

PALEO-ECOLOGICAL SIGNIFICANCE OF THE CONTINENTAL GASTROPOD ASSEMBLAGES FROM THE MAASTRICHTIAN DINOSAUR BEDS OF HAȚEG BASIN

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Abstract: The continental invertebrate assemblages from the Maastrichtian dinosaur-bearing deposits of the Hațeg Basin represent a previously unstudied component of the Hațeg paleocommunity. Preliminary results of the studies concerning these rich and diverse gastropod assemblages are presented. About 30 different genera, belonging to 14 families, were recognized within the assemblage. The specific ecological requirements of the different gastropod groups make them important for the paleoecological and paleoenvironmental reconstruction.

Keywords: Maastrichtian, Continental gastropods, Paleoenvironmental significance

INTRODUCTION

The Maastrichtian continental deposits of the Hațeg Basin are well-known especially for their rich vertebrate assemblage including reptiles and primitive mammals (Nopcsa, 1923; Grigorescu & Csiki, 2001, this volume); diverse microvertebrate assemblages were also discovered recently (Grigorescu *et al.*, 1999). However, tetrapods, regardless of how spectacular they might have been, represent only the top of the trophic pyramid, built up of different levels represented by plants and invertebrates. Rare plant remains from this deposits or deposits of comparable age in the neighboring Rusca Montană Basin (Mărgărit & Mărgărit, 1967; Petrescu & Dușa, 1982) reveal the presence of different ferns, as well as palms and other angiosperms; palynological studies (Antonescu *et al.*, 1983) also suggest similar paleofloristic assemblages and the undergoing study of recently discovered paleocarpological material might significantly contribute to the understanding of the composition of the vegetal cover of the landscapes the different vertebrate taxa lived in.

By contrary, invertebrates received far less attention, they still being a poorly understood component of the Maastrichtian paleobiocenoses of Hațeg. This contribution is a first attempt to identify some components of these basic levels of the animal food chain.

The molluscan fauna of the continental red beds of the Hațeg Basin are represented by a few indeterminate pelecypods (usually found in a bad preservation state) and a far more diverse and better preserved gastropod assemblage; this latter represents the focus of the present work. Gastropods are frequently encountered in the different beds of the Maastrichtian continental deposits, although they tend to be more abundant in the finer-grained deposits. In several occasions, they are associated with vertebrate (either macro- or microvertebrate) remains, but also occur in otherwise unfossiliferous deposits. Their wide spatial and facial distribution, together with their specific environmental and ecological requirements make them an important source of information for the reconstruction of the different paleoenvironments represented in the dinosaur beds of the Hațeg Basin.

GEOLOGICAL SETTING

The Maastrichtian-Paleogene continental deposits of the Hațeg Basin are restricted to the western part of this post-tectonic depression, cropping out on the north-western border of the basin from Răchitova in the west to Fărcădin to the east and in the south-central part of the basin, along the valleys of the Sibișel and Bărbat rivers (Figure 1). These deposits consist mostly of interbedded coarse- and finer-grained

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detritic deposits (conglomerates, sandstones, siltstones and mudstones), with minor contribution of igneous and volcanoclastic material in the northwestern part. Two main lithostratigraphic units were erected to include these deposits: the Densuș-Ciula Formation and the Sînpetru Formation, outcropping in the northwestern and central parts of the Hațeg Basin, respectively (Grigorescu, 1992; Weishampel *et al.*, 1991).

The age of these formations is relatively poorly constrained, being based mostly on their spatial relationships with better-dated marine deposits and on some admittedly poor biostratigraphic markers such as tetrapods, invertebrates and palynology. Considered for a long time of mostly latest Cretaceous (late Maastrichtian) age, possibly extending into the base of the Paleogene (Antonescu *et al.*, 1983; Weishampel *et al.*, 1991), the age of the continental deposits is now being reconsidered as Maastrichtian-Paleogene due to the data derived from recent work on the underlying marine deposits (Grigorescu & Melinte, 2001, present volume).

From a paleoenvironmental point of view, these deposits were interpreted to have been deposited in a fully continental environment, within a small intermountain basin surrounded by the raising ranges of the proto-Southern Carpathians, uplifted following the main Laramian (Maastrichtian) orogenic phase. A braided-river depositional system, draining the southern crystalline border was reconstructed for the Sînpetru Formation. A more diverse, alluvial fan - braided river depositional environment, draining both northwestern crystalline basement uplifts and western igneous source areas was proposed for the Densuș-Ciula Formation, the later source being active only in the first part of the time of deposition (Anastasiu & Csobuka, 1989; Grigorescu *et al.*, 1990). Such a depositional setting suggests diverse types of habitats inhabited by the Maastrichtian vertebrate assemblages and a high instability of the environmental conditions due to rapid shifts between the different habitats, both of these being controlled by such factors as i.e. climate, vegetation type, tectonics, uplift and erosion rates, source area composition. To reconstruct this mosaic patterned environment, habitat specific organisms (such as gastropods) may yield useful information; their specific affinity for narrow niches as running freshwater streams, lakes, marshy ponds or terrestrial environments offer the opportunity to both test the sedimentological information and better understand the paleoenvironments the last Romanian dinosaurs lived in.

