complete dentitions are necessary.

Family: **Dimylidae** Schlosser, 1887
Genus: *Plesiodimylus* Gaillard, 1897

Plesiodimylus chantrei Gaillard, 1897
Figs. 9, 10

Material: Left hemimandible and left upper jaw of a juvenile with deciduous and permanent dentition (SNM–NHM, Z-14663/1, layer No. 11b); m1 dext. (SNM–NHM, Z-14663/2, layer No. 11b); and lingual part of M1 dext. (SNM–NHM, Z-14663/3, layer No. 11b).

Description: The presence of deciduous teeth (DP3, DP4, Dp4) and permanent ones (M1, M2, p1, p3?, p4, m1, m2) with unworn crowns indicates a juvenile. Unworn crowns of loose teeth (M1 dext. and m1 dext.) indicate a juvenile specimen(-s) as well.

Only robust blunt main cusp (paracone?) of DP3 sin. with a weak posterior crest is visible together with a damaged distinct lingual cingulum. Its length dimension is probably larger than that of its width. The height of main cusp is 0.63 mm.

The sharp main cusp (paracone?) with conspicuous anterior crest dominates the crown of DP4 sin. A small accessory cusp (protocone?) is situated on the lingual side as a part of the distinct cingulum. In posterior part of the crown, a shallow basin is present. From three roots, only faint anterior and sloping lingual ones are visible. The assumed L is 2.35 mm and the height of main cusp is 0.94 mm.

The cone-shaped protocone and hypocone (= metaconule) are evident on the uncovered lingual part of left M1. The two cusps are separated by a syncline-like depression, below of which a crest-like lingual cingulum is somewhat distinctly developed. The posterior cingulum is robust. The dimensions of this molar are as follows: LL = 1.97 mm, HPR = 0.90 mm, HHY = 0.80 mm, and assumed L is 2.45 mm.

The uncovered part of M2 sin. consists of the distinct conical protocone and of the indistinct metacone, which is a part of the semicircular posterior cingulum. A notch separates the protocone and cingulum from each other. L = 1.83 mm and HPR = 0.83 mm.

Only conspicuous main cusp (protoconid?) together with posterolingual cingulid is visible from the crown of permanent left p1. Two straight roots are situated close together. L = 1.68 mm.

The permanent p3 sin.(?) is the smallest, only 0.70 mm long tooth with main cusp in front and with distinct lingual and posterior cingulids. An uncovered straight root is large and robust, slightly arched posteriorly.

The main cusp (protoconid?) dominates in the front crown part of the deciduous left Dp4. The posterior cingulid is distinct together with slightly undulated lingual one. Two roots are slanted. L = 1.66 mm.

Due to the broken anterior part of the mandible lingual side, the enamel cap of permanent p4 sin. is visible under the extruded Dp4. Unlike the deciduous tooth, the main cusp (protoconid?) of p4 is robust. The distinct cingulid forms the crown base on the lingual side. Roots are not developed yet. The assumed height of the main cusp is 1.14 mm.

Only lingual side of m1 sin. with three distinct cusps is exposed. The low paraconid is situated in front. The metaconid is robust and the entoconid is nearly as large as the former cusp. The lingual cingulid is distinctly developed in anterior part, forming a border for the trigonid basin. The molar dimensions are as follows: L = 2.38 mm, HPAD = 0.48 mm, HMED = 1.14 mm, and HEND = 1.15 mm.

Only top of the paraconid together with the metaconid and entoconid are exposed from left m2. The metaconid is tall, separated from the smaller entoconid by a syncline basin. The distinct anterior part of the lingual cingulid forms a border for the trigonid basin. The m2 dimensions are as follows: L = 2.49 mm, HPAD ~ 0.75 mm, HMED = 1.15 mm, and HEND = 1.00 mm.

More or less, only lingual side of damaged hemimandible molar part is preserved. The assumed Hm1 is 2.00 mm and Lm1-m2 is approximately 4.95 mm.

The preserved lingual part of isolated right M1 consists of three cusps. The conical protocone is taller than hypocone, being more slender. A syncline-like basin separates the two cusps from each other and a small intermediate cusp (= mesocone, according to Rabeder 1998) is situated between them on the medial side of the crown. A preserved part of the posterior cingulum is robust. The lingual cingulum is more distinct in front only. The dimensions of M1 are as follows: LM = 2.59 mm, HPR = 1.12 mm, and HHY = 1.03 mm.

The paraconid of loose m1 dext. is the smallest cusp, connected with the protoconid by the paralophid. The protoconid is larger than slender metaconid. The entoconid with short entocristid is connected with more robust hypoconid by distinct postcristid. The buccal and posterior cingulids are distinct, whereas lingual cingulid more or less bounds small trigonid basin only. The deep talonid basin is opened lingually. The molar dimensions are as follows: L = 2.42 mm, TRL = 0.77 mm, TAL = 1.13 mm, W = 1.21 mm, TRW = 0.87 mm, TAW = 1.19 mm, HPAD = 0.84 mm, HPRD = 1.23 mm, HMED = 1.11 mm, HHYD = 1.33 mm, and HEND = 1.14 mm.

