38 THE MOLLUSKS FROM PALEOCENE FORMATIONS OF TARCĂU AND VRANCEA NAPPES (EASTERN CARPATHIANS)

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Abstract: *The mollusks from the Paleocene formations of Tarcău and Vrancea Nappes (East Carpathians).* The mollusks found in the Eocene and Oligocene formations of Tarcău and Vrancea Nappes are listed and described. By systematization, there are bivalves (the most numerous), gastropods, pteropods (one species) and nautiloids (one species). Also, the biostratigraphic meaning is approached.
Key words: mollusks, Eocene, Oligocene, Tarcău Nappe, Vrancea Nappe, Eastern Carpathians

The scarcity and chance of mollusks to be found in the Paleocene Carpathian flysch deposits is an explanation of their very few studies on them. They were first found in alluvial boulders of some river channel deposits (Haloş, Rotărie, Lepşa Rivers, etc.) and it is supposed that their source area is in menilitic rocks (Matyasovsky, 1887; Bock, 1898 in Dumitrescu, 1954 p. 235; Joja, 1954) or in Sarmatian deposits (Botez, 1915; Macovei, Atanasiu, 1923). Other papers are concerned with *in situ* fossils in bituminous marls (Atanasiu, 1943; Dumitrescu, 1954), Lucăceşti Sandstone (Stoica, 1944; Grigoraş, 1955) and Kliwa Sandstone (Bogatu, 1982).

Excepting these few mentions, there are some determined genera (Cosmovici, 1913; Preda, 1917; Filipescu, 1934; Ionesi, Florea, 1982) or species including the biostratigraphic meanings (Athanasiu, 1899; Paucă, Cosmovici, 1953; Popescu et al., 1960 in Dumitrescu et al., 1970; Cosmovici, 1966; Ionesi, Ionesi, 1966; Ionesi, 1971; Ciobanu, 1977; Moisescu et al., 1996; Ionesi et al., 1996).

The stratigraphical range of fossil mollusks begins from the lower part of the Tazlău Formation (Ypresian) and ends in the Podu Morii Formation (Lower Miocene); the last one age was deduced on a nannoplankton basis. They are common to both Tarcău Nappe deposits and Vrancea Nappe deposits.

By a systematic point of view the most commonly found fossil mollusks are bivalves (the most common) gastropods, pteropods and nautiloids. In this paper, the best known fossil mollusks will be presented in a stratigraphical order, beginning from the Eocene age up to the Oligocene age.

Eocene

The fossil mollusks from Eocene deposits are mentioned in two situations: the first one with a well known origin (from the geographic, litostratigraphic and structural-geological points of view) and the second one with a less precise location.

The Tazlău Formation - Ypresian (Ionesi, 1971, p. 78)

In the lower part of the Tazlău Formation (80 m above the boundary with the Straja Formation) which is exposed on the left side of the Moldova River cutting the eastern member of the Molid syncline (Tarcău Nappe) at the village of Frasin, a mollusc assemblage was found (Ionesi, 1971; p. 78).

The fossils were found in a muddy sandstone bed (80 cm thick), together with large foraminifers. The mollusk assemblage contained only bivalves, such as: *Variamussium captiosum* Karob., *Glycimeris* aff. *jacquoti nobilis* (Gümbel), *Lucina saxorum* Lamck., *Corbula* cf. *leonina* Oppenh., *Corbula* (*Bicorbula*) *gallicula* Desh., *Nuculana* cf. *perovalis* Koenen, *Ostrea* (*Cubitostrea*) ex. gr. *plicata* Solander, *Chlamys* sp., *Libitina* sp., *Cuspidaria* sp., *Venus* sp., *Cardium* sp. (Ionesi, 1971; p. 78, Pl. XX-XXI). The shells are small and preserved as impressions and moulds sometimes with shell hash. The commonest fossil is *Variamussium captiosum*. Concerning the biostratigraphic meaning, these fossils prove the Eocene age of the deposits. Korobkov (1954) defined in Caucasus a biochronozone of Middle Eocene age with *Variamussium captiosum*.

In our case the age was established based on large nummulites (*Nummulites burdigalensis*, *Nummulites aquitanicus*, *Nummulites partschi*, etc), planktonic foraminifers (P8 with *Morozovella aragonensis*) and calcareous nannoplankton (the upper part of NP12 with *Tribrachiatus orthostylus*). Both bivalves and large foraminifers prove a warm shallow water environment (20°C) with normal salinity.