LATE SENONIAN CONTINENTAL GASTROPODS OF EUROPE

In western Europe, the Upper Senonian (Valdonian - Rognacian, approximately Campano - Maastrichtian; Babinot *et al.*, 1983) continental beds yielded the first Late Cretaceous continental vertebrates of Europe as early as 1825 (see Buffetaut *et al.*, 1993); the associated invertebrates were mentioned by about the same period by Matheron (1832) and exhaustively described by Oppenheim (1895). After this early work, gastropods were mainly looked over by the different students of these deposits or they were mentioned only due to their purported biostratigraphic value in the Latest Cretaceous and around the K/T Boundary in northern Spain and southern France (e.g. Babinot *et al.*, 1983; Bilotte *et al.*, 1983; Lepicard *et al.*, 1985; Massieux *et al.*, 1987). A remarkable exception is represented by the thorough study of Fabre-Taxy (1959) describing brackish and continental gastropods from several southern French basins (Bassin de l'Arc, Huveaune, northern and southern Alpilles, Durance and Provence) filled with Late Cretaceous-basal Paleocene and providing a lengthy list of revised gastropod taxa.

Only some recently published accounts on the faunal diversity recorded in different Late Senonian vertebrate fossil sites from western Europe include also short mentions concerning the presence of different gastropod taxa, listing occasionally some of these (e.g. Pol *et al.*, 1992; Sigé *et al.*, 1997; Garcia *et al.*, 1999). However, not more than 4 to 6 taxa per site are listed in these papers (see Table 1), and papers dealing mainly or exclusively with gastropods are extremely rare (e.g. Lepicard *et al.*, 1983; Bilotte *et al.*, 1998). In overall, western European continental gastropod faunas are still poorly known; it should be mentioned that even at this preliminary state of knowledge, some taxa were shown to have a certain biostratigraphic value. Their value as paleoecological indicators was not exploited, although this value might be more important than the biostratigraphic one; further studies on these western European gastropod assemblages will surely reveal a much higher diversity and their paleoecological significance.

MAASTRICHTIAN GASTROPODS FROM HAȚEG

Previous work

Although the presence of the gastropods in the dinosaur-bearing strata of Hațeg was for a long time noticed, they did not receive special attention until the 1983 complex study of

Antonescu *et al.* (1983). This was intended to be a biostratigraphical study of the continental deposits of the Hațeg Basin, whose age was up to that moment controversial (e.g. Dincă *et al.* 1972); the main focus of the paper was on the palinology, but gastropods were also cited to support a late Maastrichtian age of the deposits. D. Lupu (in Antonescu *et al.*, 1983) listed the following taxa from Vălioara and Sînpetru: *Bauxia bulimoides* (MATHERON), 1832, *Gastrobulimus munieri* (HANTKEN), *Paludinopsis* sp., *Planorbis* sp., *Helix* (?) sp., *Anastomopsis rotellaris* (MATHERON), *Strophomella reussi* (STOLICZKAIA), *Vidadiella darderi* (VIDAL) and *Lychnus* sp. In our subsequent studies, we were able to identify and confirm the presence of only the first four taxa; unfortunately, the material on which the published list is based was unavailable for study, thus we cannot confirm the identification given by the author. Another early mention of gastropods in these deposits is Grigorescu *et al.*, (1985) paper that reports the presence of continental gastropods such as cf. *Bauxia*, cf. *Cyclophorus* and *Lychnus* associated to a diverse microvertebrate assemblage from Pui.

New gastropod assemblages

Beginning with 1995, several field campaigns of the University of Bucharest, whose first aim was to collect microvertebrates through screen-washing of the sediments, resulted in a large sample of gastropods, usually of small size (under 1,5 mm). Further, generally larger specimens (up to 3 cm) were recovered from different macrovertebrate sites all over the basin or simply from otherwise unfossiliferous strata. The recovery procedure used for the microvertebrates allowed the thorough sampling of the microvertebrate fossil sites for gastropods as well, so that relatively diverse (and presumably parautochthonous) assemblages were recovered from all the major sites: Fântânele, Budurone, Pui and Tuștea (see Grigorescu *et al.*, 1999). Dispersed, but important material comes from other beds around Vălioara village as well as from the outcrops along the Sibișel Valley, upstream of Sînpetru village.