Remarks: Dimylid fossils are relatively frequent in Miocene deposits of Europe, represented mainly by both dental remains and cranial fragments. Besides them, deciduous teeth of these enigmatic insectivores have been found too. In spite of their scarceness, they are thus far known in several species including *Chainodus ulmensis* Ziegler, 1990, *Dimylus paradoxus* von Meyer, 1846 (Ziegler 1990a), *Dimyloides rigassi* (Engesser, 1976), and also in *Plesiodimylus chantrei* Gaillard, 1897 (Engesser 1976). However, they only represent isolated finds in most cases. Thus, the fossil record from Bonanza is one of the first finds, where upper and lower permanent dentition of *P. chantrei* has been found together with deciduous teeth in one cranial fragment, indicating the animal died in the time of its tooth replacement. Hereby, this find represents one of the first records of *P. chantrei* with preserved DP3.

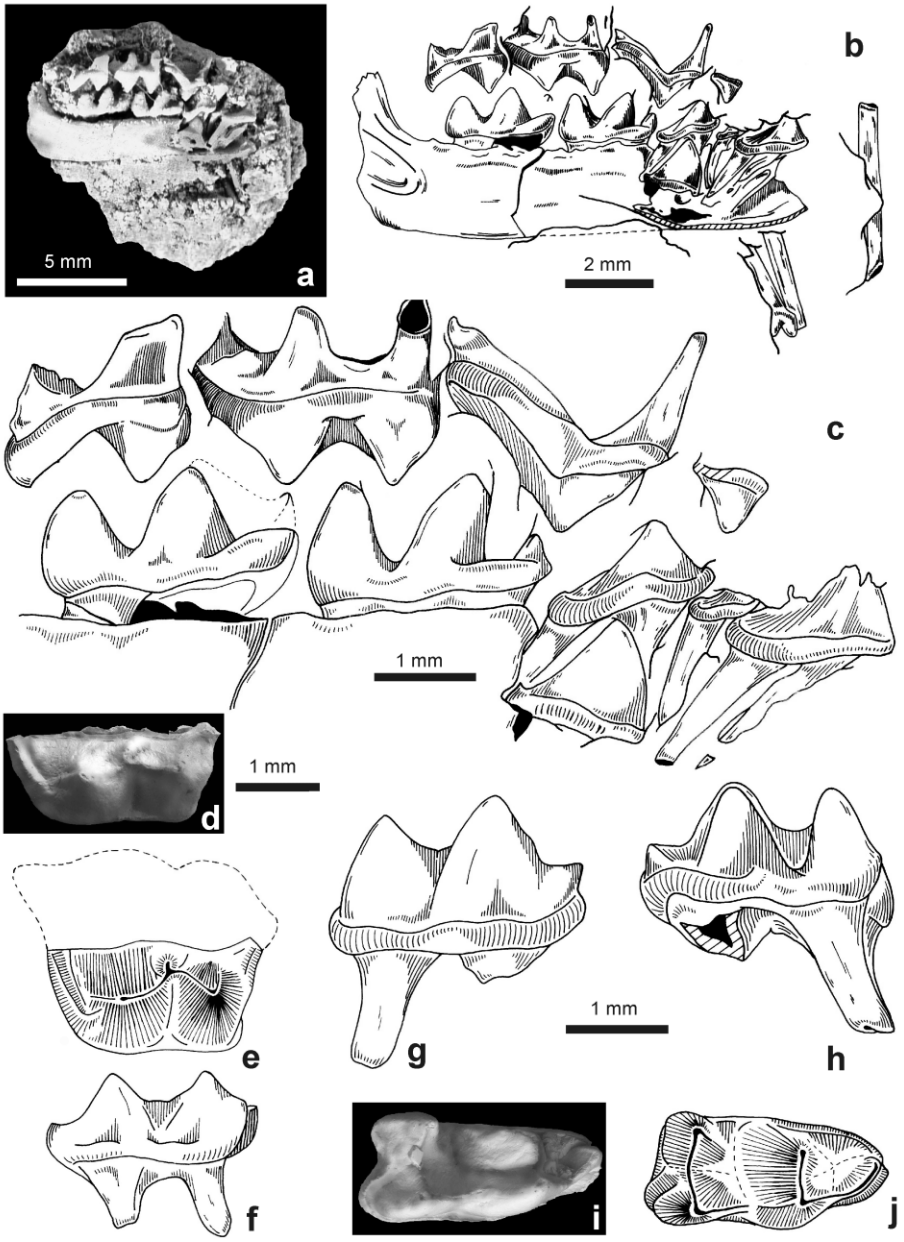

Fig. 9. Findings of *Plesiodimylus chantrei* Gaillard, 1897 from Upper Badenian deposits of Bonanza. **a–c** — left hemimandible and left upper jaw of a juvenile specimen with deciduous (DP3, DP4, Dp4) and permanent (M1–2, p1, p3?, p4, m1–2) dentition (Z-14663/1; a, b — lingual views; c — detail view to the dentition). **d–f** — lingual part of M1 dext. (Z-14663/3; d, e — occlusal views; f — lingual view). **g–j** — m1 dext. (Z-14663/2; g — buccal view; h — lingual view; i, j — occlusal views).