The Tarcău Sandstone Formation - Middle Eocene (Filipescu, 1934)

In 1934 Filipescu mentioned a few bivalve and gastropod genera (*Ostrea*, *Cardium*, *Pecten*, *Cerithium*, *Turitella*). They were found in the drainage basin of the Vărbilăului Valley at Cosminele, Podul Ursului and Valea Pietrosul, namely in Tarcău Sandstones from the Homorâciu anticline. Pătruţ (1955) confirmed the above mentioned fossils.

The fossils seem to be located in the upper part of the Tarcău Sandstone Formation (below the boundary with the Plopu Formation) and is of Middle Eocene age. Note that here the Tarcău Lithofacies is not developed in its typical features. The above mentioned mollusks are the only ones known in the Tarcău Sandstone Formation.

The Sasca River - Bartonian (Athanasiu, 1898)

The position of the fossil assemblage described by Athanasiu (1898) is not located. The author wrote that at Sasca (Râşca) River headwater, 4 km south-west of Păişeni, he found many fossils, mainly nummulites, brachiopods and

bivalves, in white quartzarenites. The fossil determination was made in Vienna and the author was supervised by Th. Fuchs. After that time there were no other mentions of fossils in the Sasca Creek drainage basin.

Such bivalves were mentioned as: *Anomya tenuistriata* Desh., *Chlamys multistriatus* (Desh.), *Chlamys plebejus* (Lamk.), *Chlamys moldavicus* (Athanasiu), *Lentipecten* cf. *corneus* (Sow.), *Pecten reconditus* Solander, *Pecten subimbricatus* Münst., *Pecten* cf. *deikei* Mayer, *Pecten halaënsis* Frauschner, *Gryphaea brongniarti* Bronn., *Gryphaea* cf. *mayeri* Frauschner, *Gryphaea* n. f. (no name specified), *Crassostrea flabetulla* (Lam.). All of them were described but only the new species were figured (*Chlamys moldavicus* and *Gryphaea* n. f.).

Also, Athanasiu noted that some of these species were also described in the Transylvanian Depression and at Porcești (Turnu Roșu) either in Middle Eocene deposits or in Middle Eocene-Lower Oligocene deposits. In order to establish the age the nummulite assemblage was also used as made of: *Nummulites perforatus obesa* Leym. (= *N. obesus* d'Arch.), *N. lucasana* Detr. (= *N. perforatus* Montf.), *N. curvispira* Menegh. (= *N. gizehensis* Forsk.). Both bivalves and nummulites prove the Bartonian age. From a stratigraphic point of view, *N. perforatus* (even if it is or not in association with *N. striatus*, *N. millecaput* and *N. uranensis*) is common in the Tarcău and Vrancea Nappes, namely in the Doamna Limestone, the Viţeu Sandstone and also in synchronous deposits of the Tazlău and Tarcău Lithofacies.

The Bisericani Formation - Priabonian (Ionesi et al., 1996)

The mollusks from the Bisericani Formation were identified on the Larga River (right side tributary of the Humor River), in a biosparit large clastic block included in mudstones, in the upper part of the Bisericani Formation (100 m below the boundary with the Ferăstrău Sandstone) outcropping on the eastern member of the Larga Syncline (Tarcău Nappe). The biosparit matrix is similar to that of the Bisericani deposits. The determined fossils are listed in Table 1.

Concerning the biostratigraphic meaning of this assemblage, most fossils are from Upper Eocene deposits. The two exceptions are *Plicatula* ex. gr. *cossmanni* Bourry which is of Lower Eocene age and *Venus* (*Ventricoloidea*) *rhombicus* Cossm. from Lower Oligocene deposits. It is possible that the first one evolved up to Upper Eocene and the second one first appeared in the Upper Eocene time.

To prove this age, the calcareous nannoplankton from biosparit boulders and mudstones was also studied and dated. The assemblage is made up of *Discoaster barbadiensis*, *Sphenolithus predistentus*, *S. pseudoradians*, *Reticulofenestra umbilica*, *Cribrocentrum reticulatum*, *Istmolithus recurvus*, *Lanternites minutus* etc. which belong to biozone NP19.
The mollusks of the biosparit block developed in a neritic environment from where they were transported to a deeper environment by turbiditic currents.