In this newly collected material, consisting of several hundred specimens, a much more diverse assemblage can be identified than previously in Hațeg Basin or in western Europe. Altogether 30 genera can be recognized within the sample at hand (some of them new), representing 14 gastropod families belonging to the Subclass Prosobranchiata (Viviparidae, Pomatiasidae, Bulimidae, Cyclophoridae, Hydrobiidae), and the Orders Basomatophora (Lymnaeidae, Planorbidae, Ancyliidae) and

Stylommatophora (Vertiginidae, Enidae, Ariophontidae, Pupillidae, Eulotidae, Helicidae) of the Subclass Pulmonata, respectively (Pană, Pană *et al.*, in prep.). A large number of cyclophorid operculae were also recovered.

Within the Prosobranchiata, one can notice the presence of both old, Paleozoic families (Viviparidae, Cyclophoridae) and younger, Cretaceous ones (Pomatiasidae, Bulimidae, Hydrobiidae) within the assemblage, as well as that of both aquatic and terrestrial (Cyclophoridae) groups.

The basomatophorans include freshwater taxa, some of them known beginning with the Paleozoic and mostly continuing up to the present (such as *Physa*, *Aplexa*, *Eustagnicola*). The Ancyliidae are especially important, because the presence of the members of this exclusively freshwater stream-populating family allow the recognition of the presence of actively flowing waters (paleo-valleys).

The presence of the stylommatophorans is especially noteworthy, because this group is represented in Hațeg by taxa reported previously from Pliocene and Quaternary deposits. This can be explained by the fact that terrestrial gastropods represent a generally poorly studied group, usually only subordinately to the co-occurring reptiles or mammals, while microgastropods (especially the Cetaceous ones) tend to be overlooked even more frequently.

From the assemblage, several taxa (especially significant are the terrestrial cyclophorids) are shared with the Late Cretaceous ("Rognacian") deposits of southern France and northern Spain, suggesting roughly similar ages for the deposits. Eight genera and 3 species of gastropods are shared by the Hațeg assemblage and that from the Latest Cretaceous of Provence (compare list in Fabre-Taxy, 1959 and Table 1). Meanwhile others represent either endemic taxa or taxa that were not yet found in the contemporaneous deposits from western Europe (due probably also to their small size). The presence of genera represented by different species in Hațeg and western Europe might be due to either stratigraphic- evolutionary or paleogeographic factors.

Paleoenvironmental significance of the gastropod assemblages

An important feature of these new assemblages is their within-site diversity, associated with their autochthonous (parautochthonous) nature. The general lithology and taphonomic features of the major microvertebrate fossil sites suggest little of no post-mortem transportation for the vertebrate

assemblages (unpubl. pers. observation); the same can be concluded for the associated gastropods as well, especially taking into consideration the fragility of their thin shells. The mixture of aquatic and terrestrial taxa point to a certain amount of allochtony within the assemblages, but it is considered that its magnitude is within the range of "parautochtony" (transport of the shells within, or immediately behind the limits of the natural habitat of the animal). Consequently, the diversity and abundance of the different taxa within the fossil assemblages reflects closely the composition of the former paleomalacocoenosis, while the differences seen between the various assemblages have paleoecological significance.

Fântânele, immediately north of Vălioara village, is the closest one to the northwestern crystalline border of the basin. It yielded one of the most important Late Cretaceous microvertebrate assemblages from Europe (Grigorescu *et al.*, 1999; Csiki & Grigorescu, 2000). The gastropod assemblage consists of a mixture of aquatic and terrestrial taxa (Figure 1). The diverse lymnaeids (*Lymnaea*, *Physa*, *Aplexa*, *Radix*), together with the hydrobiids (*Parateinostoma* OPPENHEIM, 1892) and viviparids (*Paludinopsis fluviatilis* MONTFORT, 1879) are suggestive of shallow, fluctuating freshwater bodies with temporally ponding water conditions. The terrestrial taxa include diverse cyclophorids (*Rognacia abbreviata* (MATHERON), 1832, *Ajkaia cf. gregari* TAUSCH, 1886, *Ishurostoma filholi* BOURGUIGNOT, 1884, *Maillardinus* BANDEL, 1891), pupillids (*Pupilla zoltani* n. sp.) and helicids (*Helicella antiqua* n. sp.). Their large number suggests close proximity of the land, from where these specimens were easily washed into the water. Altogether, the assemblage points to the presence of a small temporary waterhole with ponded water, within a floodplain having a fluctuating groundwater level.