Family: **Soricidae** Fischer de Waldheim, 1817
Subfamily: **Heterosoricinae** Viret et Zapfe, 1951
Genus: *Dinosorex* Engesser, 1972

Dinosorex cf. *zapfei* Engesser, 1975
Figs. 11, 12

Material: Right hemimandible with lower (i1, m1–m3) and upper (P4, M1, M2) dentition; left P4, M1, M2; and cranial(?) fragments (SNM–NHM, Z-14589, layer No. 12b).

Description: The find probably represents a fragment of skull consisting of the damaged right hemimandible with dentition, upper teeth, and cranial remains. Unworn crowns indicate a young animal.

Whereas right P4 is still situated above m1, left P4 is preserved below the hemimandible. The posterior crest of the conical paracone extends towards the laterally flattened blunt cusp (metacone?), forming a cutting edge. The buccal cingulum is more distinct below the metacone(?) only. The length of P4 dext. is 2.36 mm.

Only buccal side of both M1s is uncovered. The paracone is wider, but lower than metacone. The buccal cingulum is absent. The dimensions of molars are as follows: L = 2.27 mm (dext.) and 2.15 mm (sin.), HPA = 1.30 mm

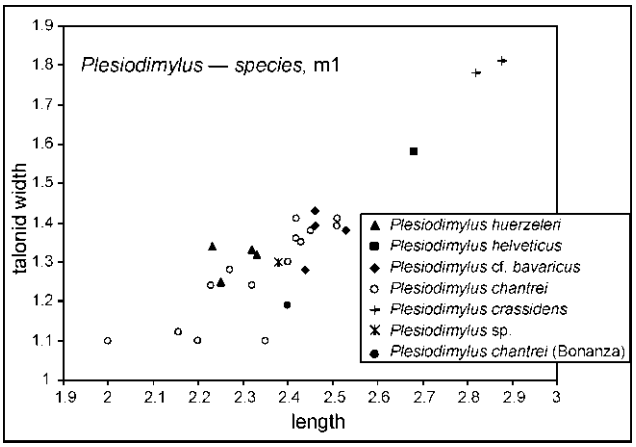

Fig. 10. Bivariate plot of m1 length/talonid width of *Plesiodimylus*-species from various Miocene sites of Europe and Turkey (used data: Baudelot 1972; Bolliger 1992; Engesser 1972, 1980; Gaillard 1899; Müller 1967; Rabeder 1998; Seemann 1938; Zapfe 1951; Ziegler & Mörs 2000).

(dext.) and 1.08 mm (sin.), HME = 1.35 mm (dext.) and 1.25 mm (sin.).

Whereas only buccal side of right M2 is visible, the whole occlusal surface of left M2 is exposed due to post-mortal processes. The paracone is large cusp with two crests, posterior one of which extends towards the mesostyle — a blunt cusp on the buccal side between the both paracone and metacone. The metacone is similar to the paracone. From two lingual cusps, the protocone is larger than the hypocone. A shallow basin opened lingually separates these cusps from each other. Next distinct basin is situated in the central crown part between the buccal cusps and lingual ones. The dimensions of the two molars are as follows: L = 1.99 mm (dext.) and 2.28 mm (sin.), LM = 1.97 mm (sin.), W = 2.40 mm (sin.), and WM = 2.05 mm (sin.).

The lower incisor is acuspidate, with a distinct cingulid on the crown base. L = 7.19 mm and W = 1.80 mm.

Only cusps on the buccal side of right lower molars are visible. The protoconid of m1 is larger and taller than the hypoconid. The distinct oblique crest extends from the hypoconid towards the protoconid-metaconid posterior wall. The buccal cingulid is marked, posteriorly weakly expanded. The front part of this molar exceeds the anterior mandible margin.

The m2 is smaller than m1. The protoconid is robust, whereas the hypoconid is smaller and more slender. The distinct buccal cingulid is somewhat more robust under the hypoflexid.

Only conspicuous protoconid is uncovered from cusps of the smallest m3. This cusp is approximately as large as the hypoconid of m2. The buccal cingulid distinctly forms the crown base.

The upper part of the coronoid process is broken off together with the condylar process, whereas the hook-like angular one is more or less preserved. The external temporal fossa is shallow, divided by a low horizontal crest in lower part. The mandible body expands anteriorly. There is an inconspicuous depression anterior to the