The Lucăcești Sandstones and Globigerina Marls - Upper Priabonian

The first paper mentioning fossils (a few broken shells of *Cardiaceae)* from Lucăcești Sandstones outcropping in the Strugilor River valley is by Stoica (1944). The same broken shells, but located near the town of Târgu Ocna, are mentioned in Grigoraș's paper (1955). The presence of broken shells in the Moldova Drainage Basin, namely in some outcrops on the Larga, Morii and Mărului Rivers and on the left side of the Moldova River the Cotului River, is noted by Ionesi (1971, pp. 102 and 145). The same author also noted a *Chlamys* mould in the Humor Halfwindow Vrancea Nappe, on the eastern member of the Vârvata Syncline. This mould seems to be similar to *Chlamys biarritzensis subtripartitus* d'Archiac, described in the Upper Eocene of the Ukraine by Korobkov (1954).

The Ferestrău Sandstone and Lingureşti Marls - Uppermost Priabonian

A rich and varied assemblage of fossils was identified in the Ferăstrău Sandstone in two outcrops in the Larga and Rusca Rivers.

1) The Larga River assemblage (Ionesi, Ionesi, 1966)

This assemblage is located on the eastern limb of the Larga Syncline (Tarcău Nappe). The fossils were found in a 3 m thick bed of quartzarenites underlain by Globigerina Marls interlayered with 25 cm thick of Lucăcești Sandstone and bentonite layers. First the 3 m thick bed was considered as Lucăcești Sandstone (Ionesi, Ionesi, 1966; Ionesi, 1971, pp. 101-103) but now its higher stratigraphic position is established (Ionesi, 1989).

The mollusk fauna was found in the upper part of the above mentioned quartzarenite bed with green schist pebbles inside. 37 taxa were determined, of which 35 are bivalves and 2 are gastropods, as follows: *Meretrix* (*Cardiopsis*) *incrassata* (Sow.), *M. hungarica* Hantk, *M.* cf. *elliptica* Traub, *Venus subeveresti* d'Arch. et Haime, *Venus subcyrenoides* d'Arch. et Haime, *Pitar* (*Callistra*) *laevigata* Lamck., *Cypricardia vicaryia* d'Arch. et Haime, *Cyprina subathooensis e* d'Arch. et Haime, *Cyprina subathooensis d* d'Arch. et Haime, *Lucina pseudoargus b* d'Arch. et Haime, *L.* cf. *pendjabensis* d'Arch. et Haime, *Corbis* aff. *elliptica* d'Arch. et Haime, *Cardita* cf. *dufrenoyi* d'Arch., *Cardita sp.*, *Limopsis* (*Pectunculina*) cf. *recisus* Defr., *Trinacria sp.*, *Cyrena crassa* Desh., *Anomia* cf. *tenuistriata* Desh., *Nuculana perovalis* Koenen, *N.* cf. *lezginica* Korob., *Nuculana sp.*, *Corbula* cf. *gallica* Lamck, *C.* cf. *leonina* Oppenh., *C. pixidicula* Desh., *Thracia* cf. *woodi* Mayer Egmar, *Divaricella* (*Lucinella*) *pulchella* Agas., *Erycina* cf. *longidentata* Desh., *Ostrea* (*Cubitostrea*) *flabellula* Lamck., *Donax* (*Paradonax*) *saccyi* Cossm., *Tellina sp.*, *Mytillus sp. 1*, *Mytillus sp. 2*, *Cardium sp.*, *Chlamys sp.*, *Chlamys sp. 1*, *Chlamys sp. 2*, *Acmaea* cf. *simplex* Dick., *Cerithium* sp. This fauna is described and figured in 5 plates.

