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Middle Miocene microvertebrate faunas from the Eastern margin of the Pannonian Basin

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Abstract. The aim of this publication is to give a summary on the field activity and elaboration of the Middle Miocene (Badenian, Sarmatian, MN6 -MN7+8) microvertebrate faunas collected in the Eastern margin of the Pannonian Basin. The scientific activity was organized by the authors in cooperation with specialists during the last two decades. During this work, we excavated the new faunas of Tăşad, Subpiatră 2/1, 2/2, 2/3, Vârciorog and we gave new interpretations on the previously known assemblages from Comăneşti and Tauț. The partial results were published in local and in international journals and conferences.

Key words. Miocene, Badenian, Sarmatian, microvertebrata, Carpathian Basin

Introduction

Pre-Pannonian non-carstic Miocene vertebrate faunas were not known in the Carpathian region before the discovery of Tauț (Feru et al. 1979) in Romania and Hasznos (Kordos 1981) in Hungary. In this „terra incognita" an intensive field activity has been managed by the authors since the 1990's with view to collecting fossil microvertebrate faunas from Badenian and Sarmatian nonmarine sediments (Fig. 1). Beyond the field campaigns we revised the classic assemblages of Comăneşti and Tauț (Fig. 2).

Because of its geographic position, as well as its complex geological context, the fossil record from the Carpathian area plays a key role for the understanding of the processes leading to the faunal interchanges between western Europe and Asia. The general aim of this work is to provide an overview of the vertebrate assemblages from the Middle Miocene in the Eastern foothill region of the Pannonian Basin, to underscore the importance of the area in the evolution of continental faunas.

Methods

Dental morphological nomenclatures followed in the text: for Sciuridae: Cuenca-Bescos (1988), for Gliridae: Daams (1981), Wu (1993), Daxner-Höck & Höck (2009), for Cricetodontini: Mein & Freudenthal (1971 b), Rummel (1998), Lopez-Guerrero et al. (2013) and for Cricetini: Mein & Freudenthal (1971 b), Daams & Freudenthal (1988).

Abbreviations in the text.

D4:	deciduous (milk) upper premolar
P4:	upper permanent premolar
M1-M2-M3:	Upper permanent molars
d4:	deciduous (milk) lower premolar
p4:	lower permanent premolar
m1-m2-m3:	lower permanent molars

Micrographs of the rodent teeth on plates I, III and VI were taken with a Zeiss light camera. Micrographs of the plates II, IV, V and VII were taken using a Canon EOS 400D camera equipped with a Canon MP-E65 macro lens. Retouching was made by the first author.

The occlusal surfaces of the rodent teeth are figured in the plates is left side. The right-side teeth are reversed by graphic methods.

Deposition of the studied material:

MMP: Municipal Museum, Pásztó;

MTCO: Ţării Crişurilor Museum, Oradea;

UBB: Babeş-Bolyai University, Cluj-Napoca;

ISER: Speleological Institute “Emil Racoviță”, Bucharest.

Localities of the Subpiatră Rece Valley

The village Subpiatră is located in the northern range of the Pădurea Craiului Mountains about 40 km east to Oradea, close to Aleşd. The presence of Middle Miocene freshwater sediments in the area have been first reported by Vadász (1957) and Istocescu & Istocescu (1974). Two fossil-bearing layers (Subpiatră 2/1 and Subpiatră 2/2) were identified by one of the authors (MV) in 2004. A third one (Subpiatră 2/3) was found by the same scholar in 2007. The productive sandy clay layer of Su 2/1 is situated in the left and right side of a small ravine (N47°00,379’, E22°18,683’). The finds from the two sides were labelled as Su 2/1R and Su 2/1L. In the field shells of freshwater molluscs were visible.

Subpiatră 2/2 (N47°00,373, E22°18,650’) is a dark brownish clay layer of 15-20 cm thickness overlaid by a 60-71 cm thick yellow clay layer, both of which being rich in planorbid shells.

Subpiatră 2/3 (N47°00,189’, E22°18,065) is a yellowish green clay layer on the surface, which contains helicid shells and carbonate concretions. 4 tones sediment were screen washed from the three localities between 2004 and 2008 (Fig. 3).

Up to the present, preliminary publications were given on the elaboration of the vertebrate finds Hír & Venczel (2005), Venczel & Hír (2008), Venczel et al. (2005). A comprehensive valuation of the faunas was hampered by the following reasons:

1. The absence of Cricetodontini.
2. The *Muscardinus* material has affinity to *Muscardinus thaleri* and not to *Muscardinus* aff. *sansaniensis* which is a unique situation among the Middle Miocene vertebrate faunas in Central Europe (Plate I: 5-15).
3. The dominant rodent is *Megacricetodon similis*, which is absent in the other Middle Miocene faunas of the Pannonian Basin (Plate III: 1-3).

The biochronological position of Su 2/1 was first classified as Late Badenian and MN6 zone (Hír & Venczel 2005, Venczel et al. 2005). At the same time Su 2/2 was regarded as Sarmatian and MN 7/8 zone. Latter this viewpoint was modified and the faunas were dated to the border of the Middle- and Late Badenian (Hír et al. 2016) after the detailed study of the *Democricetodon brevis* material (Plate III: 5-7) and the co-occurrence of *Megacriceodon similis* and *Democricetodon brevis*. In the Swiss molasse these species are found together in the *Megacricetodon similis- Megacricetodon gregarius* intervallum zone (type fauna: Mettlen-Weid, MN6), in the *Megacricetodon gregarius -Deperetomys hagni* intervallum zone (type fauna: Chräzerentobel 505 m, early MN7+8) and in *Deperetomys hagni* taxon range zone (type fauna: Anwil, early MN7+8) (Kälin & Kempf 2009). After the composition of the faunas the most probable correlation is possible to draw with Mettlen-Weid.

There are important differences among the three faunas of Subpiatră. Su 2/1 and Su 2/3 are of low diversity unbalanced faunas. The frequency of *M. similis* is 87% in Su 2/1 and 84% in Su 2/3. Su 2/2 is completely different, because the higher diversity and the higher frequency of arboreal elements: glirids, flying squirrels (Plate III: 8-12). A mild paleoclimate is possible with minimal 14,5 °C MAT, because the presence of crocodiles and monitor lizards.

Tăşad 1

The village Tăşad is found at the southwestern foothill region of the Pădurea Craiului Mountains, 20 km from Oradea. The studied exposure is situated in the Eastern side of the Brustur Valley not far from the protected cave Tăşad (N 46°55'19,7", E 22° 07' 24,1" 07' 24,1"). The studied fauna was collected from a 60 cm thick green clay in the lower part of the section. The fossiliferous level is overlaid by typical Sarmatian limestone. In the field helicid shells and bone fragments are visible in the clay without washing and magnification. The fieldwork was managed by Márton Venczel. The first test samples were taken in 1999. One tone of clay was collected and washed with the help of students in the summer of 2000.

The biochronological classification is based on the extremely rich mollusk fauna, which is undoubtedly referable to the Early Sarmatian *Mohrensteinia* zone of the Central Paratethys (Kókay in Hír et al 2002). Characteristic reptiles are: Agamidae indet., *Ophisaurus* sp., *Pseudopus* sp., Scolecophidia indet. and a freshwater crocodilian (*Diplocynodon* sp.).

The revealing fossil rodents are the following:

1. *Muscardinus* aff. *sansaniensis*. The M1s are relatively narrow and elongated. The ridges no. 3 and 5 are reduced. Those are more evolved than the M1s of the Badenian *Muscardinus* finds (Plate I: 1).
2. *Cricetodon* sp. The material is few. Only modest postulations are founded. The molars are brachyodont. The M3/m3 molars are not reduced and not stretched. Affinities to the late Middle Miocene Cricetodontini (*Hispanomys, Byzantinia*, "*Cricetodon*") are not found.
3. *Megacricetodon minor*. The mean measurements of the molars are close to the Badenian *Megacricetodon minor* populations.
4. *Democricetodon* sp. n. (sensu Kälin & Engesser 2001). The taxon was described from Nebelbergweg (Switzerland) without formal diagnosis. Tăşad 1 is the earliest occurrence of this species in the Pannonian Basin. In our first publication (Hír et al. 2002), we classified this find as *D. brevis* but later we corrected this classification (Hír et al. 2017).

This fauna can be classified as early Sarmatian, and MN 7+8 zone (Hír et al. 2002). The sedimentation has been taken place in a shallow brackish environment. In the close dry land, a dry scrub environment was possible mainly after the reptiles.

In the earlier literature rhinocerotid remains (*Lartetotherium sansaniensis* or *Gaindatherium* sp.) were reported from the vicinity of Tăşad (Istocescu & Istocescu 1974, Codrea 2000). We assume that these large vertebrate bones were found from the fossiliferous layer studied by us.