Budurone is another important microvertebrate fossil locality, few hundred meters south of Fântânele. Its gastropod assemblage is more clearly dominated by aquatic taxa, of which the lymnaeids are the most diverse (*Lymnaea maastrichta* n. sp., *L. dilatata* n. sp., *Physa patula* NICOLAS, 1890, *Aplexa galloprovincialis* (MATHERON), 1842, *Eustagnicola cretacea* n. sp.). The terrestrial gastropods are again best represented by small sized, but well-preserved cyclophorids (*Rognacia*, *Ajkaia*), along with vertiginids (*Pyramidula grigorescui* n. sp.), ariophontids (*Eoconulus* REINHART, 1883) and helicids (*Arionta precursor* n. sp.); actual representatives of several of these families are

living on plants, under fallen leaves and rocky crevices and were probably washed into the water by rain runoffs. The Budurone assemblage suggests a more wetter, marshy habitat within a poorly drained, vegetated floodplain.

Several other beds from the surroundings of Vălioara yielded gastropods; these isolated finds consist mostly or exclusively of terrestrial taxa, cyclophorids such as *Rognacia* or *Ajkaia* being the dominant ones; cyclophorid operculae are also frequently found. Rarer pupillids (*Pupilla*), helicids (*Helicella*) and aquatic pomatiasids (*Bauxia bulimoides*) also occur. These isolated finds, together with the Fântânele and Budurone assemblages suggest the development of an alluvial fan at the foothills of the proto-Poiana Ruscă Mts., crossed by bedload streams with rapidly changing courses that produced a mosaic of small patches with fully terrestrial, well-drained and poorly drained floodplains and small marshes.

At Tuștea, placed more distally on an alluvial fan, the terrestrial gastropods are dominant, with cyclophorids (of large sizes, up to as much as 1 cm in length), pupillids, enids (*Palaeoena* n. g.), while the typical pond taxa are rarer and less diverse (the lymnaeids *Lymnaea* and *Physa*); cyclophorid operculae make up the largest part of the malacofauna. An important find is represented by the ancylid *Ancylus rumanus* n. sp., a taxon strictly restricted to clear, running water courses; its occurrence suggests the presence of a stream somewhere near the site and episodic transport of within-channel living animals into the (well-drained) floodplain. These paleoenvironmental inferences are comparable to and support those derived from former taphonomical, geochemical and clay mineralogy studies (Grigorescu & Csiki, 2000).

The Sînpetru assemblage is mostly made up of isolated finds or small isolated faunules. The recurrent occurrence of gastropods typical for marshy (*Paludinopsis*, the planorbids *Planorbis* MULLER, 1774 and *Palaeoanisis septemgiratus* n. sp.), pond (lymnaeids: *Lymnaea*, *Physa*, *Eustagnicola*), well-drained floodplain (cyclophorids: *Ishurostoma*, *Cyclopoma* BLENFORD et BLENFORD, 1861; enids, ariophontids, pupillids and helicids) and stream (*Ancylus*) environments suggest that these habitats were both concomitantly and recurrently represented in the larger paleoenvironmental context of the Sînpetru Formation. The image of a braided-river depositional system with more or less permanent, clean flowing waters within the channels, already put forward (Grigorescu *et*

al., 1990; Grigorescu, 1992) surely fits this scenario.

Finally, at Pui, in the valley of the Bărbat River, gastropods were found in the easternmost outcrops of the Maastrichtian continental deposits within the basin. Several small lenses and individual beds were screen-washed, yielding, along the vertebrate remains, microgastropods as well. The assemblage is dominated by terrestrial taxa such as the cyclophorids (*Rognacia*, *Ajkaia*, *Cyclopoma*, *Ishurostoma*), pomatiasids (*Bauxia*), vertiginids (*Pyramidula*), enids (*Palaeoena*), eulotids (*Eulota* HARTMANN, 1842) and helicids (*Helicella*, *Perforatella* SCHLÜTTER, 1838), along with aquatic, standing water – related taxa such as the herbivorous viviparids (*Paludinopsis*), bulimids (*Gastrobulimus*) and planorbids (*Planorbis*). The most frequently occurring elements of the sample, especially in the case of red-coloured mudstone beds with intense bioturbations (burrows) are the cyclophorid operculae. In overall, the assemblage suggests alternating better or more poorly drained floodplain habitats in which (apparently) neither marshy conditions, nor permanent freshwater streams were particularly common.

CONCLUSIONS

The study of the invertebrate assemblages discovered in the dinosaur-bearing beds of the Hațeg Basin reveal a surprisingly diverse and rich malacofauna, represented mostly by gastropods. For the first time in the Mesozoic of Romania, a detailed systematic study of this

assemblage was conducted, resulting in an extensive taxon list with about 30 genera grouped into 14 families; several of these taxa are new to the science (Pană, Pană et al., in prep.). Their high diversity, great abundance, together with the specific and strict ecological and environmental requirements of the different groups of gastropods (paludal, lacustrine-pond, stream or terrestrial taxa) make these assemblages an important element for interpreting the local paleoenvironments. Their study thus both adds to the general diversity of the Maastrichtian Hațeg paleocommunity and might allow an independent test for the paleoecological and paleoenvironmental reconstructions, based mostly on sedimentary facies, petrological, geochemical or clay mineralogy – related features of the fossiliferous deposits.