Most bivalves are small or middle-sized and are preserved as moulds. The most numerous taxa are of the *Venus*, *Ostrea*, *Cypricardia* and *Corbula*.
Biostratigraphically, some of the taxa are mentioned as Middle and Upper Eocene (*Anomia tenuistriata*, *Corbula gallica*, *Meretrix hungarica*, *Pitar* (*Callistra*) *laevigata*, *Divaricella* (*Lucinella*) *pulchella*, *Thracia woodi*) or only as Upper Eocene (*Cyprina subathooensis e*, *Cyrena crassa*, *Nuculana lezginica*). *Meretrix incrassata*, *Corbula pixidicula*, *Nuculana*

	Pg_2^1	Pg_2^2	Pg_2^3	Pg_3^1	Pg_3^2	m_1
Arcoperna tenera Desh.			x			
Cardita astieri d'Orb.			x			
Chlamys biarritzensis bellicostatus (Wood)			x	x		
Crassostrea cyathula (Lamck.)			x	x	x	
Venus (*Ventricoloidea*) *rhombicus* Cossm.					x	
Plicatula ex. gr. *cossmanni* Bourry	x					
Avicularium ex. gr. *aviculare* (Lamck)	x	x	x			
Goniocardium ex. gr. *dubaleni* Vasseur		x				
Vepricardium ex. gr. *hausmanni* (Philippi)			x			
Venericardia ex. gr. *hortensis* de Regny			x			
Gari (*Psammoica*) ex. gr. *brevisinuatus* Cossm.			x			
Musculus ex. gr. *dilatatus* Desh.			x			
Fragum ex. gr. *reniforme* (Koenen)			x			
Pholadomya ex. gr. *puschi virgula* Michelotti			x	x		x
Ctenoides ex. gr. *eximia* (Giebel)			x	x	x	x
Avicularium sp.						
Crenella sp.						
Corbula sp.						
Arca sp.						
Cardium sp.						
Marcia (*Similivenus*) sp.						
Diplodonta sp.						
Teredo sp.						
Dentalium sp.						

Table 1. The fossil mollusks determined from the Bisericani Formation

perovalis, *Ostrea* (*Cubitostrea*) *flabellula*, *Corbula leonina* range from the Middle and Upper Eocene to the Oligocene. *Corbula leonina* is mentioned in the Upper Eocene (Gogolov Strata) of Polish Carpathians. Other three species are found in Priabonian Stratotype at Priabonian (Piccoli, Massari Degasperi, 1968) namely *Meretrix hungarica*, *Anomia tenuistriata*, *Corbula gallica*.

Seven of above mentioned taxa are also found in the Transylvanian Depression, as follows: *Anomia tenuistriata*, *Corbula gallica*, *Cyprina subathoeensis* and *Meretrix incrassata* in Middle and Upper Eocene deposits; *Corbula pixidicula*, *Ostrea flabellula* in Upper Eocene and Lower Oligocene deposits and *Nuculana perovalis* in Oligocene deposits (in the Ukraine and the Caucasus it is also found in Upper Eocene deposits).

The above mentioned taxa have a biostratigraphic meaning for the Upper Eocene which means the deposits in which they were found are of this age. In dating them, one also has to consider the age of the underlain deposits, that is of the Lucăcești Sandstone and the Globigerina Marls. On the basis of planktonic foraminifers, Olszewska (1985) established the boundary between the Eocene and the Oligocene within the Globigerina Marls. The same opinion is supported by Micu and Gheța (1984) on the basis of nannoplankton assemblages. On the other hand, Ionesi (1986), taking into account all the faunas known, maintains that the Eocene-Oligocene boundary is within the lower menilites s.l. (that is within the Lingurești Marls). The Upper Eocene age is proved for the Globigerina Marls by Oszczypko (1996) based on a calcareous nannoplankton assemblage containing: *Discoaster barbadiensis*, *Discoaster saipanensis*, *Reticulofenestra umbilica*, *Istholithus recurvus*, *Lanternitus minutus*, etc. For these reasons the place of Eocene-Oligocene boundary within the Lingurești and Ferăstrău Sandstone (or lower menilites s. l.) is proved.

2. The Rusca River assemblage (Ionesi, Florea, 1983; Moisescu et al., 1996)

The Sasca River is a left side tributary of the Suceviţa River. In the eastern limb of the Trișoara Syncline (Cernea, 1955; which is synonymous with the Dragoșina Syncline of Micu, 1981) from the Tarcău Nappe. IPEG Câmpulung (GEOMOLD SA) made some explorations for bituminous rocks. On this occasion, Ionesi and Florea (1983) found a fauna with *Glycimeris*, *Ostrea*, *Cardium*, *Chlamys*, *Cerithium*. The most numerous taxa are of *Glycimeris* with very thick shells. Subsequently, Moisescu et al. (1996) made a species

determination, as follows: *Glycimeris ionesii* Moisescu, *Crasostrea* ex. gr. *cyatula* Lam., *Chlamys* (*Aequipecten*) ex. gr. *biarritzensis* (Wood), *Cardium* sp., *Pirinella* sp., *Stossichia* sp. Note that this fauna was found in the first 10 m of brown Lingureşti Marls. It seems that here the Globigerina Marls are missing and Lingureşti Marls are underlain by the Bisericani Formation.