Tăşad 2

This locality is found in the right side of the Brustur Valley (N 45° 55' 23,6", E 22° 07' 23") close to the section of Tăşad 1. In 2000 a small sized dolphin (Kentriodontidae indet.) was excavated and described from here by Kazár & Venczel (2003).

Vârciorog 1

The studied 12 m -high section exposes in the Vişinilor Stream (N 46°58,801', E 22°15,833') NW from the village (Fig. 4). It is located in the Western slopes of the Pădurea Craiului Mountains. The section consists of gray clays and silts with a thin lignite seam, which belong to the Sarmatian Cornițel Formation (Istocescu & Istocescu 1974, Popa 2000, Filipescu et al. 2014 and citations herein). The invertebrate fauna of the locality was intensively studied by Filipescu et al. (2014). They concluded that the microfossil assemblages (Foraminifera, Ostracoda, Bryozoa) are referable to the early Sarmatian *Elphidium reginum* zone. The otolith material was investigated by Reichenbacher et al. (2019). They postulated a heterogenous nearshore environment along a rocky coast. The co-occurrence of brackish water taxa and shallow marine elements indicates a brackish to marginal marine habitat with freshwater influx from rivers draining the adjacent rising Apuseni Mountains.

The sampling for microvertebrata was initiated by Venczel Márton and Hír János in 2007. The bone-bearing blue-gray clay was found at the basis of the section close to the water level of the rivulet. In the field *Helix* and *Pomatias* shells

and rare vertebrate bones are visible. A second fossiliferous layer situated 6 m above the basis of the section (Vârciorog 2) was sampled by Vlad Codrea in 2010, but it provided only few fossils (Fig. 5). In 2015, a new field campaign was managed by Vlad Codrea, Márton Venczel, János Hír and Alexandru Solomon. The result of this activity was a divers and rich fauna (Hír et al. 2020).

In the herpetofauna (Hír et al. 2016) geckonids, scincids, *Varanu*s and the crocodilian *Diplocynodon* mirror a mild climate. The crocodilian of Vârciorog is the possible latest occurrence of alligatoroids in the Pannonian Basin.

The most important elements of the rodent fauna are the following:

1. *Miodyromys* sp. The molars fit well with the *Miodyromys* finds from Gratkorn, Austria (Late Sarmatian, MN7+8) (Daxner-Höck 2010).
2. *Muscardinus* aff. *sansaniensis.* The morphology of the M1 is referable to the structure of "*Eomuscardinus* aff. *sansaniensis*" figured by Engesser (1972: p. 223, fig. 82,2). This morphology is typical in the *Muscardinus* finds of the MN7+8 zone faunas in the Pannonian Basin (Plate I: 4.).
3. "*Cricetodon" venczeli* n. sp. After the diagnosis of the new species (Hír et al. 2020) the most important characters are: modest hypsodonty and flat occlusal surface. In M1 the splitted anterocone, the frequent complete ectoloph, lingual anteroloph, protolophule I and protocone sporn. Rarely developed or short mesoloph. In M2 frequent protocone sporn and rare anterior ectoloph. In m1 the frequency of metalophulid II is 61%, the co-occurrence of both metalophulid is 35%, there is no tooth showing metalophulid I only. In lower molars the mesolophid is short or absent (Plate VII.).

   After a detailed morphological analysis and comparison Hír et al. (2020) classified *"C." venczeli* as a first member of an evolutionary lineage including *"C."* cf. *klariankae* (Kozárd) and *"C" klariankae* (Felsőtárkány-Felnémet 2/3). The most important evolutionary trends are: increasing of hypsodonty, strengthening of anterior ectoloph of the paracone on M1, relative increasing of the length of LM2 and Lm2 (but in less degree than in *Byzantinia* species), reduction and disappearance of lingual and labial

anterolophid, protosinusid, and anterosinusid of the m1. This grouping of evolutionary trends is found only in the late Middle Miocene Cricetodontini of the Carpathian area and it differs from the evolution of the Western European *Hispanomys* and the Eastern Mediterranean *Byzantinia*.

4. *Democricetodon* sp. n. (sensu Kälin & Engesser 2001)

During the last decade the smaller *Democricetodon* species of Vârciorog was reported from different Late Astaracian -Early Vallesian faunas of Central Europe: Felsőtárkány Felnémet 2/3 and 2/7 (Hungary) (Hír 2006), Gratkorn (Austria) (Prieto et al. 2010), Hammerschmiede (Bavaria, Germany) (Kirscher et al. 2016) (Plate V: 5-8, 12-14).

5. *Democricetodon* cf. *affinis* (Schaub, 1925)

The larger *Democricetodon* species of Vârciorog refers best to *D. affinis*. It is the only occurrence of the species in the Pannonian Basin (Plate V: 1-4, 10-11, 15).

Comăneşti 1.

The locality is situated at the Eastern margin of the village Comăneşti on the right side of the rivulet Haşmaş (N 46° 31.568' E 22° 02.807'). The sands, silts and diatomites of the eleven m -high outcrop is extremely enriched in mollusc shells. The section is figured in details by Istocescu (1971) and later by Feru et al. (1980). A simplified version is published by Grigorescu & Kazár (2006). From layer 21, which contains continental vertebrates the mollusc shells of *Cardium vindobonense vindobonense, Cardium latisulcum latisulcum, Cardium graciliocostatum, Ervilia dissita podolica* and *Trochus pictus* were listed. Feru et al. (1980) classified the stratigraphical position of the fossil material as late Volhynian -earliest Bessarabian. These stratigraphical units are referable to the entire *Ervilia* zone in the Central Paratethys (Harzhauser & Piller 2004).

The continental vertebrate fossils were initially described by Feru et al. (1980) and subsequently followed by a study of the cricetid finds with the description of two new species *Democricetodon iazygum* and *Megacricetodon crisiensis* (Rădulescu & Samson 1988). Latter Grigorescu & Kazár (2008) gave

a description of the odontocete finds. Hír et al. (2011) revised the rodent material and concluded the followings.

1. *Democricetodon iazygum* is a nomen dubium. It refers to *Democricetodon* cf. *freisingensis* Fahlbusch, 1964 (Plate IV: 5-6).
2. *Megacricetodon crisiensis* is a junior synonym of *Megacricetodon minutus* Daxner, 1967.
3. The cricetodontini molars were originally classified as two species: *Hispanomys* cf. *lavocati* and *Hispanomys* cf. *bijugatus.* Hír et al. (2011) concluded that the presence of two different taxa is not probable in the limited material (6 molars). Referring to the morphology affinities to the *Byzantinia* genus were found, e.g., the stretched outline of M2 (Plate VI.).

Tauț

The vertebrate locality is situated south of the small village Tauț in the Migieşului Valley (Arad District, Western Romania). The tufaceous green clay containing *Helix* and *Planorbis* shells was originally reported by Istocescu (1971) and Istocescu & Istocescu (1974). The microvertebrate material was primarily described by Feru et al. (1979). The cricetid rodents were studied by Rădulescu & Samson (1988) with the description of *Democricetodon zarandicus* nov. sp. McNulty et al. (1999) reported the lower deciduous premolar of a small sized Pliopithecoid primate (Crouzelidae gen. at sp. indet.) from Tauț. During the 2000's Márton Venczel and János Hír tried to rediscover the locality in the field, but have been unsuccessful so far.

The herpetofauna (excluding chelonians) has been described by Venczel & Stiuca (2008). The most abundant elements are aquatic and periaquatic forms (some newts, *Latonia, Palaeobatrachus, Pelophylax*, *Natrix*), other taxa probably inhabited the surrounding terrestrial environments with azonal vegetation (*Hyla* cf. *arborea*) and areas covered with scrubs and forests (Geckonidae indet., *Ophisaurus* sp., *Hierophis* cf. *hungaricus*, *Macrovipera* sp. There are subterranean elements, like *Pelobates, Blanus* cf. *gracilis, Scolecophidia* indet. A number of taxa (e.g., *Triturus* cf. *marmoratus*, *Ophisaurus*, *Blanus* cf. *gracilis*)

indicate close palaeobiogeographic connections with the Western Paratethys and the Mediterranean areas. On the other hand, some snakes (e.g., *Coronella, Hierophis* cf. *hungaricus, Macrovipera* sp.) appear as Asiatic immigrants. The macrotherm elements (e.g., crocodilians) are absent. Based on the method presented by Böhme et al. (2006) the mean annual precipitation was calculated 709 mm ± 250-280 mm derived from the composition of the herpetofauna.