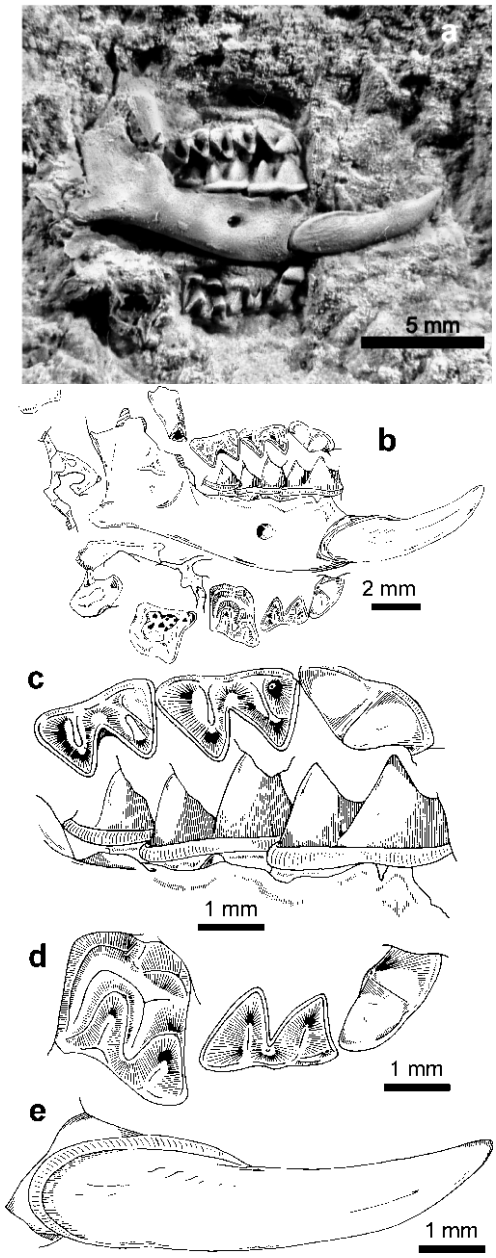

Fig. 11. *Dinosorex* cf. *zapfei* Engesser, 1975 from Upper Badenian sediments of Bonanza. **a–b** — right hemimandible with lower (i1, m1–m3) and upper (P4, M1, M2) dentition, upper left teeth (P4, M1, M2), and cranial(?) fragments (Z-14589). **c** — detail view to the lower (m1–m3) and upper (P4, M1, M2) right dentition. **d** — detail view to the upper left teeth (P4, M1, M2). **e** — detail view to the first lower incisor.

large and deep mental foramen, which is situated below the trigonid of m2. Alveoli of antemolars are present between m1 and lower incisor, but they are partly covered by rock and so their outlines are poorly evident. The dimensions of the mandible are as follows: L = 11.20 mm, Lm1–m3 ~ 6.24 mm, Hm1 = 3.25 mm, and Hm3 = 2.60 mm.

Remarks: Acuspidate lower incisor and divided masseteric fossa of the Bonanza find positively indicate the genus *Dinosorex*, thus far known in three species from the Middle Miocene of Europe — *D. zapfei* Engesser, 1975,

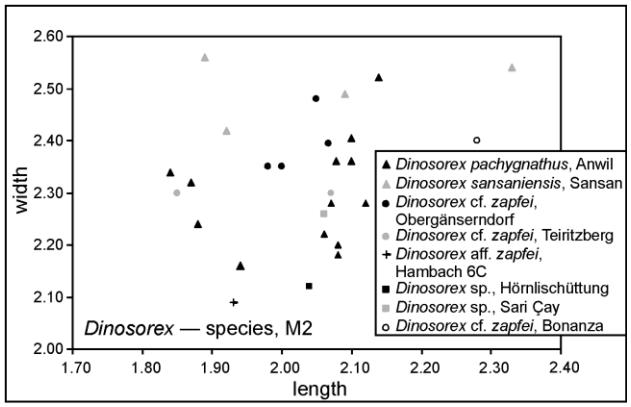

Fig. 12. Bivariate plot of M2 length/width of *Dinosorex*-species from various Miocene sites of Europe and Turkey (used data: Baudelot 1972; Bolliger 1992; Engesser 1972, 1980; Rabeder 1998; Ziegler & Mörs 2000).

D. sansaniensis (Lartet, 1851), and *D. pachygnathus* Engesser, 1972. However, the exact species determination of the fossil under study is more or less questionable, because its diagnostic characters are either not visible (occlusal surface of lower molars is covered by rock) or they are missing (the condylar process is broken off). Thus, only circumstantial characters have been used for the analysis. The classification of the Bonanza find to the species *D. pachygnathus* is excluded mainly for differences in the shape of the mandible and lower incisor, which is more slender in the fossil under study. Also, the exact determination of the find to *D. zapfei* or *D. sansaniensis* is not possible for aforementioned reasons. On the other hand, fossils of *D. zapfei* are known from nearby Devínska Nová Ves-Fissures site, a type locality for this heterosoricine taxon, dated to the Biozone MN6. From this viewpoint, it is not excluded that the *Dinosorex* remains from Bonanza belong to the same species. However, it is determined as *Dinosorex* cf. *zapfei* because not all characters could be evaluated.

Soricidae gen. et spec. indet.
Fig. 13

Material: Right upper incisor (DGP, MS-18, layer unknown).

Description: A semilunar main cusp with two distinct lateral edges dominates the slightly worn hook-like crown of this non-fissident upper incisor. Two accessory cusps are present at the talon. The buccal of them is larger and sharper than lingual one. Only the buccal cingulum is distinct. The dimensions are as follows: H = 1.03 mm, L = 1.31 mm, and LT = 0.64 mm.