The small number of taxa, with specific or only generic determination, and the new determined species do not allow for any biostratigraphic conclusion. For these reasons, in order to date the deposits use was made of the nannoplankton assemblage of marls with *Glycimeris*, containing *Lanternitus minutus*, *Ericsonia subdistichus*, *Chiasmolithus oamaruensis*, *Reticulofenestra umbilica* etc. The nannoplankton assemblage was assigned to biozone NP21 (Lower Oligocene) by Moisescu et al. (1996). In our opinion, the nannoplankton assemblage could rather be assigned with more accuracy to biozone NP20 (Upper Priabonian) or to NP21, but in a Cavelier and Pomerol (1986) meaning, so that the Eocene-Oligocene boundary be placed within it. In other words, as in case of the Larga River assemblage (with the same lithostratigraphic position), we consider that the Sasca River assemblage could be assigned to the Uppermost Priabonian.

Both mollusks on the Larga River and mollusks on the Sasca River are co-eval with the beginning of the anoxic environment period which was not proper for their development. The developing environment of these fossils was on a shelf with well oxygenated waters, from where they were accidentally transported (by mass movements but not turbiditic currents) to deeper anoxic environments of bituminous marl sedimentation (Lingureşti Marls). The quartzose sandstone (Lucăceşti Sandstone) had the source area on shelf bars.

Conclusions

The Eocene formations, with bivalves and gastropods, have many turbidite features whose sedimentation environment was not proper for faunal development. The fossil assemblage developed in a neritic environment from where they were transported together with clastic materials to deeper environments. The transport mechanisms were mass movements and turbiditic currents. These mechanisms are obvious in the case of the Lingureşti Marls. It seems that the neritic environment of faunal development belongs either to an island or an archipelago. On the other hand one cannot ignore the possibility of existence of a sunken area but close to the sea level. At the beginning of the Lingureşti Marl sedimentation there were conditions of faunal development proved by the numerous large and thick shells of *Glycimeris*. Because of the great bivalves' adaptability, they are the most numerous. The possibility of selective reworking from a land area should be rejected.

Oligocene

There are known mollusks from bituminous marls, lower dysodilic shales, the Kliwa Sandstone and the Podu Morii Formation.

Bituminous marls - Rupelian (Cosmovici, 1913, 1966; Ciobanu, 1977)

Matyasovski (1887) and later Böck (1899) supposed that the source area of mollusks fauna from alluvial blocks of the Haloş River is in menilites. Dumitrescu (1954) confirmed this source area and placed it in bituminous marls. At Cucuieţi (on the Jgheabului River) in bituminous marls, Atanasiu (1943) found some *Cardiaceae* shells. The bituminous marl fauna was studied by Cosmovici (1913, 1966) and Ciobanu (1977). The most important fossiliferous locations are at Văleni, Trei Movile-Cozla, Arsuri-Gârcina and Pietricica -Piatra Neamţ in Bistriţa Halfwindow (Vrancea Nappe). The fossil assemblage contains 28 taxa of bivalves (10 species and 18 genera) and 3 taxa of gastropods (2 species and 1 genus). The dominant bivalve genera are *Nuculana* (with 5 species) and *Polymesoda* (with 2 species) and the dominant gastropod genus is *Adeorbis* (with 2 species). (Table 2)

Concerning the biostratigraphic significance of this fauna, Moisescu (1972; p. 14) considered that *Nuculana westerndorpi gracilis* is a marker fossil for the Oligocene and has a maximum development in the Rupelian (= Stampian). *Polymedosa* species and subspecies range from Priabonian to Upper Burdigalian. These taxa are also mentioned in Transylvania.

On the basis of *Nuculana* and *Polymedosa* taxa the age of bituminous marls was established as Oligocene, namely Rupelian.