The most important results of the revision of the rodent material (Hír et al. 2011) are the followings:

1. The diagnosis of *Democricetodon zarandicus* was emended (Plate IV: 1-4, 7-16).
2. The *Myoglis ucrainicus* is regarded as an element of the early Vallesian (MN9) faunas, but the presence in Tauț indicates that it was already present in the latest Middle Miocene.
3. The presence of *Glirudinus* is a faunistic speciality and the only occurrence in the Pannonian Basin.
4. The sciurids qualitatively dominate the sample (five genera) with the presence of the flying squirrels, which are indicators of a dense canopy (Plate II.).
5. The palaeoecological characters of the Tauț assemblage resemble those of other early Pannonian faunas from the Carpathian Basin representing forested environments, being favorable for primates (e.g., Richardhof-Golfplatz, Götzendorf: Daxner-Höck & Höck 2015, Borsky Sväty Jur: Joniak 2005, Rudabánya: Daxner-Höck 2005).

Conclusions

During the last two decades intensive collecting campaigns and elaborations were managed by the authors and colleagues on the Badenian and Sarmatian microvertebrate faunas of the Carpathian area. In the Eastern margin of the Pannonian Basin important pioneer works have been taken place (Feru et al. 1979, Rădulescu &Samson 1988) and valuable new faunas were unearthed and studied.

The best faunistic similarity is possible to verify with the Middle Miocene micromammal faunas of the Swiss and South German Upper Freshwater Molasse. There is a great deal of common elements, e g. *Miopetaurista gaillardi, Neopetes hoeckarum*, *Glirudinus* sp. *Muscardinus* aff. *sansaniensis*, *Paraglirulus werenfelsi*, *Myoglis meini, Glirulus lissiensis*, *Democricetodon brevis, Democricetodon* cf. *affinis, Democricetodon* sp. n., *Megacricetodon minor, Megacricetodon cf. minutus, Megacricetodon similis*.

An immigrant from the Balkan and Anatolia is represented by cf. *Byzantinia* in Comăneşti. East European relation is possible in the case of the small sized *Miodyromys* species from Vârciorog and Comăneşti and in *Myoglis ucrainicus* from Tauț. We think, that "*Cricetodon*" *venczeli, Democricetodon zarandicus* are endemic elements.

The critical period of the Middle Miocene cooling (ca. 14 and 13,2 Ma.) is mirrored in the late Badenian Subpiatră section, and strong differences in the rodent composition occur between the different layers, suggesting a dry scrub environment for the layer Su 2/1, while the fauna from Su 2/2 points to a forested cover because of the high percentage of squirrels and dormice. During the early Sarmatian arid climate is possible, which is mirrored in the herpetofauna of Tăşad. Similar conditions are found in the North Hungarian Kozárd fauna. In Vârciorog there are humid elements (Sciurids, Petauristids represented with modest diversity), but the Cricetodontini are the dominant rodents (46%). Based on the small mammal composition and the paleoflora, increasing humidity and decreasing temperatures are proposed for the Felsőtárkány Basin in Hungary and Tauț in Romania in the late Sarmatian/earliest Pannonian period.

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Figure captions

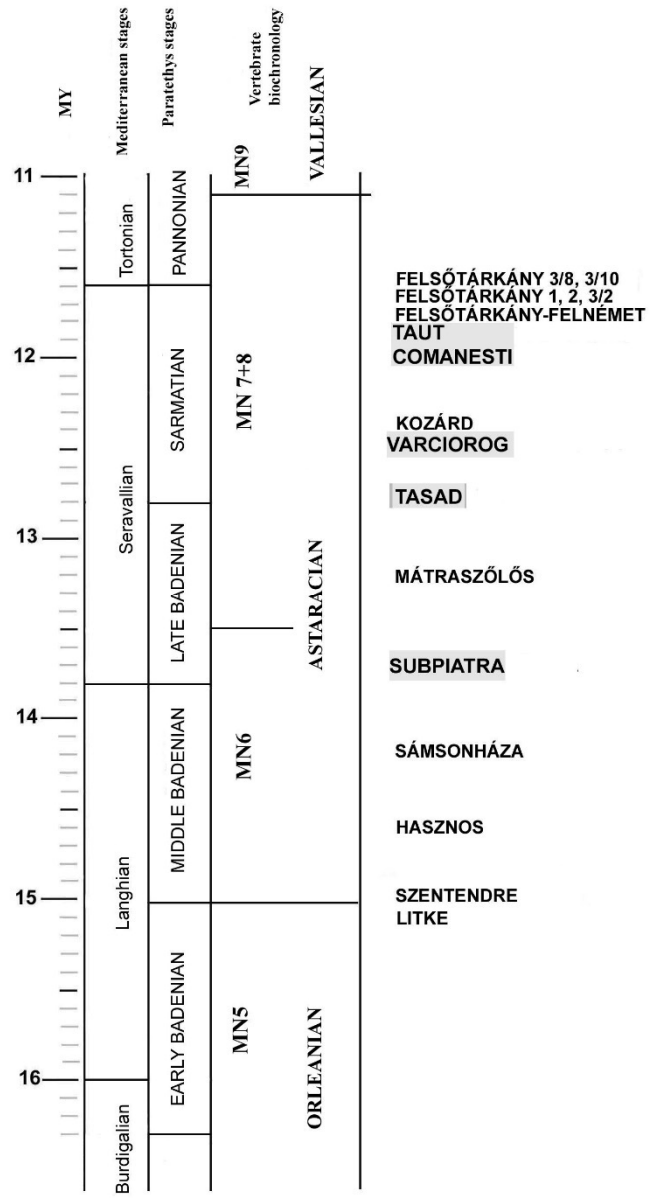

Fig. 1. Chronological range of the Badenian and Sarmatian microvertebrate localities in the Pannonian Basin

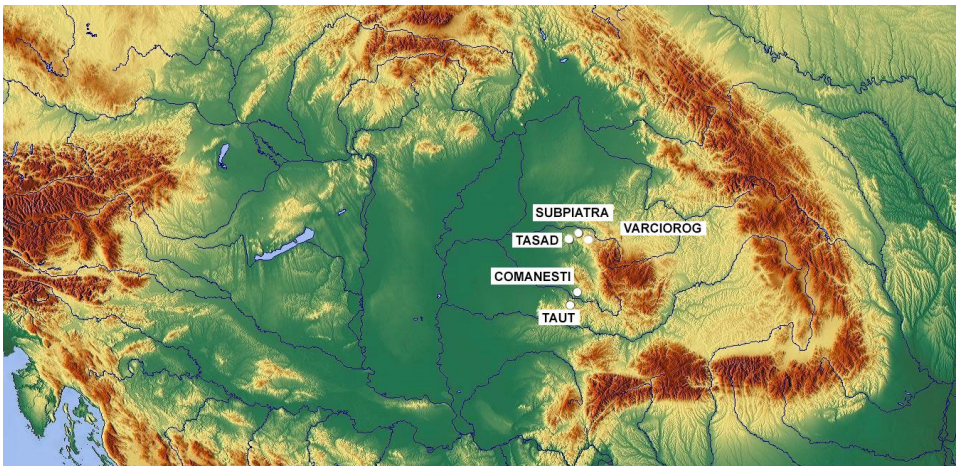

Fig. 2. Geographical position of the Badenian and Sarmatian microvertebrate localities in the Eastern margin of the Pannonian Basin.

Fig. 3. The locality Subpiatră 2/3

Fig. 4. The productive layer of the section at Tăşad

Fig. 5. View of the section Vârciorog.

Plate I.