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REFERENCES

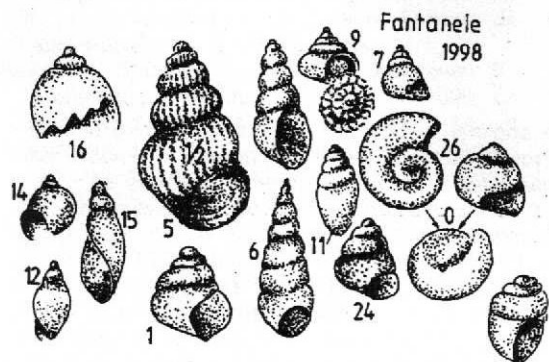
- Anastasiu, N. & Csobuka, D. 1989, Non-marine Uppermost Cretaceous deposits in the Ștei-Densuș region (Hațeg Basin): a sketch for a facies model. *Revue roumaine de géologie, géophysique, géographie*, Géologie, 33, p. 43-53, Bucharest.
- Antonescu, E., Lupu, D. & Lupu, M. 1983, Corrélation palynologique du Crétacé terminal du sud-est des Monts Metaliferi et des Dépressions de Hațeg et de Rusca Montană. *Annales de l'Institut de Géologie et Géophysique*, 59, p. 71-77, Bucharest.
- Bandel, K. 1991, Gastropoda from brackish and fresh water of the Jurassic-Cretaceous transition (a systematic reevaluation). *Berliner Geowissenschaften Abhandlung*, A, 134, p. 9-55, 7 tabs., Berlin.
- Babinot, J. F., Freitet, P., Amiot, M., Bilotte, M., Broin, F., Colombo, F., Durand, J. P., Feist, M., Floquet, M., Gayet, B., Lange-Badre, B., Masiere, A., Massieux, M., Medus, J., Tambareau, Y., Ullastre, J. & Villatte, J. 1983, Le Sénonien supérieur continental de France méridionale et de l'Espagne septentrionale: état des connaissances biostratigraphiques. *Géologie Méditerranéenne*, X, 3-4, p. 245-268, Marseille.
- Bilotte, M., Hansotte, M. & Viltatte, J. 1998, Découverte de *Lychnus elongatus* Roule, 1884, gastéropode continental dans le Campanien marin nord-pyrénéen. *Revue de Paléobiologie*, 17, 2, p. 541-547, Genève.
- Bilotte, M., Tambareau, Y. & Viltatte, J. 1983, Le Crétacé supérieur et la limite Crétacé-Tertiaire en facies continental dans le versant nord des Pyrénées. *Géologie Méditerranéenne*, X, 3-4, p. 269-276, Marseille.
- Buffetaut, E., Cuny, G. & Le Loeuff, J. 1993, The discovery of French dinosaurs. *Modern Geology*, 18, p. 161-182, Malaysia.
- Csiki, Z. & Grigorescu, D., 2000. Teeth of multituberculate mammals from the Late Cretaceous of Romania. *Acta Paleontol. Polonica*, 45, 1, p. 85-90, Warsaw.
- Dincă, A., Tocoșescu, M. & Stilla, A. 1972, Despre vârsta depozitelor continentale cu dinosaurieni din Bazinul Hațeg și Rusca Montană. *Dări de Seamă ale Institutului de Geologie și Geofizică*,