Lower dysodilic shales - Rupelian (Paucă, Cosmovici, 1913; Ciobanu, 1977)

The single outcrop in dysodilic shales where mollusks were found is at Pietricica-Piatra Neamţ (Bistriţa Halfwindow of the Vrancea Nappe). Paucă and Cosmovici (1923) described few specimens of *Nautilus moldavicus* and *Balantium meniliticum* and Ciobanu (1977) identified 25 bivalve taxa (19 species and 6 genera) and 3 gastropod taxa (2 species and 1 genus) (Table 2).

The *Nuculana* and *Polymedosa* species are the most common. There are only few gastropod taxa. Besides these taxa there are mentions of some pelagic ones (*Nautilus* and *Balantium*). This assemblage has the same biostratigraphic meaning as the one described above, that is Oligocene, namely Rupelian (=Stampian). A great number of these fossils are also known in Oligocene deposits in the Transylvanian Depression.

Both bituminous marls and dysodilic shales, such as the Lingureşti Marls, sedimented in an anoxic environment improper for benthic fauna development. They were accidentally transported from the well oxygenated neritic area (by turbiditic currents or sliding mechanisms) to the deeper anoxic environment. *Nautilus* and *Balantium* as pelagic genera sedimented in an anoxic area after their death. It seems that the presence of mollusks only in the Bistriţa Halfwindow is in relation with the Cernegura uplifted area surrounded by a shelf zone characterized by well oxygenated waters.

Table 2. The mollusks from bituminous marls and lower dysodilic shales

		Bituminous marls		Lower dysodilic shales	
		Cosmovici (1913, 1966)	Ciobanu (1977)	Paucă, Cosmovici (1953)	Ciobanu (1977)
	BIVALVIA				
1	*Nuculana westendorpi gracilis* (Desh.)		x		x
2	*Nuculana perovalis* Koen.		x		x
3	*Nuculana capillaceea* Desh.	x			x
4	*Nuculana striata* Lamck.	x			x
5	*Nuculana tumidula* Cossm.	x			
6	*Nuculana costulata* Desh.	x			
7	*Gari fischeri* (Herb. et Rén.)		x		x
8	*Chama* cf. *fimbriata* Defr.				x
9	*Polymedosa convexa convexa* (Brong.)		x		x
10	*Polymedosa convexa sirena* (Brong.)				x
11	*Polymedosa convexa brongniarti* (Bast.)		x		x
12	*Polymedosa incompta* (Desh.)				x
13	*Polymedosa* sp.	x			
14	*Isocardia* sp.				x
15	*Miocardiopsis korobkovi* Mészáros				x
16	*Callistra villanovae* (Desh.)				x
17	*Callistra herberti* (Desh.)				x
18	*Pelecypora (Cardiopsis) westendorpi* (Nyst.)				x
19	*Glycimeris obovatus* (lamck.)				x
20	*Pinna* sp.				x
21	*Chlamys biarritzensis* d'Arch.				x
22	*Pecten* sp.	x			
23	*Lentipecten corneus* (Sow.)				x
24	*Lima* sp.	x			x
25	*Spondilus podopsideus cisalpinus* Brong.				x
26	*Spondilus* sp.	x			
27	*Ostrea* sp.	x			x
28	*Mytilus* sp.	x			x
29	*Modiolus (Brachiodontes)* cf. *nysti* Nyckx et Nyst.				x
30	*Modiolus* sp.	x			
31	*Panope heberti* Bosquet				x
32	*Psammobia* sp.	x			
33	*Astarte* sp.	x			
34	*Cardium* sp.	x			
35	*Goodalia* sp.	x			
36	*Arcoperna* aff. *searlesi*	x			
37	*Tellina* sp.	x			
38	*Arca* sp.	x			
39	*Cardita* sp.	x			
40	*Yoldia* sp.	x			
41	*Exogyra* sp.	x			
42	*Cultellus* sp.	x			
43	*Adacna* sp.	x			
	GASTROPODA				
1	*Velates schmidelianus* Chemmitz				x
2	*Acmaea* cf. *simplex* Dick.				x
3	*Turitella* sp.				x
4	*Adeorbis fischeri* Desh.	x			
5	*Adeorbis decussatus* Sands	x			
6	*Fisurella* sp.	x			
	PTEROPODA				
1	*Balantium meneliticum* Paucă et Cosmovici			x	
	NAUTILOIDEA				
1	*Nautilus moldavicus* Paucă et Cosmovici				

Kliwa Sandstone - Oligocene (Bogatu, 1982)

In the lower part of the Kliwa Sandstone outcropping on the Solca River, Bogatu (1982) described a layer intercalated with *Ostrea* shells. Here 4 m of conglomerates crop out with green schist clasts overlain by 35 m of thin bedded Kliwa sandstones. In the lowermost part of the outcrop an 80 cm layer with *Ostrea* shell hash is exposed. No unbroken shells were collected.