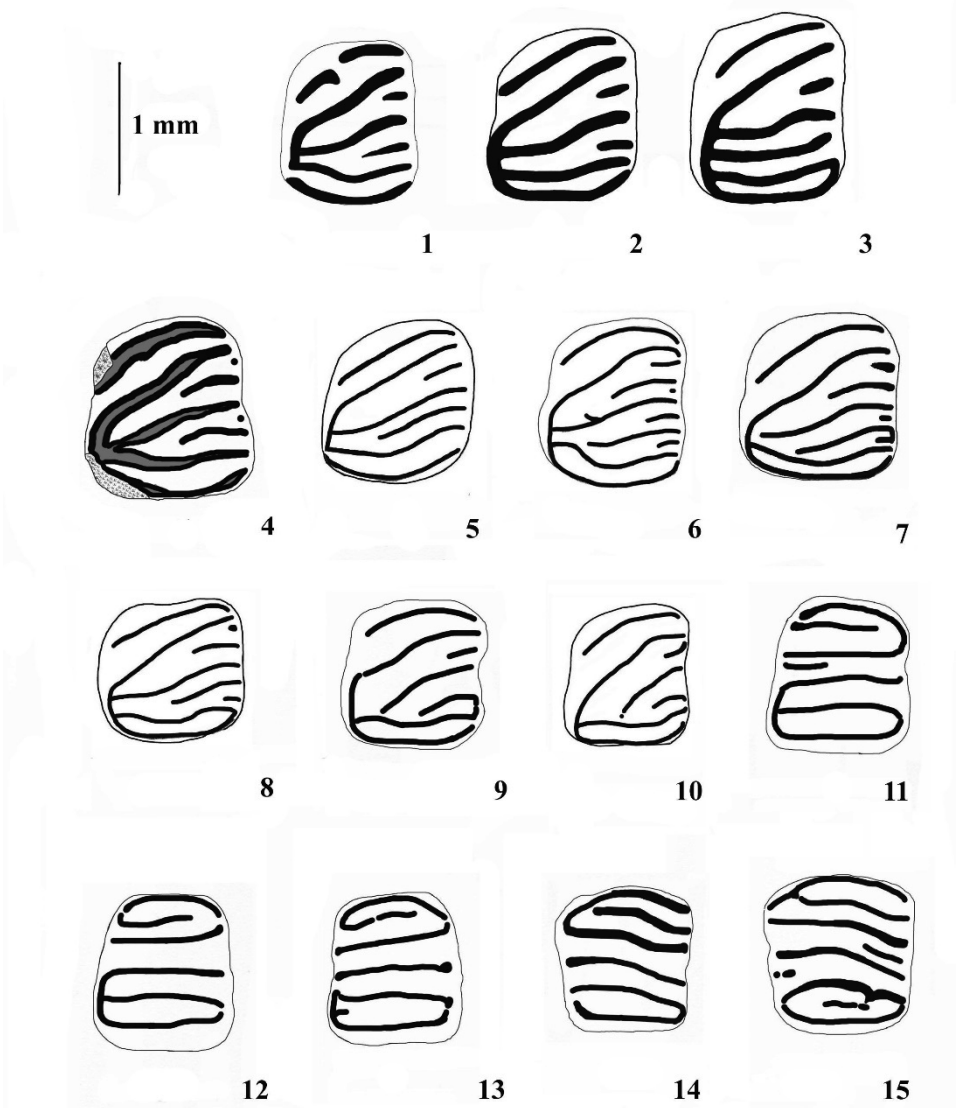

Plate I.

1.	*Muscardinus* aff. *hispanicus*	M1	Tăşad	MTCO without inv. no.
2.	*Muscardinus hispanicus*	M1	Tauț	ISEZ without inv. no.
3.	*Muscardinus hispanicus*	M1	Tauț	ISEZ without inv. no.
4.	*Muscardinus* aff. *sansaniensis*	M1	Vârciorog	MTCO-25604, reversed
5.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/2	no. 43
6.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/1	no. 398, reversed
7.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/1	no. 202, reversed
8.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/1	no. 47, reversed
9.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/3	no. 15, reversed
10.	*Muscardinus* aff. *thaleri*	M1	Subpiatră 2/1	no. 388
11.	*Muscardinus* aff. *thaleri*	m1	Subpiatră 2/1	no. 384, reversed
12.	*Muscardinus* aff. *thaleri*	m1	Subpiatră 2/1	no. 210, reversed
13.	*Muscardinus* aff. *thaleri*	m1	Subpiatră 2/1	no. 383, reversed
14.	*Muscardinus* aff. *sansaniensis*	m2	Vârciorog	MTCO-25605
15.	*Muscardinus* aff. *thaleri*	m2	Subpiatră 2/1	no. 201, reversed

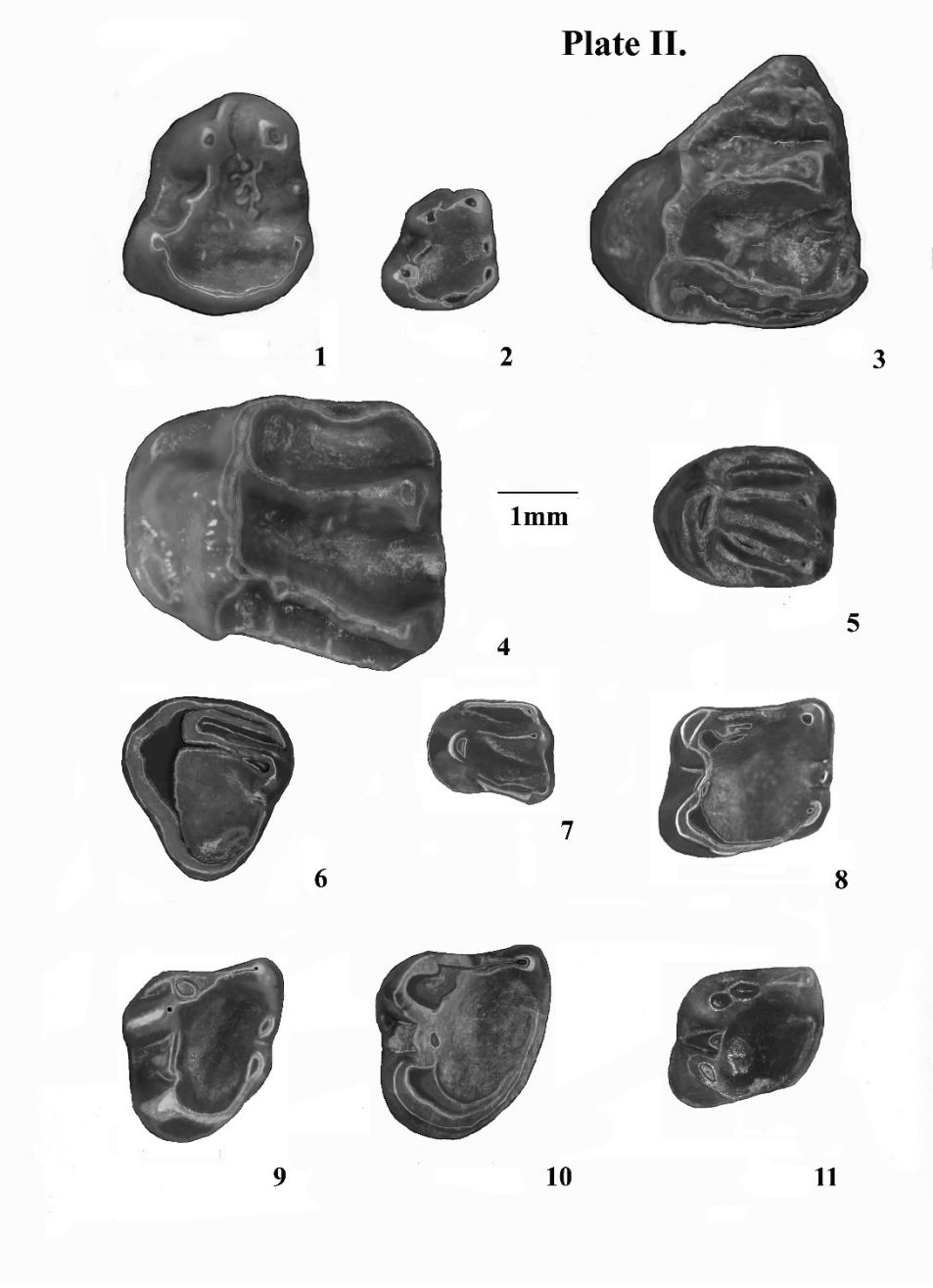

Plate II.

1.	*Albanensia* sp.	d4	Tauț	ISEZ Tt 0132, reversed
2.	*Neopetes hoeckarum*	P4	Tauț	ISEZ Tt 0144
3.	*Albanensia*	D4	Tauț	ISEZ Tt 0132
4.	*Miopetaurista* sp.	M1-2	Tauț	ISEZ Tt 0158
5.	*Spermophilinus bredai*	M1-2	Tauț	ISEZ Tt 0143/3, reversed
6.	*Spermophilinus bredai*	M3	Tauț	ISEZ Tt 0142/6, reversed
7.	*Blackia miocaenica*	M1-2	Tauț	ISEZ Tt 0162/13
8.	*Neopetes hoeckarum*	m1-2	Tauț	ISEZ Tt 0162/19
9.	*Neopetes hoeckarum*	m3	Tauț	ISEZ Tt 0147
10.	*Spermophilinus bredai*	m3	Tauț	ISEZ Tt 0162/11, reversed
11.	*Spermophilinus bredai*	m1-2	Tauț	ISEZ Tt 0162/18

Plate III.