Remarks: The described upper incisor and the find of above-mentioned *Dinosorex* cf. *zapfei* represent the only soricid fossils known from the site so far. However, the classification of the loose upper incisor to the subfamily Heterosoricinae is excluded because of its different crown shape and dimensions. Among non-heterosoricine soricids, approximately 30 species are known from the Europe-

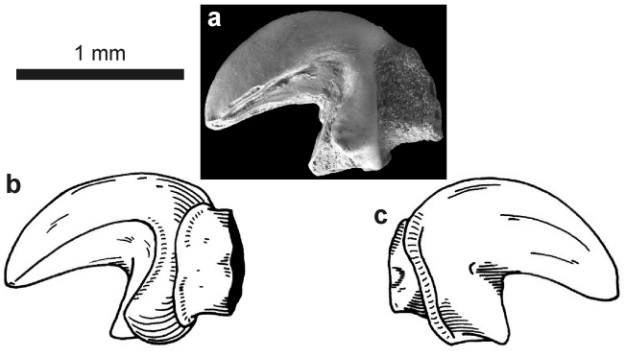

Fig. 13. Soricidae gen. et spec. indet.; right upper incisor (MS-18), Late Badenian, Bonanza. **a–b** — lingual view, **c** — buccal view.

an Miocene so far. Seven of them (*Miosorex grivensis* (Depéret, 1892); *M. desnoyersianus* (Lartet, 1851); *Lartetium dehmi* (Viret et Zapfe, 1951); *L. prevostianum* (Lartet, 1851); *Paenelimnoecus crouzeli* Baudelot, 1972; *Hemisorex robustus* Baudelot, 1972; and "*Allosorex*" *gracilidens* (Viret et Zapfe, 1951)) have been found in sediments, dated to the MN6 Zone (Ziegler 1999). From the morphological and metric point of view, the incisor under study can belong to some representative of the subfamily Crocidosoricinae — it is very similar to that of *M. grivensis* figured by Engesser (1972, Abb. 12b). However, no comparative material has been seen and so the find is only determined as Soricidae gen. et spec. indet. so far.

?Lipotyphla gen. et spec. indet
Fig. 14

Material: Fragment of the juvenile left pentadactyl forelimb (SNM–NHM, Z-14578, layer unknown).

Description: The forelimb fragment of a small mammal consists of four metacarpals (McII–V), five proximal phalanges, three medial phalanges, and one distal pyramidal phalanx of the second finger. The metacarpals, the third of which is the largest bone, are either relatively massive (McII, McV) or slender (McIII, McIV). The proximal phalanges are short to long and slender, whereas medial finger bones are shorter than proximal ones. The proximal part of the distal pyramidal phalanx is widened and its distal part is tapered to the point.

Remarks: Although the exact position and exact determination of this forelimb fragment are unknown, it is not excluded that it can belong to a young (free epiphyses) specimen of *Dinosorex* or *Plesiodimylus*, whose juvenile fossils have been found in the same light, solid, laminated calcareous sandstone as well. However, it is determined as ?Lipotyphla gen. et spec. indet. because much more complete material for the exact determination is necessary.

Biostratigraphic considerations

Insectivores have less high stratigraphic value than rodents mainly due to the ignorance of their lineages (Ziegler 2003).

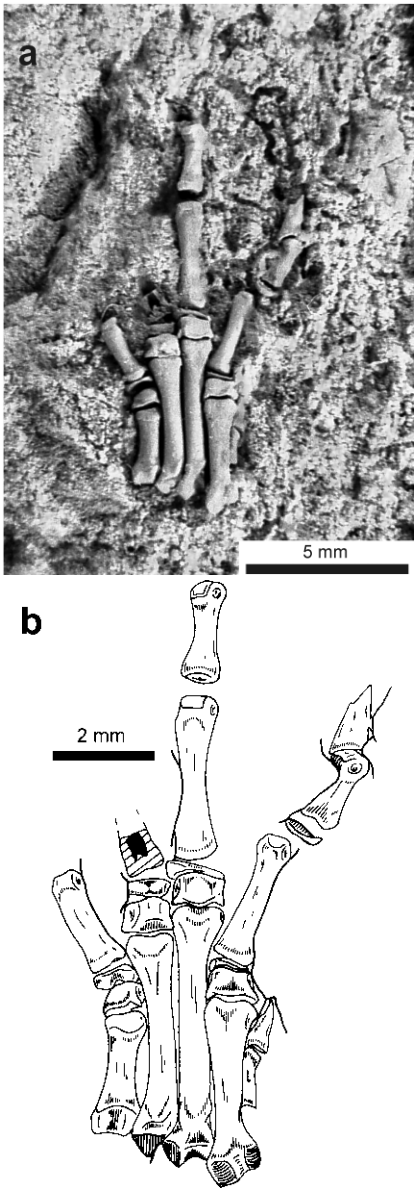

Fig. 14. ?Lipotyphla gen. et spec. indet.; a fragment of the left forelimb of a juvenile specimen (Z-14578), Late Badenian, Bonanza. **a–b** — dorsal view.

The stratigraphic ranges of individual species found in Bonanza are outlined in order according to Ziegler (1999).

The stratigraphic range of *Lantanotherium sansaniense* is from MN6 to MN8, though slightly smaller *L.* aff. *sansaniense* is also known from MN5 sites (e.g. Viehhausen, Maßendorf or Hambach 6C). This lesser form apparently represents an ancestor of *L. sansaniense* (Ziegler, 1999). To the contrary, the Bonanza find represent a larger form than *Lantanotherium* fossils from the Sansan type-site (MN6). Because it is assumed that the size differences can lie within the variability of the species, *Lantanotherium* from Bonanza could represent a Late Badenian insular form of this galericine erinaceid (see also below).