From the tectonic point of view, this outcrop is located in the southern part of the Sucevița Halfwindow (*sensu* Ionesi, Grasu, 1986). We consider that is an important fossiliferous point whose meaning has to be approached. On the basis of the *Ostrea* thickness bed (80 cm), it seems to be a littoral environment possibly of an island with a green schist bedrock.

The Podu Morii Formation - Lower Miocene (Popescu et al., 1960)

In this litostratigraphic unit of the Tarcău Nappe outcropping in the Buzău Valley such bivalves were identified as (*Nuculana peregrina* Desh., *Syndesmya bosquetti* Semper., *Ervilia oligocenica* Cossm.) and gastropods (*Cerithium evaricosum* Sandb., *Turritella geinitzi* sp) (Popescu et al., 1960). The researcher considered that the fauna proved the Oligocene age but based on the calcareous nannoplankton of the same formation the Lower Miocene age was proved. The Podu Morii Formation age topic is still open.

Conclusions

In the Oligocene deposits of the Vrancea and Tarcău Nappes (excepting the Podu Morii Formation) a mollusk fauna is known containing bivalves (46 taxa) and gastropods (8 taxa), pteropods (one taxon) and nautiloids (one taxon). They are mainly from small to middle size. Excepting the *Ostrea* shells from the Kliwa Sandstone, they all are from bituminous facies (bituminous marls and dysodilic shales). The fauna is co-eval with the host rocks but it was not developed in their sedimentation area (anoxic). They needed the well oxygenated waters of a neritic environment. The planktonic fauna and the fossil fishes lived in a water column and sedimented after their death in the anoxic environment. The fossil assemblage proves the Rupelian (Stampian) age for bituminous marls and lower dysodilic shales.

References:

Atanasiu, I. (1943), *Les facies du Flysch marginal dans la partie moyenne des Carpathes moldaves*, An. Inst. Geol. Rom., XXII, București, pp. 149-176.

Athanasiu, S. (1899), *Uber eine Eocänfauna aus der nordmoldauischen Flyschzone*, Verhand. d. k. k. geol. Reich., 9, Wien, pp. 256-267.

Bogatu, L. (1982), *Prezența unui nivel cu ostreide în depozitele oligocene de fliș din Carpații Orientali*, Univ. "Al. I. Cuza" Iași, Lucr. ses. șt. "Gr. Cobălcescu", oct. 1981, pp. 297-301.

Botez, G. (1915), *Comunicare preliminară asupra studiilor făcute în jud. Putna*, D. S. Inst. Geol. Rom., IV, București, pp. 42-47.

Cavelier, C., Pomerol, Ch. (1986), *Stratigraphy of the Paleogene*, Bull. Soc. géol France, 8e sér., t. II, no. 2, pp. 255-265.

Ciobanu, M. (1977), *Fauna fosilă din Oligocenul de la Piatra Neamț*, Ed. Acad. Rom. București, 159 p, XLVIII pl.

Cosmovici, L. (1913), *Note sur une faune oligocène du Flysch Moldave*, Ann. Sci. Univ. Jassy, VII/4, Iași, 276-279.

Cosmovici, L. (1966), *Notă asupra Gasteropodelor și Lamellibranchiatelor oligocene de la Piatra Neamț*, D. S. Inst. Geol. Rom., LII/1 (1955), București, 383-384.

Dumitrescu, I. (1954), *Studiul geologic al regiunii dintre Oituz și Coza*, An. Com. Geol., XXIV (1952), București, 195-270.

Dumitrescu, I., Săndulescu, M., Bandrabur, T. (1970), *Notă explicativă la foaia 29 - Covasna. Harta Geologică a României, sc. 1: 200 000*, Inst. Geol., București.