- 58, 4, p.83-94, Bucharest.
- Fabre-Taxy, S. 1959, Faunes lagunaires et continentales du Crétacé supérieur de Provence. III. Le Maastrichtien et le Danien. *Annales de Paléontologie*, 45, p. 55-124, Paris.
- Garcia, G., Duffaud, S., Feist, M., Marandat, B., Tambareau, Y., Villatte, J. & Sigé, B. 2000, La Neuve, gisement à plants, invertébrés et vertébrés du Bégudien (Sénonien supérieur continental) du bassin d'Aix-en-Provence. *Géodiversitas*, 22, 3, p. , Paris.
- Grigorescu, D. 1992, Nonmarine Cretaceous Formations of Romania. In Matter, N.J. & Pei-Ji, Ch (eds) *Aspects of Nonmarine Cretaceous Geology*, China Ocean Press, p. 142- 164, Beijing.
- Grigorescu, D., Hartenberger, J.-L., Rădulescu, C., Samson, P.-M. & Sudre, J. 1985 Découverte de mammifères et dinosaures dans le Crétacé supérieur de Pui (Roumanie). *Comptes rendus Académie des Sciences Paris*, 301, 19, p. 1365-1368, Paris.
- Grigorescu, D., Avram, E., Pop, G., Lupu, M., Anastasiu, N. & Rădan, S., 1990, Guide to excursions, IGCP Projects 245 and 262 Symposium, 109 p., Bucharest.
- Grigorescu, D., Veńczel, M., Csiki, Z. & Limborea, R., 1999, New microvertebrate fossil assemblages from the Uppermost Cretaceous of the Hațeg Basin (Romania). *Geologie en Mijnbouw*, 78, p. 301-314, Netherlands.
- Grigorescu, D. & Csiki, Z. 2000, Sedimentology, taphonomy and paleoecologic reconstruction of the Tuștea nesting site from the Upper Maastrichtian of the Hațeg Basin (Romania). *Abstracts of the Fifth European Workshop on Vertebrate Paleontology*, Karlsruhe.
- Grosu, A. 1955, *Fauna Republicii Populare Române, Mollusca*. Vol. III, fasc. 1. Gastropoda, Pulmonata. Ed. Academiei Române, Bucharest.
- Lepicard, B., Bilotte, M., Massieux, M., Tambareau, Y. & Villatte, J. 1985. Faunes et flores au passage Crétacé-Tertiaire en facies continental dans les Petites Pyrénées (zone Sous-Pyrénéenne, Haute-Garonne). *Géobios*, 18, 6, p. 787-800, Lyon.
- Massieux, M., Rey, J. & Villatte, J. 1987, Sur l'âge maastrichtien de l'affleurement de la Rouquette (Commune de Paraze, Minervois). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 123, p. 151-157, Toulouse.
- Matheron, P. 1832. Observations sur les terrains tertiaires des Bouches du Rhone et description des coquilles fossiles inédites ou peu connues qu'ils renferment. *Annales des Sciences et de l'Industrie du Midi de la France*, III
- Mărgărit, G. & Mărgărit, M. 1967, Asupra prezenței unor resturi de plante fosile în împrejurimile localității Densuș (bazinul Hațeg). *Studii și cercetări de geologie, geofizică, geografie*, seria Geologie, 12, 2, p. 471-476, Bucharest.
- Nopcsa, F. 1923, On the geological importance of the primitive Reptilian fauna in the Uppermost Cretaceous of Hungary; with a description of a new tortoise (*Kallokibotio*). *Quarterly Journal of the Geological Society*, 29, 1, p. 100-116, London.
- Oppenheim, P. 1895. Beiträge zur Binnenfauna der provencalischen Kreide. *Palaeontographica*, A, p. 309-378, Stuttgart.
- Petrescu, I. & Dușa, A. 1982, Paleoflora din Senonianul bazinului Rusca Montana. *Dări de Seamă ale Institutului de Geologie și Geofizică*, 69, 3, p.107-124, Bucharest.
- Pol, C., Buscalioni, A. D. , Carballera, J., Francés, V., Lopez-Martinez, N., Marandat, B., Moratalla, J. J., Sanz, J. L., Sigé, B. & Villatte, J. 1992, Reptiles and mammals from the Late Cretaceous new locality Quintanilla del Cobo (Burgos Province, Spain). *Neues Jahrbuch für Geologie und Paläontologie Abhandlung*, 184, 3, p. 279-314, Stuttgart.
- Rey, R. & Villatte, J. 1971 Gastéropodes des calcaires lacustres de Thanétien sious-pyrénéen entre les vallées du Douctouyre et de l'Aude. *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 107, 3-4, p. 151-157, Toulouse.
- Sigé, B., Buscalioni, A. D. , Duffaud, S., Gayet, M., Orth, B., Rage, J.-C. & Sanz, J. L.. 1997, Etat des données sur le gisement Crétacé supérieur continental de Champ-Garimond (Gard, Sud de la France). *Münchner Geowissenschaften Abhandlung*, A34, p. 111-130, München.
- Weishampel, D. B., Grigorescu, D. & Norman, D. B. 1991, The Dinosaurs of Transylvania. *Natonal Geographic Research & Exploration*, 7, 2, p. 196-215, Washington, USA .
- Wenz, W. 1923-1930, Gastropod extramarina tertiaria. *Fossilium Catalogus*, I, 4, 3387 pp., Berlin.
- Wenz, W. & Zilch, A. 1960, Gastropoda, Euthyneura, In Schindewolf, O. H. (ed.) *Handbuch der Paläozoologie*, 6, 835 pp., Gebrüder Borntraeger, Berlin.