Talpa minuta is one of the most common talpids, which probably arrived in Europe during the Early Orleanian immigration wave. Its fossils are known from many sites in Germany, Bohemia, Slovakia, Poland, France and Spain, correlated with MN3 (or MN2 (cf.) resp.) to MN9 (Ziegler 1999).

Storchia was known only from the Late Miocene to the Early Pliocene up to now. Thus, the new species (*S. meszaroshi*) extends the genus range to the Middle Miocene.

Plesiodimylus chantrei is also one of the most common Miocene insectivore species, widespread especially in Western and Central Europe. Its fossils are known from many sites dated from MN4 (aff., cf.) to MN11 (Ziegler 1999).

The stratigraphic range of *Dinosorex zapfei* is restricted only to MN6, though its close relative forms (aff., cf.) are also referred from MN4 and MN5 sites (e.g. Petersbuch 2, Hambach, Obergänserndorf 2, Teiritzberg 1 and 2).

With respect to this, the stratigraphic range of the determined species of the found insectivore assemblage from Bonanza enables us to correlate the age of the site probably with MN5 to MN6 Zone. However, a rodent fauna from the same site indicates Late Badenian part of MN6 Zone (Sabol in prep.), which is in good agreement with the opinion of Holec et al. (1987). On the basis of lithological circumstances, they date the site to a younger period than a nearby locality Devínska Nová Ves-Fissures, whose faunal assemblage represents the lower part of MN6 Zone (upper part of the Middle Badenian) (Fejfar 1990, 1997).

Paleoenvironmental aspects

Unlike their biostratigraphical use, insectivores are relatively good indicators of paleoenvironmental conditions.

The geographical distribution of extant representatives of Galericinae, to which extinct *Lantanotherium* belongs, is today restricted to relic areas of South-eastern Asia only. They live in subtropical forested environment, often close to water (Ziegler 1999). The largest extant form, *Echinosorex gymnurus* Raffles, 1821, is the largest extant insectivore as well. Its diet consists of worms, beetles, termites, centipedes, spiders, fish, and frogs including tadpoles (Gaisler et al. 1995).

The Talpini is an Old World tribe. The presence of *Talpa* in an assemblage is not very informative for paleoenvironmental and paleoclimatic questions (Ziegler 2003).

All modern water-moles are well adapted for a life in water and near water (semi-aquatic habitat) — whereas *Desmana moschata* (Linnaeus, 1758) lives on the overgrown banks of slowly flowing rivers and lakes, the Pyrenean water-mole (*Galemys pyrenaicus* (Geoffroy, 1811)) inhabits the banks of pure streams (Gaisler et al. 1995). The same surely goes for extinct taxa too. Thus, the presence of freshwater habitat in the near vicinity of the site during the deposition of fossiliferous sediments is assumed. From the viewpoint of diet, extant desmans feed on molluscs, worms, insects, small fish, frogs and their tadpoles, and plants. It is possible to assume the same diet composition in most of the extinct water-moles with inflated lower cheek teeth, whereas the narrow lower molars of *Storchia*-species indicate an enhanced cutting capability.

The dimylids are assumed to be semi-aquatic malacophagous extinct insectivores (Ziegler 1999). However, no post-

cranials of these enigmatic mammals are known until now, so their semi-aquatic mode of life is questionable (Ziegler & Mörs 2000). On the other hand, the find of *Plesiodimylus chantrei* together with fossils of other semi-aquatic vertebrates (water-mole, frogs) on the site can support the opinion on their inhabitation of a habitat close to water. The dentition of *Plesiodimylus*-species is mostly slightly specialized. For this reason, it is assumed a more insectivorous dietary habit for them than for other representatives of Dimylidae (Ziegler 1999).

The value of soricids (mainly those of extinct subfamilies and/or species) in the reconstruction of the paleoenvironment is relatively low. Most of them are terrestrial, but some are semi-aquatic or burrowing occasionally. They are insectivorous or carnivorous, some also herbivorous animals (Ziegler 1999).

The insectivore assemblage under study indicates a forested environment close to water. However, in detailed paleoenvironmental reconstruction, the whole fossil assemblage should be analysed. Besides insectivores, representatives of Sciuridae, Cricetidae, Gliridae, Eomyidae, Viverridae, Phocidae, Mustelidae, Chiroptera, Cervidae, and Mammutidae are known from the site. Reptiles, frogs, fish, 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 the 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 good evidence of this assumption.

Composition of insectivore assemblage

The Miocene insectivore fossil record shows greater diversity than the extant European insectivore fauna. The absence of plesiosoricids and dimylids is an illustrative case among recent insectivores. On the other hand, the number of insectivore taxa and the composition of individual fossil insectivore assemblages frequently vary both in space and time. Despite the incompleteness of the fossil record, this compositional variability can be evoked by various factors, mainly by environmental and climatical changes.