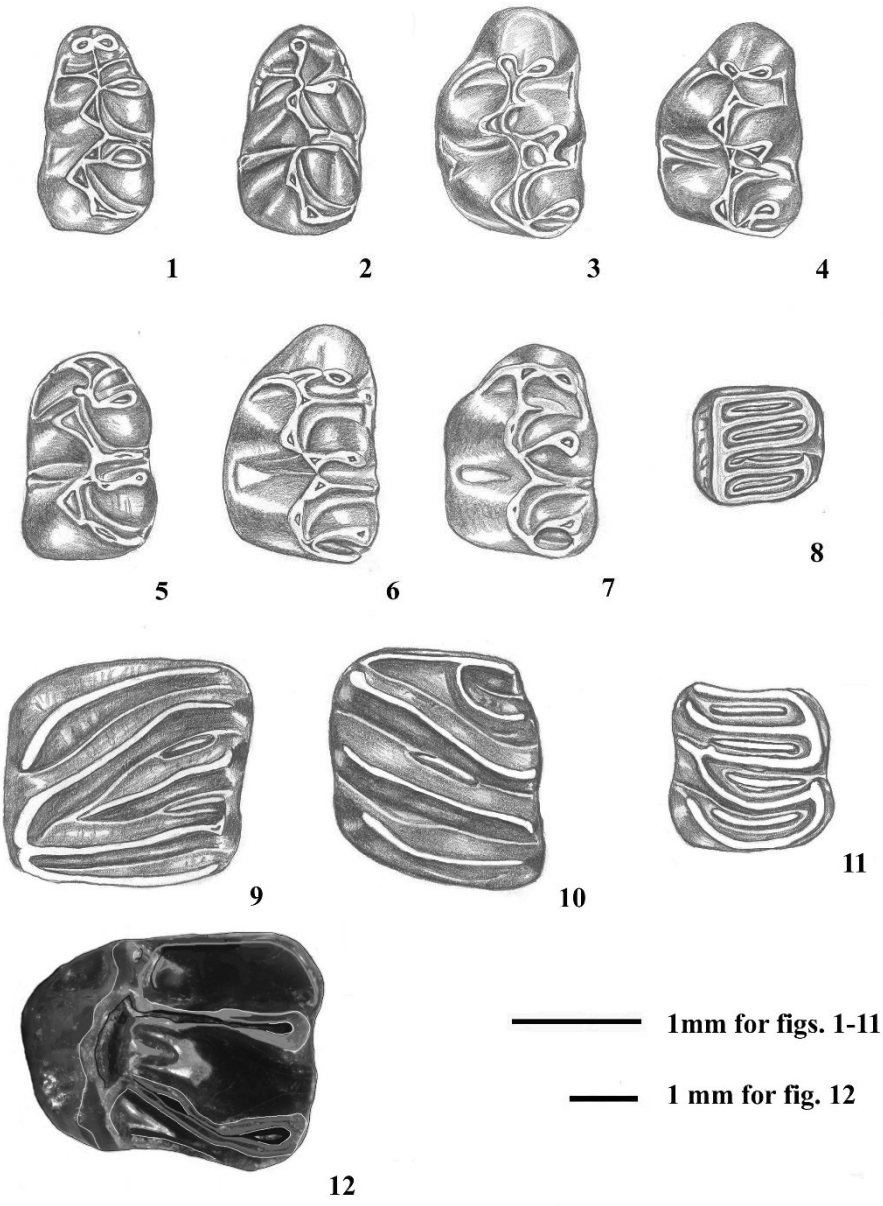

Plate III.

1.	*Megacricetodon similis*	m1	Subpiatră 2/1R	no. 29., reversed
2.	*Megacricetodon similis*	m1	Subpiatră 2/2	no. 3., reversed
3.	*Megacricetodon similis*	M1	Subpiatră 2/1	no. 281.
4.	*Megacricetodon similis*	M1	Subpiatră 2/1R	no. 110.
5.	*Democricetodon brevis*	m1	Subpiatră 2/2	no. 1., reversed
6.	*Democricetodon brevis*	M1	Subpiatră 2/2	no. 59.
7.	*Democricetodon brevis*	M1	Subpiatră 2/1R	no. 8
8.	*Glirulus lissiensis*	M2	Subpiatră 2/2	no. 48.
9.	*Myoglis meini*	M1	Subpiatră 2/2	no. 25.
10.	*Myoglis meini*	m1	Subpiatră 2/2	no. 37.
11.	*Paraglirulus werenfelsi*	m1	Subpiatră 2/2	no. 45., reversed
12.	*Miopetaurista gaillardi*	M1-2	Subpiatră 2/2	no. 9/4

Plate IV.

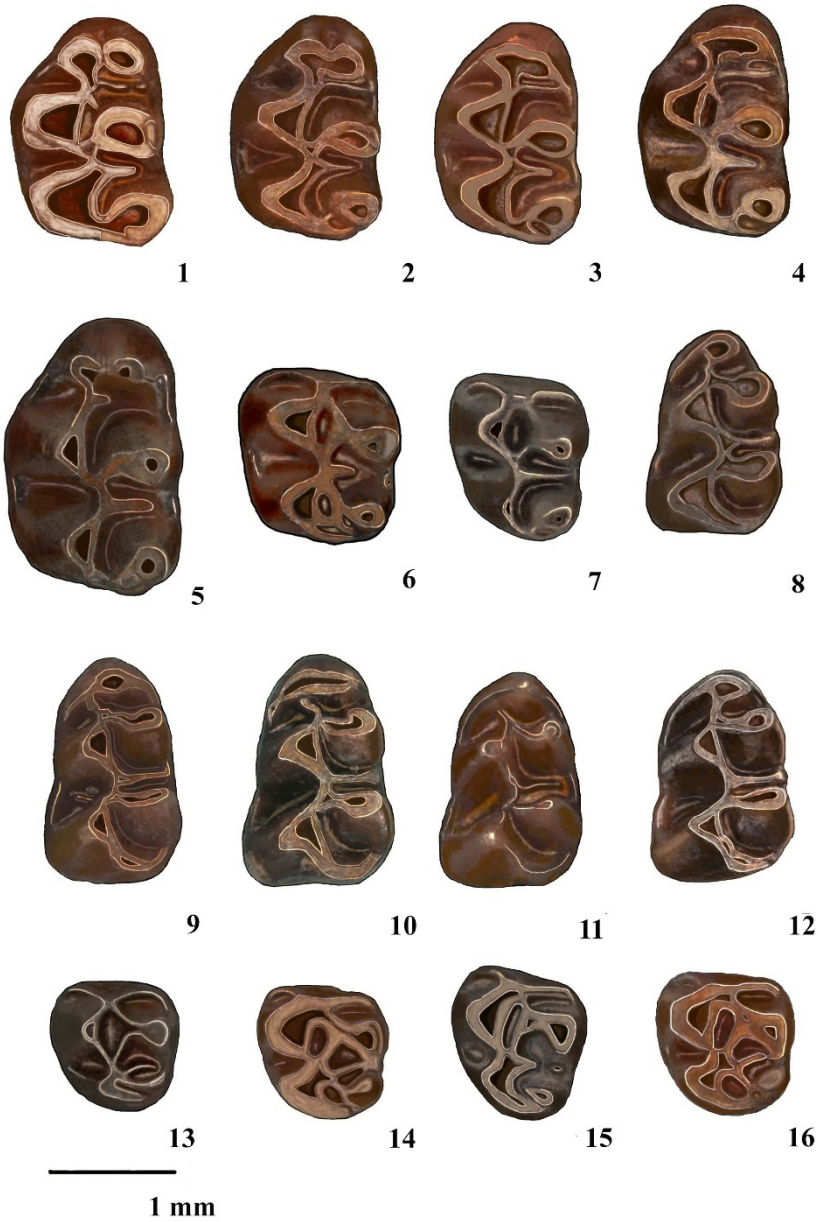

Plate IV.

1. *Democricetodon zarandicus* M1, Tauț, ISEZ. Tt 0176., reversed
2. *Democricetodon zarandicus* M1, Tauț, ISEZ. Tt 0175.
3. *Democricetodon zarandicus* M1, Tauț, ISEZ. Tt 0178.
4. *Democricetodon zarandicus* M1, Tauț, ISEZ. Tt /0188.
5. *Democricetodon* cf. *freisingensis* M1, Comăneşti 1, ISEZ. Cm-1/018.
6. *Democricetodon* cf. *freisingensis* M2, Comăneşti 1, ISEZ. Cm-1/019.
7. *Democricetodon zarandicus* M2, Tauț, ISEZ. Tt 0173., reversed
8. *Democricetodon zarandicus* m1, Tauț, ISEZ. Tt 0154.
9. *Democricetodon zarandicus* m1, Tauț, ISEZ. Tt 0149.
10. *Democricetodon zarandicus* m1, Tauț, ISEZ. Tt 0152., reversed
11. *Democricetodon zarandicus* m1, Tauț, ISEZ. Tt 0155.
12. *Democricetodon zarandicus* m1, Tauț, ISEZ. Tt 0148.
13. *Democricetodon zarandicus* M3, Tauț, ISEZ. Tt 0185/1.
14. *Democricetodon zarandicus* M3, Tauț, ISEZ. Tt 0183/1.
15. *Democricetodon zarandicus* M3, Tauț, ISEZ. Tt 0185/2.
16. *Democricetodon zarandicus* M3, Tauț, ISEZ. Tt 0183/2.