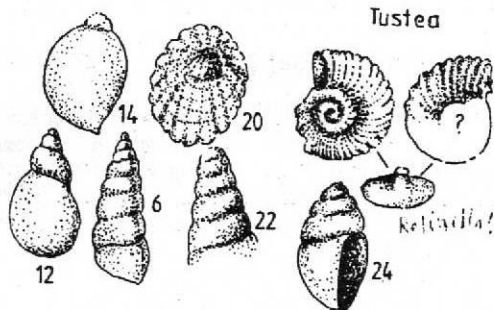
CAPTIONS OF THE FIGURES

Figure 1. Gastropod assemblages from the Maastrichtian continental beds of the Hațeg Basin (Romania). Numbers refer to gastropod taxa as follows: Subclass Prosobranchiata, Fam. Viviparidae: 1. *Paludinopsis fluviatilis obesa* n.ssp; Fam. Pomatiasidae: 2. *Bauxia bulimoides*; Fam. Bulimidae: 3. *Bulimus* sp.; Fam. Cyclophoridae: 4. *Rognacia abbreviata*; 5. *Ajkaia cf. gregaria*; 6. *Ischurostoma filholi*; 7. *Maillardinus carpathicus* n. sp.; 8. *Cyclopoma* sp.; 9. *Palaeocyclophorus* sp.; 10. *Strophostomella* sp.; Fam. Hydrobiidae: 11. *Parateinostoma dilatata* n. sp. Subcl. Pulmonata, Ord. Basomatophora, Fam. Lymnaeidae: 12. *Lymnaea maastrichta* n. sp.; 13. *Lymnaea dilatata* n. sp.; 14. *Physa patula*; 15. *Aplexa galloprovincialis* 16. *Radix* sp. 17. *Eustagnicola cretacea* n.g., n.sp.; Fam. Planorbidae: 18. *Planorbis planorbis*; 19. *Palaeoanisis septemgiratus* n.g. n.sp.; Fam. Ancyliidae: 20. *Ancylus rumanus* n. sp.; Ord. Stylommatophora, Fam. Vertiginidae: 21. *Pyramidula grigorescui* n. sp.; Fam. Enidae: 22. *Ena (Palaeoena)* sp.; Fam. Ariophontidae: 23. *Eoconulus* sp.; Fam. Pupillidae: 24. *Pupilla zoltani* n. sp.; Fam. Eulotidae: 25. *Eulota* sp.; Fam. Helicidae: 26. *Helicella instabilis antiqua* n. ssp.; 27. *Theba* sp.; 28. *Perforatella(?)* sp.; 29. *Arionta precursor* n. sp.; 30. *Cepaea* sp. 31. Cyclophorid operculae; 32. Indeterminate operculae.

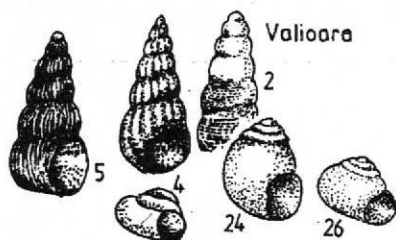
Fantanele
1998



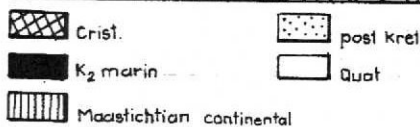
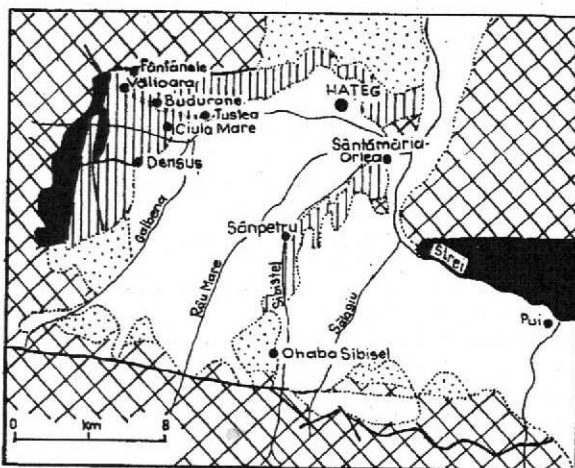
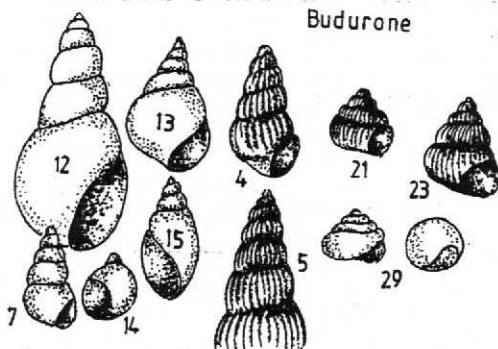
Tusteia