From the viewpoint of the similarity of assemblages from some important European sites dated from MN5 to MN8 (Table 1) on the level of insectivore genera, the Bonanza insectivore assemblage displays the largest analogy especially with that of Devínska Nová Ves-Fissures (Neudorf-Spalte, MN6). The only difference is observed in the number of talpid taxa. Whereas five taxa of talpids are known from Fissures (*Talpa minuta*, "*Scaptonyx*" *edwardsi*, ?*Urotrichus dolichochir*, and two undeterminable moles), the Bonanza assemblage thus far contains only two talpid species (*T. minuta* and *Storchia meszaroshi*). This absence of urotrichine taxa together with the presence of a water-mole within the whole insectivore assemblage under study probably reflects the paleoecological changes connected with the terrestrial–marine environmental transition before and/or during the Late Badenian transgression in the territory of the Devínska Kobyla Hill.

The insectivore assemblages of Sansan (MN6) and Anwil (MN8) also display a relatively great index of similarity with the Bonanza sample. However, detailed comparisons are more or less limited, as the insectivore fossil record from the site under study is very scarce.

Conclusions

Eight specimens of insectivores (*Lantanotherium* aff. *sansaniense*, Erinaceidae gen. et spec. indet., *Talpa minuta*, *Storchia meszaroshi* nov. sp., *Plesiodimylus chantrei*, *Dinosorex* cf. *zapfei*, Soricidae gen. et spec. indet., and ?Lipotyphla gen. et spec. indet.) were collected in the Bonanza fossil site. This insectivore assemblage comprises several new faunal elements including a new form of water-mole from the Middle Miocene (*Storchia meszaroshi* sp. nov.).

The composition of the insectivore assemblage, supported by records of rodents, validated the assumed Late Badenian age of the site (MN6).

The found insectivores indicate a forested coastal subtropical environment with neighbouring freshwater lagoon, marsh or delta, situating in an insular or peninsular area on the eastern side of the Vienna Basin.

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Table 1: The number of insectivore taxa from some Middle Miocene European sites and the comparison of similarity of individual assemblages with the 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).

Site	Number of insectivore taxa					Index of Similarity	Reference
	Erinaceidae	Talpidae	Dimylidae	Plesiosoricidae	Soricidae		
Hambach 6C	2	5	2	1	4	0.40	Ziegler & Mörs 2000
Franzensbad	2	6	2	1	4	0.32	Fejfar & Sabol (in press)
Sansan	5	4	1	–	5	0.44	de Bruijn et al. 1992
Neudorf-Spalte	2	5	1	–	3	0.57	Zapfe 1951
La Grive	5	6	3	–	5	0.27	de Bruijn et al. 1992
Anwil	2	5	2	1	3	0.53	Engesser 1972
Bonanza	2	2	1	–	2	–	

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References

Baudelot S. 1972: Etudes des Chiropteres, Insectivores et Rongeurs du Miocene de Sansan (Gers). *Manuscript,* Toulouse, 1–364.

Bolliger T. 1992: Kleinsäugerstratigraphie in der miozänen Hörnlischüttung (Ostschweiz). *Documenta Naturae* 75, 1–296.

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. *Newslett. Stratigr.* 26, 2, 3, 65–118.

Dahlmann T. 2001: Die Kleinsäuger der unter-pliozänen Fundstelle Wölfersheim in der Wetterau (Mammalia: Lipotyphla, Chiroptera, Rodentia). *Cour. Forschungsinst. Senckenberg* 227, 1–109.

Engesser B. 1972: Die obermiozäne Säugetierfauna von Anwil (Baselland). *Tätigk.-Ber. Naturforsch. Gesell. Baselland*, Band 28, (1969–1970), 37–363.

Engesser B. 1976: Zum Milchgebiss der Dimyliden (Insectivora, Mammalia). *Eclogae Geol. Helv.* 69, 3, 795–808.

Engesser B. 1980: Insectivora und Chiroptera (Mammalia) aus dem Neogen der Türkei. *Schweiz. Paläont. Abh.* Band 102, 47–149.

Fejfar O. 1990: The Neogene VP sites of Czechoslovakia. A contribution to the Neogene terrestric biostratigraphy of Europe based on rodents. In: Lindsay E.H., Fahlbusch V. & Mein P. (Eds.): European Neogene mammal chronology. *NATO ASI (New York), Series A* 180, 211–236.

Fejfar O. 1997: Miocene biochronology. In: Aguilar J.P., Legendre S. & Michaux J. (Eds.): Actes du Congrés BiochroM '97. *Mém. Trav. E.P.H.E., Inst. de Montpellier*, 21, 795–802.

Fejfar O. & Sabol M. 2005: Neogene Insectivores of the Bohemian massive and Western Carpathians. In: Hoek Ostende L.W., van den Reumer J. & Doukas C.D. (Eds.): The fossil record of the Eurasian Neogene insectivores (Erinaceomorpha, Soricomorpha, Mammalia). *Scr. Geol.*, *Spec. Issue* 5, (in press).

Gaillard C. 1899: Mammifères miocènes nouveaux ou peu connus de La Grive-St.-Alban. *Arch. Mus. Hist. Natur. Lyon*, 7.

Gaisler J., Zejda J., Knotek J. & Knotková L. 1995: Mammals. *Aventinum,* Praha, 1–496 (in Czech).