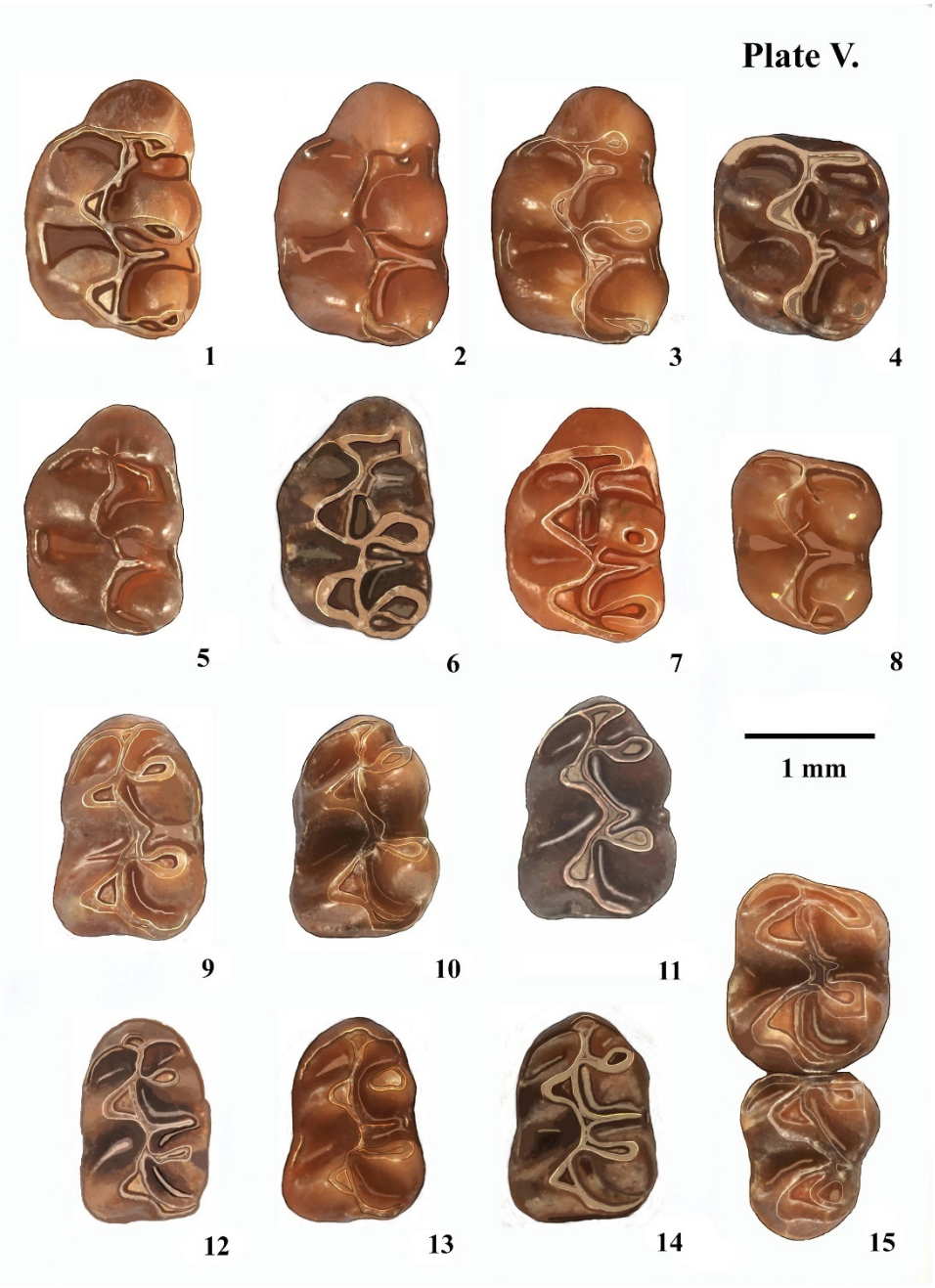

Plate V.

1.	*Democricetodon* cf. *affinis*	M1	Vârciorog 1	UBBVrc-1-12
2.	*Democricetodon* cf. *affinis*	M1	Vârciorog 1	UBBVrc-1-16
3.	*Democricetodon* cf. *affinis*	M1	Vârciorog 1	UBBVrc-1-14 reversed
4.	*Democricetodon* cf. *affinis*	M2	Vârciorog 1	UBBVrc-1-22
5.	*Democricetodon* n. sp.	M1	Vârciorog 1	MTCO.25607
6.	*Democricetodon* n. sp.	M1	Kozárd	MMP.2016.14.
7.	*Democricetodon* n. sp.	M1	Vârciorog 1	UBBVrc-1-11
8.	*Democricetodon* n. sp.	M2	Vârciorog 1	UBBVrc-1-26 reversed
9.	*Democricetodon* cf. affinis	m1	Vârciorog 1	UBBVrc-1-33
10.	*Democricetodon* cf. *affinis*	m1	Vârciorog 1	UBBVrc-1-28
11.	*Democricetodon* cf. *affinis*	m1	Vârciorog 1	MTCO-25613 reversed
12.	*Democricetodon* n. sp.	m1	Vârciorog 1	MTCO-25614
13.	*Democricetodon* n.sp.	m1	Vârciorog 1	UBBVrc-1-35
14.	*Democricetodon* n. sp.	m1	Vârciorog 1	UBBVrc-1-32
15.	*Democricetodon* cf. *affinis*	m2-m3	Vârciorog 1	UBBVrc-1-29

Plate VI.

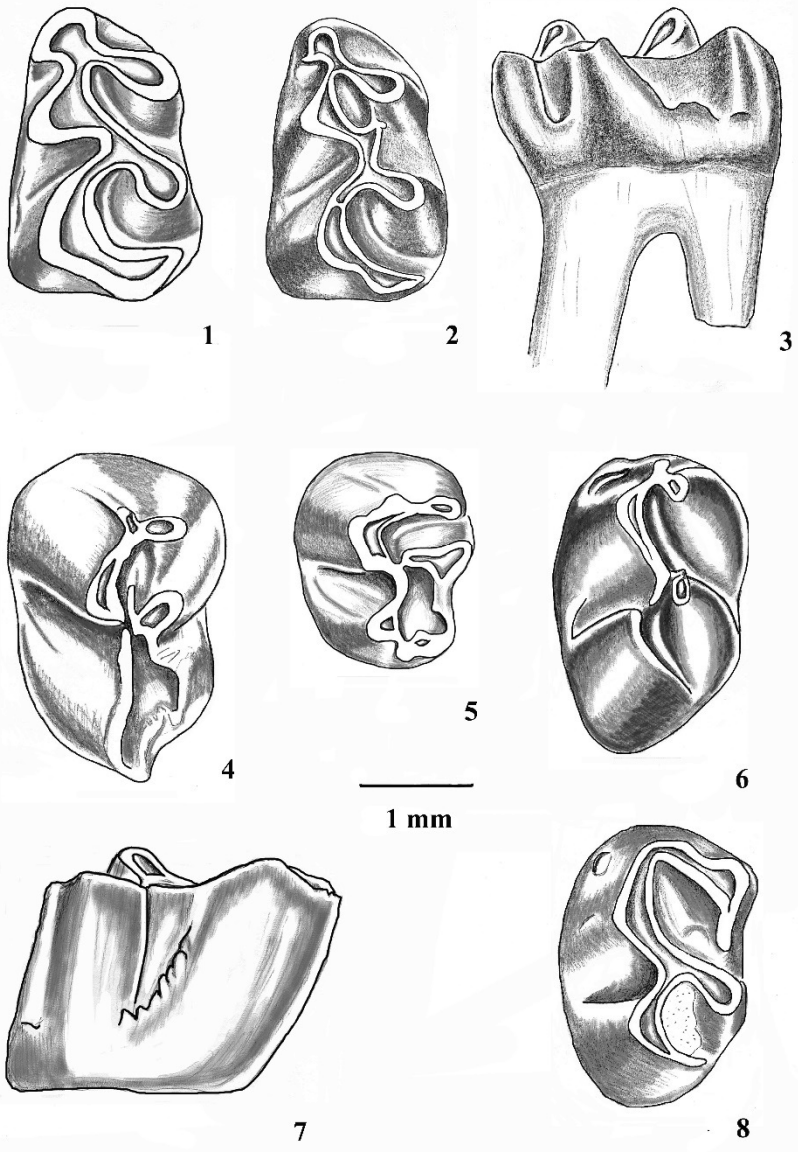

Plate VI.