Filipescu, M. (1934), *Cercetări geologice între valea Teleajenului și valea Doftanei (jud. Prahova)*. Ed. Göbl. București.

Grigoraș, N. (1955), *Studiul comparativ al faciesurilor Paleocenului dintre Putna și Buzău*, An. Com. Geol., XXVIII, București, 99-220.

Ionesi, L. (1971), *Flișul paleocen din bazinul văii Moldovei*, Ed. Acad. Rom., București, 250 p, XXI pl.

Ionesi, L. (1988), *On the Eocene-Oligocene boundary in the Carpathians' External Flysch*, Acad. Rom. Mem. Sec. Șt., s. IV, t. V/2, București, 387-398.

Ionesi, L. (1989), *Sur la présence de quelques bentonites dans l'Eocène supérieur du flysch externe carpathique*, Anal. Șt. Univ. "Al. I. Cuza" Iași, XXXV, géol.-géogr., 11-14.

Ionesi, L., Ionesi, Bica (1966), *Asupra prezenței unei faune de lamellibranhiate în gresia de Lucăcești*, Anal. Șt. Univ. București, XV(2), geol.-geogr., 81-102.

Ionesi, L., Florea, Fl. (1983), *Présence d'une faune à Glycimeris dans les ménilites inférieurs*, Anal. Șt. Univ. "Al. I. Cuza" Iași, XXIX, geol.-geogr., 33-36.

Ionesi, L., Moisescu, V., Melinte Mihaela (1996), *Au sujet d'une lumachelle à Mollusques de la formation de Bisericani (le Flysch Externe des Carpathes Orientales)*, Rom. J. Paleont., 76, 1995, Bucharest, 33-36.

Joja, T. (1954), *Cercetări geologice între valea Râșcei și Valea Agapiei*, An. Com. Geol., XXIV (1952), București, 95-134.

Korobkov, I. A. (1954), *Spravicinik i metodiceskoe rukovodstve tretieinîm molluscam*, Leningrad.

Macovei, G., Atanasiu, I. (1923), *Câteva date asupra constituției geologice a zonei Flișului din regiunea Văilor Slănicului și Oituzului*, D. S. Inst. Geol. Rom., XI, București, 29-56.

Micu, M., Gheța, N. (1986), *The Eocene-Oligocene boundary in Romania in the calcareous nannoplankton*, D. S. Inst. Geol. Rom., 70-71/4, București, 289-308.

Moisescu, V. (1972), *Mollusques et Échinides Stampiens et Égériens de la région de Cluj-Huedin-Românași (Nord-Ouest de la Transylvanie)*, Inst. Géol. Mém., XVI, Bucharest, 152 p, XXXVII pl.

Moisescu, V., Melinte, Mihaela, Florea, Fl. (1996), *La faune à Glycimeris des marnes de Lingurești (Le flysch externe - Carpathes Orientales)*, Rom. J. Paleont., 76, 1995, Bucharest, 63-66.

Paucă, M., Cosmovici, L. (1953), *Moluște fosile din Oligocenul de la Piatra Neamț*, Bul. șt., sec. șt. biol., agronom., geol., geogr., V/4, București, 695-702,

Pătruț, I. (1955), *Geologia și tectonica regiunii Vălenii de Munte-Cosminele-Buștenari*, An. Com. Geol., XXVIII, București, 5-98.

Piccoli, G., Massari Degasperi, Graziella (1968), *Les mollusques du stratotype du Priabonian et leur signification paléoécologique*, Mém. RRGM, 58, Paris, 245-252.

Preda, M. D. (1917), *Geologia regiunii subcarpatice din partea de sud a regiunii Bacău*, An. Inst. Geol. Rom., VII, București.

Olszowska, B. (1985), *Remarks concerning the Eocene-Oligocene boundary in the Polish External Carpathians. Results of Foraminiferal investigations*, Proc. rep. XIIIth Congr. KBGA, Part I, Krakow, 57-59.

Oszczypko, Marta (1996), *Calcareous nannoplankton of the Globigerina Marls (Leluchów Marls Member), Măgura Nappe, West Carpathians*, Anal. Sci. Geol. Poloniae, 66/1, Krakow.

Stoica, C. (1944), *Paleocenul din Valea Sibiciului* (jud. Buzău), Rev. Muz. geol.-miner., Univ. Cluj, VIII/1.