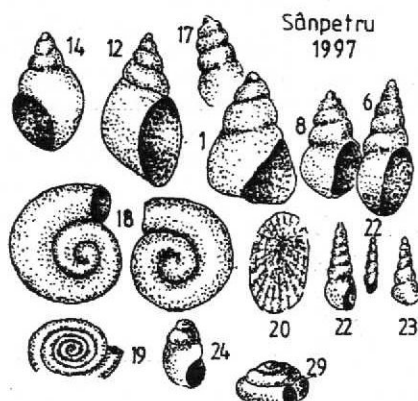
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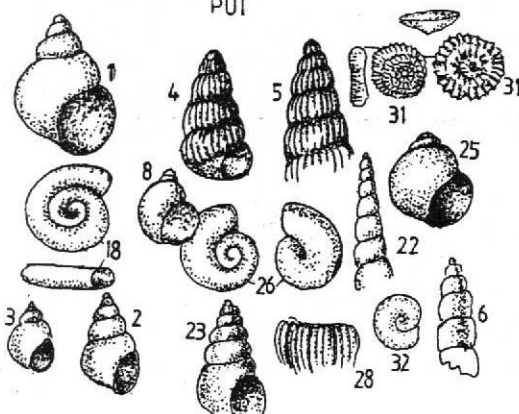
Budurone



Sânpetru
1997



PUI



Bilotte et al., 1983	Lepicard et al., 1985	Massieux et al., 1987	Pol et al., 1992	Sigé et al., 1997	Garcia et al., 1999	Pană et al. present study
<p>Vignevielle, north of Pyrenees</p> <p><i>Bauxia bulimoides</i> <i>B. disjuncta</i> <i>Rognacia abbreviata</i> ?<i>Dissostoma pyreneicum</i></p>	<p>Haute Garonne, Petites Pyrénées</p> <p>?<i>Islandia</i> (= <i>Valvata</i>) <i>indecisa</i> <i>Parateinostoma</i> sp. <i>Campilostylus</i> sp. <i>Dissostoma pyreneicum</i> <i>Palaeostea</i> sp. <i>Prosoalbinulla</i> sp.</p>	<p>La Rouquette – north of Pyrenees</p> <p><i>Physa delecta</i> <i>Planorbidae</i> <i>Islamia</i> n. sp. <i>Bythinidae</i> <i>Palaeostoa andreae</i></p>	<p>Quintanilla del Coco, Burgos, Spain</p> <p><i>Physa patula</i> <i>Pomatisidae</i> n. g., n. sp. <i>Bythinella</i> sp. <i>Pyrgulifera armata</i> <i>Lychnus</i></p>	<p>Champ-Garimond, Gard, Provence</p> <p><i>Aplexa galloprovincialis</i> <i>Aplexa</i> sp. <i>Lychnus mariani</i> <i>Enneopsis elongatus</i> <i>Palaeocyclophorus heberti</i> <i>P. solarius</i></p>	<p>Vitrolles-Couperigne, Aix-en-Provence</p> <p><i>Pupa patula</i> <i>Leptopoma boylai</i> <i>Buliminidae</i> <i>Cyclophoridae</i> <i>Handkeria</i> sp. <i>Rognacia</i> sp.</p>	<p>Hațeg Basin, Romania</p> <p>* <i>Paludinopsis fluviatilis obesa</i> n. ssp. <i>Bauxia bulimoides</i> <i>Gastrobulimus</i> sp. <i>Rognacia abbreviata</i> <i>Ajkaia cf. gregaria</i> <i>Ishurostoma folhdi</i> * <i>Maillardinus carpathicus</i> n. sp. <i>Cyclopoma</i> sp. <i>Palaeocyclophorus</i> sp. <i>Strophostromella</i> sp. * <i>Parateinostoma dilatata</i> n. sp. * <i>Lymnaea maastrichta</i> n. sp. * <i>L. obesa</i> n. sp. <i>Physa patula</i> <i>Aplexa galloprovincialis</i> <i>Radix</i> sp. * <i>Eustagnicola cretacea</i> n. g., n. sp. <i>Planorbis planorbis</i> * <i>Palaeoanusis septemgiratus</i> n. g., n. sp. * <i>Ancyluss rumanus</i> n. sp. * <i>Piramidula grigorescui</i> n. sp. <i>Dissostoma pyreneicum</i> * <i>Pupilla zoltani</i> n. sp. <i>Eulota</i> sp. * <i>Arionta precursor</i> n. sp. <i>Perforatella</i> sp. * <i>Helicella antiqua</i> n. sp.</p>
<p>Table 1. Campanian – Maastrichtian continental gastropod assemblages from Europe. * - new taxa (genera, species, sub-species) described from the Hațeg gastropod assemblage</p>						