1. cf. *Byzantinia* sp. or div. sp. m1 Comăneşti 1 ISEZ Cm1- 0132/1
2. cf. *Byzantinia* sp. or div. sp. m1 Comăneşti 1 ISEZ Cm1 -0131/1 reversed
3. cf. *Byzantinia* sp. or div. sp. m1 Comăneşti 1 ISEZ Cm1 -0131/1 reversed, labial view
4. cf. *Byzantinia* sp. or div. sp. M2 Comăneşti 1 ISEZ Cm1 -0134/1 reversed
5. cf. *Byzantinia* sp. or div. sp. M3 Comăneşti 1 ISEZ Cm1 -0135/1 reversed
6. cf. Byzantinia sp. or div. sp. m3 Comăneşti 1 ISEZ Cm1 -0133/1
7. cf. *Byzantinia* sp. or div. sp. M2 Comănesti 1 ISEZ Cm1 -0134/1 reversed, lingual view
8. cf. *Byzantinia* sp. or div. sp. m3 Comănesti 1 ISEZ Cm1 -0136/1 reversed

Plate VII.

Plate VII.

1.	“Cricetodon” venczeli	M1	Vârciorog 1	UBBVrc -1-60, reversed, *holotype*
2.	“Cricetodon” venczeli	M1	Vârciorog 1	MTCO 25560, reversed
3.	“Cricetodon” venczeli	M1	Vârciorog 1	MTCO 25581/1
4.	“Cricetodon” venczeli	M3	Vârciorog 1	MTCO 25581/3
5.	“Cricetodon” venczeli	M2	Vârciorog 1	UBBVrc 104
6.	“Cricetodon” venczeli	M2	Vârciorog 1	MTCO 25563
7.	“Cricetodon” venczeli	M2	Vârciorog 1	MTCO 25581/2, reversed
8.	“Cricetodon” venczeli	M3	Vârciorog 1	UBBVrc-1-110
9.	“Cricetodon” venczeli	m1	Vârciorog 1	UBBVrc-1-74, *paratype*
10.	*“Cricetodon” venczeli*	m1	Vârciorog 1	MTCO 25575
11.	*“Cricetodon” venczeli*	m1	Vârciorog 1	MTCO 25576, reversed
12.	*“Cricetodon” venczeli*	m3	Vârciorog 1	MTCO 25573

Appendix: faunal lists of the studied localities

Faunal lists of the Subpiatră localities

Amphibia et Reptilia Hír & Venczel (2005)

	Su 2/1	Su2/2	Su2/3
Triturus sp.	+	+	
Lissotriton sp.		+	
Salamandridae indet.	+		
Latonia gigantea (LARTET, 1851)	+	+	
Palaeobatrachus sp.		+	
Rana (*Pelophylax* sp.)			
Hyla cf. *arborea* (LINNAEUS, 1758)		+	
Emydidae indet.	+		
Diplocynodon sp.	+	+	
Geckonidae indet.		+	
Lacerta sp.	+		
Lacertidae indet. sp. 1.		+	
Lacertidae indet. sp. 2.		+	
Ophisaurus sp.	+	+	
Varanidae indet.	+		
Colubrinae indet.	+	+	
Vipera sp.	+		

Aves Kessler (2013), KESSLER & VENCZEL (2009, 2011)

Proardeola walkeri HARRISON, 1979

Anas albae JÁNOSSY, 1979

Palaeortyx gallica MILNE-EDWARDS, 1869

Perdicidae gen. et sp. indet.
Gruidae gen. et sp. indet.
Rallidae gen. et sp. indet.
Meropidae gen. et sp. indet.
Sittidae gen. et sp. indet.
Certhidae gen. et sp. indet.
Muscicapidae gen. et sp. indet.
Sylviidae gen. et sp. indet.
Laniidae gen. et sp.indet.
Passeriformes indet.

Lagomorpha et Rodentia Hír & Venczel (2005)

	Su 2/1	Su2/2	Su2/3
Eurolagus fontannesi (DEPERÉT, 1887)	+	+	+
Palaeosciurus sp.		+	
Spermophilinus bredai (VON MEYER, 1848)	+	+	+
Sciuridae indet.		+	
Blackia miocaenica MEIN, 1970		+	
Albanensia sp.			+
Miopetaurista gaillardi (MEIN, 1970)		+	
Neopetes hoeckarum (DE BRUIJN, 1998)		+	+
Paraglirulus werenfelsi ENGESSER, 1972		+	
Glirulus lissiensis (HUGUENEY & MEIN, 1965)		+	
Myoglis meini (BAUDELOT, 1965)		+	+
Muscardinus aff. *thaleri* (DE BRUIJN, 1966 a)	+	+	+
Democricetodon brevis (SCHAUB, 1925)	+	+	+
Megacricetodon similis FAHLBUSCH, 1964	+	+	+
Eumyarion medius (LARTET, 1851)		+	
Anomalomys gaudryi GAILLARD, 1900		+	

Faunal list of Tăşad 1

Mollusca: KÓKAY in HÍR et al. (2002)

Gastropoda

Calliostoma anceps joanneum (HILBER, 1897)
Calliostoma styriacum (HILBER, 1897)
Calliostoma politioanei JEKELIUS, 1944
Gibbula biangulata (EICHWALD, 1830)
Gibbula cf. *picta* HÖRNES, 1856
Hydrobia stagnalis (BASTEROT, 1940)
Hydrobia stagnalis suturata FUCHS, 1897
Mohrensterni inflata (ANDRZEJOWSKY, 1933)
Mohrensternia inflata sarmatica FRIEDBERG, 1923
Mohrensternia inflata hydrobioides (HILBER, 1897)
Mohrensternia pseudinflata HILBER, 1897
Mohrensternia angulata (EICHWALD, 1853)
Mohrensternia pseudosarmatica FRIEDBERG,1923
Mohrensternia sp.
Rissoina sp.
Granulolabium picta bicostata (EICHWALD, 1853)
Granulolabium picta nympha (EICHWALD,1853)
Bittium deforme (EICHWALD, 1830)
Vulgarocerithium rubiginosum (EICHWALD, 1830)
Polinices catena helicina (BROCCHI, 1814)
Atys miliaris (BROCCHI, 1814)
Actaeocina lajonkaireana (BASTEROT, 1825)

Extramarin gastropoda

Abida antiqua grossecostata (GOTTSCHICK & WENZ, 1919)
Cochlicopa ex. gr. *subrimata* KLEIN & GOTTSCHICK, 1928
Gastrocopta cf. *suevica* (SANDBERGER, 1875)
Truncatellina lentilii (MILLER, 1900) var.
Semilimax intermedia crassitesta (ANDREAE, 1902)
Nesovitrea (Perpolita) ex. gr. *subhammonis* GOTTSCHICK, 1928
Triptychia cf. *suturalis* (SANDBERGER, 1875)
Cochlodina cf. *oppoliensis* (NORDSIECK,1969)
Limax crassus CLESSIN, 1894
Milax loerentheyi (GAÁL, 1910)

Bivalvia

Musculus sarmaticus (GATUEV, 1935)
Cardium vindobonense (PARTSCH, 1935)
Cardium praeplicatum (HILBER, 1882)
Cardium pseudoplicatum (FRIEDBERG, 1934)
Ervilia dissita podolica (EICHWALD, 1935)
Ervilia trigonula (SOKOLOW, 1935)
Irus gregarius (PARTSCH, 1870)

Reptilia HÍR et al. (2002) and VENCZEL & HÍR (2013)

Agamidae indet.
Lacerta sp. 1.
Lacerta sp. 2.
Ophisaurus sp.
cf. *Pseudopus* sp.
Colubridae indet.

Crocodilidae indet.

Aves KESSLER (2010, 2013)

Miocorvus larteti (MILNE-EDWARDS, 1871)

Eulipotyphla HÍR et al. (2002)

Schizogalerix cf. *pasalarensis* ENGESSER, 1980

Rodentia HÍR et al. (2002)

Spermophilinus bredai (VON MEYER, 1848)
Muscardinus aff. *sansaniensis* (LARTET, 1851)
Eliomys sp.
Megacricetodon cf. *minor* (LARTET, 1851)
Democricetodon sp. n. sensu KÄLIN & ENGESER, 2001
Eumyarion medius (LARTET, 1851)
Cricetodon sp.