Holec P., Klembara J. & Meszároš Š. 1987: Discovery of new fauna of marine and terrestrial vertebrates in Devínska Nová Ves. *Geol. Zbor. Geol. Carpath.* 38, 3, 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 Mus. Morav., Sci. Geol.* LXXXIII, 159–172.

Jong de 1988: Upper Aragonian and Lower Vallesian Insectivora. In: Freudenthal M. (Ed.): Biostratigraphy and paleoecology of the Neogene micromammalian faunas from the Calatayud-Teruel Basin. *Scr. Geol.*, *Spec. Issue* 1, 1–302.

Joniak P. 2005: New rodent assemblage from Upper Miocene deposits of the Vienna and Danube Basins. *Manuscript,* Bratislava, 1–130.

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 Contrib. Paleobiol.* 93, 163–178.

Mayr H. & Fahlbusch V. 1975: Eine unterpliozäne Kleinsäugetierfauna aus der Oberen Süßwasser-Molasse Bayerns. *Mitt. Bayer. St.- Samml. Paläont. Hist. Geol.* 15, 91–111.

McKenna M.C. & Bell S.K. 1997: Classification of mammals. Above the species level. *Columbia University Press,* New York, 1–634.

Mein P. & Ginsburg L. 2002: Sur l'âge relatif des différents dépôts karstiques miocènes de La Grive-Saint-Alban (Isère). *Cah. Scientifique — Mus. His. Natur.* 2, 7–47.

Müller A. 1967: Die Geschichte der Familie Dimylidae (Insectivora, Mamm.) auf Grund der Funde aus tertiären Spaltenfüllungen Süddeutschlands. *Bayerische Akad. Wiss.*, *Math.-Nat. Kl.* 129, 1–99.

Pipík R. & Sabol M. 2005: *Paenelimnoecus* sp. (Lipotyphla, Mammalia) from the Late Miocene deposits of the Turiec Basin (Slovakia) and its paleoenvironment. *Beitr. Paläont.* (in press).

Rabeder G. 1973: *Galerix* und *Lanthanotherium* (Erinaceidae, Insectivora) aus dem Pannon des Wiener Beckens. *Neu. Jb. Geol. Paläont.* 7, 429–446.

Rabeder G. 1998: Säugetiere (Mammalia) aus dem Karpat des Korneuburger Beckens. 1. Insectivora, Chiroptera und Marsupialia. *Beitr. Paläont.* 23, 347–362.

Reumer J.W.F. 1984: Ruscinian and early Pleistocene Soricidae (Insectivora, Mammalia) from Tegelen (The Netherlands) and Hungary. *Scr. Geol.* 73, 1–174.

Rümke C.G. 1985: A review of fossil and recent Desmaninae (Talpidae, Insectivora). *Utrecht Micropaleont. Bull.*, *Spec. Publ.* 4, 1–242.

Seemann I. 1938: Die Insektenfresser, Fledermäuse und Nager aus der obermiozänen Braunkohle von Viehhausen bei Regensburg. *Palaeontographica*, *Abt. A* 89.

Špinar Z.V., Klembara J. & Meszároš Š. 1993: A new toad from the Miocene at Devínska Nová Ves (Slovakia). *Západ. Karpaty, Sér. Paleont.* 17, 135–160.

Viret J. 1940: Etude sur quelques Erinacéidés fossiles genres *Plesiosorex*, *Lanthanotherium*. *Trav. Lab. Géol. Fac. Sci. Lyon* 39, 28, 33–68.

Zapfe H. 1951: Die fauna der miozänen Spaltenfüllung von Neudorf a.d. March (ČSR). Insectivora. *Sitz.-Ber. Akad. Wiss. (Wien)*, *Math.-Naturwiss. Kl., Abt. I,* 160, 449–480.

Ziegler R. 1983: Odontologische und osteologische Untersuchungen an *Galerix exilis* (Blainville) (Mammalia, Erinaceidae) aus den miozänen Ablagerungen von Steinberg und Goldberg im Nördlinger Ries (Süddeutschland). *Manuscript,* München, 1–244.

Ziegler R. 1990a: Didelphidae, Erinaceidae, Metacodontidae und Dimylidae (Mammalia) aus dem Oberoligozän und Untermiozän Süddeutschlands. *Stuttgarter Beitr. Naturkunde*, *Serie B (Geol. und Paläont.)* 158, 1–99.

Ziegler R. 1990b: Talpidae (Insectivora, Mammalia) aus dem Oberoligozän und Untermiozän Süddeutschlands. *Stuttgarter Beitr. Naturkunde*, *Serie B (Geol. und Paläont.)* 167, 1–91.

Ziegler R. 1999: Order Insectivora. In: Rössner G.E. & Heissig K. (Eds.): The Miocene land mammals of Europe. *Verlag Dr. Friedrich Pfeil,* München, 53–74.

Ziegler R. 2003: Moles (Talpidae) from the late Middle Miocene of South Germany. *Acta Palaeont. Pol.* 48, 4, 617–648.

Ziegler R. & Mörs T. 2000: Marsupialia, Lipotyphla und Chiroptera (Mammalia) aus dem miozän des Braunkohlentagebaus Hambach (Niederrheinische Bucht, NW-Deutschland). *Palaeontographica*, *Abt. A* 257, 1–26.