Faunal lists of Vârciorog

Foraminifera FILIPESCU et al. (2014)

Cycloforina badenensis (D'ORBIGNY,1846)
Quinqueloculina hauerina D'ORBIGNY, 1846
Quinqueloculina bogdanowiczi (SEROVA,1955)
Quinqueloculina buchiana D'ORBIGNY, 1846
Quinqueloculina seminuda TERQUEM, 1878
Quinqueloculina akneriana D' ORBIGNY, 1846
Varidentella latelacunata (VENGLINSKI, 1953)

Varidentella reussi (BOGDANOWICZ, 1952)
Pseudotriloculina consobrina (D'ORBIGNY, 1846)
Articulina sarmatica (KARRER, 1877)
Articularia articulinoides GERKE & ISSAEVA, 1952
Articulina problema BOGDANOWICZ, 1952
Bolivina moldavica DIDKOWSKI, 1959
Bolivina nisporenica MAISSURADZE, 1988
Bolivina pseudoplicata HERON-ALLEN & EARLAND, 1930
Bolivina sarmatica DIDKOWSKI, 1959
Fursenkoina sarmatica (KENGLINSKI, 1958)
Fursenkoina pontoni (CUSHMAN, 1932)
Schackoinella imperatoria (D'ORBIGNY, 1846)
Elphidium grilli PAPP, 1963
Elphidium rugosum D'ORBIGNY, 1846
Elphidium flexuosum D'ORBIGNY, 1846
Elphidium josephinum D'ORBIGNY, 1846
Elphidium reginum (D' ORBIGNY, 1846)
Elphidium hauerinum (D' ORBIGNY, 1846)
Elphidium aculeatum (D' ORBIGNY, 1846)
Elphidium crispum (LINNAEUS, 1767)
Elphidium fichtelianum (D'ORBIGNY, 1846)
Elphidium obtusum (D'ORBIGNY, 1846)
Porosononion granosum (D'ORBIGNY, 1846)
Pseudotriloculina consobrina (D'ORBIGNY, 1846)
Ammonia becarii LINNAEUS, 1758
Amonia tepida (CUSHMAN, 1926)
Lobatula lobatula (WALKER & JACOB, 1798)
Varidentella reussi (BOGDANOWICH, 1952)
Nonion commune (D'ORBIGNY, 1825)
Eponides sp. (?)
Rosalina bradyi (CUSHMAN, 1915)

Buliminella elegantissima (D'ORBIGNY, 1825)
Miliolonella sp.
Sinuloculina consobrina (D'ORBIGNY, 1846)
Caucasina schichkinskye (SAMOYLOVA, 1947)

Ostracoda FILIPESCU et al. (2014)

Cytherella sp.
Iliocypris sp.
Heterocypris sp.
Callistocythere tokajensis PIETRZENIUK, 1973
Callistocythere pantoi PIETRZENIUK, 1973
Callistocythere maculata PIETRZENIUK, 1973
Cytheridea hungarica ZALÁNYI, 1913
Hemicyprideis dacica (HÉJJAS, 1895)
Miocyprideis sarmatica ZALÁNYI, 1913
Hemicytherida omphaloides (REUSS, 1850)
Aurila mehesi (ZALÁNYI, 1913)
Aurila merita (ZALÁNYI, 1913
Senesia vadaszi (ZALÁNYI, 1913)
Tenedocythere cruciata BONADUCE, RUGGIERI & RUSSO, 1986
Loxoconcha kochi MÉHES 1908 (sensu CERNAJSEK 1974)
Loxoconcha sp.1
Loxoconcha sp. 2
Xestoleberis aff. *tumida* (REUSS, 1850)
Xestoleberis ex. gr. *dispar* MÜLLER, 1894

Gastropoda FILIPESCU et al. (2014)

Tectura aff. *zboroviensis* FRIEDBERG, 1928
Agapilia picta (FERUSSAC, 1825)
Gibbula cf. *guttenbergi* (HILBER, 1897)
Granulolabium bicinctum (BROCCHI, 1814)
Thericium rubiginosum (EICHWALD, 1830)
Potamides nodosoplicatum (HÖRNES, 1855)
Hydrobia sp. 1
Hydrobia soceni JEKELIUS, 1944
Hydrobia cf. *subprotracta* JEKELIUS, 1944
Staja tholsa JEKELIUS, 1944
Staja immutata (HOERNES, 1856)
Staja depressa (JEKELIUS, 1944)
Rissoa banatica JEKELIUS, 1944
Mohrensternia hydrobioides HILBER, 1897
Mohrensternia angulata EICHWALD, 1830
Mohrensternia pseudoangulata HILBER, 1897
Mohrensternia inflata (ANDZEJOWSKI, 1835)
Mohrensternia sarmatica FRIEDBERG, 1923
Bithynia sp. (operculum)
Pomatias cf. *conicus* (KLEIN, 1853) (operculum)
Duplicata duplicata (SOWERBY, 1832)
Clavatula doderleini (HÖRNES, 1856)
Acteocina lajonkaireana (BASTEROT, 1825)
Cornirostra moesiensis (JEKELIUS, 1944)
Clausiliidae indet.
Tropidomphalus sp.
Musculus sarmaticus (GATUJEV, 1916)
Loripes niveus (EICHWALD, 1853)
Ervilia dissita (EICHWALD, 1830)
Cardiidae indet.

Teleostei REICHENBACHER et al. (2018)

Atherina carnevalei n. sp.
Aphanolebias sarmaticus n. sp.
Aphanolebias sp. 1
Aphanius cf. *stoliczkanus* (DAY, 1872)
Blennius ? *martinii* n. sp.
Gobius apusenensis n. sp.
Gobius holcovae n. sp.
Gobius manfredi n. sp.
Gobius sp. 1
Gobius sp. 2
Gobius ? sp. 1
Lesueurigobius ? sp. 1
Pomatoschistus ? sp.
Eleogobius prochazkai n. sp.
Gobiidae
Gobiidae sp. indet.
Sparidae indet.

Amphibia et Reptilia HÍR et al. (2016)

Lissotriton sp.
Latonia gigantea (LARTET, 1851)
Palaeobatrachus sp.
Hyla cf. *arborea* (LINNAEUS, 1758)
Geckonidae indet.
Ophisaurus sp. (s.l.)
Pseudopus sp.
Lacerta sp.
Scincidae indet.

Varanus sp.
Natrix sp.
Hierophis cf. *hungaricus* (BOLKAY, 1913)
Macrovipera sp.
Diplocynodon sp.

Eulipotyphla HÍR et al. (2016)

Schizogalerix cf. *voesendorfensis* RABEDER, 1973

Rodentia HÍR et al. (2019)

Spermophilinus bredai (VON MEYER, 1848)
Blackia miocaenica MEIN, 1970
Pliopetes sp.
Miodyromys sp.
Myoglis meini BAUDELOT, 1965
Muscardinus aff. *sansaniensis* (LARTET, 1851)
„Cricetodon" venczeli n. sp.
Democricetodon sp. nov. (sensu KÄLIN & ENGESSER 2001)
Democricetodon cf. *affinis* (SCHAUB, 1925)
Megacricetodon minor (LARTET, 1851)- *Megacricetodon minutus* DAXER, 1967 gr.
Eumyarion sp.

Faunal list of the vertebrata of Comăneşti 1

Pisces indet. FERU et al. (1980)
Anura indet. VENCZEL & HÍR (2008)
Testudinata div. indet. FERU et al. (1980)

Eulipotyphla FERU et al. (1980)

Galerix socialis (VON MEYER, 1865)
cf. *Desmanella* sp.

Lagomorpha et Rodentia HÍR et al. (2011)

Prolagus oeningensis (KÖNIG, 1825)
Miodyromys aff. grycivensis NESIN & KOWALSKI, 1997
cf. *Byzantinia* sp. or div. sp.
Democricetodon cf. *freisingensis* vel. cf. *gaillardi*
Megacricetodon cf. *minutus* DAXNER, 1967

Ruminantia FERU et al. (1980)

Cervidae indet I.
Cervidae indet II.

Cetacea GRIGORESCU & KAZÁR 2006)

Delphinoidea indet.

Faunal list of Tauţ

Amphibia et Reptilia VENCZEL & ŞTIUCĂ (2008)

Chelotriton paradoxus POMEL, 1853
Carpathotriton sp.
Lissotriton sp.
Triturus cf. *marmoratus* RAFINESQUE, 1815
Latonia gigantea (LARTET, 1851)
Palaeobatrachus cf. *hiri* VENCZEL, 2004
Pelobates sp.

Bufotes (=*Bufo*) cf. *viridis* LAURENTI, 1768
Hyla cf. *arborea* (LINNAEUS, 1758)
Pelophylax sp.
Geckonidae indet.
Lacerta sp.
Lacertidae indet.
Ophisaurus sp.
Blanus cf. *gracilis* WAGLER, 1830
Scolecophidia indet.
Coronella miocaenica VENCZEL, 1998
Hierophis cf. *hungaricus* (BOLKAY, 1913)
Natrix cf. *rudabanyensis* SZYNDLAR, 2005
Macrovipera sp.

Rodentia HÍR et al. (2011)

Spermophilinus bredai (VON MEYER, 1848)
Miopetaurista sp.
Albanensia sp. ?
Neopetes hoeckarum (DE BRUIJN, 1998)
Blackia miocaenica MEIN, 1970
Eomyops oppligeri ENGESSER, 1972
Muscardinus hispanicus DE BRUIJN, 1966 b
Glirulus lissiensis (HUGUENEY & MEIN, 1965)
Myoglis ucrainicus NESIN & KOWALSKI, 1997
Democricetodon zarandicus RADULESCU & SAMSON, 1988
Eumyarion sp.
Glirudinus sp.

Primates MC NULTY et al. (1999)

Crouzelidae gen. et sp. indet.